The non-automatic bridges will not be able to send or receive "hello" messages. The automatic bridges will not recognize the non-automatic bridges in the network. There is the probability of creating multiple paths between LAN segments if an automatic bridge changes its single-route broadcast parameter settings.

A similar result can occur if some bridges are set to automatic and some are set to manual in the same network. If all of the Bridge Programs in your network provide automatic single-route broadcast, then all bridges should be set the same way — either all automatic or all manual.

- The IBM LAN Manager

  The IBM LAN Manager Version 2.0 can change the bridge parameter settings for automatic or manual single-route broadcast and for single-route broadcast on or off.

  The IBM LAN Manager Version 1.0 can change only the manual single-route broadcast parameter values to on or off. The single-route broadcast selection mode must be set to manual before the IBM LAN Manager Version 1.0 can change the on/off setting.

  If you are using automatic single-route broadcast in your network, using the IBM LAN Manager to change single-route broadcast settings may disrupt the automatic single-route broadcast process. You may need to reevaluate and change single-route broadcast parameter settings manually throughout the network.

- Path cost and bridge ID

  The Bridge Program tries to assign as designated bridges those on the shortest path between LAN segments (lowest path cost), and those with the lowest bridge ID (for parallel bridges). The root bridge will always be the active bridge with the lowest bridge ID.

  By assigning bridge labels and path cost increments with the selection rules in mind, you, as network administrator, can determine which bridges will be selected as root and designated bridges.

  - The root bridge should be in a central location in your network in order to provide the shortest paths to all connecting LAN segments.

- Automatic single-route broadcast uses the bridge ID to decide which parallel bridge should be the root bridge or a designated bridge (should have single-route broadcast active).

  To make sure that one particular parallel bridge is always selected as the root bridge or a designated bridge, assign a lower 2-byte bridge label to that bridge than you assign to the other bridges parallel to it.

  To make sure that a certain parallel bridge is selected as the root bridge or a designated bridge ONLY if all of the other parallel bridges are not active, assign the highest bridge label to that bridge.

  If you use the default value (X'8000') for the bridge label on more than one bridge (the bridge IDs are the same), automatic single-route broadcast uses the adapter address in the bridge ID to select the designated bridge from two or more parallel bridges.

- Automatic single-route broadcast uses the path cost to choose the shortest parallel path between two LAN segments. You can influence the choice by the values you assign to the path cost increment for each bridge in the path.

  For example, you may have two parallel paths to a LAN segment in your network and want single-route broadcast frames to travel the longer path instead of the shorter one. Assigning a very large path cost increment to one or more bridges in the shorter path will cause its last bridge to become a stand-by bridge. The last bridge in the longer path will become a designated bridge. The stand-by bridge in the shorter path would become a designated bridge only if one or more bridges in the longer path leave the network.

- The time required for a single-route broadcast frame to travel from one end of a path to the other is affected by Bridge Program processing time, adapter type, LAN segment data rate, and type (processing power) of bridge computer. You need to consider all of these factors in assigning bridge labels and path cost increments.

  For example, a reason for choosing a longer path over a shorter one for the single-route broadcast path may be that the longer path uses more powerful (faster) bridge computers

or contains LAN segments with faster data rates than the shorter path.

See "Bridge Performance Analysis" on page C-18 for bridge performance considerations.

Early Token Release

ETR is an adapter configuration option used only in 16 Mbps token-ring network segments. It provides more efficient LAN segment utilization by allowing network adapters more frequent access to a free token.

On a 4 Mbps LAN segment, token access operates as follows:

- An adapter with data to send on the network (the sender)
  - Receives the first available token
  - Adds the data and routing information to make a frame
  - Sends the frame out on the network
- The frame travels to its destination. The receiving adapter
  - Copies the frame from the network
  - Updates the frame to acknowledge receipt
  - Sends the frame back out on the network
- The sender
  - Receives the acknowledged frame
  - Removes the frame from the network
  - Releases a new free token on the network.

On a 4 Mbps LAN segment, there can be only one token or one frame on the network at a time. The sender cannot release the new token until the acknowledged frame is received.

On a 16 Mbps LAN segment, there can be one or more frames and a free token on the network at a time. The use of ETR allows the sender to release a new token without waiting for the acknowledged frame to return.

In deciding whether to set ETR on or off for the bridge adapters, consider the following:

- Each token contains a priority indicator. If a program requires more frequent access to tokens than other programs on the network, the program can indicate the required priority to its network adapter. The adapter then uses tokens that have a priority indicator equal to or lower than the program's required priority. The adapter follows a procedure for setting the priority indicator in the new tokens it releases, so that adapters with lower priorities are not prevented from getting tokens.
- If ETR is used on all of the adapters on a LAN segment, the priority process no longer functions as it does normally (it is essentially disabled).
- If ETR is used on some but not all of the adapters on a LAN segment, priority functioning is unpredictable.
- On a LAN segment connected to a bridge, if there are programs that MUST use a higher priority to acquire tokens more frequently than other programs, then ETR must be set OFF for all adapters on the LAN segment (including the bridge adapters).
- If priority token access is not required by the programs on the LAN segment, then ETR can be set ON for any adapters on the LAN segment.
- Though some programs written to run on the IBM Token-Ring Network do set a higher than normal priority (the Bridge Program does), most of these programs should function normally with ETR active.
- You will need to determine whether there are any programs that require priority token access on the LAN segments connected to the bridge adapters, and set ETR accordingly.

Bridge Performance Analysis

The Bridge Program contains functions to help you evaluate and manage traffic through the bridge. The functions are:

- **Performance Counters**
  - The Bridge Program performance counters
    - Accumulate numbers of frames and bytes forwarded and frames not forwarded from each LAN segment to the other through the bridge
    - Can be displayed at the bridge station
  - All of the counters except the "Frames not routed across this bridge" counter
    - Can be displayed at an IBM LAN Manager station
    - Can be recorded by the IBM LAN Manager, Version 2.0 in a counter file on disk.
- **Performance Statistics**
  - The Bridge Program
    - Allows the user to specify the **Bridge performance threshold** configuration parameter value, that is, the maximum number of frames per 10 000 arriving at the bridge that are not forwarded, before a "threshold exceeded" statistic is generated.
    - Displays the number of times that the threshold is exceeded within each 5 minutes of a 24-hour period
    - Sends a performance notification to network manager programs each time the **Bridge performance threshold** is exceeded.

The following sections describe the Bridge Program performance functions, and explain how to use the performance information to evaluate and manage the traffic through a bridge.

Bridge Program Performance Counters

The Bridge Program maintains several counters for each LAN segment connected to a bridge. In this manual, each counter is identified by a letter for purposes of reference in the performance evaluation process.

The counters record the following information:

- **(A)** Broadcast frames forwarded

  Counter A contains the number of broadcast and single-route broadcast frames successfully forwarded from one LAN segment to the other by the bridge.

- **(B)** Broadcast bytes forwarded

  Counter B contains the number of broadcast and single-route broadcast bytes successfully forwarded from one LAN segment to the other by the bridge.

  Not all of the bytes in each frame are counted. The bytes counted for each frame are those between and included in the Access Control Field and the Information Field (see the frame format in Figure C-4 on page C-21).

- **(C)** Non-broadcast frames forwarded

  Counter C contains the number of non-broadcast frames successfully forwarded from one LAN segment to the other by the bridge.

- **(D)** Non-broadcast bytes forwarded

  Counter D contains the number of non-broadcast bytes successfully forwarded from one LAN segment to the other by the bridge.

  Not all of the bytes in each frame are counted.

  - For bridges connecting two rings, the bytes counted for each frame are those between and included in the Access Control Field and the Frame Check Sequence (see the frame format in Figure C-4 on page C-21).
  - For bridges connecting two buses or one bus and one ring, the bytes counted for each frame are those between and included in the Access Control Field and Information Field (see the frame format in Figure C-4 on page C-21).

- **(E)** Frames not forwarded; target LAN segment inoperative

  - For a target ring

    Counter E contains the number of frames discarded by the bridge because the frames arrived during a period when the target ring was beaconing. The count also includes frames waiting at the bridge to be forwarded when the ring began beaconing; these frames are also discarded.

- For a target bus

  Counter E contains the number of frames discarded by the bridge because the frames arrived during a period when the target bus was in a continuous-carrier condition or a no-carrier condition. The count also includes frames that the bridge discarded after experiencing 16 consecutive collisions in trying to forward the frames to the target bus.

- **(F)** Frames not forwarded; adapter congestion

  Counter F contains the number of frames lost because

  - Frames are coming to the bridge from the source LAN segment faster than the Bridge Program can process them.
  - The destination LAN segment is too busy to accept frames as fast as the Bridge Program is processing and trying to forward them.

  For the IBM Token-Ring Network, counter F contains the number of frames intended to cross this bridge but not forwarded due to adapter congestion.

  For the IBM PC Network, counter F contains the total number of frames arriving at a bridge adapter that is experiencing adapter congestion. (Frames received by but not routed across this bridge are counted in counter H when there is no bridge adapter congestion.)

- **(G)** Frames not forwarded for other reasons

  Counter G contains the number of frames not forwarded due to an IBM adapter failure or to the presence of a non-IBM adapter on the network causing invalid frame lengths or invalid Routing Information (RI) fields. The specific occurrences counted are:

  - Frame length is less than the minimum allowed
    - Minimum broadcast frame = 20 bytes
    - Minimum non-broadcast frame = 22 bytes
  - Frame length exceeds the maximum allowed.
    - IBM Token-Ring Network maximum lengths of the frame information field (some adapter types allow lower maximum lengths than these absolute values)
      - 16 Mbps Token-Ring Network segment = 8144 bytes
      - 4 Mbps Token-Ring Network segment = 4472 bytes.
    - IBM PC Network maximum length of the frame information field

- 2 Mbps PC Network segment = 2052 bytes.

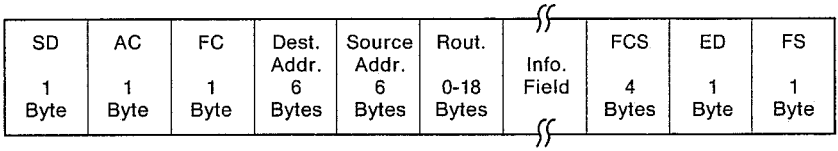
See Table C-1 on page C-22 for the largest frame size in bytes depending on the type of adapters in the bridge computer.

– RI field is invalid
  — Source LAN segment number is in the RI field, but is not last (broadcast frames only)
  — Duplicate LAN segment numbers in the RI field (non-broadcast frames only)
  — Source LAN segment number is not in the RI field (broadcast frames only)
  — Destination LAN segment number is not in the RI field (non-broadcast frames only).

- **(H)** Frames not routed across this bridge

  Counter H contains the number of frames received by an IBM PC Network bridge adapter that are not intended to be forwarded across this bridge (the IBM PC Network bridge adapter is not experiencing congestion).

  Any frames arriving at an IBM PC Network bridge adapter that is experiencing congestion are counted in Counter F.



Where:
SD = Start delimiter
AC = Access control field
FC = Frame control field
FCS = Frame check sequence
ED = End delimiter
FS = Frame status field

Figure C-4. Frame Format

Largest Frame Size

The type of adapter installed in the bridge computer affects the largest frame size that the Bridge Program can support. For application programs sending frames across a bridge, adjust the application to send a maximum frame size less than or equal to the largest frame size that the bridge can process. See Table C-1 for the largest frame size in bytes depending on the type of adapters in the bridge computer.

Table C-1. Largest Frame Sizes in Bytes

	Primary Adapter	
Alternate Adapter	**PC Network/A adapters**	**Token-Ring Network Adapter/A at 4 Mbps**
PC Network/A adapters	2052	2052
Token-Ring Network Adapter/A at 4 Mbps	2052	2052
Token-Ring Network 16/4 Adapter/A at 4 Mbps	2052	2052
Token-Ring Network 16/4 Adapter/A at 16 Mbps	2052	2052

	Primary Adapter	
Alternate Adapter	**Token-Ring Network 16/4 Adapter/A at 4 Mbps**	**Token-Ring Network 16/4 Adapter/A at 16 Mbps**
PC Network/A adapters	2052	2052
Token-Ring Network Adapter/A at 4 Mbps	2052	2052
Token-Ring Network 16/4 Adapter/A at 4 Mbps	4472	4472
Token-Ring Network 16/4 Adapter/A at 16 Mbps	4472	8144

The Bridge Program contains three copies of the performance counters:

- The Bridge Program user interface uses one copy. The user can display the Bridge Program Performance Counters panel to obtain the current values of the counters. From the Performance Counters panel the counters can be cleared to zeroes and then

displayed again after a period of time to gather information about bridge traffic during a specific time period. See "Bridge Traffic Evaluation" on page C-27 for more details.

If these counters reach the maximum values that they can contain, the counters roll over to zeroes and counting continues. When any of the counters roll over, the Bridge Program displays a message indicating that the counters have overflowed and need to be reset.

- The Bridge Program Performance Statistics function uses the second copy of the counters to determine when the **Bridge performance threshold** has been exceeded. See "The Performance Statistics Panel" on page 4-29 and "Bridge Program Performance Statistics" on page C-25 for more information.

  If the counts reach the maximum values that these counters can contain, they are not incremented again until they are reset to zeroes when the next 1-minute measurement interval begins.

- The Bridge Program uses the third copy of the counters to respond to network manager program requests to receive the current counter values from the Bridge Program. A network manager program (such as the IBM LAN Manager) can establish a communication link with the Bridge Program, and request to receive the counter values over the link from the Bridge Program. The IBM LAN Manager provides functions to

  - Request and display the current counter values (IBM LAN Manager Version 1.0 and Version 2.0)
  - Record the counter values in a disk file each time a specified time interval elapses (IBM LAN Manager Version 2.0).

  Note: The "Frames not routed across this bridge" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel or in the counter file.

  If the counts reach the maximum values that these counters can contain, the counters roll over to zeroes and counting continues. These counters are reset to zeroes when the Bridge Program is started again, but cannot be reset by the user. This allows more than one network manager program to obtain the same counter information from a bridge.

Table C-2 shows the counter lengths in bytes, and their maximum values.

Table C-2. Bridge Program Performance Counters

Counter	Length in Bytes	Maximum Value
(A) Broadcast frames forwarded	4	4 294 967 295
(B) Broadcast bytes forwarded	6	281 474 976 710 655
(C) Non-broadcast frames forwarded	4	4 294 967 295
(D) Non-broadcast bytes forwarded	6	281 474 976 710 655
(E) Frames not forwarded; target LAN segment inoperative	4	4 294 967 295
(F) Frames not forwarded; adapter congestion	4	4 294 967 295
(G) Frames not forwarded; other reasons	4	4 294 967 295
(H) Frames not routed across this bridge	4	4 294 967 295

Bridge Program Performance Statistics

The Bridge Program Performance Statistics provide an indication that frames are not being forwarded through the bridge. The bridge is operating under a condition that may be detrimental to end-user performance. (Each time one or more frames are not forwarded due to such a condition, a Bridge Program Performance Counter is incremented; the Performance Statistics indicate only that the condition occurred.) Such conditions include:

- The occurrence of a high rate of invalid frames from a defective network station
- A momentary bridge overload due to fluctuations in the traffic through the bridge or on the destination (target) LAN segment.

The Bridge Performance Threshold

The **Bridge performance threshold** is a parameter in the Bridge Program configuration file. The threshold specifies the maximum number of frames per 10 000 frames arriving at the bridge that are not forwarded to the other LAN segment before a performance statistic is generated and recorded. The Configuration Program packaged with the Bridge Program allows you to set the threshold value that is acceptable for the applications and users that send and receive data through the bridge.

Workloads on the network and the requirements of end users and application programs vary widely. Some end users and application programs may be able to detect that 1 out of 1000 frames was not forwarded through the bridge; others, because of different workloads and performance requirements, will be satisfied if no more than 1 out of 100 frames is not forwarded.

Over time you should adjust the **Bridge performance threshold** value for each bridge in your network to provide better correlation between the occurrence of the threshold being exceeded and the end-user being able to perceive a problem in response time, data exchange, or application program operation.

The Performance Statistics

Once each minute the Bridge Program uses the performance counter values to determine whether the **Bridge performance threshold** has been exceeded. A high value in one or more of the three "Frames not forwarded" performance counters E, F, and G can cause the threshold to be exceeded.

If the threshold is exceeded, the following two events occur:

1. The count of the number of times the threshold has been exceeded is incremented in a 5-minute interval in the Bridge Program Performance Statistics.

   The user can display the Bridge Program Performance Statistics panel to see the number of times the threshold was exceeded during any 5-minute interval of a 24-hour period.

2. A performance notification is sent to any network manager programs that have established links with the Bridge Program. The performance notification contains the bridge and LAN segment numbers, the number of frames not forwarded per 10 000 frames arriving at the bridge, and the values of the performance counters (except the "Frames not routed across this bridge" counter).

Procedures for accessing the performance notifications in the IBM LAN Manager Event Log are described in the *IBM LAN Manager User's Guide* (packaged with the IBM LAN Manager program).

Bridge Traffic Evaluation

You can use the Bridge Program performance information to obtain the following information:

- A characterization of the traffic flowing through a bridge
- An evaluation of bridge traffic on a LAN segment to which two or more bridges are connected.

The **first step** in evaluating bridge traffic is to determine the length of time for which you want the Bridge Program to count frames and bytes before you begin the analysis. This length of time is called the *measurement period.*

The length of the measurement period can be from a few minutes to several hours, and will vary with the purpose of the evaluation.

Use a short measurement period (a few minutes) to:

- Isolate a specific problem
- Observe traffic at a particular time of day
- Observe traffic generated as particular devices or programs use the network.

Use a longer measurement period (an hour or more) to obtain information about average bridge traffic during a busy period of the day.

The **second step** is to obtain the bridge performance counter values accumulated during the measurement period. You can obtain the counters:

- At a bridge station, from the Bridge Program directly
- At a station running a network manager program that can request the values from a Bridge Program.

  Further discussions in this section describe the use of the IBM LAN Manager.

You can use the performance counter values in a series of calculations to provide additional information about the bridge traffic flow, including:

- User traffic through the bridge in frames per second and bytes per second
- Percentage of frames not forwarded due to causes indicated by counters E and G
- The number of frames not processed by the Bridge Program due to bridge adapter congestion (counter F).

The following sections discuss two methods of obtaining the counter values and performing the calculations:

- The Worksheet Method
  - Display the counters at the bridge station.
  - Manually record the counter values on a worksheet.
  - Use the recorded values to do the calculations shown on another worksheet.

  See "The Worksheet Method" on page C-29 below for using the worksheets at the bridge station.

  A similar method is described in the *IBM LAN Manager User's Guide* Version 2.0 for displaying and recording the counters at the LAN Manager station.

- The Counter File Method
  - Use the function provided by the IBM LAN Manager Version 2.0 to record the counter values in a disk file each time the specified performance notification interval elapses.
  - Use a program that you write to read the file, do the analysis calculations, and present the results.

  The Counter File Method is discussed in "The Counter File Method" on page C-33 and in the *IBM LAN Manager User's Guide* Version 2.0.

Note: The "Frames not routed across this bridge" counter (H) is not sent to the IBM LAN Manager. If a bridge in your network has experienced adapter congestion (counter F is not zero), you should use the Worksheet Method at the bridge station to evaluate more exactly the traffic for that bridge. Although the calculations done without using counter H may yield an acceptable approximation, the use of counter

H refines the adapter congestion calculations for a more precise result.

The Worksheet Method

Two worksheets help you to record by hand the counter values for one measurement period, and to perform the calculations:

- The Bridge Performance Analysis Worksheet (see page D-6).
- The Bridge Performance Analysis Calculations Worksheet (see page D-5).

The following sections describe the use of the worksheets and the meaning of the resulting information.

The Bridge Performance Analysis Worksheet

Use the Bridge Performance Analysis Worksheet at the bridge station to record the values of the performance counters displayed on the Bridge Program Performance Counters panel.

To use the Bridge Performance Analysis Worksheet:

1 Make at least one copy of the blank original worksheet. Save the original to copy again later.

2 At the bridge station, select "Configuration Data" from the Main Menu.

3 On a copy of the worksheet:

- Fill in the current date.
- Fill in the bridge name or number.

  You can use the bridge number, or some other identifier that will uniquely identify this bridge.
- Record the Bridge Program Level shown on the Configuration Data panel.
- Fill in the LAN segment types.

4 Determine the length of time for the measurement period.

5 Return to the Bridge Program Main Menu and select "Performance Counters."

6 When the Performance Counters panel is displayed, press **F9 (Reset)** to clear the performance counters to zeros. (Pressing **F9** will not affect the performance counters accessible from the IBM LAN Manager or those used for the Performance Statistics.)

On the copy of the worksheet, record the date and time the counters were reset to zeros. The times are displayed and should be recorded on the worksheet in the format hours (hh), minutes (mm), and seconds (ss) (hh:mm:ss). (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

7 Wait until the desired measurement period has elapsed.

Other Bridge Program functions can be used during the measurement period.

If the message "ECCBR189W Performance counters have overflowed, press reset to clear them" appears during the measurement period, the measurement will be in error. Return to step 6 and use a shorter measurement period.

8 At the end of the desired measurement period, display the Performance Counters panel again.

If you were using another Bridge Program function, return to the Performance Counters panel from the Main Menu.

If no other Bridge Program function was used and the Performance Counters panel is still displayed, press **F5 (Refresh)** to update the panel information to the current performance counter values and time of day.

9 On the copy of the Bridge Performance Analysis Worksheet, record the date and time of day the counters were refreshed, and the performance counter values.

10 Add the counter values for the two LAN segments to obtain and record the bridge totals.

Use the information recorded on the worksheet in making the calculations on the Bridge Performance Analysis Calculations Worksheet.

The Bridge Performance Analysis Calculations Worksheet

The performance counter values obtained at the Bridge Program station represent numbers of frames and bytes processed by the bridge during the measurement period, which could vary from a few minutes to a few hours.

The Bridge Performance Analysis Calculations Worksheet contains a number of bridge traffic measurement computations, including frames per second and bytes per second through the bridge. Not all of the computations are required for most analysis purposes.

To use the Bridge Performance Analysis Calculations Worksheet:

1 Make at least one copy of the blank original worksheet (both sides). Save the original to copy again later.

2 Obtain the completed Bridge Performance Analysis Worksheet containing the times and performance counter values from the bridge station.

3 Write the date, bridge name or number, Bridge Program level, LAN segment types, and LAN segment numbers on the Calculations Worksheet (copy from the Performance Analysis Worksheet).

4 Calculate and record on the worksheet the value for J, the length of the measurement period in seconds.

The times are recorded in the format hours (hh), minutes (mm), and seconds (ss) (hh:mm:ss). (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

a. Convert the first time shown on the Bridge Performance Analysis Worksheet to seconds (the time the counters were reset to zeroes at the bridge station):

   (((HH x 60) + MM) x 60) + SS = J1

b. Convert the second time shown on the Bridge Performance Analysis Worksheet to seconds (the time the counters were refreshed at the bridge station):

   (((HH x 60) + MM) x 60) + SS = J2

c. Subtract the first time in seconds from the second time in seconds to obtain and record the value for J on the Calculations Worksheet:

   (J2 - J1) = J

5 Perform the calculations indicated by the formulas on both sides of the Calculations Worksheet. Record the answers in the spaces provided.

- The letters A through H, followed by a number to indicate a LAN segment value or a bridge total, identify the performance counters on the Bridge Performance Analysis Worksheets and in the formulas. For example:

  A1 = Broadcast frames forwarded from the LAN segment in the left column

  A2 = Broadcast frames forwarded from the LAN segment in the right column

  A3 = Broadcast frames forwarded from either LAN segment to the other for the bridge total.

  Where the letters A through H appear in the formulas, use the corresponding counter values from the Bridge Performance Analysis Worksheet.

  Note: If you are using counter values obtained at the IBM LAN Manager station, assume a value of zero for counter H.

- The letters K through Q, (excluding O), followed by a number to indicate a LAN segment value or a bridge total, identify calculation answers that are used in later calculations. Where the letters K through Q appear in the for-

mulas to the left of an = sign, use the corresponding value obtained in an earlier calculation and written to the right of an = sign on the Calculations Worksheet.

The Counter File Method

The IBM LAN Manager (Version 2.0, not any earlier versions) provides a function that:

- Automates the recording of bridge performance counter values, except for the "Frames not routed across this bridge" counter (H).
- Can record counter values for each bridge with which the IBM LAN Manager has established a communication link (up to 64 bridges).

When you use the **Configure Bridge** function of the IBM LAN Manager to specify a non-zero performance notification interval for a bridge, the IBM LAN Manager:

- Creates a disk file with the same name as the bridge and a file extension of PRF
- Requests the Bridge Program at the bridge station to begin sending counter values each time the performance notification interval elapses
- Writes a data record in the file each time counter values are received from the Bridge Program.

The Counter File

Each disk file in which the IBM LAN Manager records counter values (one file per bridge) contains one header record and up to 1440 100-byte records of binary data. This allows for one record per minute over 24 hours.

The data records in the counter file can be used in a way similar to reading the counter values from the IBM LAN Manager Performance Counter panel. Each data record contains a reading of the counter values. For each two consecutive data records in the counter file, you subtract the counter values in the first record from the counter values in the second record to obtain the values accumulated during one performance notification interval.

The file format is described in the *IBM LAN Manager User's Guide* Version 2.0.

The Analysis Program

To use a counter file for bridge performance analysis, you will need to write a program to:

- Read the file records.

  The program must open and close the file, convert binary values to decimal where needed, and establish constants and variables needed for input to the calculations and for saving the results.

- Do the analysis calculations.

  The program can do only the calculations described in the Work-sheet Method, or you can add other calculations to meet the needs of your establishment.

  The program must make up for the counters rolling over (reaching their maximum value, resetting to zero, and continuing to count) during a performance notification interval.

  Calculations can be done for

  - A single interval
  - Multiple intervals (sequential or non-sequential)
  - Selected time periods.

- Present the results.

  Your program can do one or more of the following actions

  - Save the results in a disk file or data base
  - Print the results in tables and graphs
  - Display the results
  - Present just the results
  - Present both the results and the values used to obtain the results.

  The results you choose to obtain can vary with your reasons for evaluating bridge traffic, such as

  - Isolating a problem
  - Tracking peaks and trends
  - Balancing traffic flow and workload
  - Anticipating future growth and change.

Bridge Performance Considerations

The following considerations may be useful in managing the traffic flowing through a bridge.

Bridge performance is a part of total network performance. The Bridge Program performance counters and statistics are intended to provide part of the information you need to diagnose and correct problems reported by users of the network.

Diagnosis

One difficulty in problem diagnosis is that, from the user's perspective, different problems appear to have the same symptom. For example, slow response time can result from:

- File server overload (too many concurrent users)
- Data-base fragmentation from modifications
- Heavy network traffic
- Heavy bridge traffic.

Diagnosis will depend upon your knowledge of network operation in addition to the available status, error information, and bridge traffic measurements.

LAN Segment Utilization

For an IBM Token-Ring Network, the recommendation in the *IBM Token-Ring Network Introduction and Planning Guide* concerning ring utilization can also help in regulating bridge utilization. If ring utilization is planned to average 30 % of capacity, a bridge could handle the flow even if all of the ring traffic were sent through the bridge. On a 4 Mbps ring only, the IBM Token-Ring Network Trace and Performance Program can be used to measure source and destination ring utilization.

For an IBM PC Network, the Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual provide

a function to measure the percent of utilization of a bus. Once started, the Network Utilization function runs continuously until you stop it, and displays:

- Average use
- Present use
- Highest use
- Lowest use.

The percentages are updated on the panel as the utilization of the bus changes.

Frames Not Forwarded

The **Bridge Performance Threshold** configuration parameter of the Bridge Program indicates the maximum acceptable number of frames not forwarded per 10 000 frames received at the bridge. One or more occurrences of the threshold being exceeded can result in a problem detectable by network users. The performance statistics collected by the Bridge Program show the number of times the threshold is exceeded in each 5-minute interval of a 24-hour period.

If the occurrences of the threshold being exceeded are frequent, you might consider:

- Increasing the threshold parameter value in the Bridge Program configuration file, if the occurrences do not seem to be connected with or causing user problems.
- Investigating further if the occurrences correspond to particular periods of the day and to user complaints.

The values of the Bridge Program performance counters E, F, and G (see Table C-2 on page C-24) indicate possible causes of the threshold being exceeded. A high value in:

- Counter E indicates that the target (destination) LAN segment is malfunctioning and is unable to receive frames from the bridge.

  The count also includes

  - Frames discarded by the bridge that were waiting at the bridge when the destination ring began beaconing, if the destination is a token-ring network segment

- Frames that the bridge discarded after experiencing 16 consecutive collisions in attempting to forward the frames to the target bus, if the destination is a PC network segment.

There should be other status and error indications to isolate the LAN segment problem (from the Bridge Program, the IBM Token-Ring Network Trace and Performance Program on 4 Mbps LAN segments, the IBM LAN Manager, or an application program on the malfunctioning LAN segment).

- Counter F has two possible causes
  - The bridge is overloaded. A symptom will be a high percentage of frames not processed in both flow directions through the bridge.

    This condition can be caused by frames arriving at the bridge from the source LAN segment faster than the Bridge Program can process them.

    This condition can also result from using a slower bridge computer between two fast LAN segments (for example a PS/2 Model 50 between two 16 Mbps rings).

  - The destination (target) LAN segment is too busy to accept frames as fast as the bridge is forwarding them.

    This condition could happen when a source user LAN segment is sending frames to a busy backbone LAN segment, or when a fast source LAN segment (a 16 Mbps ring, for example) is sending frames to a slower destination LAN segment (a 2 Mbps bus, for example).

Possible solutions for these conditions include:

- For a bridge connecting two IBM PC Network segments
  1. Reevaluate utilization of LAN segments.
  2. Physically separate one or both LAN segments, and place bridges between suitable LAN segments.

3. Place some stations on a different frequency pair. Place bridges as needed between segments and frequency pairs, but do not create parallel bridges between PC Network segments using the same frequency pair.
4. Install a bridge computer with a faster processor.

   For example, upgrade the bridge computer from a PS/2 Model 50 to a PS/2 Model 80.

- For a bridge connecting an IBM Token-Ring Network segment and an IBM PC Network segment

  1. Reevaluate utilization of LAN segments.
  2. Rearrange applications so that those that send and receive large amounts of data are all connected to the IBM Token-Ring Network segment.
  3. Physically separate one or both LAN segments, and place bridges between selected LAN segments.
  4. Separate one or both LAN segments by frequency pair. Place some stations on a different frequency pair. Place bridges as needed between selected LAN segments and frequency pairs, but do not create parallel bridges between IBM PC Network segments using the same frequency pair.
  5. Install a bridge computer with a faster processor.

     For example, upgrade the bridge computer from a PS/2 Model 50 to a PS/2 Model 80.

- For a bridge connecting two IBM Token-Ring Network segments

  1. Reevaluate source and destination LAN segment utilization.
  2. Rearrange applications to put those that exchange large amounts of data on the same LAN segment.