

# Data Structures, Tables, and Variables

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## Data Structures and Tables

MSL drivers must create and/or maintain several data structures and tables in order to interface with the NetWare SFT III operating system. Additional structures are optional and can be defined and used by the driver as needed.

Most MSL drivers will require the following tables and structures:

- *DriverStatistics Table*
- *IOConfigurationStructure*
- *AdapterOptionStructure*
- *AESEventStructure*
- *TimerDataStructure*

A brief description of these tables and structures is provided below. The following pages then provide detailed information.

The *DriverStatistics* table contains various diagnostic counters that the driver must maintain. Each physical adapter will have a corresponding statistics table.

The *IOConfigurationStructure* contains information about the adapter's hardware configuration. The structure is required when the driver calls various operating system support routines.

The *AdapterOptionStructure* allows the driver to provide lists of valid configuration options available for the adapter's hardware. These lists are used by the *ParseDriverParameters* support routine to prompt for and validate configuration information entered from the load command line or interactively from the operator console. The *ParseDriverParameters* routine uses the information to fill out the driver's *IOConfigurationStructure*.

The *AESEventStructure* and *TimerDataStructure* are used to schedule *callback* events to a specified driver routine after a designated interval. For example, a driver routine could be scheduled for callback in order to monitor for and recover from timeout conditions or to perform retry operations at a later time. The *AESEventStructure* is used to schedule callbacks to driver routines that must run at *process time*. The *TimerDataStructure* is used to schedule *interrupt time* callbacks.

## DriverStatistics Table

The *DriverStatistics* table is a structure containing various diagnostic counters used to monitor operations related to the MSL driver or adapter. The format of the statistics table is strictly defined and is illustrated below. A description of each field follows the sample.

The table is divided into two general sections: the generic (or standard) MSL statistics required by NetWare, and the custom statistics defined by the driver. Your driver must maintain *all counters* in the table.

The driver must provide external processes (upper layer applications) access to the statistics table information through the *DriverControl* procedure, *GetMSLStatistics*. When called, this procedure creates a copy of the statistics table in a buffer provided by the caller. Refer to Chapter 4, "MSL Driver Procedures," for more information on this routine.

*	DriverStatistics	db	0 dup (?)
	StatisticsMajorVersion	db	01
	StatisticsMinorVersion	db	00
	NumGenericCounters	dw	(GenericEnd - GenericBegin) / 4
	NotSupportedMask	dd	000000000000000000000000111111111111111b
*	GenericBegin	db	0 dup (?)
	TransmitPacketCount	dd	0
	ReceivePacketCount	dd	0
	TransmitBurstPacketCount	dd	0
	MSLRejectPacketCount	dd	0
	TransmitMsgCount	dd	0
	ReceiveAckCount	dd	0
	ReceiveMsgCount	dd	0
	TransmitAckCount	dd	0
	TransmitHoldCount	dd	0
	ReceiveHoldCount	dd	0
	OSHoldMsgCount	dd	0
	OSCallbackCount	dd	0
	OSRejectMsgCount	dd	0
	ServerCommErrorCount	dd	0
	ReceiveErrorCount	dd	0
	TransmitErrorCount	dd	0
	ReceiveEmergencyCount	dd	0
	RetryTxCount	dd	0
*	GenericEnd	db	0 dup (?)
	NumCustomCounters	dw	(CustomEnd-CustomBegin)/4
*	CustomBegin	db	0 dup (?)
	CustomCounter1	dd	0
	:		
	:		
	CustomCounterN	dd	0
*	CustomEnd	db	0 dup (?)
*	CustomStrings	db	0 dup (?)
*	These fields are 0 bytes in length and function as labels. (This syntax is a feature of the Phar Lap assembler.)		

### Statistics Table Field Descriptions

Offset	Name	Bytes	Description
00h	StatisticsMajorVersion	1	This field contains the major version number of the statistics table. The version number is controlled by Novell and is currently v1.00; therefore, 1 is the major version number.
01h	StatisticsMinorVersion	1	This field contains the minor version number of the statistics table. This version number is controlled by Novell and is currently v1.00; therefore, 00 is the minor version number.
02h	NumGenericCounters	2	This field contains the number of generic counters present in the statistics table (but not necessarily supported or used). Currently, this field should be set to 18 (decimal).
04h	NotSupportedMask	4	This field contains a bit mask indicating which <i>generic</i> counters of the statistics table are implemented. The 18 most significant bits correspond to each of the generic counters (with the most-significant bit matching <i>TransmitPacketCount</i> ). If the bit is 0, the counter is supported; if the bit is 1, the counter is not supported. The remaining 14 bits should be padded with ones.
08h	TransmitPacketCount	4	Total number of <i>message packets</i> successfully transmitted by this MSL adapter.
0Ch	ReceivePacketCount	4	Total number of <i>message packets</i> successfully received by this MSL adapter.
10h	TransmitBurstPacketCount	4	Total number of <i>burst message packets</i> transmitted by the MSL adapter. Burst packets are constructed by the <i>DriverBuildSend</i> routine after <i>DriverISR</i> receives a message acknowledgment. Typically these packets contain multiple messages but might contain only 1 message. (see Chapter 4)
14h	MSLRejectPacketCount	4	Number of packets MSL rejects.
18h	TransmitMsgCount	4	Total number of messages transmitted.
1Ch	ReceiveAckCount	4	Total number acknowledgments received. (should correspond to <i>TransmitMsgCount</i> )
20h	ReceiveMsgCount	4	Total number of messages received.
24h	TransmitAckCount	4	Total number of acknowledgments transmitted. (should correspond to <i>ReceiveMsgCount</i> )
28h	TransmitHoldCount	4	Total number of hold notifications transmitted.
2Ch	ReceiveHoldCount	4	Total number of hold notifications received.
30h	OSHoldMsgCount	4	Total number of messages that the OS held off before accepting. (This is the number of times <i>ReceiveServerCommPointer</i> returns a status code of 2 or 3)

## Statistics Table Field Descriptions

-(continued)-

34h	OSCallbackCount	4	Total number of times the OS has requested to be called back after the driver copied the message to system memory. (This is the number of times <i>ReceiveServerCommPointer</i> returns a status code of 1)
38h	OSRejectMsgCount	4	Total number of messages rejected (ignored) by the OS. (This is the number of times <i>ReceiveServerCommPointer</i> returns a status code of 4)
3Ch	ServerCommErrorCount	4	Total number of times the driver called the OS procedure <i>ServerCommDriverError</i> .
40h	ReceiveErrorCount	4	Total number of receive errors.
44h	TransmitErrorCount	4	Total number of transmit errors.
48h	ReceiveEmergencyCount	4	Total number of emergency notification packets received from the other server.
4Ch	RetryTxCount	4	Number of transmit retries.
50h	NumCustomCounters	2	This field contains the number of custom counters defined by the driver.
52h . . .	CustomCounter1 . . .	4 each	These fields contain custom counters that can be defined for the specific needs of the MSL driver or adapter design. Each custom counter must have a corresponding string in the custom strings area (defined below).
??h	CustomStrings	?	<p>The CustomStrings area provides diagnostic strings that correspond to the custom counters. The first word of the CustomStrings area contains the size of the area in bytes. Each string must be null terminated. The table of strings is terminated with two nulls.</p> <pre> CustomStrings      db      0 dup (?) CustomStringsSize  dw      EndStrings-CustomStrings                   db      'Custom String 1', 0                   db      'Custom String 2', 0                   db      'Custom String 3', 0                   .                   .                   db      'Custom String N', 0                   db      0, 0 EndStrings         db      0 dup (?) </pre>

## IOConfigurationStructure

The *IOConfigurationStructure* defined by NetWare contains fields describing information about the adapter's hardware configuration including I/O ports, memory decode addresses, interrupts, and DMA channels. The configuration structure is shown on the following page. A description of each field follows the example.

The MSL driver uses the structure primarily during initialization to reserve file server hardware resources.

The following OS support routines require the structure:

- *ParseDriverParameters*
- *RegisterHardwareOptions*
- *DeRegisterHardwareOptions*
- *RegisterServerCommDriver*

The driver calls *ParseDriverParameters* to fill in the fields of the structure using information entered from the load command line and/or interactively from the operator console. All fields of the structure must be zeroed prior to calling *ParseDriverParameters*, unless noted otherwise. (Chapter 5 describes the *ParseDriverParameters* support routine in detail.)

Once the configuration table is filled in, the driver calls *RegisterHardwareOptions* to reserve the configuration options with the OS. The driver *must not modify any field* in the configuration structure after calling *RegisterHardwareOptions*.

The driver must provide external processes (upper layer applications) access to the configuration table information through the *DriverControl* procedure, *GetMSLConfiguration* (see Chapter 4). When called, this procedure creates a copy of the configuration table in a buffer provided by the caller.

```

IOConfigurationStructure      struc
    CLink                     dd      ?
    CFlags                     dw      ?
    *   CSlot                   dw      ?

    *   CIOPort0                dw      ?
    *   CIOLength0              dw      ?
    *   CIOPort1                dw      ?
    *   CIOLength1              dw      ?

    *   CMemoryDecode0          dd      ?
    *   CMemoryLength0          dw      ?
    *   CMemoryDecode1          dd      ?
    *   CMemoryLength1          dw      ?

    *   CInterrupt0             db      ?
    *   CInterrupt1             db      ?

    *   CDMAUsage0              db      ?
    *   CDMAUsage1              db      ?

    CIOResourceTag             dd      ?

    CConfiguration              dd      ?
    CCommandString              dd      ?
    CLogicalName                 db     18 dup (?)
    CIOReserved                  db     16 dup (?)

IOConfigurationStructure      ends

DriverConfiguration           IOConfigurationStructure
                                <0,0,0,
                                0,0,0,0,
                                0,0,0,0,
                                0FFh,0FFh,
                                0FFh,0FFh,
                                0,0,0,0,0>

```

- \* These values are configurable from the command line and/or interactively from the server console at load time.



### Configuration Field Descriptions

Offset	Name	Bytes	Description
00h	CLink	4	Reserved by NetWare. Drivers should not change this field.
04h	CFlags (sharing flags)	2	<p>Setting these bits indicates that the MSL adapter can share I/O ports, memory ranges, interrupts, and/or DMA channels. (Note: Set bit 0 to 0.)</p> <p>This field must be initialized <i>before</i> calling the <i>ParseDriverParameters</i> routine. Set this field to zero unless the hardware options are shared on all the adapters using this driver. For shared I/O device addresses, interrupts, etc., place the following value in this field:</p> <pre style="margin-left: 40px;"> IODetached           01h IOSharablePort0Bit   02h IOSharablePort1Bit   04h IOSharableMem0Bit    08h IOSharableMem1Bit    10h IOSharableInt0Bit    20h IOSharableInt1Bit    40h IOSharableDMA0Bit    80h IOSharableDMA1Bit    100h </pre>
06h	CSlot	2	If an MSL adapter is running in an MCA or EISA machine, this field holds the slot number where the adapter is installed. (zero if not used)
08h	CIOPort0	2	This field contains the primary base I/O port for the MSL adapter. (zero if not used)
0Ah	CIOLength0	2	This field contains the number of I/O ports starting at <i>CIOPort0</i> . (zero if not used)
0Ch	CIOPort1	2	This field contains the secondary base I/O port for the MSL adapter. (zero if not used)
0Eh	CIOLength1	2	This field contains the number of I/O ports starting at <i>CIOPort1</i> . (zero if not used)
10h	CMemoryDecode0	4	This field contains the <i>absolute</i> address of primary shared memory used by the MSL adapter. (zero if not used)
14h	CMemoryLength0	2	This field contains the amount of memory (in paragraphs) that the MSL adapter uses, starting at <i>CMemoryDecode0</i> . (zero if not used)
16h	CMemoryDecode1	4	This field contains the <i>absolute</i> address of secondary shared memory used by the adapter. (zero if not used)

## Configuration Field Descriptions

-(continued)-

1Ah	CMemoryLength1	2	This field contains the amount of memory (in paragraphs) that the MSL adapter uses, starting at <i>CMemoryDecode1</i> . (zero if not used)
1Ch	CInterrupt0	1	This field contains the primary interrupt number used by the adapter. (FFh if not used)
1Dh	CInterrupt1	1	This field contains the secondary interrupt number used by the adapter. (FFh if not used)
1Eh	CDMAUsage0	1	This field contains the primary DMA channel used by the MSL adapter. (FFh if not used)
1Fh	CDMAUsage1	1	This field contains the secondary DMA channel used by the MSL adapter. (FFh if not used)
20h	CIOResourceTag	4	This field contains the resource tag with a <i>IORegistrationSignature</i> acquired by the driver during initialization. (see <i>AllocateResourceTag</i> )
24h	CConfiguration	4	Reserved. MSLs should not use this field.
28h	CCommandString	4	If the driver needs to append something to the command line or replace the default command line in the AUTOEXEC.NCF file for the I/O Engine (IOAUTO.NCF), this field will contain a long pointer to the new or additional command line string. If the driver does not use this option, the field must be cleared. If this field is used, then bits 9 and 10 of <i>CFlags</i> need to be set appropriately.
2Ch	CLogicalName	18	MSLs should not use this field. This field contains the logical name of the MSL driver, if it is given one at load time.  For example: <code>load &lt;driver&gt; name="_____"</code>
3Eh	CIOReserved	16	Reserved for the MSL's use.

## AdapterOptionStructure

The *AdapterOptionStructure* is defined in the MSL.INC file and is shown below. In order to use the NetWare support routine *ParseDriverParameters* to parse the load command line, an MSL driver must maintain a single instance (or more if more than one adapter type is supported by the same driver) of this structure.

The *AdapterOptionStructure* serves as a template defining the available choices for various adapter configuration options. *ParseDriverParameters* uses this template to parse the load command line, query the operator for any required options not found on the command line, validate the selected values, and fill in the associated fields in the *IOConfigurationStructure*.

```

AdapterOptionStructure  struc
    IOSlot                dd      ?
    IOPort0               dd      ?
    IOLength0            dd      ?
    IOPort1               dd      ?
    IOLength1            dd      ?
    MemoryDecode0        dd      ?
    MemoryLength0        dd      ?
    MemoryDecode1        dd      ?
    MemoryLength1        dd      ?
    Interrupt0           dd      ?
    Interrupt1           dd      ?
    DMA0                  dd      ?
    DMA1                  dd      ?
AdapterOptionStructure  ends

```

Each field in the structure is a pointer to a length-preceded list of allowable options for that field. The first option in the list is used as the default value. Each list assumes the following form:

```

List  dd  n          ;number of entries
      dd  entry1     ;first (default) value
      dd  entry2
      .
      .
      dd  entryn     ;last available value

```

If entries are not used in the *AdapterOptionStructure*, the pointer to the associated list should be set to zero. The fields are explained in detail under the *IOConfigurationStructure* description in the previous section.

Refer to the *ParseDriverParameters* description in Chapter 5, "NetWare SFT III Support Routines," for additional information on the use of this structure.

## AESEventStructure

The *AESEventStructure* is required to schedule *process level callbacks* to a specified driver routine after a designated interval. For example, a driver routine could be scheduled for callback in order to monitor for and recover from transmit timeout conditions, or to perform retry operations at a later time.

The OS support routines, *ScheduleSleepAESProcessEvent* and *ScheduleNoSleepAESProcessEvent* described in Chapter 5, are used to schedule the callback events for either *blocking* or *non-blocking* process level driver routines.

```

AESEventStructure      struc
  AESLink              dd    ?
  AESWakeUpDelayAmount dd    ?
  AESWakeUpTime        dd    ?
  AESProcessToCall     dd    ?
  AESRTag              dd    ?
  AESOldLink           dd    ?
  MessageTimeOutTime  dd    ? ;optional
  AdapterTimeOutTime  dd    ? ;optional
AESEventStructure     ends

```

Field Name	Description
AESLink	Used internally by the NetWare OS; do <i>not</i> modify this field.
AESWakeUpDelayAmount	The amount of time in system clock ticks (1 tick $\approx$ 1/18 second) before the callback procedure is invoked. Generally, this interval should be small enough to provide reasonable recovery time, but not so small as to affect overall server performance.
AESWakeUpTime	Used internally by the NetWare OS; do <i>not</i> modify this field.
AESProcessToCall	A pointer to the routine that will be called once for each <i>ScheduleAESProcessEvent</i> call.
AESRTag	Resource tag with an <i>AESProcessSignature</i> obtained by the MSL driver during initialization. This allows the OS to track the AES resource.
AESOldLink	Maintained for backward compatibility.
MessageTimeOutTime (optional)	Set this field to the value of <i>ServerCommACKTimeOut</i> when beginning a message timeout sequence. This value is the maximum time (in ticks) you should wait for the other server's acknowledgment before calling <i>ServerCommDriverError</i> .
AdapterTimeOutTime (optional)	This field is used for adapters that support the transmit complete feature. When the driver initiates a transmission, it should set this value to the maximum time (in ticks) to wait for that transmission to complete. This can be used to detect a "dead" adapter.

## TimerDataStructure

The *TimerDataStructure* is required to schedule *interrupt level callbacks* to a specified driver routine after a designated interval. The OS support routine used to schedule the callback is *ScheduleInterrupt-TimeCallBack*. This routine adds an event to the list of events that will be called by the timer tick interrupt handler.

```

TimerDataStructure      struc
    TLink                dd      ?    ;reserved
    TCallbackProcedure   dd      ?
    TCallbackEBXParameter dd      ?
    TCallbackWaitTime    dd      ?
    TResourceTag         dd      ?
    TWorkWakeUpTime      dd      ?    ;reserved
    TSignature           dd      ?    ;reserved
TimerDataStructure      ends

```

The reserved fields of this structure are used internally by the NetWare OS and should not be modified by the driver. The remaining fields are filled in by the driver as follows:

Field Name	Description
TCallbackProcedure	Pointer to the procedure to be called by the timer interrupt handler. When the procedure is called, interrupts are disabled.
TCallbackEBXParameter	The value EBX should contain when the call back procedure is invoked.
TCallbackWaitTime	The amount of time (in ticks) before the callback procedure is invoked.
TResourceTag	Resource tag with a <i>TimerSignature</i> acquired by the driver for interrupt time callbacks. (see <i>AllocateResourceTag</i> )

**Note:** The four fields described above are not changed by the operating system. If the driver reschedules another callback, it does not need to reinitialize these fields.

## Global Data Variables

This section describes the global data variables that have special meaning for MSL drivers. All variables described in this section are external to the driver. The driver will either need to initialize, maintain, or access these variables during the course of its operation.

### **MaximumCommDriverDataLength: dword**

The driver must set this variable during initialization so that the operating system knows the maximum message size (not including the *message header*) that the driver can transmit.

### **PacketSizeNowAvailable: dword**

The OS maintains this variable to let the driver know the size of the next message (not including the *message header*) that the OS has queued for transmission. This value may be positive, zero, or negative. A negative value indicates that the OS has no messages queued for transmission. A value of zero indicates a *message header only* with no *message data*.

### **PacketSizeDriverCanNowHandle: dword**

The driver maintains this variable to let the OS know whether it can call the *DriverSend* or *DriverBuildSend* routines to send the next message. This value may be positive, zero, or negative. A negative value indicates the driver can send no more messages (typically until an acknowledgement is received from the other server for a previous message). A value of zero indicates the driver can send a *message header only* with no *message data*.

There are several cases when the OS does not check this variable before calling the driver to send a message:

**Case 1.** When the MSL driver initially registers with the mirrored server interface by calling *RegisterServerCommDriver*, the OS assumes that the driver is ready to send a message.

**Case 2.** When the OS sends an initial "I'm alive" message and receives an acknowledgement, it will send the next message in the initial link protocol between the two servers without checking this variable. The OS assumes that if the MSL driver has received an acknowledgement from the initial message, it should be ready to transmit another message.

**Case 3.** The OS sends an initial "I'm alive" message and times out waiting for the acknowledgement. The OS then switches into a "listening" state. Upon reception of an "I'm alive" message, the OS will send a reply message without checking this variable. The OS assumes that if the first message has timed out, the MSL should be ready to transmit another message.

### **ServerCommACKTimeout: dword**

The OS sets this variable to the maximum time in ticks the driver should wait for a message acknowledgement. The MSL driver uses this value in conjunction with the *DriverTimeout* routine to determine if the mirrored server-to-server link is still active.

When the MSL driver sends a message, it initializes a counter to the value of *ServerCommACKTimeout*. The *DriverTimeout* routine (which is called back at 1 tick intervals) will decrement the counter. If the value becomes zero before the acknowledgement is received, the timeout routine should notify the OS that the link between the mirrored servers is no longer valid by calling the *ServerCommDriverError* routine.

The OS may dynamically change the *ServerCommACKTimeout* value; therefore, each time a new message timeout is started, the counter should be reinitialized to the current *ServerCommACKTimeout* value.

## **Indirect OS Calls**

The following global variables are defined and maintained by the NetWare SFT III operating system. These variables contain pointers to specific OS procedures that the MSL driver must access. This section provides a brief description of these indirect calls. Each procedure is then described in detail in Chapter 5.

### **GetNextPacketPointer: dword**

This variable contains a pointer to the current OS procedure used to get the next message (or group of messages) that the OS has queued for transmission. The MSL driver must call this procedure after it receives an acknowledgement. This procedure initiates a possible multi-message packet building sequence.

### **ReceiveServerCommPointer: dword**

This variable contains a pointer to the current OS procedure used to notify the OS when a message is received from the other server. This

procedure then returns a completion code indicating to the driver what action to take for the message.

**SendServerCommCompletedPointer: dword**

This variable contains a pointer to the current OS procedure used to notify the OS when any message acknowledgements are received from the other server.