

# ***SPECIFICATION FOR THE DWARF WRITING LIBRARY***

***Draft #6***

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# ***Debugging Information***

The include file "dw.h" should be included to access the DW library.

## ***Data Types***

The following types are defined in "dwnf.h" and may be redefined if the entire library is to be recompiled. ("dw.h" automatically includes "dwnf.h".);

<i><b>Type</b></i>	<i><b>Description</b></i>
dw_sym_handle	Has a client defined meaning; the DW library will pass these back to the client in <b>CLIRelocs</b> for <b>DW_W_STATIC</b> , and <b>DW_W_SEGMENT</b> .
dw_targ_addr	The contents of <b>dw_targ_addr</b> is unimportant to the DW library; it is only used for <b>sizeof( dw_targ_addr )</b> . A <b>dw_targ_addr</b> is the type that will be emitted for relocations to run-time addresses.
dw_targ_seg	This is the size of the quantity that <b>DW_W_SEGMENT</b> emits.

<code>dw_addr_offset</code>	The type used for offsets from some base address. For example, the <b>start_scope</b> parameter to typing routines, or the <b>addr</b> parameter to line number information. The code assumes this is an unsigned integer type.
<code>dw_addr_delta</code>	An integer type that can hold the largest possible difference between the <b>addr</b> parameter for two subsequent calls to <b>DWLineNum</b> .
<code>dw_linenum</code>	A line number. It must be an unsigned integer type.
<code>dw_linenum_delta</code>	<code>dw_linenum_delta</code> is a type that can hold the largest possible difference between two adjacent line numbers passed to <b>DWLineNum</b> or <b>DWReference</b> .
<code>dw_column</code>	A column number. It must be an unsigned integer type.
<code>dw_column_delta</code>	Type that can hold the largest possible difference between two adjacent column numbers passed to <b>DWReference</b> .
<code>dw_size_t</code>	Used for sizes of various things such as block constants (i.e. for <b>DWAddConstant</b> ) and the <b>size</b> parameter to <b>CLIWrite</b> .
<code>dw_uconst</code>	An unsigned integer type that can hold the largest possible unsigned integer constant.
<code>dw_sconst</code>	A signed integer type that can hold the largest possible signed integer constant.
<code>dw_sectnum</code>	Enumerated type that can hold all defined Dwarf sections, passed to client functions
<code>dw_out_offset</code>	A integer type that can hold the largest possible section offset passed to <b>CLISseek</b> and returned by <b>CLITell</b>
<code>dw_reloc_type</code>	A integer type that can hold the all relocation type

## Initialization and Finalization

In the following functions, unless specified otherwise all strings are assumed to be null-terminated.

The DW library does not assume that a pointer passed to it is valid beyond the function call used to pass it. For example, you can pass the address of an auto-buffer that contains a string.

All names passed to the DW library should be unmangled.

The **cli** parameter required for all DW functions except **DWInit** is assumed to be a valid value returned by a call to **DWInit**.

Currently **DWENTRY** is defined to be nothing. It was created in case there is ever a need to put the DW library into a DLL.

**dw\_client DWENTRY DWInit( dw\_init\_info \*info );**

Initialization for a compilation unit. Return an unique client id. This function will call client functions passed to it, so any client function initialization must be done before the call to DWInit.

```
typedef struct {
    void (*reloc)( dw_sectnum, uint, ... );
    void (*write)( dw_sectnum, const void *, dw_size_t );
    void (*seek)( dw_sectnum, dw_out_offset, int );
    dw_out_offset (*tell)( dw_sectnum );
    void (*alloc)( size_t );
    void (*free)( void * );
} dw_funcs;

typedef struct {
    dw_lang language;
    uint_8 compiler_options;
    const char *producer_name;
    jmp_buf exception_handler;
    dw_funcs funcs;
} dw_init_info;
```

<i>Member</i>	<i>Description</i>
language	Language used.

<i>Constant</i>	<i>Language</i>
DWLANG_C	ISO/ANSI C
DWLANG_CPP	C++
DWLANG_FORTRAN	FORTRAN77

compile\_options    Compilation option, which is a combination of bits:

<i>Bit</i>	<i>Description</i>
DW_CM_BROWSER	The library generates the debugging information for the class browser.
DW_CM_DEBUGGER	The library generates the debugging information for the debugger.
DW_CM_UPPER	For FORTRAN - The compiler converts all identifier names to upper case.
DW_CM_LOWER	For FORTRAN - The compiler converts all identifier names to lower case.

producer	A string that identifies the compiler.
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exception\_handler If the library ends up in a situation which it can't handle (can we say bug ;-) ) this jmp\_buf will be called with a non-zero value. This is a fatal exit, and the client should not call any of the DW functions. (FIXME: The library is currently not very good at cleaning up memory in these situations.);

funcs These functions are described in a later section. The initialization routines may call any of them; so any initialization necessary for these routines must be done before DWInit is called.

The details of the above functions are discussed in Part 3.

**void DWENTRY DWFinl( dw\_client cli );**

Finalize the debugging information generator. This routine must be called last. It frees any structures that the DW library required, and flushes all the debugging information.

**dw\_handle DWENTRY DWBeginCompileUnit( dw\_client cli, const char \*source\_filename, const char \*directory, dw\_loc\_handle segment, const unsigned offset\_size );**

This function is called some time after **DWInit**. The only other DW functions that can be called in between are those dealing with location expressions.

<i>Parameter</i>	<i>Definition</i>
source_filename	Name of the source file.
directory	Compilation directory.
segment	A location expression who's result is the code segment portion of the low_pc and high_pc.
offset_size	The size in bytes of the offset portion of an address in this compile unit

The following CLIRelocs will be required:

DW\_W\_HIGH\_PC  
DW\_W\_LOW\_PC  
DW\_W\_SECTION\_POS  
DW\_W\_UNIT\_SIZE

**void DWENTRY DWEndCompileUnit( dw\_client cli );**

This function pairs up with **DWBeginCompileUnit**. After this, until the next **DWBeginCompileUnit**, the only valid calls are those made to location expression routines (or **DWFinl**).

# ***Ordering Considerations***

In general the DW routines are called in an order that matches the order of the declarations during the source program. The sole exception to this are the Macro information routines. Since it is possible to have a separate preprocessor pass, the library assumes that these routines can be called before any of the other routines. That is why the macro routines have a separate mechanism for specifying file and line number.



# *Macro Information*

**void DWENTRY DWMacStartFile( dw\_client cli, dw\_linenum line, const char \*name );**

Subsequent DWMac calls refer to the named file.

**void DWENTRY DWMacEndFile( dw\_client cli );**

End the current included file.

**dw\_macro DWENTRY DWMacDef( dw\_client cli, dw\_linenum line, const char \*name );**

Defines a macro. **name** is the name of the macro. A **dw\_macro** is returned and must be used in a subsequent call to **DWMacFini** (and possibly **DWMacParam**).

**void DWENTRY DWMacParam( dw\_client cli, dw\_macro mac, const char \*name );**

Adds a parameter to the macro definition **mac**. **name** is the name of the parameter with no leading or trailing white-space. The order of parameters must be the same as they appear in the source program.

**void DWENTRY DWMacFini( dw\_client cli, dw\_macro mac, const char \*def );**

Finishes the macro definition **mac**. **def** is the definition string.



**void DWENTRY DWMacUnDef( dw\_client cli, dw\_linenum line, const char \*name );**

Undefines the macro named **name**.

**void DWENTRY DWMacUse( dw\_client cli, dw\_linenum line, const char \*name );**

Indicate where the macro named **name** is used.

# ***File and Line-Number Management***

**void DWENTRY DWSetFile( dw\_client cli, const char \*file );**

Specifies the current file. The default is for the source\_filename parameter from the dw\_init\_info to be the current file.

**void DWLineNum( dw\_client cli, uint info, dw\_linenum line, uint col, dw\_addr\_offset addr );**

Sets the current source line number and machine address. The line numbers information of all instructions, not just declarations, are stored by this routine. Note that all source line numbers are relative to the beginning of their corresponding source file. So the line number of the first line of an included file is one.

***Parameter***  
info

***Definition***

The information about the line, which is established by the combination of the following bits:

***Bit***

DW\_LN\_DEFAULT

***Description***

There is no special information about the line.

	DW_LN_STMT	The line is the beginning of a statement.
	DW_LN_BLK	The line is the beginning of a block.
line	Source line number, numbered beginning with one on the first line of the file.	
col	Source column number, which begins at 1.	
addr	Address of instruction relative to the beginning of the compilation unit. If it is at all possible the client should call <b>DWLineNum</b> with increasing <b>addrs</b> . The line parameter does not have to be increasing. The size of the emitted line number information is smaller if increasing <b>addrs</b> are used. (There is also an implementation limitation that the maximum decrease of <b>addr</b> between two calls is 32768.);	

**void DWENTRY DWDeclFile( dw\_client cli, const char \*name );**

Subsequent declarations are from the file named **name**.

**void DWENTRY DWDeclPos( dw\_client cli, dw\_linenum line, dw\_column column );**

The next declaration occurs at the indicated line and column in the source file set by the last call to **DWDeclFile**. Note that the position is only used for the immediate next declaration. If there are multiple declarations on the same line, then multiple calls should be made.

**void DWENTRY DWReference( dw\_client cli, dw\_linenum line, dw\_column column, dw\_handle dependant );**

Indicate that in the source code there is a reference to the dependant. This reference is attributed to the current scope of debugging information. (i.e., if it is done inside a structure, then the structure is considered to be the "referencer").

# ***Location Expression Routines***

Many functions require a **dw\_loc\_handle**. These are handles for expressions that the debugger will evaluate. A **dw\_loc\_handle** can be either a single expression, or a list of expressions created by **DWListFini**. The BROWSER is only interested in whether a location expression is present or not; so when creating BROWSER output the client may create an empty location expression and use that wherever appropriate.

The expressions are evaluated on a stack machine, with operations described later. In some cases the stack will be initially empty, in other cases (such as when calculating the address of a structure field) some base address will be on the stack.

A location expression is limited to roughly 64K. Since each op-code is a single byte, this shouldn't pose much of a limitation (famous last words). The destination of the branch instructions **DW\_LOC\_BRA** and **DW\_LOC\_SKIP** must be within 32K of the current instruction. (This is a limitation of the DWARF format, not a limitation of the DW library.);

**dw\_loc\_id DWENTRY DWLocInit( dw\_client cli );**

First function called to create a location expression for a symbol. An unique **dw\_loc\_id** is returned to the front end.

**dw\_loc\_label DWENTRY DWLocNewLabel( dw\_client cli, dw\_loc\_id loc );**

Create a label for the location expression being built in **loc**. This label can be used for forward or backward references by **DW\_LOC\_SKIP** and **DW\_LOC\_BRA**.

**void DWENTRY DWLocSetLabel( dw\_client cli, dw\_loc\_id loc, dw\_loc\_label label );**

Give the label **label** the address of the next operation emitted into the location expression **loc**.

**void DWENTRY DWLocReg( dw\_client cli, dw\_loc\_id loc, uint reg );**

This 'operation' informs the debugger that the value it seeks is in the register named by **reg**. **FIXME**: need to define the possible values of **reg**.

**void DWENTRY DWLocStatic( dw\_client cli, dw\_loc\_id loc, dw\_sym\_handle sym );**

This operation pushes the address of **sym** on the stack.

**void DWENTRY DWLocSegment( dw\_client cli, dw\_loc\_id loc, dw\_sym\_handle sym );**

This operation pushes the segment of the address of **sym** on the stack.

**void DWENTRY DWLocConstU( dw\_client cli, dw\_loc\_id loc, dw\_uconst value );**

Pushes an atom which is has an unsigned constant value **value**.

**void DWENTRY DWLocConstS( dw\_client cli, dw\_loc\_id loc, dw\_sconst value );**

Pushes an atom which is has a signed constant value **value**.

**void DWENTRY DWLocOp0( dw\_client cli, dw\_loc\_id loc, dw\_loc\_op op );**

Performs one of the operations listed below.

### *Operation*

DW\_LOC\_ABS

DW\_LOC\_AND

DW\_LOC\_DEREF

### *Description*

It pops the top stack entry and pushes its absolute value.

It pops the top two stack values, performs the logical AND operation on the two, and pushes the result.

It pops the top stack entry and treats it as an address. The value retrieved from that address is pushed. The size of data retrieved from the dereferenced address is an addressing unit.

DW_LOC_DIV	It pops the top two stack values, divides the former second entry by the former top of the stack using signed division, and pushes the result.
DW_LOC_DROP	It pops the value at the top of the stack.
DW_LOC_DUP	It duplicates the value at the top of the stack.
DW_LOC_EQ	Pop two entries from stack, push 1 if they are equal; push 0 otherwise.
DW_LOC_GE, DW_LOC_GT, DW_LOC_LE, DW_LOC_LT	These operation pop the top two stack values, compare the former top of stack from the former second entry, and pushes 1 onto stack if the comparison is true, 0 if it is false. The comparisons are signed comparison.
DW_LOC_MINUS	It pops the top two stack values, subtracts the former top of the stack from the former second entry, and pushes the result.
DW_LOC_MOD	It pops the top two stack values, and pushes the result of the calculation: former second stack entry modulo the former top of the stack.
DW_LOC_MUL	It pops the top two stack values, multiplies them together, and pushes the result.
DW_LOC_NE	Pop two entries from stack, push 0 if they are equal; push 1 otherwise.
DW_LOC_NEG	It pops the top value and pushes its negation.
DW_LOC_NOP	A placeholder; has no side-effects.
DW_LOC_NOT	It pops the top value and pushes its logical complement.
DW_LOC_OR	It pops the top two stack entries, performs the logical OR operation on them, and pushes the result.
DW_LOC_OVER	It duplicates the entry currently second in the stack at the top of the stack.
DW_LOC_PLUS	It pops the top two stack entries, and pushes their sum.
DW_LOC_ROT	It rotates the first three stack entries. The entry at the top of the stack becomes the third entry, the second entry becomes the top, and the third entry becomes the second.
DW_LOC_SHL	It pops the top two stack entries, shifts the former second entry left by the number of bits specified by the former top of the stack, and pushes the result.
DW_LOC_SHR	It pops the top two stack entries, shifts the former second entry right (logically) by the number of bits specified by the former top of the stack, and pushes the result.
DW_LOC_SHRA	It pops the top two stack entries, shifts the former second entry right (arithmetically) by the number of bits specified by the former top of the stack, and pushes the result.
DW_LOC_SWAP	It swaps the top two stack entries.

DW_LOC_XDEREF	It provides an extended dereference mechanism. The entry at the top of the stack is treated as an address. The second stack entry is treated as an "address space identifier" for those architectures that support multiple address spaces. The top two stack elements are popped, a data item is retrieved through an implementation-defined address calculation and pushed as the new stack top. The size of data retrieved is an addressing unit.
DW_LOC_XOR	It pops the top two stack entries, performs the logical EXCLUSIVE-OR operation on them, and pushes the result.

**void DWENTRY DWLocOp( dw\_client cli, dw\_loc\_id loc, dw\_loc\_op op, ... );**

Performs one of the following operations:

<i>Operation</i>	<i>Description</i>
DW_LOC_BRA	It is followed by a dw_loc_label operand. This operation pops the top stack entry, if the value is not zero, then jump to the label.
DW_LOC_BREG	Followed by two operands, the first is a register, and the second is an dw_sconst to add to the value in the register. The result is pushed onto the stack.
DW_LOC_FBREG	Takes one dw_sconst parameter which is added to the value calculated by the frame_base_loc parameter to the current subroutine, then pushed on the stack.
DW_LOC_PICK	It is followed by a uint operand which is an index. The stack entry with the specified index (0 through 255, inclusive; 0 means the top) is pushed on the stack.
DW_LOC_PLUS_UCONST	It is followed an dw_sconst operand. It pops the top stack entry, adds it to the operand and pushes the result.
DW_LOC_SKIP	It is followed by a dw_loc_label operand. Control is transferred immediately to this label.

**dw\_loc\_handle DWENTRY DWLocFin( dw\_client cli, dw\_loc\_id loc );**

Ends the location expression for a symbol, and returns a handle that may be passed to other DW routines.

**dw\_list\_id DWENTRY DWListInit( dw\_client cli );**

First function called to create a location list for a symbol.

**void DWENTRY DWListEntry( dw\_client cli, dw\_list\_id id, dw\_sym\_handle beg, dw\_sym\_handle end, dw\_loc\_handle loc );**

Define an entry in the location list.

<i><b>Parameter</b></i>	<i><b>Description</b></i>
beg	A beginning address. This address is relative to the base address of the compilation unit referencing this location list. It marks the beginning of the range over which the location is valid.
end	A ending address. This address is relative to the base address of the compilation unit referencing this location list. It marks the first address past the end of the range over which the location is valid. Overlapping ranges are possible and are interpreted to mean that the value may be found in one of many places during the overlap. A CLIReloc for <b>DW_W_LABEL</b> will be made for each dw_sym_handle.
loc	A location expression describing the location of the object over the range specified by the beginning and end addresses.

**dw\_loc\_handle DWENTRY DWListFini( dw\_client cli, dw\_list\_id );**

Finishes the creation of the location list.

**void DWENTRY DWLocTrash( dw\_client cli, dw\_loc\_handle loc );**

Frees the memory associated with the location expression or list loc. A location expression/list can be created and used over and over again until it is freed by calling this function.





# ***Typing Information***

Unless otherwise noted, calls to these functions emit debugging information immediately. The DWARF format requires that debugging information appear in the same order as it does in the source code. So, for example, a structure's fields must be created in the same order that they appear in the source program.

Some of the following functions have common parameters. Here is the documentation for these common parameters:

<i><b>Parameter</b></i>	<i><b>Description</b></i>
char *name	A null-terminated type name. i.e., "struct foobar {" has the name foobar. If this parm is NULL then no name is emitted.
dw_addr_offset	start_scope This is the offset from the low_pc value for the enclosing block that the declaration occurs at. This is most commonly 0.
uint flags	Some routines have additional flags available here; but unless otherwise noted, the following are always available:

<i><b>Flag</b></i>	<i><b>Description</b></i>
DW_DECLARATION	The object is a declaration, not a definition
DW_FLAG_PRIVATE	The object has the C++ private attribute.
DW_FLAG_PROTECTED	The object has the C++ protected attribute.
DW_FLAG_PUBLIC	The object has the C++ public attribute.

**dw\_handle DWENTRY DWFundamental( dw\_client cli, char \* name, unsigned fund\_idx, unsigned size );**

Get a handle for a fundamental type. fund\_idx is one of the following:

DW\_FT\_ADDRESS  
DW\_FT\_BOOLEAN  
DW\_FT\_COMPLEX\_FLOAT  
DW\_FT\_FLOAT  
DW\_FT\_SIGNED  
DW\_FT\_SIGNED\_CHAR  
DW\_FT\_UNSIGNED  
DW\_FT\_UNSIGNED\_CHAR

For convenience, DW\_FT\_MIN, and DW\_FT\_MAX are defined. A valid fundamental type is in the range DW\_FT\_MIN <= ft < DW\_FT\_MAX. The DW library will always return the same handle when called with the same fundamental type (so the client does not need to save fundamental type handles).

<i>Parameters</i>	<i>Description</i>
name	The name of the type being defined.
size	The size in bytes of the type being defined.

**dw\_handle DWENTRY DWModifier( dw\_client cli, dw\_handle base\_type, uint modifiers );**

Specifies a modifier to a type. **base\_type** is the base type to be modified with the modifier **modifier**. The available modifiers are:

<i>Modifier Constant</i>	<i>Description</i>
DW_MOD_CONSTANT	The object is a constant
DW_MOD_VOLATILE	The object is volatile.
DW_MOD_NEAR	The object is a near object.
DW_MOD_FAR	The object is a far object.
DW_MOD_HUGE	The object is a huge object.
DW_MOD_FAR16	The object is a far16 object.

**dw\_handle DWENTRY DWTypedef( dw\_client cli, dw\_handle base\_type, const char \*name, dw\_addr\_offset start\_scope, uint flags );**

This function gives a name to a type. The **name** must not be NULL. The flag value **DW\_FLAG\_DECLARATION** is not allowed.

**dw\_handle DWENTRY DWPointer( dw\_client cli, dw\_handle base\_type, uint flags );**

Declares a pointer type.

<i>Parameter</i>	<i>Description</i>
base_type	The pointed-at type.
flags	Only the following flags are available:

<i>Flags</i>	<i>Description</i>
DW_FLAG_REFERENCE	Declare a pointer that is dereferenced automatically.
DW_PTR_TYPE_NORMAL	A normal pointer (i.e. a model dependant pointer).
DW_PTR_TYPE_NEAR16	A near 16-bit pointer.
DW_PTR_TYPE_FAR16	A far 16-bit pointer.
DW_PTR_TYPE_HUGE	A huge 16-bit pointer.
DW_PTR_TYPE_NEAR32	A near 32-bit pointer.
DW_PTR_TYPE_FAR32	A far 32-bit pointer.

**dw\_handle DWENTRY DWString( dw\_client cli, dw\_loc\_handle string\_length, dw\_size\_t byte\_size, const char \*name, dw\_addr\_offset start\_scope, uint flags );**

Declares a type to be a block of characters.

<i>Parameter</i>	<i>Description</i>
string_length	If this parameter is non-NULL then it is a location expression that the debugger executes to get the address where the length of the string is stored in the program. In this case the <b>byte_size</b> parameter describes the number of bytes to be retrieved at the location calculated. If <b>byte_size</b> is 0, then the debugger will use <b>sizeof( long )</b> .
byte_size	If <b>string_length</b> is NULL then this parameter is the number of bytes in the string. Otherwise see <b>string_length</b> .

**dw\_handle DWENTRY DWMemberPointer( dw\_client cli, dw\_handle containing\_struct, dw\_loc\_handle use\_location, dw\_handle base\_type, const char \*name, unsigned flags );**

Declares a C++ pointer type to a data or function member of a class or structure.

<i>Parameter</i>	<i>Description</i>
containing_struct	A handle to the class or struct to whose members objects of this type may point.
use_location	This refers to the location expression which describes how to get to the member it points to from the beginning of the entire class. It expects the base address of the structure/class object to be on the stack before the debugger starts to execute the location description.
base_type	The type of the member to which this object may point to.

## Array Types

**dw\_handle DWENTRY DWBeginArray( dw\_client cli, dw\_handle elt\_type, uint stride\_size, const char \*name, dw\_addr\_offset scope, uint flags );**

Begin the declaration of an array. This function call must be followed by calls to **DWArrayDimension** and **DWEndArray**.

<i>Parameter</i>	<i>Description</i>
elt_type	Handle for the type of the elements of this array.
stride_size	If this value is non-zero then it indicates the number of bits of each element of the array. (Useful if the number of bits used to store an element in the array is different from the number of bits used to store an individual element of type <b>elt_type</b> .);

**void DWENTRY DWArrayDimension( dw\_client cli, const dw\_dim\_info \*info );**

Add a dimension to the previously started array. This function must be called for each dimension in the order that the dimensions appear in the source program. **info** points to an instance of the following structure:

```
typedef struct {
    dw_handle    index_type;
    dw_uconst    lo_data;
    dw_uconst    hi_data;
} dw_dim_info;
```

<i>Field</i>	<i>Description</i>
hi_bound_fmt	This is similar to <b>lo_bound_fmt</b> but describes the high bound of this dimension.
index_type	This is the handle of the type of the indices for this dimension.
lo_data	The low bound of the array.
hi_data	The upper bound of the array.

**void DWENTRY DWEndArray( dw\_client cli, dw\_handle array\_hdl, dw\_handle elt\_type, uint stride\_size, const char \*name, dw\_addr\_offset scope, uint flags );**

This finishes the writing of the record to describe the array. A sufficient number of calls to **DWArrayDimension** must have been made before **DWEndArray** is called.

# Structure Types

**dw\_handle DWENTRY DWStruct( dw\_client cli, uint kind );**

Create a handle for a structure type that will be defined later. This handle can be used for other DW routines even before **DWBeginStruct** has been called.

<i>Kind</i>	<i>Description</i>
DW_ST_CLASS	A C++ class type.
DW_ST_STRUCT	A structure type.
DW_ST_UNION	A union type.

**void DWENTRY DWBeginStruct( dw\_client cli, dw\_handle struct\_hdl, dw\_size\_t size, const char \*name, dw\_addr\_offset scope, uint flags );**

Begin the declaration of the structure reserved by a call to **DWStruct**. This function begins a nesting of the debugging information. Subsequent calls, up to the corresponding **DWEndStruct** call, to the DW library become children of this structure. i.e., this function marks the beginning of the scope of the structure definition.

<i>Parameter</i>	<i>Description</i>
struct_hdl	A dw_handle returned by a call to <b>DWStruct</b> .
size	If this is non-zero it indicates the number of bytes required to hold an element of this structure including any padding bytes.

**void DWENTRY DWAddFriend( dw\_client cli, dw\_handle friend );**

Add **friend** as a friend to the current structure.

**dw\_handle DWENTRY DWAddInheritance( dw\_client cli, dw\_handle ancestor, dw\_loc\_handle loc, uint flags );**

Indicate the the current structure inherits from another structure.

<i>Parameter</i>	<i>Description</i>
ancestor	The handle of the ancestor to be inherited.

loc	A location expression that describes the location of the beginning of the data members contributed to the entire class by the ancestor relative to the beginning of the address of the data members of the entire class.
flags	In addition to the common values of <b>flags</b> , the flag <b>DW_FLAG_VIRTUAL</b> may be supplied to indicate that the inheritance serves as a virtual base class. As well, the flag <b>DW_FLAG_DECLARATION</b> is not allowed here.

**dw\_handle DWENTRY DWAddField( dw\_client cli, dw\_handle field\_hdl, dw\_loc\_handle loc, const char \*name, uint flags );**

Add a data member to a structure.

<i>Parameter</i>	<i>Description</i>
field_hdl	The dw_handle of the type of this field.
loc	A location expression which expects the base address of the structure to be pushed on the stack and calculates the base address of this field. If the structure is a union type, then this parameter may be NULL. If this is a static data member of a class then this parameter may be NULL if the actual definition of the parameter is outside the class.
flags	The additional flag <b>DW_FLAG_STATIC</b> may be used to indicate a static structure member.

**dw\_handle DWENTRY DWAddBitField( dw\_client cli, dw\_handle field\_hdl, dw\_loc\_handle loc, dw\_size\_t byte\_size, uint bit\_offset, uint bit\_size, const char \*name, uint flags );**

Add a bitfield member to a structure.

<i>Parameter</i>	<i>Description</i>
field_hdl	the dw_handle of the type of this field.
loc	A location expression which expects the base address of the structure most closely containing the bit field to be pushed and the stack, and which calculates the base address of this field.
byte_size	This field must be the non-zero byte size of the unit of storage containing the bit-field. This is required only if the storage required cannot be determined by the type of the bit-field (i.e., padding bytes). If the size can be determined by the type of the bit-field, then this value may be 0.
bit_offset	The number of bits to the left of the leftmost (most significant) bit of the bit field value.
bit_size	The number of bits occupied by this bit-field value.

**void DWENTRY DWEndStruct( dw\_client cli );**

End the current structure. Client must ensure proper Begin/End matching.

## *Enumeration Types*

**dw\_handle DWENTRY DWBeginEnumeration( dw\_client cli, dw\_size\_t byte\_size, const char \*name, dw\_addr\_offset scope, uint flags );**

Begin the definition of an enumerated type. **byte\_size** is the number of bytes required to hold an instance of this enumeration. This call must be followed by calls to **DWAddConstant** and **DWEndEnumeration**. No other DW calls may be made before the call to **DWEndEnumeration**. The DWARF standard requires that the constants be defined in *reverse* order to which they appear in the source program.

**void DWENTRY DWAddConstant( dw\_client cli, dw\_uconst value, const char \*name );**

Add the constant **value** (that is **byte\_size** bytes large as determined by the parameter to **DWBeginEnumeration**); with the name **name** to the current enumeration.

**void DWENTRY DWEndEnumeration( dw\_client cli );**

Finish the current enumeration.

## *Subroutine Type Declarations*

These function calls deal with declarations of subroutines. That is, their prototypes, or for use in creating function pointers.



**dw\_handle DWENTRY DWBeginSubroutineType( dw\_client cli, dw\_handle return\_type, const char \*name, dw\_addr\_offset scope, uint flags );**

Begin the nested declaration of the subroutine type. All calls to the DW library after this, until **DWEndSubroutineType** are in the scope of the declaration of the subroutine type. (i.e., if it's a prototyped C function, then declarations before **DWEndSubroutineType** are similar to declarations inside the prototype.) Parameters for this type are declared using the entries **DWAddParmToSubroutineType** and **DWAddEllipsisToSubroutineType**.

<i>Parameter</i>	<i>Description</i>
return_type	If the function is void, this parameter must be NULL. Otherwise it is a handle for the return type of the subroutine.
flags	In addition to the standard flags, <b>DW_FLAG_PROTOTYPED</b> indicates that the declaration of the subroutine type was prototyped in the source code. As well, the "address class" set of flags used in <b>DWPointer</b> are also allowed here (e.g. <b>DW_TYPE_FAR16</b> etc.)

**void DWENTRY DWEndSubroutineType( dw\_client cli );**

The client must ensure that proper Begin/End matching is done.

## Lexical Blocks

**dw\_handle DWENTRY DWBeginLexicalBlock( dw\_client cli, dw\_loc\_handle segment, const char \*name );**

Begin a new lexical scope. **name** may be NULL indicating an un-named scope. Two CLIReloc calls will be made, one for **DW\_W\_LOW\_PC** and one for **DW\_W\_HIGH\_PC** which indicate the first byte of the scope, and the first byte beyond the end of the scope. **segment** if non-null is an expression that evaluates to the segment this block is in.

**void DWENTRY DWEndLexicalBlock( dw\_client cli );**

End a lexical scope. As usual, the client must ensure that Begin/End pairs match.

# Common Blocks

**dw\_handle DWENTRY DWBeginCommonBlock( dw\_client cli, dw\_loc\_handle loc, dw\_loc\_handle segment, const char \*name, unsigned flag );**

Begin the declarations for the common block named **name** and located at **loc**. **segment** if non-null indicates which segment the common block is in. The only flag that is valid for the **flag** parameter is **DW\_FLAG\_DECLARATION**.

**void DWENTRY DWEndCommonBlock( dw\_client cli );**

End of declarations for the common block.

**dw\_handle DWENTRY DWIncludeCommonBlock( dw\_client cli, dw\_handle common\_block );**

Used in the subroutine scope that references the common block.

# Subroutines

**dw\_handle DWENTRY DWBeginInlineSubroutine( dw\_client cli, dw\_handle out\_of\_line, dw\_loc\_handle ret\_addr, dw\_loc\_handle segment );**

Begin a definition of a particular instance of an inlined subroutine. **out\_of\_line** is a handle to the "out of line" instance of the subroutine (i.e., a handle from a **DWBeginSubroutine** call that had the **DW\_FLAG\_OUT\_OF\_LINE** flag). Each instance of the inlined subroutine must have it's own copies of entries describing parameters to that subroutine and it's local variables. **ret\_addr** gives the location of the return address (if any). **segment** if non-null indicates which segment the expansion occurs in.

**dw\_handle DWENTRY DWBeginSubroutine( dw\_client cli, dw\_call\_type call\_type, dw\_handle return\_type, dw\_loc\_handle return\_addr\_loc, dw\_loc\_handle frame\_base\_loc, dw\_loc\_handle structure\_loc, dw\_handle member\_hdl, dw\_loc\_handle segment, const char \*name, dw\_addr\_offset start\_scope, uint flags );**

Begin a declaration/definition of a subroutine or entry point. This begins a nesting of the debugging information, and must be followed by calls to **DWFormalParameter** et al to declare the parameters, types, and variables for this subroutine. Unless **DW\_FLAG\_DECLARATION** is set, this will require a **DW\_W\_LOW\_PC** and/or a **DW\_W\_HIGH\_PC**.

<i>Parameter</i>	<i>Description</i>
call_type	Not currently used, but should be one of:  DW_SB_NEAR_CALL DW_SB_FAR_CALL DW_SB_FAR16_CALL
return_type	Handle for the return type. Must be NULL for void-type subroutines.
return_addr_loc	If non-NULL then this is a location expression that calculates the address of memory that stores the return address.
frame_base_loc	If non-NULL then this is a location expression that describes the "frame base" for the subroutine or entry point. (If the frame base changes during the subroutine, it might be desirable for local variables to be calculated from the frame base, and then use a location list for the frame base.);
structure_loc	For member functions of structure types, this calculates the address of the slot for the function within the virtual function table for the enclosing class or structure.
member_hdl	If this is a definition of a member function occurring outside the body of the structure type, then this is the handle for the type definition of the structure.
segment	If non-null then this is a location expression that evaluates to the segment for this subprogram.

The following additional flags are available:

flag	description
DW_FLAG_PROTOTYPED	The function was declared with ANSI-C style prototyping, as opposed to K&R-C style parameter lists.
DW_FLAG_ARTIFICIAL	The function was created by the compiler (i.e. not explicitly declared in any of the user's source files)
DW_FLAG_VIRTUAL	This is a virtual subroutine.
DW_FLAG_PURE_VIRTUAL	This is a pure virtual subroutine.
DW_FLAG_MAIN	For Fortran PROGRAM-type subroutines.
DW_SUB_STATIC	A file static subroutine or function. Also used for a static member function, and for nested subroutine declarations.

DW\_SUB\_ENTRY A FORTRAN Entry point. DW requires only a DW\_W\_LOW\_PC for this type of function.

DW\_FLAG\_WAS\_INLINED The function was generated inline by the compiler.

DW\_FLAG\_DECLARED\_INLINED The function was declared inline by the user.

**void DWENTRY DWEndSubroutine( dw\_client cli );**

End the current nesting of **DWBeginSubroutine** or **DWBeginInlineSubroutine**.

**dw\_handle DWENTRY DWFormalParameter( dw\_client cli, dw\_handle parm\_type, dw\_loc\_handle parm\_loc, dw\_loc\_handle segment, const char \*name, uint default\_value\_type, ... );**

Declare a formal parameter to the current function.

parm_type	The type of the parameter.
parm_loc	A location description that yields the address of the parameter. May be NULL indicating unknown address.
segment	A location expression that yields the segment of the parameter. May be NULL indicating the default segment.
default_value_type	One of the following:

DW\_DEFAULT\_NONE There is no default value for this parameter.

DW\_DEFAULT\_FUNCTION The default value for this parameter is returned by a function with no args, that is specified by a CLIR reloc for DW\_W\_DEFAULT\_FUNCTION.

DW\_DEFAULT\_STRING The default value is a null-terminated string that is specified as an extra parameter to this **DWFormalParameter**.

DW\_DEFAULT\_BLOCK The default value is a constant block of data that is specified by extra "const void \*" and "dw\_size\_t" parameters to **DWFormalParameter**.

... Extra parameters depend on the **default\_value\_type**.

**dw\_handle DWENTRY DWEllipsis( dw\_client cli );**

Indicate that the current subroutine has unspecified parameters. Used for "..." in C.

**dw\_handle DWENTRY DWLabel( dw\_client cli, dw\_loc\_handle segment, const char \*name, dw\_addr\_offset start\_scope );**

Declare a label inside a subroutine. **start\_scope** will usually be 0, but is here for future compatibility. A CLIR reloc for **DW\_W\_LABEL** will be made. **segment** if non-null indicates which segment the label belongs to.

**dw\_handle DWENTRY DWVariable( dw\_client cli, dw\_handle type, dw\_loc\_handle loc, dw\_handle member\_of, dw\_loc\_handle segment, const char \*name, dw\_addr\_offset start\_scope, uint flags );**

Declare a variable.

type	The type of this variable.
loc	A location expression yielding the address of this variable.
member_of	If this is the definition of a static data member then this is the handle to the structure type. Otherwise this is NULL.
segment	If this is non-null then it evaluates to the segment the variable is in.
flags	If <b>DW_FLAG_GLOBAL</b> is set then this is a global variable. Otherwise it is a local variable. File static variables in C and C++ are considered local variables. If <b>DW_FLAG_ARTIFICIAL</b> is set then this is a variable that has been created by the compiler.

**dw\_handle DWENTRY DWConstant( dw\_client cli, dw\_handle type, const void \*value, dw\_size\_t len, dw\_handle member\_of, const char \*name, dw\_addr\_offset start\_scope, uint flags );**

Declare a named constant.

type	The type of this constant.
value	Pointer to the value for this constant.
len	The length of this constant. If len is 0, then value is considered to be a null-terminated string.
member_of	If this is the definition of a constant member of a structure type, then this is the handle to the structure type. Otherwise it is NULL.

**void DWENTRY DWAddress( dw\_client cli, uint\_32 len );**

DWARF builds a table of all the addresses attributed to a compilation unit. The client calls this function to add addresses to this table. **len** is the length of this address range. The base of the address range is filled in by a CLIREloc for **DW\_W\_ARANGE\_ADDR**.

**void DWENTRY DWPubname( dw\_client cli, dw\_handle hdl, const char \*name );**

These are used to speed up the debugger. This should be called for any name that has global scope. **hdl** is the handle for the debugging entry that declares/defines the **name**.

# ***Required Client Routines***

The debugging information has several sections indicated by the following enumerated type:

<i><b>Constant</b></i>	<i><b>Description</b></i>
DW_DEBUG_INFO	This section is called <code>.debug_info</code> , which stores all the debugging information entries.
DW_DEBUG_PUBNAMES	This section is called <code>.debug_pubnames</code> , which stores a table consisting of object name information that is used in lookup by Name.
DW_DEBUG_ARANGES	This section is called <code>.debug_aranges</code> , which stores a table consisting of object address information that is used in lookup by Address.
DW_DEBUG_LINE	This section is called <code>.debug_line</code> , which stores the line number information generated for the compilation units.
DW_DEBUG_LOC	This section is called <code>.debug_loc</code> , which stores the location lists information.
DW_DEBUG_ABBREV	This section is called <code>.debug_abbrev</code> , which stores abbreviation declarations.
DW_DEBUG_MACINFO	This section is called <code>.debug_macro</code> , which stores macro information.
DW_DEBUG_REF	This section is called <code>.WATCOM_references</code> , which contains information about the symbols of every instructions in the source files.

DW\_DEBUG\_MAX

Defined for convenience; it is the number of sections.

## Performance Considerations

The DW library does it's best to try and group CLIWrite operations together into one larger CLIWrite, and to try and avoid using CLISseek. But the library does not go out of it's way to provide this massaging of output. The client should attempt to buffer the data itself. CLISseek is most often called on the DW\_DEBUG\_INFO, and the DW\_DEBUG\_LOC sections. The other sections may have one CLISseek performed at the DWFinis stage, and the seek will be to the zero offset. The client might wish to optimize performance for only the DW\_DEBUG\_INFO and the DW\_DEBUG\_LOC sections.

**void CLISseek( uint section, long offset, uint mode );**

Repositions the pointer in **section** so that subsequent output occurs at the new pointer.

<i>Mode</i>	<i>Description</i>
-------------	--------------------

DW_SEEK_SET	The position is set to the absolute location <b>offset</b> .
-------------	--

DW_SEEK_CUR	<b>offset</b> is added to the current position.
-------------	---

DW_SEEK_END	The position is set to <b>offset</b> bytes from the current end of <b>section</b>
-------------	---

**long CLITell( uint section );**

Return the offset of the next byte to be written to the section.

**void CLIReloc( uint section, uint reloc\_type, ... );**

Even when writing BROWSER information, relocations such as DW\_W\_LOC\_PC may be asked for. This is because the DWARF format requires the presence of certain fields to indicate something specific about a record. For example, if a subroutine record doesn't have a low pc then it is assumed to be a declaration of the subroutine rather than a definition.

section	The section to write a relocation entry to.
---------	---

reloc_type	The type of the relocation, as follows:
------------	---

DW_W_LOW_PC	Emit a dw_targ_addr. Used by various entry points to get the low pc address of an object.
-------------	---

DW_W_HIGH_PC	Emit a dw_targ_addr. Used by various entry points to get the high pc address of an object.
--------------	--

**DW\_W\_STATIC** Emit a `dw_targ_addr`. This relocation has an extra parameter of type `dw_sym_handle`. This parameter is the target of the relocation; the offset of the symbol should be generated. This is used any time a location expression involving a **DWLocStatic** is generated.

**DW\_W\_SEGMENT** Emit a `dw_segment`. This relocation has an extra parameter of type `dw_sym_handle`. It indicates that the segment portion of the address of the symbol should be generated. This is used any time a location expression involving a **DWLocSegment** operation is generated.

**DW\_W\_LABEL** Emit a `dw_targ_addr`. Used by **DWLabel**.

**DW\_W\_SECTION\_POS** Emit a `uint_32`. This relocation has an extra parameter of type `uint` called **targ\_sect**. **targ\_sect** parameter is the number of a section for which the current offset is the target of the relocation. The relocation is emitted into **section**.

**DW\_W\_DEFAULT\_FUNCTION** Emit a `dw_targ_addr`. Used by **DWFormalParameter**.

**DW\_W\_ARANGE\_ADDR** Emit a `dw_targ_addr`. Used by **DWAddress**.

**DW\_W\_UNIT\_SIZE** Emit an `uint_32` that is the number of bytes of code in the current compilation unit.

**DW\_W\_MAX** Defined for convenience. This enumerated type starts at 0 and goes to **DW\_W\_MAX**.

**void CLIWrite( uint section, const void \*block, size\_t len );**

Writes out the debugging information.

<i>Parameter</i>	<i>Description</i>
section	The section to which the debugging information is written.
block	Points to the debugging information block.
len	Length of the debugging information block.

**void \*CLIAAlloc( size\_t size );**

Allocates a memory block of size **size** for the library and returns its address. This function cannot return NULL.

**void CLIFree( void \*blk );**

Free the block pointed by **blk**.





# ***Examples***

**This section needs a major rewrite.**

The example below shows what functions should be called in order to store the debugging information for this C program.

N.B. In this example, for all the `CLIWrite()` calls, only the section id is accurate. Also for all `DWLineNum()` calls, the advances in machine instruction address are inaccurate.

```
test.c:

1 #include <stdlib.h>

2 int    a;

3 typedef near char NCHAR;

4 void main();
5 {
6     NCHAR    b;

7     b := 5;
8 }
```

Functions called by the client and the DWARF library:

Client:

```
cli_id = DWInit( DW_LANG_C89, DW_CM_DEBUGGER, "test.c",
                 "c:\mydir", 0x123, 1, CLILoc, CLIType,
                 CLIName, CLIWrite, CLIAAlloc, CLIFree );
```

DWARF Library:

```
/* Initialize the .debug_line section */
CLIWrite( DW_DEBUG_LINE, 0, &info, 20, block );

/* Initialize the .debug_abbrevs section */
CLIWrite( DW_DEBUG_ABBREVS, 0, &info, 50, block );

/* Initialize the .debug_pubnames section */
CLIWrite( DW_DEBUG_PUBNAMES, 0, &info, 50, block );

/* Initialize the .debug_aranges section */
CLIWrite( DW_DEBUG_ARANGES, 0, &info, 50, block );

/* Write all strings to the string table */
CLIWrite( DW_DEBUG_STR, 0, &info, 17, block );
```

Client:

```
#include <stdlib.h>

DWLineNum( cli_id, DW_LN_STMT|DW_LN_BLK, 1, 1, 0 );
DWIncl( id, "stdlib.h" );
...Function calls for "stdlib.h"...
DWInclFini( cli_id );
```

DWARF Library:

```
CLIWrite( DW_DEBUG_LINE, 0, &info, 28, block );
CLIWrite( DW_DEBUG_INFO, 30, &info, 12, block );
```

Client:

```
int    a;

DWLineNum( cli_id, DW_LN_STMT, 1, 1, 4 );
a_dw_handle = DWModSym( cli_id, a_cg_handle, DW_SM_VAR,
                        DW_SM_GLO|DW_SM_FILE, DW_SM_NULL );
```

DWARF Library:

```
name = CLIName( a_cg_handle );
/* It returns the string "a". */
type = CLIType( a_cg_handle );
/* It returns DW_FT_INTEGER. */
loc = CLILoc( a_cg_handle );
CLIWrite( DW_DEBUG_LINE, 0, &info, 28, block );
CLIWrite( DW_DEBUG_INFO, 0, &info, 24, block );
CLIWrite( DW_DEBUG_PUBNAMES, 0, &info, 12, block );
```

Inside CLILoc():

```
loc_id = DWLocInt();
DWLocAtom( cli_id, a_cg_handle, DW_LOC_STATIC );
/* The actual address will be filled in by the client when
   the debugging information is written to the object
file.*/
a_loc_hd = DWLocFini( loc_id );
return a_loc_hd;
```

Client:

```
typedef near char NCHAR;

DWLineNum( cli_id, DW_LN_STMT, 1, 1, 14 );
mod_handle = DWMod( cli_id, DW_FT_CHAR, DW_MOD_NEAR );
nchar_handle = DWModSym( cli_id, nchar_cg_handle,
    DW_SM_TYPEDEF, DW_SM_NULL, DW_SM_NULL );
```

DWARF Library:

```
name = CLIName( nchar_cg_handle );
/* It returns the string "NCHAR". */
type = CLIType( nchar_cg_handle );
/* It returns mod_handle. */
CLIWrite( DW_DEBUG_LINE, 0, &info, 20, block );
CLIWrite( DW_DEBUG_INFO, 0, &info, 24, block );
```

Client:

```
void main();

DWLineNum( cli_id, DW_LN_DEFAULT, 1, 1, 23 );
pro_handle = DWBegProc( cli_id, DW_SB_NEAR_CALL,
    DW_FT_VOID,
    ret_loc_hd, DW_LOC_NULL,
    DW_SB_GLOBAL_SUB | DW_SB_FUNC_PROTOTYPE );
```

In order to get ret\_loc\_ad:

```
loc_id = DWLocInit();
DWLocAtom( cli_id, some_cg_handle, DW_LOC_STATIC );
/* Assume that the return address of main() is
stored
    in a symbol with some_cg_handle as its handle.
    The actual address will be filled in by the
    client when the debugging information is written
    to the object file.
*/
ret_loc_ad = DWLocFini( cli_id );
```

DWARF Library:

```
CLIWrite( DW_DEBUG_LINE, 0, &info, 20, block );
```

Client:

```
{
    DWLineNum( cli_id, DW_LN_BLK, 1, 1, 0 );
```

DWARF Library:

```
CLIWrite( DW_DEBUG_LINE, 0, &info, 24, block );
```

Client:

```
NCHAR b;

DWLineNum( cli_id, DW_LN_STMT, 1, 1, 10 );
b_handle = DWModSym( cli_id, b_cg_handle, DW_SM_VAR,
                    DW_SM_NULL, DW_SM_LOC|DW_SM_ROUT );
```

DWARF Library:

```
loc = CLILoc( b_cg_handle );
name = CLIName( b_cg_handle );
    /* It returns the string "b". */
type = CLIType( b_cg_handle );
    /* It returns nchar_handle. */
CLIWrite( DW_DEBUG_LINE, 0, &info, 20, block );
```

Inside CLILoc():

```
loc_id = DWLocInt();
DWLocAtom( cli_id, b_cg_handle, DW_LOC_STACK );
/* The offset from stack frame base will be filled in by
   the client when the debugging information is written
   to the object file. */
b_loc_hd = DWLocFini( loc_id );
return b_loc_hd;
```

Client:

```
b := 5;
DWLineNum( cli_id, DW_LN_STMT, 1, 4, 14 );
```

DWARF Library:

```
CLIWrite( DW_DEBUG_LINE, 0, &info, 24, block );
```

Client:

```
}  
DWLineNum( cli_id, DW_LN_DEFAULT, 1, 1, 4 );  
DWEndProc( cli_id, pro_handle );  
main_handle = DWModSym( cli_id, main_cg_handle, DW_SM_SUB,  
                        DW_SM_NULL, DW_SM_NULL );
```

DWARF Library:

```
name = CLIName( main_cg_handle );  
/* It returns the string "main" */  
type = CLIType( main_cg_handle );  
/* It returns pro_handle */  
CLIWrite( DW_DEBUG_LINE, 0, &info, 24, block );  
CLIWrite( DW_DEBUG_INFO, -50, &info, 86, block );  
CLIWrite( DW_DEBUG_REF, 0, &info, 12, block );  
CLIWrite( DW_DEBUG_PUBNAMES, 0, &info, 12, block );  
/* For the global object "main" */
```

Client:

```
DWFin( cli_id );
```

DWARF Library:

```
CLIWrite( DW_DEBUG_LINE, 0, &info, 24, block );  
CLIWrite( DW_DEBUG_INFO, -120, &info, 54, block );
```

# ***Revision History***

<b><i>Draft</i></b>	<b><i>Description</i></b>
Draft 5	Changed the arguments to a number of the function calls for use with draft 5 of dwarf.
Draft 6	Changed the arguments to a number of the function calls for use with draft 6 of dwarf.