



IBM Net.Data for OS/400

Net.Data Language Environment Interface Reference

Version 5





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Note

Before using this information and the product it supports, read the information in "Notices" on page 55.

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This edition applies to:

- IBM HTTP Server for AS/400 (Program 5769-DG1), Version 4 Release 4 Modification 0
- IBM HTTP Server for iSeries® (Program 5722-DG1), Version 5 Release 1 Modification 0

and to all subsequent releases and modifications until otherwise indicated in new editions.

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Preface

Thank you for selecting Net.Data[®], the IBM[®] development tool for creating dynamic Web pages! With Net.Data you can rapidly develop Web pages with dynamic content by incorporating data from a variety of data sources and by using the power of programming languages you already know.

About Net.Data

With IBM's Net.Data product, you can create dynamic Web pages using data from both relational and non-relational database management systems (DBMSs), including DB2[®] and databases that can be accessed through DRDA[®], and using applications written in programming languages such as Java, JavaScript, C, C++, COBOL, and REXX.

Net.Data is a macro processor that executes as middleware on a Web server machine. You can write Net.Data application programs, called *macros*, that Net.Data interprets to create dynamic Web pages with customized content based on input from the user, the current state of your databases, other data sources, existing business logic, and other factors that you design into your macro.

A request, in the form of a URL (uniform resource locator), flows from a browser, such as Netscape Navigator or Internet Explorer, to a Web server that forwards the request to Net.Data for execution. Net.Data locates and executes the macro, and builds a Web page that it customizes based on functions that you write. These functions can:

- Encapsulate business logic within applications written in, but not limited to, C, C++, RPG, COBOL, Java, or REXX programming languages
- Access databases such as DB2
- Access other data sources such as flat files

Net.Data passes this Web page to the Web server, which in turn forwards the page over the network for display at the browser.

Net.Data can be used in server environments that are configured to use interfaces such as HyperText Transfer Protocol (HTTP) and Common Gateway Interface (CGI). HTTP is an industry-standard interface for interaction between a browser and Web server, and CGI is an industry-standard interface for Web server invocation of gateway applications like Net.Data. These interfaces allow you to select your favorite browser or Web server for use with Net.Data.

About this book

This book describes Net.Data's Language Environment Interface (LEI), which you can use to develop your own custom language environments for Net.Data.

This book might refer to products or features that are announced, but not yet available.

More information including sample Net.Data macros, demos, and the latest copy of this book, is available from the following World Wide Web site: <http://www.ibm.com/systems/i/software/netdata>.

Who should read this book

People who want to extend the functionality of Net.Data to meet the needs of their particular enterprise can use this book to write their own language environments for Net.Data.

To understand the concepts discussed in this book, you should be familiar with the following information:

- The C programming language
- The information in *Net.Data Administration and Programming Guide* and *Net.Data Reference*

About examples in this book

Examples used in this book are kept simple to illustrate specific concepts and do not show every way `Net.Data` constructs can be used. Some examples are fragments that require additional code to work.

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Chapter 1. About Net.Data language environments

Net.Data uses language environments as pluggable interfaces accessed as DLLs, shared libraries, or service programs, depending on your operating system environment. In this document, the term *shared library* is used when generically referring to these types of objects. Net.Data provides a set of language environments to interface with certain data sources and programming languages, but when these do not meet your application's needs, you can create your own using the Net.Data language environment interface. For example, you may need to interface with a different product, or with an internal application with a proprietary interface. Also, you may want to encapsulate some reusable, common business logic in a language environment.

These tasks can be accomplished using either the DTW_DIRECTCALL or DTW_SYSTEM Language Environments, but implementing your own customized language environment can optimize these tasks for significant performance benefits. The language environments exist as shared libraries in Net.Data's address space, with direct access to Net.Data and a simple and fast method of passing parameters and manipulating table variables.

The Net.Data initialization file associates each language environment name with a shared library. Each language environment must support a standard set of interfaces defined by Net.Data. Net.Data loads the shared library specified in the initialization file the first time that a function call for a FUNCTION block specifying that language environment is encountered.

Net.Data parses the Net.Data macro, maintains the Net.Data variables, communicates with the language environments, and formats the output according to the REPORT and MESSAGE block specifications. The language environment supports the interfaces defined to Net.Data, makes the Net.Data parameters accessible to the language processor in some language-dependent manner, calls the language interpreter, and receives the variables back from the language interpreter in some language-dependent manner.

Figure 1 demonstrates Net.Data's interaction with language environments.

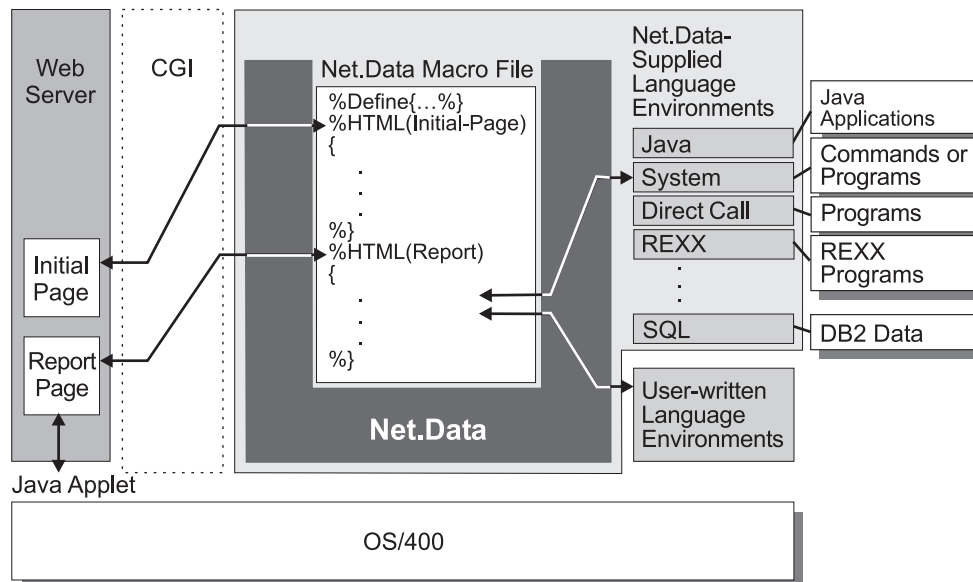


Figure 1. Net.Data and Language Environments

This book describes the Net.Data language environment interface used to create new language environments. The Net.Data-supplied language environments are described in the language environment chapter of the *Net.Data Administration and Programming Guide*.

Chapter 2. Creating a new language environment

Creating a new language environment involves the following steps:

- Determine what interfaces and functions you must provide for the language environment. The `dtw_execute()` interface must be provided, and all provided interfaces must match exactly the prototypes that are defined in the `dtwle.h` C language header.
- Build a shared library that implements the set of language environment interface routines you want to provide. See the documentation for your compiler to understand how to build shared libraries.
- Make all interfaces externally available from the shared library so `Net.Data` can call them.
- Determine your `ENVIRONMENT` configuration statement, then add it to the `Net.Data` initialization file.
- Add functions to the `Net.Data` macro that uses the new language environment.

This chapter describes how to design the language environment.

- “Creating a shared library”
- Chapter 3, “Language environment interface structures,” on page 9
- “Language environment interface functions”
- Chapter 4, “Designing the language environment statement,” on page 13

To learn about the language environment programming interface, see Chapter 5, “Language environment APIs,” on page 15.

Creating a shared library

When you build a language environment, you can use the template supplied in Appendix B, “Language environment template,” on page 45, which provides the environment interface functions and the communication structures used by `Net.Data` to communicate with your language environment and to pass parameters to and from the language environment.

The following sections describe concepts and design issues for the functions and structures. The utilities provided in the language environment interface are described in Chapter 5, “Language environment APIs,” on page 15.

- “Language environment interface functions”
- “Processing input parameters” on page 6
- “Processing user requests” on page 6
- “Processing OUT and INOUT parameters” on page 7
- “Communicating error conditions” on page 7

Language environment interface functions

When you write a language environment, you must determine which interfaces to provide. Your choices depend on what you intend the language environment to do. For example, if the language environment will be accessing database data, you'll make different choices than if it is for a scripting language.

`Net.Data` uses four interface functions with a language environment.

1. `dtw_initialize()`
2. `dtw_execute()`
3. `dtw_getNextRow()`
4. `dtw_cleanup()`

You provide one or more of these functions. Three of these functions are optional, but every language environment must have a `dtw_execute()` interface function. If a `Net.Data` macro references a language environment that does not have a `dtw_execute()` interface function, `Net.Data` returns an error message and stops processing the `Net.Data` macro.

To call a language environment, reference it on the `FUNCTION` block of the `Net.Data` macro. The language environment interface functions will be called if they are defined by the language environment:

When `Net.Data` encounters a call to a function that uses the language environment, it uses the following steps to call the language environment:

1. `Net.Data` calls `dtw_initialize()` if it has been defined for this language environment, and if it is the first function call for this language environment. The function performs any initialization tasks required by the language environment, such as connecting to databases, or allocating variables.
2. `Net.Data` calls `dtw_execute()` to process the macro `FUNCTION` block containing statements or a command that the language environment must process.
3. `Net.Data` calls `dtw_getNextRow()` if, upon successful return, `dtw_execute()` indicated that `dtw_getNextRow()` should be called.
4. When the `Net.Data` macro processing is complete, `Net.Data` calls `dtw_cleanup()` to clean up the environment (for example, disconnecting from a database or releasing resources), if this function has been defined for the language environment, and then returns to the Web server.

The following sections describe the interface functions:

- “`dtw_initialize()`”
- “`dtw_execute()`”
- “`dtw_getNextRow()`” on page 5
- “`dtw_cleanup()`” on page 5

`dtw_initialize()`

Format:

```
int dtw_initialize(dtw_lei_t *);
```

The `dtw_initialize()` interface function performs any special initialization that the language environment requires, such as connecting to a database or allocating resources. This interface function is optional.

`Net.Data` calls a language environment's `dtw_initialize()` interface function only once per macro, the first time `Net.Data` calls a `FUNCTION` block for that language environment. Subsequent calls to the language environment bypass the call to the `dtw_initialize()` interface function.

This interface function does not affect message block processing. A positive or zero return code means that processing continues; a negative return code means that processing does not continue. If the return code is non-zero and a default message is defined in the `default_error_message` field of the `dtw_lei_t` structure, `Net.Data` issues the default message; if no default message exists, `Net.Data` issues an error message.

`dtw_execute()`

Format:

```
dtw_execute(dtw_lei_t *);
```

The `dtw_execute()` interface function processes `FUNCTION` blocks on each function call. The `FUNCTION` blocks can contain statements or a command that will be processed in the `dtw_execute()` function.

The `dtw_execute()` interface function is called whenever a `Net.Data` macro calls a function that refers to the language environment. When the `dtw_execute()` interface function completes, `Net.Data` checks the

return code and the flags field of the `dtw_lei_t` structure. If the return code is 0, `Net.Data` checks to see if `DTW_LE_CONTINUE` is set in the flags field. If it is, then `Net.Data` will call the `dtw_getNextRow()` interface function (see “`dtw_getNextRow()`”). If the return code is not zero, `Net.Data` will check the global and local MESSAGE blocks to determine the next course of action. If no MESSAGE blocks exists or if `Net.Data` cannot find a matching return code entry in any MESSAGE block, `Net.Data` will continue processing if the return code is positive, or it will end macro processing if the return code is negative.

You can optimize performance by having the `dtw_execute()` interface function do all the processing necessary to produce the input for the report block processing. For example, your `dtw_execute()` interface function can generate an entire table to be processed during the report block phase

dtw_getNextRow()

Format:

```
int dtw_getNextRow(dtw_lei_t *);
```

The `dtw_getNextRow()` interface function retrieves input for row-at-a-time processing of `Net.Data` REPORT blocks. It is called as long as the `DTW_LE_CONTINUE` flag is set, indicating that another row of data needs to be processed for the table. This interface function is optional.

`Net.Data` calls `dtw_getNextRow()` when one of the following conditions are met:

- The call to the language environment's `dtw_execute()` completes successfully (return value of zero), and has set the `DTW_LE_CONTINUE` flag in the `dtw_lei_t` structure
- The previous `dtw_getNextRow()` interface function completed successfully and has set the `DTW_LE_CONTINUE` flag in the `dtw_lei_t` structure.

When the `dtw_execute()` function sets the `DTW_LE_CONTINUE` flag to on and the return code is 0, `Net.Data` performs the following steps:

1. Processes the REPORT block header.
2. Calls language environment's `dtw_getNextRow()` interface function to retrieve a row.
3. Processes the message block for the return value of the `dtw_getNextRow()` interface function.
4. Processes the ROW block.
5. Determines whether `dtw_getNextRow()` has turned on the `DTW_LE_CONTINUE` flag:
 - If yes, processing continues with the `dtw_getNextRow()` interface function call in step 2.
 - If no, the REPORT block footer is processed and `Net.Data` continues processing the macro.

When `dtw_getNextRow()` is called, the `row` field in the `dtw_lei_t` structure is set to point to a row object. To manipulate the row object, use the `Net.Data` utility functions, `dtw_row_SetCols()` and `dtw_row_SetV()`. `Net.Data` assumes that after the first call to the `dtw_getNextRow()` interface function the row object contains the column headings for the table. Subsequent calls contain the actual table data.

The `dtw_getNextRow()` function continues to be called as long as `DTW_LE_CONTINUE` is set in the flags field and the return code is 0. If the return code is not zero, `Net.Data` checks the global and local MESSAGE blocks to decide the next course of action. If no MESSAGE block exists, or `Net.Data` could not find a matching entry in any MESSAGE block, `Net.Data` will continue processing if the return code is positive, or it will end macro processing if the return code is negative.

dtw_cleanup()

Format:

```
int dtw_cleanup(dtw_lei_t *);
```

Use the `dtw_cleanup()` interface function to cleanup the language environment. Consider using this interface function if you use `dtw_initialize()` to allocate resources. Use this function for such tasks as disconnecting from a database or releasing resources. This interface function is optional.

While handling a `Net.Data` request, `Net.Data` calls a language environment's `dtw_cleanup()` interface function once when macro processing ends normally or abnormally. This interface is not called if no function calls were made for the language environment.

`Net.Data` sets `DTW_END_ABNORMAL` in the `flags` field of the `dtw_lei_t` structure if the macro is terminating abnormally. The following list shows the conditions in which `Net.Data` would terminate abnormally:

- A language environment interface function indicates that a fatal error occurred by setting the `DTW_LE_FATAL_ERROR` bit in the `flags` field in the `dtw_lei_t` structure.
- `Net.Data` encounters an unrecoverable error.
- The macro invoked the built-in function `DTW_EXIT()`.

If a language environment's interface function sets the `le_opaque_data` field with a parameter to be passed between interface functions, use the `dtw_cleanup()` to release the resources associated with the field when processing ends.

This interface function does not affect message block processing. If the return value is non-zero, a default message is issued; if no default message exists, `Net.Data` issues an error message.

Processing input parameters

The `Net.Data` language environments use the `dtw_execute()` interface to receive and process parameters. The `dtw_execute()` interface uses the `dtw_lei_t` structure, which `Net.Data` creates to communicate with the language environment. Use the following recommendations for input parameter processing, when writing your language environment.

- Specify any implicit parameters in the `ENVIRONMENT` statement for the language environment, in the `Net.Data` initialization file. `Net.Data` passes the parameters specified there on all function calls to the language environment after it passes the parameters specified by the macro writer on the `FUNCTION` block being executed.
- Receive input parameters to the `dtw_execute()` interface as part of the `dtw_lei_t` structure. The macro writer determines the order that `Net.Data` passes the parameters when specifying them in the `FUNCTION` block definition of the `Net.Data` macro.

The `processInputParms()` routine in the program template, in Appendix B, "Language environment template," on page 45 shows one method of processing input parameters.

Processing user requests

How a language environment processes a user request depends on how the language environment receives the request. `Net.Data` provides several different ways for a macro to communicate a request to your language environment:

- Through the function name specified on a `FUNCTION` block. On every function call, `Net.Data` passes the function name to the language environment in the `function_name` field of the `dtw_lei_t` structure.
- Through the `FUNCTION` block parameter list. You can specify that a parameter in the parameter list can indicate a user request. On every function call, `Net.Data` passes parameters to the language environment in the `parm_data_array` field of the `dtw_lei_t` structure.
- Through the `executable-statements` section of a `FUNCTION` block. On every function call, `Net.Data` passes any executable statements specified in the `FUNCTION` block to the language environment in the `exec_statement` field of the `dtw_lei_t` structure.

- Through the function's EXEC block. If a macro specifies a command in a function's EXEC block, Net.Data passes the command to the language environment in the `exec_statement` field of the `dtw_lei_t` structure, and turns on `DTW_STMT_EXEC` in the `flags` field of the `dtw_lei_t` structure.

Returning results to the caller

A variable specified on the RETURNS clause of a FUNCTION block is added to the parameter list, after the parameters from the function block and before any parameters from the ENVIRONMENT statement. If the language environment sets a value for this variable, the value will be returned to the caller. If the function call to the language environment is a parameter to another function call, this result will be passed as the parameter. If the function call is part of a literal string or a dynamic variable reference, then the result will become part of the string that Net.Data resolves. Otherwise, Net.Data will print the result to the Web server.

Processing OUT and INOUT parameters

The method you use to process output and input-output parameters depends entirely on your language environment and how it processes user requests. However, once the language environment has the data it needs to return to the Net.Data macro, you can design the language environment to modify the values of parameters passed in the `parm_data_array` field of the `dtw_lei_t` structure. The `processOutputParms()` routine in the program template, in Appendix B, "Language environment template," on page 45, shows one possible way of processing output and input-output parameters, as well as examples of how to set both string and table parameter values.

Communicating error conditions

The success or failure of a function call can be communicated to Net.Data by the return value of an interface function. How Net.Data processes the error code depends on the interface function that is called.

`dtw_initialize()`

A positive or zero return code means that processing continues; a negative return code means that processing does not continue. If the return code is not zero and a default message is defined in the `default_error_message` field of the `dtw_lei_t` structure, Net.Data issues the default message; if no default message exists, Net.Data issues an error message.

`dtw_cleanup()`

If the return code is non-zero and a default message is defined in the `default_error_message` field of the `dtw_lei_t` structure, Net.Data issues the default message; if no default message exists, Net.Data issues an error message.

`dtw_execute()` and `dtw_getNextRow()`

A positive or zero return code means that processing continues; a negative return code means that processing does not continue. If the return code is not zero, Net.Data processes the MESSAGE blocks. If you do not specify a MESSAGE block or do not have an entry in a specified MESSAGE block to handle the return code, Net.Data displays the contents of the `default_error_message` field of the `dtw_lei_t` structure. This field can be set by the language environment at any time in the `dtw_execute()` or `dtw_getNextRow()` routines. The `setErrorMessage()` routine in the program template (Appendix B, "Language environment template," on page 45) shows an example of how to set the `default_error_message` field.

Chapter 3. Language environment interface structures

Net.Data uses two structures to communicate with your language environment. Your language environment must work with these structures to receive information from and to pass information to Net.Data.

- dtw_lei_t
- dtw_parm_data_t

Net.Data passes a structure of type dtw_lei_t to the language environment function that it calls. The structure contains, among other things, an array that contains a list of parameters to the language environment function. The language environment called by Net.Data processes the request, updates the parameters in the parameter array (if applicable), and returns to Net.Data.

Net.Data then goes through the parameter array, updates its copies of the output and input-output parameters to reflect the new values set by the language environment function, and continues processing the Net.Data macro.

The dtw_lei_t structure

The interface function of each language environment receives a pointer to the dtw_lei_t structure. The dtw_lei_t structure has the following format:

```
typedef struct dtw_lei_t {
    char *function_name;          /* Lang. Env. Interface */
    int  flags;                  /* Function block name */
                                /* Lang. Env. Interface flags */

    char *exec_statement;       /* Lang. Env. statement(s) */

    dtw_parm_data_t *parm_data_array; /* Parameter array */
    char *default_error_message; /* Default message */
    void *le_opaque_data;        /* Lang. Env. specific data */

    void *row;                  /* For row-at-a-time processing*/

    char reserved[64];          /* Reserved */
} dtw_lei_t;
```

Fields in the dtw_lei_t structure:

function_name

The function_name field contains a pointer to a string containing the name of the function block. This can be useful to specify the FUNCTION block name in error messages displayed by the language environment. This pointer should not be freed or modified, and the string contents should not be modified.

flags The flags field is used by Net.Data to communicate with the language environment. Specify the flags field by performing an OR operation using the following constants:

- Net.Data sets DTW_STMT_EXEC to tell the dtw_execute() interface function that the exec_statement field contains the file name and parameters from an EXEC statement.
- DTW_END_ABNORMAL is set by Net.Data to tell the dtw_cleanup() interface function that an abnormal or unexpected condition has occurred and that Net.Data is halting execution of the macro.
- DTW_ERROR_LOG_ENABLED is set by Net.Data if it has been configured for error logging.
- DTW_LE_FATAL_ERROR is set by a language environment interface function to tell Net.Data that a fatal error has occurred in the language environment. If this flag is set, Net.Data stops

processing the `Net.Data` macro, calls `dtw_cleanup()` for all active language environments with `DTW_END_ABNORMAL` set in the `flags` field, prints the default message, and exits. The flag is verified only if a non-zero return value is returned on a language environment call.

- `DTW_LE_MSG_KEEP` is set by a language environment interface function to tell `Net.Data` that the storage pointed to by `default_error_message` should not be freed. If this constant is not set, `Net.Data` attempts to free the storage.
- `DTW_LE_CONTINUE` is set by the `dtw_execute()` interface function to tell `Net.Data` to call the `dtw_getNextRow()` interface function. `Net.Data` calls `dtw_getNextRow()` only if the flag is set and the return value from the call to the `dtw_execute()` interface function is zero. `Net.Data` will continue to call `dtw_getNextRow()` until `DTW_LE_CONTINUE` is not set in the `flags` field.
- `DTW_TRACE_LOG_ENABLED` is set by `Net.Data` if it has been configured for tracing. This flag is provided for the `dtw_log_tracemsg()` function.

exec_statement

The `exec_statement` field contains one of the following pointers:

- To a string containing the executable statements (after variable substitution) from the `FUNCTION` block.
- To the file name and parameters from an `EXEC` statement. If `DTW_STMT_EXEC` is set in the `flags` field, the `exec_statement` field contains a filename.

This pointer should not be freed or modified, and the statement's contents should not be modified.

parm_data_array

The `parm_data_array` field contains a pointer to an array of `dtw_parm_data_t` structures. The array ends with a `parm_data` structure containing zeros. The `dtw_parm_data_t` structure is used by `Net.Data` to pass variables and the associated value to a language environment and to retrieve any changes to the variable value that may be made by the language environment. This pointer should not be freed or modified. See “The `dtw_parm_data_t` structure” on page 11 for a description of the structure.

default_error_message

The `default_error_message` field is set by the language environment to a character string that describes an error condition. If the return value from a call to a language environment interface function is non-zero and the return value does not match the value of a message in a `MESSAGE` block, the default message is displayed. Otherwise, `Net.Data` displays the message selected from the `MESSAGE` block.

`Net.Data` will free the space to which `default_error_message` points. To prevent `Net.Data` from freeing this storage, ensure that `DTW_LE_MSG_KEEP` is set in the `flags` field.

le_opaque_data

The `le_opaque_data` field is set by any of the interface functions in the language environment to pass parameters from one interface function to another. `Net.Data` saves the pointer and passes it to every other interface function that `Net.Data` calls. On each request, `Net.Data` initializes `le_opaque_data` to `NULL` before the first call to the language environment. This field can be used to store data relevant to the current request and cannot be used to share data with other requests. Use this field only if you have a `dtw_cleanup()` interface function, so that the function can free the storage associated with the `le_opaque_data` field.

row The `row` field is set by `Net.Data` to a row object prior to calling a language environment's `dtw_getNextRow()` interface function. The `dtw_getNextRow()` function inserts a row of table data in the object using the `Net.Data` row utility interface functions. `Net.Data` then processes the row and calls `dtw_getNextRow()` until the language environment indicates no more rows are left to process.

The reserved field is for IBM use only.

The `dtw_parm_data_t` structure

Net.Data uses the `dtw_parm_data_t` structure to pass parameters to a language environment. Parameters are obtained from three sources:

- Explicit parameters that are specified on the FUNCTION block definition
- The return variable that is specified in the RETURNS clause on a FUNCTION block definition
- Parameters that are specified on the ENVIRONMENT configuration statement in the Net.Data initialization file

Net.Data passes explicit parameters first, followed by the return variable, and then the parameters specified on the ENVIRONMENT statement.

The `dtw_parm_data_t` structure has the following format:

```
typedef struct dtw_parm_data_t {          /* Parameter data          */
    int  parm_descriptor;                 /* Parameter descriptor    */
    char *parm_name;                      /* Parameter name          */
    char *parm_value;                    /* Parameter value         */
    void *res1;                           /* Reserved                 */
    void *res2;                           /* Reserved                 */
} dtw_parm_data_t;
```

Fields in the `dtw_parm_data_t` structure:

parm_descriptor

The `parm_descriptor` field describes the type and use of the parameter being passed to the language environment. Net.Data sets the field by performing an OR operation using the following constants:

- `DTW_IN` indicates that a parameter is an input-only parameter.
- `DTW_OUT` indicates that a parameter is an output-only parameter.
- `DTW_INOUT` indicates that a parameter is an input and output parameter.
- `DTW_STRING` indicates that parameter value is a pointer to a string.
- `DTW_TABLE` indicates that the parameter value is a pointer to a table.

Net.Data always sets the `parm_descriptor` field to `DTW_IN`, `DTW_OUT`, or `DTW_INOUT` and uses a logical OR with `DTW_STRING` or `DTW_TABLE`. Do not modify this value.

parm_name

The `parm_name` field is a pointer to a string that contains the name of the parameter. Net.Data sets this pointer to `NULL` if the parameter is a literal string. This pointer should not be freed or modified, and the name's contents should not be modified.

parm_value

The `parm_value` field is a pointer to an object that contains the value of the parameter. This pointer is set to `NULL` by Net.Data if the parameter is a variable that is not already defined.

The `parm_value` field points to an object allocated from the Net.Data run-time *heap*, the area of memory used for dynamic memory allocation by Net.Data. If `parm_value` is replaced with another string, the original string must be freed and replaced with a pointer to a character string allocated from the Net.Data heap. Use the `dtw_malloc()` and `dtw_free()` utility functions to allocate and free character strings, and use `dtw_table_New()` and `dtw_table_Delete()` to allocate and free table objects. Table objects and character strings can also be modified without freeing and reallocating space.

The `parm_value` pointer and its contents should not be modified for input parameters. Also, do not delete or replace table objects in a parameter list.

The `res1` and `res2` fields are reserved fields.

Chapter 4. Designing the language environment statement

Each language environment has an ENVIRONMENT statement in the Net.Data initialization file that contains information specific to that language environment. When you create a new language environment, you need to design an ENVIRONMENT statement for the initialization file and document how users should add it to the initialization file.

The ENVIRONMENT statements specify information about the language environment that Net.Data requires to call and load the language environment shared library, such as the language environment name, shared library name, and the list of parameters to be passed to the language environment for each function call.

Net.Data reads the configuration information when it is invoked, but does not load language environment shared libraries until a FUNCTION block identifying that language environment is called from within the macro. The shared library remains loaded as long as Net.Data is loaded.

The following sections provide information about syntax, parameter descriptions, and examples that you can use in your documentation.

ENVIRONMENT statement syntax

An ENVIRONMENT statement has the following format:

```
ENVIRONMENT(type) shared-library-name ([specification parameterN, ...])
```

Each ENVIRONMENT statement must be on a single line.

The following are the parameters you must specify for each language environment:

- *type*

The name that associates this language environment with a FUNCTION block definition in a Net.Data macro. You use this name on a FUNCTION block definition to associate the function with the language environment. See the "Function Block" section in *Net.Data Reference* for more information about the FUNCTION block.

Important: The name cannot begin with the prefix DTW. This prefix is reserved for language environments shipped with Net.Data. If you use the DTW prefix, Net.Data cannot load your language environment DLL.

- *shared-library-name*

The fully qualified name of the shared library containing the language environment interfaces that are called by Net.Data.

- *specification*

The parameter passing specification that indicates whether Net.Data uses the parameter for input, output, or input and output. Possible values:

IN An parameter used for input

OUT A parameter used for output

INOUT

A parameter used for both input and output

- *parameterN*

Specifies parameters that are passed to the language environment on each function call, in addition to parameters specified in the FUNCTION block definition and in the FUNCTION block RETURNS clause. They are passed in the *parm_data_array* field of the *dtw_lei_t* structure following the parameters

specified in the FUNCTION block definition. You must define these parameters as variables in your Net.Data macro before the function call is made. If a function modifies the values of the output and input-output parameters, the parameters retain the modified value once the function finishes processing.

ENVIRONMENT statement examples

The following example shows an ENVIRONMENT statement for language environment called MY_LE.

```
ENVIRONMENT (MY_LE) /QSYS.LIB/LELIB.LIB/MYLE.SRVPGM ( IN INPUT1, OUT OUTPUT1 )
```

Chapter 5. Language environment APIs

Net.Data provides a application programming interfaces (APIs) for you to use when designing a new language environment. The language environment interface has functions that access Net.Data services that manage memory and configuration variables, and provide table and row manipulation features. Appendix B, "Language environment template," on page 45 provides a template that you can use as a model when designing your language environment.

The Net.Data APIs fall into the following categories:

- "Functions for managing memory"
- "Functions for managing configuration variables"
- "Functions for table manipulation" on page 16
- "Functions for row manipulation" on page 16
- "Functions for logging" on page 16

Functions for managing memory

Language environments use the memory management functions to allocate storage owned by Net.Data, and to free storage that it allocated using the Net.Data runtime library.

The following example illustrates the need for these utility functions. Suppose that Net.Data is written using compiler A, with its corresponding run-time library. A programmer writes a new language environment, but uses compiler B, which has a different run-time library. The language environment cannot free storage that Net.Data allocated, and Net.Data cannot free storage that was allocated by the language environment because of potential incompatibilities between the two runtime libraries.

Table 1. Memory management functions

Function name	Description
"dtw_malloc()" on page 22	Allocate storage from Net.Data's run-time heap using dtw_malloc().
"dtw_free()" on page 18	Free storage allocated from Net.Data's run-time heap using dtw_malloc().
"dtw_strdup()" on page 25	Allocate storage from Net.Data's run-time heap and copy the specified string into the allocated storage using dtw_malloc().

Functions for managing configuration variables

The management functions for the configuration variables let language environments access configuration information stored in the Net.Data initialization file. Using these functions, all language environments can share the Net.Data initialization file and use information in it for configuring language environments.

Table 2. Configuration functions

Function name	Description
"dtw_getvar()" on page 19	Retrieve the value of a configuration variable from the Net.Data initialization file.

Functions for table manipulation

Use the table functions to manipulate any Net.Data macro table variables that are passed to the language environment.

Row and column numbers begin with one (1).

Table 3. Table functions

Function name	Description
"dtw_table_New()" on page 36	Create a table object.
"dtw_table_Delete()" on page 28	Delete a table object.
"dtw_table_SetCols()" on page 39	Set the width of a table and allocate storage for the column headers.
"dtw_table_GetV()" on page 32	Retrieve a table value.
"dtw_table_SetV()" on page 41	Set a table value.
"dtw_table_GetN()" on page 31	Retrieve a table column heading.
"dtw_table_SetN()" on page 40	Set a table column heading.
"dtw_table_Rows()" on page 38	Retrieve the current number of rows in a table.
"dtw_table_Cols()" on page 27	Retrieve the current number of columns in a table.
"dtw_table_MaxRows()" on page 35	Retrieve the maximum allowable number of rows in a table.
"dtw_table_QueryColnoNj()" on page 37	Retrieve the column number of a column.
"dtw_table_AppendRow()" on page 26	Add one or more rows to the end of a table.
"dtw_table_InsertRow()" on page 34	Insert one or more rows in a table.
"dtw_table_DeleteRow()" on page 30	Delete one or more rows from a table.
"dtw_table_InsertCol()" on page 33	Insert one or more columns in a table.
"dtw_table_DeleteCol()" on page 29	Delete one or more columns from a table.

Functions for row manipulation

The row functions manipulate the row object that is passed to a language environment's `dtw_getNextRow()` interface function during row-at-a-time processing.

Row numbers begin with one (1).

Table 4. Row functions

Function name	Description
"dtw_row_SetCols()" on page 23	Set the width of a row.
"dtw_row_SetV()" on page 24	Set a table value.

Functions for logging

The logging functions allow you to capture error messages and add tracing facilities to your language environment.

Table 5. Logging functions

Function name	Description
"dtw_log_errormsg()" on page 20	Prints a message to the error log.

Table 5. Logging functions (continued)

Function name	Description
<code>"dtw_log_tracemsg()" on page 21</code>	Prints a message to the trace log.

Net.Data API syntax reference

This section describes each of the functions, their format, usage, and parameters, as well as providing a simple example.

dtw_log_errormsg()

Usage

Use this function to write messages to the Net.Data error log, if error logging is enabled. Use the `DTW_ERROR_LOG_ENABLED` of the `dtw_lei_t` structure to determine if error logging has been enabled.

Format

```
int dtw_log_errormsg(dtw_lei_t *lei, char *message)
```

Parameters

<i>lei</i>	A pointer to the <code>dtw_lei_t</code> structure that is passed to the language environment.
------------	---

<i>message</i>	The message to be entered into the error log.
----------------	---

Examples

```
char errorstr[1000];
int errcode;

if ((lei->flags & DTW_ERROR_LOG_ENABLED) != 0)
{
    sprintf(errorstr, "error occured in dtw_execute(), errcode=%d", errcode);
    dtw_log_errormsg(lei, errorstr);
}
```

dtw_log_tracemsg()

Usage

Use this function to write messages to the Net.Data trace log, if tracing is enabled. Use the DTW_TRACE_LOG_ENABLED flag of the dtw_lei_t structure to determine if tracing is enabled.

Format

```
int dtw_log_tracemsg(dtw_lei_t *lei, char *message)
```

Parameters

<i>lei</i>	A pointer to the dtw_lei_t structure that is passed to the language environment.
<i>message</i>	The message to be entered into the trace log.

Examples

```
char tracestr[1000];
char *var1;
int var2;

if ((lei->flags & DTW_TRACE_LOG_ENABLED) != 0)
{
    sprintf(tracestr, "checkpoint1: Var1='%s' Var2='%d'", var1, var2);
    dtw_log_tracemsg(lei, tracestr);
}
```


dtw_row_SetCols()

Usage

Assigns the width of the row and allocates storage for the column headings. You can use the `dtw_row_SetCols()` utility function once for each row.

Format

```
int dtw_row_SetCols(void *row, int cols)
```

Parameters

<i>row</i>	A pointer to a newly created row which has not yet allocated any columns.
------------	---

<i>cols</i>	The initial number of columns to allocate in the new row.
-------------	---

Examples

```
void *myRow;
```

```
rc = dtw_row_SetCols(myRow, 5);
```

dtw_row_SetV()

Usage

Assigns a table value. The caller of the `dtw_row_SetV()` utility function retains ownership of the memory pointed to by `src`. To delete the current table value, assign the value to `NULL`.

Format

```
int dtw_row_SetV(void *row, char *src, int col)
```

Parameters

<i>row</i>	A pointer to the row to modify.
<i>src</i>	A character string containing the new value to set.
<i>col</i>	The column number of the value to set.

Examples

```
void *myTable;  
char *myFieldValue = "newValue";  
  
rc = dtw_row_SetV(myRow, myFieldValue, 3);
```


dtw_table_AppendRow()

Usage

Adds one or more rows to the end of the table. Assign the table values of the new rows with the dtw_table_SetV() utility after rows are appended to the table.

Format

```
int dtw_table_AppendRow(void *table, int rows)
```

Parameters

<i>table</i>	A pointer to the table to be appended to.
--------------	---

<i>rows</i>	The number of rows to append.
-------------	-------------------------------

Examples

```
void *myTable;
```

```
rc = dtw_table_AppendRow(myTable, 10);
```


dtw_table_DeleteCol()

Usage

Deletes one or more columns beginning at the column specified in *start_col*. To delete all of the rows and columns of a table, substitute the utility function `dtw_table_Cols()` for the *cols* parameter.

```
dtw_table_DeleteCol(table, 1, dtw_table_Cols());
```

Format

```
int dtw_table_DeleteCol(void *table, int start_col, int cols)
```

Parameters

<i>table</i>	A pointer to the table to modify.
--------------	-----------------------------------

<i>start_col</i>	The column number of the first column to delete.
------------------	--

<i>rows</i>	The number of columns to delete.
-------------	----------------------------------

Examples

```
void *myTable;
```

```
rc = dtw_table_DeleteCol(myTable, 1, 10);
```

dtw_table_DeleteRow()

Usage

Deletes one or more rows beginning at the row specified in *start_row*.

Format

```
int dtw_table_DeleteRow(void *table, int start_row, int rows)
```

Parameters

<i>table</i>	A pointer to the table to modify.
<i>start_row</i>	The row number of the first row to delete.
<i>rows</i>	The number of rows to delete.

Examples

```
void *myTable;
```

```
rc = dtw_table_DeleteRow(myTable, 3, 10);
```

dtw_table_GetN()

Usage

Retrieves a column heading. Net.Data owns the memory pointed to by *dest*; do not modify or free it.

Format

```
int dtw_table_GetN(void *table, char **dest, int col)
```

Parameters

<i>table</i>	A pointer to the table from which a column heading is retrieved.
<i>dest</i>	A pointer to the character string to contain the column heading.
<i>col</i>	The column number of the column heading.

Examples

```
void *myTable;  
char *myColumnHeading;  
  
rc = dtw_table_GetN(myTable, &myColumnHeading, 5);
```

dtw_table_GetV()

Usage

Retrieves a value from a table. Net.Data owns the memory pointed to by *dest*; do not modify or free it.

Format

```
int dtw_table_GetV(void *table, char **dest, int row, int col)
```

Parameters

<i>table</i>	A pointer to the table from which a value is retrieved.
<i>dest</i>	A pointer to the character string that is to contain the value.
<i>row</i>	The row number of the value to retrieve.
<i>col</i>	The column number of the value to retrieve.

Examples

```
void *myTable;  
char *myTableValue;  
  
rc = dtw_table_GetV(myTable, &myTableValue, 3, 5);
```


dtw_table_InsertCol()

Usage

Inserts one or more columns after the specified column.

Format

```
int dtw_table_InsertCol(void *table, int after_col, int cols)
```

Parameters

<i>table</i>	A pointer to the table to modify.
<i>after_col</i>	The number of the column after which the new columns are to be inserted. To insert columns at the beginning of the table, specify 0.
<i>cols</i>	The number of columns to insert.

Examples

```
void *myTable;
```

```
rc = dtw_table_InsertCol(myTable, 3, 10);
```

dtw_table_InsertRow()

Usage

Inserts one or more rows after the specified row.

Format

```
int dtw_table_InsertRow(void *table, int after_row, int rows)
```

Parameters

<i>table</i>	A pointer to the table to modify.
<i>after_row</i>	The number of the row after which the new rows are inserted. To insert rows at the beginning of the table, specify 0.
<i>rows</i>	The number of rows to insert.

Examples

```
void *myTable;
```

```
rc = dtw_table_InsertRow(myTable, 3, 10);
```

dtw_table_MaxRows()

Usage

Returns the maximum number of rows allowed for the Net.Data table as defined by the `dtw_table_New()` utility function's parameter, *row_lim*.

Format

```
int dtw_table_MaxRows(void *table)
```

Parameters

<i>table</i>	A pointer to the table from which the maximum number of rows is returned.
--------------	---

Examples

```
void *myTable;  
int maximumRows;  
  
maximumRows = dtw_table_MaxRows(myTable);
```

dtw_table_New()

Usage

Creates a Net.Data table object and initializes all column headings and field values to NULL. The caller specifies the initial number of rows and columns, and the maximum number of rows. If the initial number of rows and columns is 0, you must use the `dtw_table_SetCols()` function to specify the number of fields in a row before any table function calls.

Format

```
int dtw_table_New(void **table, int rows, int cols, int row_lim)
```

Parameters

<i>table</i>	The name of the new table.
<i>rows</i>	The initial number of rows to allocate in the new table.
<i>cols</i>	The initial number of columns to allocate in the new table.
<i>row_lim</i>	The maximum number of rows this table can contain.

Examples

```
void *myTable;  
rc = dtw_table_New(&myTable, 20, 5, 100);
```

dtw_table_QueryColnoNj()

Usage

Returns the column number associated with a column heading.

Format

```
int dtw_table_QueryColnoNj(void *table, char *name)
```

Parameters

<i>table</i>	A pointer to the table to query.
<i>name</i>	A character string specifying the column heading for which the column number is returned. If the column heading does not exist in the table, 0 is returned.

Examples

```
void *myTable;  
int columnNumber;  
  
columnNumber = dtw_table_QueryColnoNj(myTable, "column 1");
```


dtw_table_SetCols()

Usage

Sets the number of columns of the table and allocates storage for the column headings. Specify the column headings when the table is created; otherwise, you must specify them by calling this utility function before using any other table functions. You can only use the `dtw_table_SetCols()` utility function once for a table. Afterwards, use the `dtw_table_DeleteCol()` or `dtw_table_InsertCol()` utility functions.

Format

```
int dtw_table_SetCols(void *table, int cols)
```

Parameters

<i>table</i>	A pointer to a new table that has no columns or rows allocated.
<i>cols</i>	The initial number of columns to allocate in the new table.

Examples

```
void *myTable;  
  
rc = dtw_table_SetCols(myTable, 5);
```

dtw_table_SetN()

Usage

Assigns a name to a column heading. The caller of the `dtw_table_SetN()` utility function retains ownership of the memory pointed to by the `src` parameter. To delete the column heading, assign the column heading value to `NULL`.

Format

```
int dtw_table_SetN(void *table, char *src, int col)
```

Parameters

<i>table</i>	A pointer to the table whose column heading is assigned.
<i>src</i>	A character string being assigned to the new column heading.
<i>col</i>	The number of the column.

Examples

```
void *myTable;  
char *myColumnHeading = "newColumnHeading";  
  
rc = dtw_table_SetN(myTable, myColumnHeading, 5);
```


dtw_table_SetV()

Usage

Assigns a value in a table. The caller of the `dtw_table_SetV()` utility function retains ownership of the memory pointed to by the `src` parameter. To delete the table value, assign the value to `NULL`.

Format

```
int dtw_table_SetV(void *table, char *src, int row, int col)
```

Parameters

<i>table</i>	A pointer to the table whose value is being assigned.
<i>src</i>	A character string assigned to the new value.
<i>row</i>	The row number of the new value.
<i>col</i>	The column number of the new value.

Examples

```
void *myTable;  
char *myTableValue = "newValue";  
  
rc = dtw_table_SetV(myTable, myTableValue, 3, 5);
```

Appendix A. Net.Data technical library

The Net.Data technical library is available from the Net.Data Web site at <http://www.ibm.com/systems/i/software/netdata/docs>.

Document	Description
<i>Net.Data Administration and Programming Guide</i>	Contains conceptual and task information about installing, configuring, and invoking Net.Data. Also describes how to write Net.Data macros, use Net.Data performance techniques, use Net.Data language environments, manage connections, and use Net.Data logging and traces for trouble shooting and performance tuning.
<i>Net.Data Reference</i>	Describes the Net.Data macro language, variables, and built-in functions.
<i>Net.Data Language Environment Interface Reference</i>	Describes the Net.Data language environment interface.
<i>Net.Data Messages and Return Codes</i>	Lists Net.Data error messages and return codes.

Related documentation

The following documents might be useful when using Net.Data and related products:

- *DB2 for IBM i SQL Programming*
- *IBM i Distributed Database Programming*

Additionally, OS/400 documentation and redbooks, including books about DB2, are available at the following URL:

<http://publib.boulder.ibm.com/html/as400/infocenter.html>

Appendix B. Language environment template

Use this template to create your own language environments.

```
/******  
*/  
/* File Name */  
/* Description */  
/*  
/* Flag Reason Date Developer Description */  
/* -----  
/*  
/******  
#include "dtwle.h"  
  
/*-----*/  
/* */  
/* Function */  
/* dtw_initialize */  
/* Purpose */  
/* Format */  
/* int dtw_initialize(dtw_lei_t *le_interface) */  
/* Parameters */  
/* le_interface A pointer to a structure containing the  
/* following fields:  
/*  
/* function_name */  
/* flags */  
/* exec_statement */  
/* parm_data_array */  
/* default_error_message */  
/* le_opaque_data */  
/* row */  
/* Returns */  
/* Success ..... 0 */  
/* Failure ..... 0 */  
/*-----*/  
int dtw_initialize(dtw_lei_t *le_interface)  
{  
    return rc;  
}  
  
/*-----*/  
/* */  
/* Function */  
/* dtw_execute */  
/* Purpose */  
/* Format */  
/* int dtw_execute(dtw_lei_t *le_interface) */  
/* Parameters */  
/* le_interface A pointer to a structure containing the  
/* following fields:  
/*  
/* function_name */  
/* flags */
```

```

/*      exec_statement          */
/*      parm_data_array        */
/*      default_error_message  */
/*      le_opaque_data         */
/*      row                     */
/*                               */
/* Returns                       */
/* Success ..... 0             */
/* Failure ..... 0             */
/*-----*/
int dtw_execute(dtw_lei_t *le_interface)
{
    /*-----*/
    /* Determine if %exec statement was specified.          */
    /*-----*/
    if (le_interface->flags & DTW_STMT_EXEC) {
        /*-----*/
        /* Parse the %exec statement                        */
        /*-----*/
        rc = processExecStmt(le_interface->exec_statement);
        if (rc)
        {
        }
    }
    else {
        /*-----*/
        /* Parse the inline data                            */
        /*-----*/
        rc = processInlineData(le_interface->exec_statement);
        if (rc)
        {
        }
    }

    /*-----*/
    /* Parse the input parameters                          */
    /*-----*/
    rc = processInputParms(le_interface->parm_data_array);
    if (rc)
    {
    }

    /*-----*/
    /* Process the request                                 */
    /*-----*/
    rc = processRequest();
    if (rc)
    {
    }

    /*-----*/
    /* Process the output data                             */
    /*-----*/
    rc = processOutputParms(le_interface->parm_data_array);
    if (rc)
    {
    }

    /*-----*/
    /* Process the return code and default error message   */
    /*-----*/
    if (rc)
    {
        setErrorMessage(rc, &(le_interface->default_error_message));
    }

    /*-----*/
    /* Cleanup and exit program.                           */
    /*-----*/
    return rc;
}

```

```

/*-----*/
/*
/* Function
/* dtw_getNextRow
/*
/* Purpose
/*
/* Format
/* int dtw_getNextRow(dtw_lei_t *le_interface)
/*
/* Parameters
/* le_interface A pointer to a structure containing the
/* following fields:
/*
/* function_name
/* flags
/* exec_statement
/* parm_data_array
/* default_error_message
/* le_opaque_data
/* row
/*
/* Returns
/* Success ..... 0
/* Failure ..... 0
/*-----*/
int dtw_getNextRow(dtw_lei_t *le_interface)
{
    return rc;
}

/*-----*/
/*
/* Function
/* dtw_cleanup
/*
/* Purpose
/*
/* Format
/* int dtw_cleanup(dtw_lei_t *le_interface)
/*
/* Parameters
/* le_interface A pointer to a structure containing the
/* following fields:
/*
/* function_name
/* flags
/* exec_statement
/* parm_data_array
/* default_error_message
/* le_opaque_data
/* row
/*
/* Returns
/* Success ..... 0
/* Failure ..... 0
/*-----*/
int dtw_cleanup(dtw_lei_t *le_interface)
{
    /*-----*/
    /* Determine if this is normal or abnormal termination.
    /*-----*/
    if (le_interface->flags & DTW_END_ABNORMAL) {
        /*-----*/
        /* Do abnormal termination cleanup.
        /*-----*/
    }
    else {

```

```

        /*-----*/
        /* Do normal termination cleanup. */
        /*-----*/
    }

    return rc;
}

/*-----*/
/*
/* Function */
/* processInputParms */
/*
/* Purpose */
/*
/* Format */
/* unsigned long processInputParms(dtw_parm_data_t *parm_data) */
/*
/* Parameters */
/* dtw_parm_data_t *parm_data */
/*
/* Returns */
/* Success ..... 0 */
/* Failure ..... */
/*
/*-----*/
unsigned long processInputParms(dtw_parm_data_t *parm_data)
{
    /*-----*/
    /* Loop through all the variables in the parameter data array. */
    /* The array is terminated by a NULL entry, meaning the parm_name */
    /* field is set to NULL, the parm_value field is set to NULL, and */
    /* the parm_descriptor field is set to 0. However, the only valid */
    /* check for the end of the parameter data array is to check */
    /* parm_descriptor == 0, since the parm_name field is NULL when a */
    /* literal string is passed in, and the parm_value field is set */
    /* to NULL when an undeclared variable is passed in. */
    /*-----*/
    for (; parm_data->parm_descriptor != 0; ++parm_data) {
        /*-----*/
        /* Determine the usage of each input parameter. */
        /*-----*/
        switch(parm_data->parm_descriptor & DTW_USAGE) {

            case(DTW_IN):
                /*-----*/
                /* Determine the type of each input parameter. */
                /*-----*/
                switch (parm_data->parm_descriptor & DTW_TYPE) {
                    case DTW_STRING:
                        break;
                    case DTW_TABLE:
                        break;
                    default:
                        /*-----*/
                        /* Internal error - unknown data type */
                        /*-----*/
                        break;
                }
                break;

            case(DTW_OUT):
                break;

            case(DTW_INOUT):
                break;

            default:

```



```

                /*-----*/
                /* Internal error - unknown usage */
                /*-----*/
                break;
            }
        }
    }
    return rc;
}

/*-----*/
/*
/* Function */
/* processOutputParms() */
/*
/* Purpose */
/*
/* Format */
/* unsigned long processOutputParms(dtw_parm_data_t *parm_data) */
/*
/* Parameters */
/* dtw_parm_data_t *parm_data */
/*
/* Returns */
/* Success ..... 0 */
/* Failure ..... -1 */
/*
/*-----*/
unsigned long processOutputParms(dtw_parm_data_t *parm_data) {
    /*-----*/
    /* Get output data in some language environment-specific manner. */
    /* This is entirely dependent on what the language environment */
    /* is interfacing to, and how the LE chooses to interface to it. */
    /*-----*/

/    /*-----*/
    /* Loop through all the parms in the parameter data array, */
    /* looking for output parameters. */
    /*-----*/
    for (; parm_data->parm_descriptor != 0; ++parm_data) {

        /*-----*/
        /* Determine usage of each parameter. */
        /*-----*/
        if (pd_i->parm_descriptor & DTW_OUT) {
            /*-----*/
            /* Determine the type of each input parameter. */
            /*-----*/
            switch (pd_i->parm_descriptor & DTW_TYPE) {
                case DTW_STRING:
                    /*-----*/
                    /* Give a string parameter a new value. If the */
                    /* parameter value is not currently NULL, the */
                    /* storage must be freed using an LE interface */
                    /* utility function if it was allocated by */
                    /* Net.Data. */
                    /*-----*/
                    if (parm_data->parm_value != NULL)
                        dtw_free(parm_data->parm_value);
                    parm_data->parm_value = dtw_strdup(newValue);
                    break;
                case DTW_TABLE:
                    /*-----*/
                    /* Change the size of a table parameter. Use the */
                    /* LE interface utility functions to modify the */
                    /* table object. */
                    /*-----*/
                    /*-----*/

```

```

/* First get the pointer to the table object.      */
/*-----*/
void *myTable = (void *) parm_data->parm_value;
/*-----*/
/* Next get the current size of the table.        */
/*-----*/
cols = dtw_table_Cols(myTable);
rows = dtw_table_Rows(myTable);
/*-----*/
/* Now set the new size (assumes the new size     */
/* values are valid).                             */
/*-----*/

/*-----*/
/* Set the columns first.                         */
/*-----*/
if (cols > newColValue)
{
    dtw_table_DeleteCol(myTable,
                        newColValue + 1,
                        cols - newColValue);
}
else if (cols < new_col_value)
{
    dtw_table_InsertCol(myTable,
                       cols,
                       newColValue - cols);
}

/*-----*/
/* Now set the rows.                             */
/*-----*/
if (newColValue > 0) {
    if (rows > newRowValue)
    {
        dtw_table_DeleteRow(myTable,
                            newRowValue + 1,
                            rows - newRowValue);
    }
    else if (rows < new_row_value)
    {
        dtw_table_InsertRow(myTable,
                            rows,
                            newRowValue - rows);
    }
}

/*-----*/
/* Now get the last row/column value.            */
/*-----*/
dtw_table_GetV(myTable,
               &myValue;,
               newRowValue,
               newColValue);

/*-----*/
/* Delete the last row/column value.            */
/*-----*/
dtw_table_SetV(myTable,
               NULL,
               newRowValue,
               newColValue);

/*-----*/
/* Set the last row/column value.               */
/*-----*/
dtw_table_SetV(myTable,
               dtw_strdup(myNewValue),

```

```

        newRowValue,
        newColValue);

        break;
    default:
        /*-----*/
        /* Internal error - unknown data type */
        /*-----*/
        break;
    }
}
}

return 0;
}

/*-----*/
/* */
/* Function */
/* setErrorMessage() */
/* */
/* Purpose */
/* */
/* Format */
/* unsigned long setErrorMessage(int returnCode, */
/* char **defaultErrorMessage) */
/* */
/* Parameters */
/* int returnCode */
/* char **defaultErrorMessage */
/* */
/* Returns */
/* Success ..... 0 */
/* Failure ..... -1 */
/* */
/*-----*/
unsigned long setErrorMessage(int returnCode,
                             char **defaultErrorMessage)
{
    /*-----*/
    /* Set the default error message based on the return code. */
    /*-----*/
    switch(returnCode) {
        case LE_SUCCESS:
            break;
        case LE_RC1:
            *defaultErrorMessage = dtw_strdup(LE_RC1_MESSAGE_TEXT);
            break;
        case LE_RC2:
            *defaultErrorMessage = dtw_strdup(LE_RC2_MESSAGE_TEXT);
            break;
        case LE_RC3:
            *defaultErrorMessage = dtw_strdup(LE_RC3_MESSAGE_TEXT);
            break;
        case LE_RC4:
            *defaultErrorMessage = dtw_strdup(LE_RC4_MESSAGE_TEXT);
            rc = LE_RC1INTERNAL;
            break;
    }
    return 0;
}

```

Appendix C. Sample OS/400® CL

Assuming the following conditions, use the subsequent steps to build a Language Environment® on AS/400®:

- SRC is the source file (written in C).
- MYLE contains the exportable procedure, dtw_execute.
- The file, QSRVSRC, member MYLEEXP, contains the specifications for exporting the procedure dtw_execute.

1. Create the module:

```
CRTCMOD MODULE(MYLIB/MYLE) SRCFILE(MYLIB/SRC)
```

2. Create the service program:

```
CRTSRVPGM SRVPGM(MYLIB/MYLE) MODULE(MYLIB/MYLE)  
SRCFILE(MYLIB/QSRVSRC) SRCMBR(MYLEEXP)  
BNDSRVPGM(QHTTPSVR/QTMJLE)
```

Note: Prior to V4R3, the service program that contained the Net.Data API is QTCP/QTMHLE.

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Glossary

absolute path

The full path name of an object. Absolute path names begins at the highest level, or "root" directory (which is identified by the forward slash (/) or back slash (\) character).

ANSI American National Standard for Information Systems

API Application Programming Interface

applet A Java program included in an HTML page. Applets work with Java-enabled browsers, such as Netscape Navigator, and are loaded when the HTML page is processed.

BLOB Binary large object.

CGI Common Gateway Interface.

CLOB Character large object.

commitment control

The establishment of a boundary within the process that Net.Data is running under where operations on resources are part of a unit of work.

Common Gateway Interface (CGI)

A standardized way for a Web server to pass control to an application program and receive data back.

cookie A packet of information sent by an HTTP server to a Web browser and then sent back by the browser each time it accesses that server. Cookies can contain any arbitrary information the server chooses and are used to maintain state between otherwise stateless HTTP transactions.
Free Online Dictionary of Computing

current working directory

The default directory of a process from which all relative path names are resolved.

database

A collection of tables, or a collection of table spaces and index spaces.

database management system (DBMS)

A software system that controls the

creation, organization, and modification of a database and access to the data stored within it.

DATALINK

A DB2 data type that enables logical references from the database to a file stored outside the database.

data type

An attribute of columns and literals.

DBCLOB

Double-byte character large object.

DBMS

Database management system.

firewall

A computer with software that guards an internal network from unauthorized external access.

flat file interface

A set of Net.Data built-in functions that let you read and write data from plain-text files.

HTTP HyperText Transfer Protocol

hypertext markup language

A tag language used to write Web documents.

hypertext transfer protocol

The communication protocol used between a Web server and browser.

Internet

An international public TCP/IP computer network.

Intranet

A TCP/IP network inside a company firewall.

Java

An operating system-independent object-oriented programming language especially useful for Internet applications.

language environment

A module that provides access from a Net.Data macro to an external data source such as DB2 or a programming language such as REXX.

LOB Large object.

middleware

Software that mediates between an application program and a network. It manages the interaction between a client application program and a server through the network.

null A special value that indicates the absence of information.

path A search route used to locate files.

path name

Tells the system how to locate an object. The path name is expressed as a sequence of directory names followed by the name of the object. Individual directories and the object name are separated by a forward slash (/) or back slash (\) character.

persistence

The state of keeping an assigned value for an entire transaction, where a transaction spans multiple Net.Data invocations. Only variables can be persistent. In addition, operations on resources affected by commitment control are kept active until an explicit commit or rollback is done, or when the transaction completes.

port A 16-bit number used to communicate between TCP/IP and a higher level protocol or application.

registry

A repository where strings can be stored and retrieved.

relative path name

A path name that does not begin at the highest level, or "root" directory. The system assumes that the path name begins at the process's current working directory.

secure endpoint URL

Endpoint beginning with https

SSL Secure Sockets Layer

TCPIP Transmission Control Protocol/Internet Protocol

uniform resource locator

An address that names a HTTP server and optionally a directory and file name, for example: `http://www.ibm.com/software/data/net.data/index.html`.

unit of work

A recoverable sequence of operations that

are treated as one atomic operation. All operations within the unit of work can be completed (committed) or undone (rolled back) as if the operations are a single operation. Only operations on resources that are affected by commitment control can be committed or rolled back.

URL Uniform resource locator.

Web server

A computer running HTTP server software, such as Internet Connection.

wire All the underlying components that are responsible for physically sending or receiving a message on the web

XML eXtensible Mark-up Language

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