Avaya Least Cost Routing (LCR) Feature Documentation on the MPS Platform

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Chapter 1: Preface

Scope

This manual provides all pertinent information for using, administrating, and application programming for the Least Cost Routing (LCR) feature in both MPS 2.1 and MPS 3.0 environments.

Important:

All references to MPS 3.0 in this document (such as document titles, software versions, and illustrations) apply to all releases of MPS 3.X.

Important:

The minimum software release for the Least Cost Routing feature is:

- Patchbundle 9 or higher for MPS 2.1
- Patchbundle 3 or higher for MPS 3.0

If you are working in an MPS 3.0 environment, refer to the MPS 3.0 suite of documents. If you are working in an MPS 2.1 environment, refer to the MPS 2.1 suite of documents.

To use the LCR feature, it must first be installed on your system. To install LCR, refer to Installing MPS Software on the Windows Platform or Installing MPS Software on the Solaris Platform.

Note:

The LCR feature is supported for MPS 2.1 after patchbundle 9 but is not enabled during system installation. To enable the LCR feature, install patchbundle 9 to get the LCR configuration files, then run the lcrinstall script located in the $MPSHOME/bin directory. Also, before uninstalling patchbundle 9, run the lcrremove script located in the $MPSHOME/bin directory. If it is an N+1 system and the LCR daemon is configured on a primary node, you must run the lcrinstall script on the secondary node and add the secondary node name to the $MPSHOME/common/etc/nameservers.cfg file on each primary node.

Intended Audience

This manual is directed at system operators and application developers responsible for administrating and implementing call applications that will use LCR. This guide assumes that the user has completed an on-site system familiarization training program conducted as part of the initial system installation. In addition, they should be familiar with other site-specific operating procedures relating to the Avaya Media Processing Server (MPS) Series Platform and with any other equipment to which the system may be connected. Basic knowledge of the Solaris and/or Windows operating systems is also assumed.

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This manual uses many standard terms relating to computer systems, software application functions, and the Internet. However, it contains some terminology that can be explained only in the context of the MPS Series. Refer to the Glossary of Avaya Media Processing Server Series Terminology for definitions of MPS Series specific terms.

Read this manual from start to finish at least once. When you are familiar with the document, you can use the Table of Contents to locate topics of interest for reference and review.

If you are reading this document online, use the cross-reference links (shown in blue) to quickly locate related topics. Position your cursor over the cross-reference link and click once. Click any point in a Table of Contents entry to move to that topic. Click the page number of any Index entry to access that topic page.

Familiarize yourself with various specialized textual references within the manual, see Conventions Used in This Manual on page 10.

Note:

Periphonics is now part of Avaya. The name Periphonics, and variations thereof, appear in this manual only in reference to a product (for example, the PERImps package, the perirev command, and so on).

Organization of This Manual

This manual is organized into separate chapters that explain the various aspects of the LCR feature. The following summarizes the contents of each chapter.

- Chapter 1 - Description of Least Cost Routing (LCR) Contains a general description of LCR and the elements that comprise it.
- Chapter 2 - LCR Administration Contains detailed descriptions of the configuration tables and procedures for maintaining them.
- Chapter 3 - LCR Application Programming Contains information for application developers to build LCR into call applications.
- Chapter 4 - Selection Quotas and Statistics Contains information on how LCR selects quota based routes and maintains quota statistics.
- Chapter 5 - Route Preferences, Rate Adders and Multipliers Contains information on how LCR selects user preference based routes.

Conventions Used in This Manual

This manual uses different fonts and symbols to differentiate between document elements and types of information. These conventions are summarized in the following table.

Table 1: Conventions Used in This Manual

Notation	Description
Normal text	Normal text font is used for most of the document.
important term	The Italics font introduces new terms, highlights meaningful words or phrases, or distinguishes specific terms from nearby text.
system command	This font indicates a system command or its arguments. Enter such keywords exactly as shown (that is, do not fill in your own values).
command, condition and alarm	Command, Condition and Alarm references appear on the screen in magenta text and reference the Command Reference Manual, the MPS Developer User Guide, or the Alarm Reference Manual, respectively. Refer to these documents for detailed information about Commands, Conditions, and Alarms.
file name / directory	This font highlights the names of disk directories, files, and extensions for file names. It also shows what is displayed on a text-based screen (for example, to show the contents of a file.)

Notation	Description
on-screen field	This font indicates field labels, on-screen menu buttons, and action buttons.
<KEY NAME>	A term that appears within angled brackets denotes a terminal keyboard key, a telephone keypad button, or a system mouse button.
Book Reference	This font indicates the names of other publications referenced within the document.
cross-reference	A cross-reference appears on the screen in blue. Click the cross-reference to access the referenced location. A cross-reference that refers to a section name accesses the first page of that section.
	The Note icon identifies notes, important facts, and other keys to understanding.
	The Caution icon identifies procedures or events that require special attention. The icon indicates a warning that serious problems may arise if the stated instructions are not followed implicitly.
	The flying Window icon identifies procedures or events that apply to the Windows operating system only. [1]
	The Solaris icon identifies procedures or events that apply to the Solaris operating system only. [2]

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Solaris and Windows Conventions

This manual depicts examples (command line syntax, configuration files, and screen shots) in Solaris format. Windows-specific commands, procedures, or screen shots are shown when required. The following table lists general operating system conventions used with either the Solaris or Windows operating system.

	Solaris	Windows
Environment	$MPSHOME	%MPSHOME%
Paths	$MPSHOME/common/etc	%MPSHOME%\common\etc
Command	<command> &	start /b <command>

Two-Button (Windows) vs. Three-Button (Solaris) Mouse

<SELECT>	Left button
<ADJUST>	Left and Right together
<MENU>	Right button



<SELECT>	Left button
<ADJUST>	Middle button
<MENU>	Right button



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Product Nomenclature Changes

The following product names changed with the latest Avaya MPS software release. All other references to the former name with respect to environment variables, directory paths, software package names, and so on remain the same. For example, the PeriProducer product is now referred to as the Media Processing Server Developer; however, its package name remains PERIppro.

Former Product	Name New Product Name
IVR Software	Media Processing Server Release x.x
PeriProducer	Media Processing Server Developer
PeriView	Media Processing Server Manager
PeriStudio	Media Processing Server Studio
PeriReporter	Media Processing Server Reporter
PeriSQL	Media Processing Server RDB
PeriVXML	Media Processing Server VXML Browser
CTI Suite	Communications Control Toolkit (CCT)
Open Signal Computing and Analysis Resource (OSCAR)	Speech Server

Chapter 2: Description of Least Cost Routing (LCR)

This chapter covers:

1. Description of LCR
2. LCR Configuration Table Structure
3. System Operation
4. LCR Functions and Features

Description of Least Cost Routing (LCR)

The Least Cost Routing (LCR) feature is an optional standalone service that provides outbound call routing capabilities based on cost and user preferences. LCR is generally used on Avaya Media Processing Server (MPS) Series system with the Avaya Calling Card Platform (PCCP) application, but can operate in conjunction with any outbound call application. For information on the MPS, refer to the MPS 500 Overview Manual. For information on the PCCP, refer to the Avaya Calling Card Platform Operator's Guide. To use the LCR feature, it must be installed on your system. To install LCR, refer to Installing MPS Software on the Windows Platform or Installing MPS Software on the Solaris Platform. Also, refer to the Note under the heading Scope on page 7.

When a call is to be routed to an outbound line, the application queries a database of long distance and local carriers. The returned rates determine the least cost route based on various criteria (for example, time of day, day of week, and so on). Carrier and route preferences and preference weights can be assigned by the database or the call application The LCR database is maintained using a standard spreadsheet application and text files.

LCR includes an automated method to configure the various business rules and rate tables. The rules configuration and rate tables are stored within the LCR memory and can be manipulated using standard worksheet programs (for example, Microsoft Excel). The options can be manipulated by creating the appropriate worksheet tables and saving the worksheets in standard comma separated variable (CSV) data format. This data format is accepted by LCR. The section LCR Administration on page 31 describes the table creation and maintenance process in detail. A basic understanding of Excel and the skills necessary to create, edit, and save spreadsheets is a prerequisite to rate table generation and maintenance.

The functions supported by the LCR include all features and facilities necessary to create and administer a least cost routing function that permits:

- Routing that is based upon call destination, call origination, carrier volume preferences, time of day, day of week, network load and user supplied data.
- Virtually unlimited flexibility in routing criteria.
- Real-time system monitoring and event reporting mechanism.
- Statistics output which provides individual carrier reports.
- Fault tolerant configuration option for telephony routes.

Control of LCR is accomplished by the Media Processing Server (MPS) Developer application. The PERItlkt contains tools for building LCR functions into call processing applications. See LCR Application Programming on page 43.

LCR maintains statistics on route selection and usage which are output automatically to daily log files in CSV format. These statistics data may then be viewed and manipulated using standard worksheet programs. See Selection Quotas and Statistics on page 61.

LCR Configuration Table Structure

LCR maintains two separate data domains. One domain contains the comma delimited text (.csv) files that can be created, edited, and printed using Excel or another suitable spreadsheet application. The second data domain, which is derived from the content of the .csv files, is the internal LCR runtime database. In order to maintain security and prevent interruptions of runtime LCR services, this domain is not directly user accessible. Utilities are provided to generate reports derived form the internal database and to import the content of the .csv configuration files. The following diagram shows the relationship between the configuration tables.

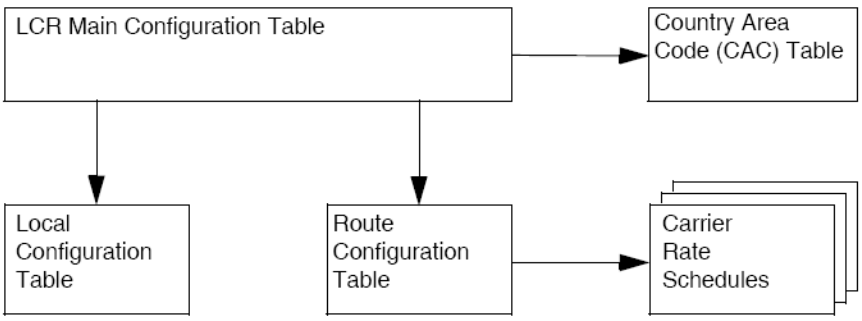


Figure 1: LCR Configuration Tables

LCR Configuration Table Content

- LCR Main - This is the master configuration table. It provides pointers to the remaining configuration tables.
- Country/Area Code (CAC) Table - Contains a master list of valid country codes that are accessible by any carrier. At run time, this table will be imported into the internal database and linked to the individual carriers for each destination.
- Local Configuration Table - Contains site-specific (system name, country/area code, and national/international prefix code) information required to dial out.
- Route Configuration Table - Associates the MPS internal pool names with Carrier Identification Code (CIC) and carrier rate information.
- Carrier Rate Table - Contains carrier specific rate schedule information. The system administrator will create one for each carrier.

User configuration of LCR services consists of creating and maintaining the following configuration files:

- Local Configuration Table (local_config_file.csv)
- Route Configuration Table (route_config_file.csv)
- Carrier Rate Table (rate_sched_<CIC>.csv)

An Excel template (.xls) is provided for the initial creation of each .csv LCR configuration file. (See LCR Administration on page 31.)

System Operation

There is one LCR daemon running in every MPS cluster, an MPS cluster is one or more MPS systems. When an application makes an LCR Request, the MediaXact (MX) library locates the machine where the LCR daemon is running and establishes a connection with LCR. The MX library is responsible for the following actions:

- Providing the interface between the call applications and the LCR engine.
- Hosting the least cost routing engine.
- Receiving and interpreting route requests and updates.
- Formatting and sending route list response messages.
- Generating system alarms and LCR log messages.
- Getting the updated statistics for the selected route from LCR daemon.

The intelligence of LCR resides in the least cost routing engine. This is the part of LCR that gets the route request with the call destination number from a call application, such as PCCP,

and implements the selection strategies used to determine the least cost route list. The selection strategies are based on the business rules and rate schedules defined by the application service provider in LCR configuration tables. One or more of the following strategies may be used:

- Providing a list of available routes to support overflow and redundancy features.
- Analysis of the destination number in order to either select or disallow routes based on destination country, city or area code, local exchange, subscriber number, or special service code.
- Comparison of carrier rate schedules based on destination, time of day and day of week.
- Traffic volume quota requirements for each route based on number of calls, duration of calls, or cost of calls.
- Load balancing across routes.
- Dynamic preference for specific route or type of route based on incoming trunk group, caller identification, or service requested.
- Dynamic modification of rate schedules, traffic volume quotas, or route preferences.

The routing configuration and rate data from the LCR configuration tables are stored in internal memory to provide a flexible and efficient way of using the data to satisfy route requests without effecting application performance. These data include:

- A country and area code table containing a master list of valid country codes and area codes that may be accessible through one or more of the carriers.
- A local configuration table containing site-specific information required by LCR.
- A route configuration table associating the MPS internal pool names with the Carrier Identification Code (CIC), carrier rate information, and traffic volume quotas.
- Carrier rate tables containing carrier specific rate schedule information.

LCR Functions and Features

Functional Overview

Basic Functions

The Least Cost Routing (LCR) service is used in systems which have the capability of placing outbound calls to more than one telephony service provider, typically long distance carriers.

LCR selects the best route available among the various carriers. The best route determination will use rate schedules based on full destination number, time of day, day of week, and other special rate features as specified by your application requirements.

Carrier quota requirements (traffic volume) may modify the route determination. Alternative route choices are also determined. If the first choice is unavailable, the application can try the next route in the priority list.

The destination number parser supports the specific requirements of the Avaya Calling Card Platform (PCCP).

Application Data Requirements

The factors governing the route determination are maintained locally by LCR. For each route request the application needs to provide only the destination number. LCR's response to the application contains the routes selected and the exact dialable number to be passed to the selected telephony device. In addition, the route response contains supplementary information which the application needs to properly place and log the call. At the end of the outbound call the application updates LCR with the actual selected route and duration of the call. (See LCR Process Flow on page 20.)

Trunk Selection

The LCR database contains information about carriers, their rate schedules, quotas, and preferences. The LCR responds to the application's route request by returning a list of names of the telephony device pools associated with the eligible carriers. This route list is not a final trunk selection, but an ordered list of eligible trunk pools. The actual outbound trunk will be selected by the MPS Pool Manager at the time the application requests a call to one of the routes listed by LCR. If an outbound call fails, it is the application's responsibility to try again with another route from the original list supplied by LCR.

Internal Data Base

For each service carrier, LCR maintains a rate schedule (rate_sched_<CIC>.csv) based on call destination and rate period including time of day and day of week. The LCR also maintains other parameters such as route quotas and dialable prefixes. This database is protected by standard access security procedures (i.e., file permissions). All elements of the LCR database can be reviewed and updated dynamically as rate schedules or other parameters change.

Statistics Reports

LCR maintains route request and selection statistics. Detailed LCR event monitoring (logging) is available. The LCR statistics report mechanism includes automatically writing to a file the route selection and call volume statistics for each route. The LCR reports include an analysis of cost savings achieved by LCR.

Alarm and Diagnostic Support

LCR generates system alarms when an error is detected either in the route request data, in internal database consistency, or in the software state.

LCR Process Flow

The following illustration shows how a typical application uses call routing, what occurs at each step in the process, and the files that are accessed in the configuration data base.

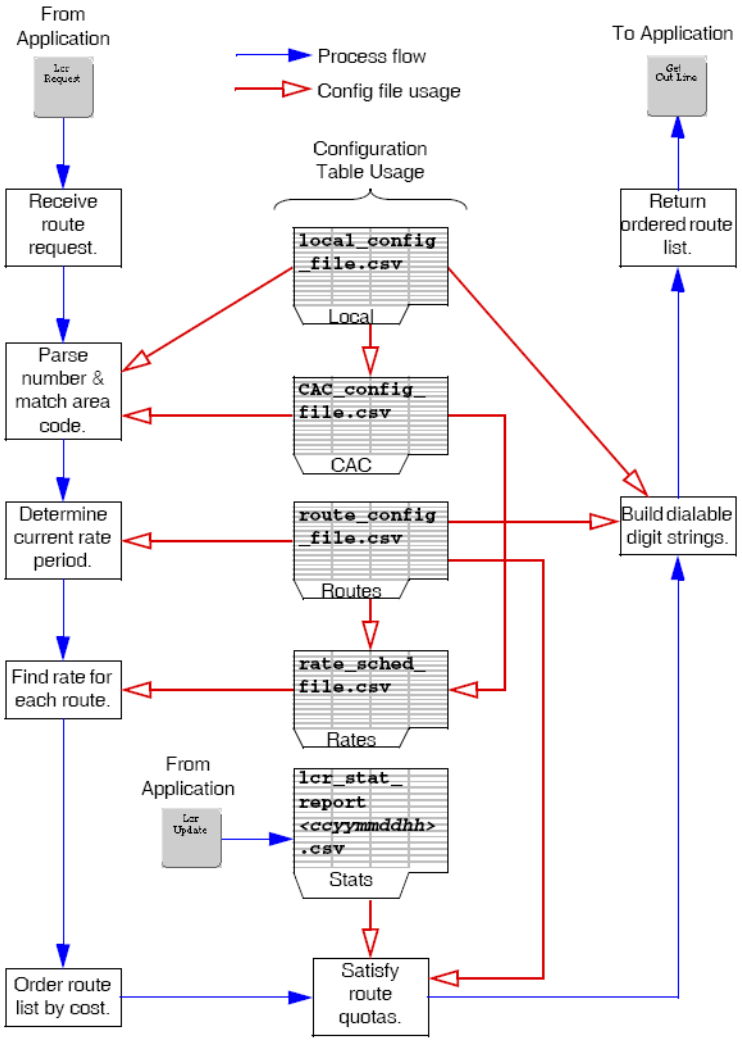


Figure 2: LCR Process Flow

Destination Number

Canonical Number Elements

LCR accepts the full destination number of a desired phone call. To do this, the internal application data folder representation of that number is based on the elements of the canonical phone number format. This ITU standard format is used to identify the various elements of any

destination number as a character string, allowing optional elements of arbitrary lengths. As a formal character string, the canonical format is defined by the ITU to have the following syntax:

```
<[DPR1, DPR2,…, DPRn] +CC (NPA) SN *SA xEXT>Name
```

Note:
International Telecommunications Union (ITU), formerly the Consultative Committee for International Telephone and Telegraph (CCITT). Standard canonical notation is described under Canonical Encoding Rules (CER) of ITU Technical Recommendation X.690.

The following elements are defined in the canonical format.

- DPR1, DPR2, …, DPRn — Dial Plan Rules These rules are character strings that define the meaning of the other elements.
- CC — Country Code This is an alphabetic code designating a country or common plan region such as North America.
- NPA — Number Plan Area This is an alphabetic code which may identify a geographical area (area code) or city (city code) within the country code domain. This code may also identify a special service independent of geographical area.
- SN — Subscriber Number This is a character string that is the address of a logical device within a number plan area, also known as the directory number or local number. In North American NPA it is composed of an Office Code or Exchange identifier (NXX or NNX) followed by a four-digit string (SN=NXX-XXXX).
- SA — Sub-Address A character string that identifies devices that share a subscriber number with other devices through bridging.
- EXT — Extension number A character string that identifies multiple phones serviced by a single subscriber number.
- Name This is the name associated with the device addressed by the phone number

The special character sets "<...>...", “[…, …]”, “+…”, “(…)”, “*…”, and “x…”, delimit the various optional number elements. This format is intended to be user friendly and some of the identifying characters are in common use such as “+” for country code, “()” for area code, “x” for extension number.

Available Destination Elements

The canonical format is useful when destination numbers are obtained from an arbitrary database (either manual input or electronic), or passed between telephony devices that are “black boxes” to each other. However LCR does not need to use this character string internally, only the relevant data elements.

In a typical call application, it is not expected that the destination phone number would be entered in the canonical format. In general the number is a raw, unpunctuated sequence of digits, input by the caller, that will be parsed and interpreted (for example, 16314689000). The

country code and area code for international and long distances calls, respectively, are recognized. This parsing may done by the call application, LCR, or partly by both.

The LCR selection engine works with the information that the call application provides in its route request. Although the information about the call destination number is presented in a format consistent with the elements of canonical numbers, that does not imply that the call application can supply those elements in canonical form. The Dial Plan Rules (DPRn) element is used by an application to tell LCR how to interpret the available destination number information.

The LCR phone number parser supports the PCCP application. The PCCP application has the destination number in the form of Country Code (CC) and either national number (National Prefix, plus NPA, plus SN) or local number (SN). LCR assumes that the national number conforms to the public dial plan for the destination country.

Important:

Any translation of the digit string input by the caller based on received digits or incoming route must be done by the application. This includes, for example, speed dialing which is supported by the PCCP application. The translated destination number is passed to LCR for routing.

Dial Plan Rule

The dial plan rule strings, specified by the call application in its route request, define how the LCR number parser will function. The PCCP application will use the Dial Plan Rule “PCCP1” to inform LCR that the following rules apply.

Access Code and International Prefix

The PCCP application strips any access code or International Prefix before presenting the number to LCR. The LCR parser does not search for access codes.

Country Code

The PCCP application determines the destination Country Code and supplies this to LCR as a canonical element, separate from the rest of the destination number.

Area Code

The PCCP application does not separate the Area Code (NPA) from the subscriber number. When necessary to obtain a destination match, the LCR parser searches for an Area Code within the destination number provided by PCCP.

Office Code

For certain routes, such as those using Specialized Common Carriers (SCCs), Tielines, or Foreign Exchange (FX) trunks, it may be necessary to parse the destination number to extract the local Office Code. The PCCP version of LCR does not search specifically for an Office Code. This capability can be added to the parser at a later date.

Mobile and Special Service Codes

Mobile and special service codes are treated by LCR as Area Codes.

Country and Area Codes

LCR maintains a master call destination table called the Country/Area Code (CAC) Table. (See Country/Area Code (CAC) Table on page 34.) The CAC table contains a list of all current Country Codes. Some Country Code entries are broken down further into Area or City Codes, corresponding to destinations specifically included in carrier rate schedules. Different versions of the CAC Table may be used depending on the set of destination areas required.

Each call destination listed in a rate schedule is linked to one or more entries in the CAC Table, which represents a superset over all the rate schedules used by LCR. When matching a requested call destination, LCR needs to search only the CAC Table, not all of the rate schedules. This provides flexibility for the rate schedules as well as efficiency at run time.

LCR uses the CAC Table to help determine if the destination number needs to be parsed further. LCR will parse the destination number only if it needs to search for specific area, city, mobile, or special service codes (that is, only if the CAC Table contains multiple entries for the destination Country Code).

LCR also uses information stored in the LCR Local Configuration Table to help determine if the requested call destination is local or should contain an area code. This information includes any National Prefix required for national calls and the maximum length of local calls where applicable. (See Local Configuration Table on page 35.)

Dialable Number

LCR supplies the dialable digit string for an outbound call. This string is constructed from prefix codes required by the carrier or local phone equipment, any applicable country, city, and area codes, and the subscriber number. The dialable digit string may include the following elements.

Dialable Prefix

Some outbound call routes require an access code (such as “9” for a local PBX). This access code is stored as the route's Dialable Prefix in the LCR Route Configuration Table. (See Route Configuration Table on page 36.)

International Prefix

If the destination country code is not the same as the service site’s, the call is international. The appropriate International Prefix is taken from the LCR Local Configuration Table. (See Local Configuration Table on page 35.)

Country Code

For international calls, the destination Country Code will follow the International Prefix. (This Country Code is provided by the PCCP application.)

National Prefix

If the destination country code is the same as the service site's, the call is national or local. To avoid ambiguity between national and local calls, any required National Prefix should be included in the destination number provided by the PCCP application.

Area/City Code

If the call requires an area, city, mobile, or special service codes, it must be included in the destination number provided by the PCCP application.

Subscriber Number

The Subscriber Number is included in the dialable number just as it was received from the application.

Rate Schedules

Outbound Call Cost

The LCR algorithm calculates the cost of using an outbound route based on the latest information provided by the carrier. This is not to be confused with the cost charged to the end user being billed for the call, which is based on a different rate schedule and is calculated by the PCCP application.

The carrier rate data are maintained by the Application Service Provider and stored in the LCR Rate Schedule Tables. (See Rate Schedule Table on page 39.) One Rate Schedule Table is maintained for each route specified in the LCR Route Configuration Table. (See Route Configuration Table on page 36.)

Rate Schedule Organization

Destination Country

Each rate schedule is organized by the destination Country Code (CC) and includes all country codes serviced by the carrier.

Area Code

For each country, the rate schedule is organized by the Number Plan Area (NPA) code and includes specific entries for those area codes which have their own associated rates. One entry with a blank area code field represents all other area codes within the destination country.

Mobile or other Special Code

The list of area codes may include mobile or other special codes which serve the same routing function and have their own associated rates.

Rate Periods

The rate schedules are divided into rate periods. These rate periods are defined in the LCR Route Configuration Table and may be different for each route. (See Route Configuration Table on page 36.) The rate schedules may be divided into weekday and weekend rates, daytime, evening, and night rates, peak and off-peak periods, or any other daily range of times and weekly range of days.

Area Pattern Code

Each entry in the LCR rate schedules contains an Area Pattern Code (APC) which further controls the search for eligible routes for the requested call. (See Rate Schedule Table on page 39.) For a given route, any particular destination may be independently disabled and reenabled.

Cost-Based Routing List

Route Eligibility

LCR first finds a call destination in the CAC Table, then consults the associated rate schedule entries to determine which routes are eligible to service that destination. For a route to be eligible, it must have a rate schedule record for that destination (pointed to by the CAC Table). That record must contain an enabling Area Pattern Code, and the current rate period field in that record must contain a valid rate value. (See Rate Schedule Table on page 39.)

Base Cost

After determining the eligible routes, LCR obtains the call cost for each route serving the destination. The base cost for each route is determined from the rate schedule entry for the current time period defined for that route.

Equal Costs

After determining the adjusted cost for each eligible route, LCR arranges the list of routes according to this cost. When two or more routes have the same cost, LCR will select their list order randomly. When arranging multiple routes in a list over many calls, this method is more efficient and effective than other techniques such as round robin or fixed route lists.

Cost-Based List

The route list, based solely on cost, is reordered to take into account traffic quotas that need to be satisfied.

Traffic Volume Quotas

Quota Dependencies

LCR can target a minimum level of traffic volume for each carrier as specified by the application service provider. This traffic volume may consist of one of the following:

- Total Number of Calls — LCR keeps track of the total number of calls placed to each carrier.
- Total Duration of the Calls — After an outbound call has terminated, the call application updates LCR with the length of the call. LCR keeps track of the total length of all calls placed to each carrier.
- Total Cost of the Calls — LCR multiples the length of the call by the rate for the call, and keeps track of the total cost of all calls placed to each carrier.

Quota Periods

This volume will need to be achieved for specified periods. This period will be specified as part of the LCR database parameters.

Quota Attainment

LCR maintains traffic volume statistics for each carrier. For each route request, the LCR engine retrieves those statistics and compares them against the quota requirements for each carrier on the cost-based route list.

Carriers that have quota remaining to be satisfied will be given priority over carriers with no remaining quota. The route list will be reordered accordingly, based on rules implemented in the LCR engine algorithm.

The traffic volume statistics can be ignored by the LCR engine when all quotas on the route list have been satisfied. However the statistics will continue to be updated by LCR for report purposes.

Note:
See Selection Quotas and Statistics on page 61 for a full discussion of traffic volume quotas.

Route Request and Response

Route Selection List

A call application such as PCCP, makes a Route Request by sending the requested destination number to LCR, along with any route preference specific to this request.

The route list returned by LCR (Route Response) takes into account destination service, published cost, and quotas. For each route, the LCR engine adds the dialable number, the cost as determined for the cost-based route list, the carrier name, and the service type. This final route selection list is then returned to the application.

The routes will be in the form of telephony device pools, connected to the various available carriers. The application will use this list to place the outbound call.

Overflow and Redundancy

- Overflow Feature — The routes in the returned list will generally use different carriers, arranged in order of carrier priority. If the call cannot be placed with the priority carrier, then a next choice must be tried.
- Redundancy Feature — There may be more than one device pool per carrier. This allows the same carrier to be serviced by different device pools in different parts of the MPS system.

See LCR Application Programming on page 43 for full details on application route request and LCR response.

Route Selection Statistics

See for a full discussion of route selection statistics. See for full details on route updates by the application.

Route Selected

After each outbound call has terminated, the call application notifies LCR which route was actually used for the call (Route Update). This allows LCR to maintain its carrier usage statistics and satisfy traffic volume requirements.

Length of Call

Some carrier quota requirements may involve the total call time. The Route Update sent by the application to LCR contains the call duration, so the total call time statistics can be maintained.

Statistics Reports

LCR regularly reports all route selection and traffic volume statistics by automatically generating statistics log files. These reports also include diagnostic information and some cost savings analysis.

See Selection Quotas and Statistics on page 61for a full discussion of route selection statistics. See Statistics Update Mechanism on page 74 for full details on route updates by the application.

Chapter 3: LCR Administration

This chapter covers:

1. Creating Initial Templates
2. Editing and Maintaining Configuration Tables
3. Internal Database Updates

LCR Administration

Avaya provides sample files (*.csv) for creating the individual configuration tables. They are installed with the MPS patch installation package in $MPSHOME/common/etc/lcrd.

Important:

The directory name $MPSHOME is the environment variable name for the MPS home directory. By default, it is defined as /opt/vps for the Solaris Platform and DriveName: \Program Files\Avaya for the Windows Platform.

Initial Configuration Template Files

Since the LCR configuration files are in Microsoft Excel file format, they cannot be directly maintained from the Media Processing Server (MPS) Manager workstation. The best situation is a PC or Windows workstation with network access to the system, running Microsoft Excel 97 or higher. If a Windows platform does not have network access to the system, the files need to be transferred using a floppy diskette each time they are modified.

The initial templates are the following seven *.csv files which reside in the $MPSHOME/common/etc/lcrd directory.

```
lcrd_config_file.csv
CAC_config_file.csv
local_config_file.csv
route_config_file.csv
CIC1_rate_sched.csv
CIC2_rate_sched.csv
CIC3_rate_sched.csv
```

These *.csv files are used to create the configuration tables that will be used by the LCR database. An offline backup of these files should be kept for future use. These files should also

be copied or moved to a maintenance directory on the PC or NT workstation where they can be developed and updated as needed. They become active in the LCR database only when moved to $MPSHOME/common/etc/lcrd and an LCR update utility is executed. (See LCR Internal Database Updates on page 41.)

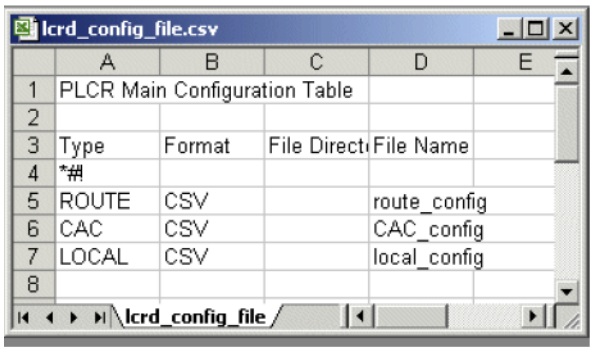
Some of the template files are mostly complete and will require little or no modification except for specific site/application requirements, custom criteria, or until the information becomes outdated (for example, new area codes). The lcrd_config_file.csv file should never be modified, since it calls upon the CAC_config_file.csv, local_config_file.csv, and route_config_file.csv files. The following sections describe how to edit and maintain these files.

Editing and Maintaining the Configuration Tables

There are certain features that are common to the data contained in all the configuration tables. The following rules and guidelines must be considered whenever editing the files:

- For all LCR configuration tables and rate schedules, the data portion of the table starts with the first record (row) after the LCR Logo string “*#!”. Everything preceding the LCR Logo string will be ignored by the LCR software.
- Within the data portion of the tables, commas must not be used, except in the last notes field. LCR treats all commas after the LCR Logo in the *.csv files as field delimiters, except in the last expected field in each row.
- There are some important format constraints to note if using Microsoft Excel to generate the *.csv files. All entries in LCR configuration files and rate schedules must have data cells formatted as category “text”. In the Format Cells dialog box (Format > Cells), select the Number tab and choose Category: Text. This allows leading zeroes to be retained in area codes and dial prefixes.

Main Configuration Table

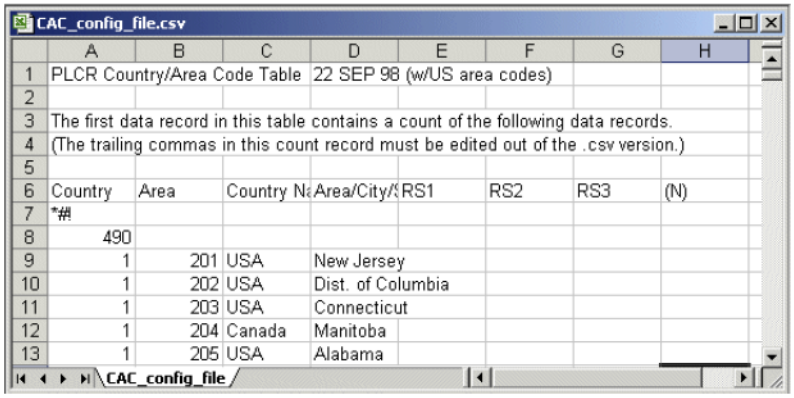


The LCR main configuration table controls the initialization format of LCR, and directs the LCR data base to the other configuration tables. For the current release of LCR, Do not modify this table.

Table 2: Main Configuration Table Data (lcrd_config_file.csv)

Records/Fields	Description
File Type	Fixed text identifying the configuration files. The current File Types are “ROUTE”, “CAC”, and “LOCAL”, and must be listed in that order.
Format	Fixed text identifying the file type. The only configuration format currently supported is “CSV” for *.csv files.
File Directory	Not used in the current release of LCR, and shall be left blank. LCR uses the environment variable PLCR_CONFIG_DIR to locate the configuration files. (See LCR Internal Database Updates on page 41.)
File Name	Contains the name of the configuration file. The current LCR Release will accept only the standard file names “route_config_file”, “CAC_config_file”, and “local_config_file”.

Country/Area Code (CAC) Table



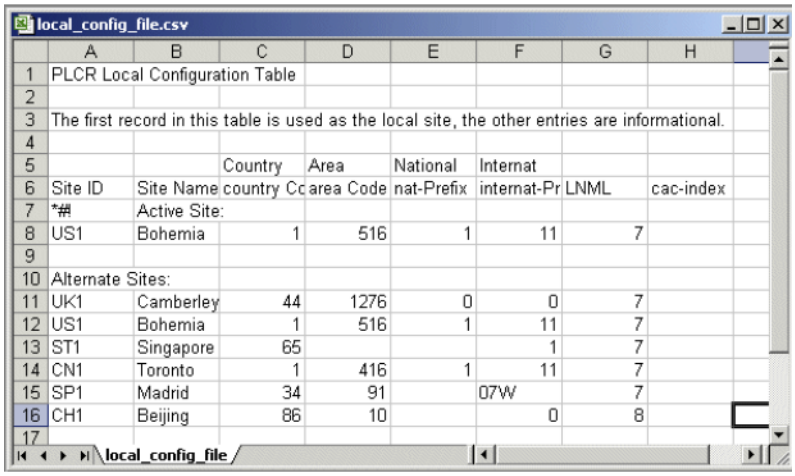
The country/area code (CAC) table contains a master list of all the telephone number destinations (countries, areas, cities) known to LCR.

Table 3: Country/Area Code (CAC) Data (CAC_config_file.csv)

Records/Fields	Description
Data record count	The first data record (the row immediately following the LCR Logo string “*#!”) must contain the number of data records in the remainder of the table.
Country Code	Contains the standard country code defined by the international public telephone dialing plan. The CAC table is intended to include a complete list of country codes.
Area	Contains the area code, city code, or STD code defined by the public telephone dialing plan for that country. For most countries there will be an entry in the CAC table which has a blank Area Code field. This represents “none” or “other” and covers all the dialing areas not specifically listed in the rate schedules. The CAC table should contain a superset of the areas listed in all the rate schedules but is not a complete list of local area/city/STD codes.
Country Name and Area Name	May contain any descriptive text but no commas. The LCR software reads these fields but does not currently use them.
RSn	The RS1, RS2, and RS3 fields are reserved for indices into the various Carrier Rate Tables (rate schedules). These values will be generated automatically by the LCR software. The number of RSn fields must match the number of routes listed in the route configuration table (route_config_file.csv). In the CAC configuration file these fields should contain blanks.

Records/Fields	Description
(N) (notes)	Provided for reference purposes, it may contain any text.

Local Configuration Table


local_config_file.csv

	A	B	C	D	E	F	G	H
1	PLCR Local Configuration Table							
2								
3	The first record in this table is used as the local site, the other entries are informational.							
4								
5			Country	Area	National	Internat		
6	Site ID	Site Name	country Cc	area Code	nat-Prefix	internat-Pr	LNML	cac-index
7	*#	Active Site:						
8	US1	Bohemia	1	516	1	11	7	
9								
10	Alternate Sites:							
11	UK1	Camberley	44	1276	0	0	7	
12	US1	Bohemia	1	516	1	11	7	
13	ST1	Singapore	65			1	7	
14	CN1	Toronto	1	416	1	11	7	
15	SP1	Madrid	34	91		07W	7	
16	CH1	Beijing	86	10		0	8	
17								

local_config_file

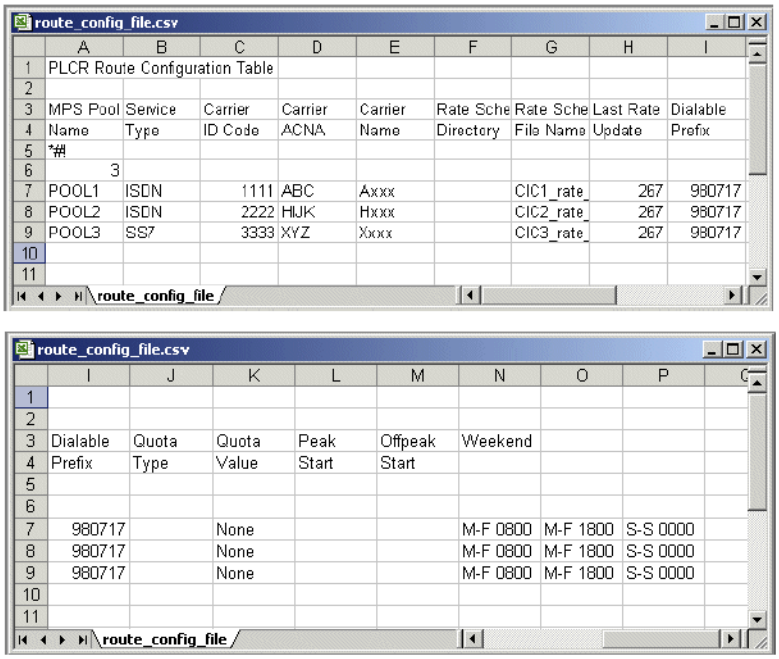
The local configuration table contains parameters required for the local system site. Any number of alternate local sites may be listed for informational purposes.

Table 4: Local Configuration Table Data (local_config_file.csv)

Records/Fields	Description
Local site	The LCR software will read only the first data record (the row immediately following the LCR Logo string “*#!”) as the active local site and ignore everything after that record. This feature is useful for testing and site maintenance purposes. Information on alternate local sites may be stored in this table without affecting the active site data.
Site ID and Site Name	May contain any descriptive text but no commas.
Country Code	Must contain the same value that appears in the CAC table for the country in which the local site is located.
Area Code	Contains the area or city code for the local site. The code may or may not appear explicitly in the CAC Table. If no area code or city code applies to the local site then the Area Code field must be left blank.
National Prefix	Contains the digit sequence, if any, that must be dialed from within the site country for all non-local calls within that country. Examples: “1” for the US; “0” for the UK.

Records/Fields	Description
International Prefix	Contains the digit sequence that must be dialed from within the site country for all international calls Examples: “011” for the US; “00” for the UK.
LNML	Local Number Maximum Length. This is the maximum length for local phone numbers in the site country (not just the local area). It is used to help resolve certain destination ambiguities and should be defined.
CAC Index	Reserved for an index into the CAC Table. This value will be generated automatically by the LCR software. Leave this field blank.
(Notes)	Provided for reference purposes, it may contain any text.

Route Configuration Table



route_config_file.csv

	A	B	C	D	E	F	G	H	I
1	PLCR Route Configuration Table								
2									
3	MPS Pool	Service	Carrier	Carrier	Carrier	Rate Sche	Rate Sche	Last Rate	Dialable
4	Name	Type	ID Code	ACNA	Name	Directory	File Name	Update	Prefix
5	*#								
6	3								
7	POOL1	ISDN	1111	ABC	Axxx		CIC1_rate_	267	980717
8	POOL2	ISDN	2222	HIJK	Hxxx		CIC2_rate_	267	980717
9	POOL3	SS7	3333	XYZ	Xxxx		CIC3_rate_	267	980717
10									
11									

route_config_file

route_config_file.csv

	I	J	K	L	M	N	O	P
1								
2								
3	Dialable	Quota	Quota	Peak	Offpeak	Weekend		
4	Prefix	Type	Value	Start	Start			
5								
6								
7	980717		None			M-F 0800	M-F 1800	S-S 0000
8	980717		None			M-F 0800	M-F 1800	S-S 0000
9	980717		None			M-F 0800	M-F 1800	S-S 0000
10								
11								

route_config_file

The route configuration table contains one entry (row) for each route (outbound telephony pool) known to the LCR software. This table contains all the information specific to a given route.

Note:

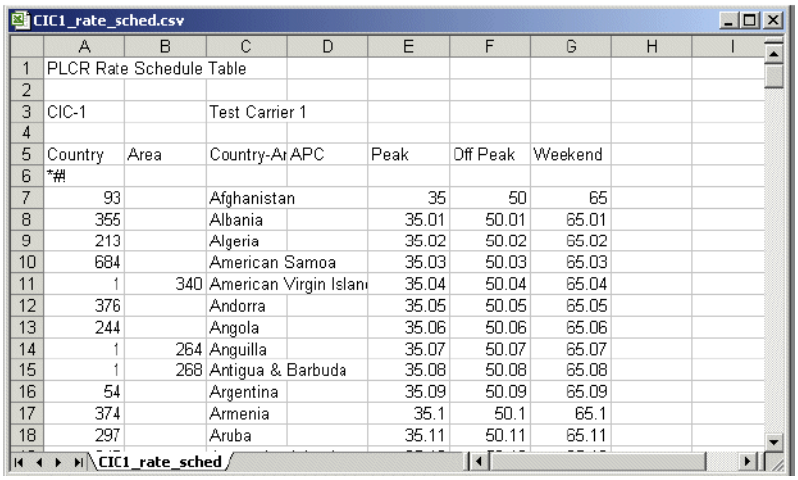
Typically each telephony pool will use a different carrier but this is not required. Although the same carrier may be used for more than one pool, LCR will treat each pool as independent, with its own rate schedule and route parameters, including quotas.

Table 5: Route Configuration Table Data (route_config_file.csv)

Records/Fields	Description
Data record count	The first data record (the row immediately following the LCR Logo string “*#!”) contains the number of data records in the remainder of the table.
MPS Pool Name	Identifies the telephony device pool used for the route. This pool name can be obtained from the tms.cfg file in the section that defines the protocol packages to load. The pool names entered into the route configuration table must be consistent with the tms.cfg file.
Service Type	Contains the type of telephony service used by the route. Standard service types are defined to be “ISDN”, “SS7”, “T1”, and “E1”.
Carrier ID Code	Contains the standard CIC assigned to the carrier used by the route. This is the carrier identification used throughout the system and should be specified.
Carrier ACNA	Contains the common acronym for the carrier as another common form of identification. This field is optional and may be left blank.
Carrier Name	Contains the name of the carrier used by the route. This field is optional and may be left blank.
---	A blank field is included after the Carrier Name field for future use.
Rate Sched File Name	Contains the file name of the rate schedule that applies to this route. (See Rate Schedule Table on page 39.)
Rate Records	Contains the number of Country/Area data records (rows) in the Rate Schedule. The LCR software will expect, and read in, only this number of records. There may be additional records in the file but they will be ignored. Note that the various Rate Schedules may have different sizes.
Rate Update	This field should be maintained as a record of the date of the current Rate Schedule.
Dialable Prefix	Contains the digit sequence, if any, that must be dialed to access the route through the telephony equipment. The Dialable Prefix may be different for each route depending on how the local equipment is connected. For example, if a route is connected through a local PBX, a “1” or “9” (or some other digit) may need to be dialed to access an outside connection. This dialable prefix is not to be confused with the national and international prefixes specified in other configuration tables.
Quota Type	Specifies the metric used to satisfy a route quota requirement. This field may contain one of the following characters: (blank) — No quota defined for this route. “N” — Quota based on the total number of calls successfully completed. “T” — Quota based on the total time of calls successfully completed. “C” — Quota based on the total cost of calls successfully completed.

Records/Fields	Description
Quota Value	Specifies the value that will satisfy the quota requirement. This value is a number given in units that correspond to the Quota Type. Time is in minutes, cost is in carrier rate units times minutes divided by 100 (scale factor).
Quota Period	Specifies the period of time over which the Quota Value is to be met. This field may contain one of the following characters: “M” - Quota Period is the current month. "D“- Quota Period is the current day. “1” - Quota Period is the first defined Rate Period (typically peak). “2” - Quota Period is the second defined Rate Period (typically off peak). “3” - Quota Period is the third defined Rate Period (typically weekend).
Rate Periods: Peak Start Offpeak Start Weekend	The Rate Period definition fields (in this case Peak Start, Off Peak Start and Weekend) all share the format “D-D HHMM”, where “D-D” specifies the start and end days of the week and “HHMM” specifies the hour-min for the start time of the period. The end time of the period is implicit (that is, LCR will assume no time gaps are intended). The time field is in 24-hour format. The valid data values for the “D-D” field are “M-F” for Mon- Fri, “S-S” for Sat-Sun, or “n-m”, where n and m are integers 1 through 7 for Monday through Sunday. Individual days or any day range may be specified in this way. The space between “D-D” and “HHMM” is required. The number of rate periods is not restricted to the three shown in this example. Additional time period columns may be included. The paradigm is generic and not restricted to peak, off peak, and weekend. The number of rate periods is not restricted to the three shown in this example. Additional time period columns may be included. The paradigm is generic and not restricted to peak, off peak, and weekend. The number of rate periods is not restricted to the three shown in this example. Additional time period columns may be included. The paradigm is generic and not restricted to peak, off peak, and weekend. The number of rate periods is not restricted to the three shown in this example. Additional time period columns may be included. The paradigm is generic and not restricted to peak, off peak, and weekend.
(Notes)	Provided for reference purposes, it may contain any text.

Rate Schedule Table


CIC1_rate_sched.csv

	A	B	C	D	E	F	G	H	I
1	PLCR Rate Schedule Table								
2									
3	CIC-1		Test Carrier 1						
4									
5	Country	Area	Country-Ar	APC	Peak	Off Peak	Weekend		
6	*#								
7	93		Afghanistan		35	50	65		
8	355		Albania		35.01	50.01	65.01		
9	213		Algeria		35.02	50.02	65.02		
10	684		American Samoa		35.03	50.03	65.03		
11	1	340	American Virgin Islan		35.04	50.04	65.04		
12	376		Andorra		35.05	50.05	65.05		
13	244		Angola		35.06	50.06	65.06		
14	1	264	Anguilla		35.07	50.07	65.07		
15	1	268	Antigua & Barbuda		35.08	50.08	65.08		
16	54		Argentina		35.09	50.09	65.09		
17	374		Armenia		35.1	50.1	65.1		
18	297		Aruba		35.11	50.11	65.11		

CIC1_rate_sched

Each rate schedule table contains the destination rate schedules that apply to a particular route. There should be one rate schedule file for each one defined in Route Configuration Table on page 36the under Rate Sched File Name.

Table 6: Rate Schedule Table Data (rate_sched.csv)

Records/Fields	Description
Country	Contains the country Code for the destination country. Every country code that appears in a rate schedule table must also appear in the CAC table. (See Country/Area Code (CAC) Table on page 34.) The CAC table distributed with LCR should contain all current country codes.
Area	Contains the area or city code for the destination, if any. Each area/city code that appears in a rate schedule table must also appear in the CAC table. (See Country/Area Code (CAC) Table on page 34.) If new area codes are added to a rate schedule table it may be necessary to add corresponding entries in the CAC Table. If this is done, be sure to maintain the correct record count in the first data record of the CAC Table. The country/area code entries are matched with the CAC table to generate pointers from the CAC table to the rate schedule tables. Therefore, the country/area code entries in the rate schedule tables must be unique. Repeated entries with the same country and area codes will not be recognized. (Note: inactive, informational-only entries may appear in the rate schedule table if the Area field contains characters such as “NA” so they will not be found by a CAC table match.)

Records/Fields	Description
	A rate schedule table generally does not contain all the area/city codes applicable to the destination country. Many country codes do not have any area/city codes. For each country code, the rate schedule table should contain one entry (row) which contains a blank Area field. Area Code entries which appear in the CAC table but not in a rate schedule table will all point to the blank-area-code entry for that country. The rates defined for the blank-area-code entry apply to all area/city codes not explicitly included in the rate schedule table. Note that the various rate schedule tables may have a different mix of specific area/city code entries, but they are all subsets of the CAC table entries.
Country-Area Name	May contain any descriptive text but no commas. If the rate schedules are imported from files that contain a name field, that field may need to be edited to remove commas.
APC	Area Pattern Code field provides the ability to easily deselect a specific destination for the associated route. If the field is blank (default value), this route will be considered for Least Cost Routing selection. If an asterisk (*) or “N” is entered in the APC field, the associated route will not be considered. This provides the option of deselecting and reselecting a specific country/area destination for a specific route without editing the rate fields or removing the destination entry.
Rate Periods: Peak Offpeak Weekend	A rate field column is provided for each Rate Period defined in the route configuration table. (See Route Configuration Table on page 36.) The configuration shown in this example provides for three rate periods corresponding to peak, off peak, and weekend rates. More rate periods may be added but the rate field columns in each rate schedule must match the Rate Period definition fields in the route configuration table for a given route. (See Route Configuration Table on page 36.) A rate field column which is not used by a given rate schedule must be there but can be left blank. If a rate field for a defined Rate Period is left blank, LCR will not consider the associated route for that destination while the current time falls within that rate period. Note that a “0” in the rate field does not have the same effect; “0” will be accepted as a valid rate.
(N) (notes)	Provided for reference purposes, it may contain any text.

Note:

Data may be copied from a carrier-provided Excel spreadsheet to save time, reduce manual data entry, and improve data integrity. If the data fields in the carrier provided table are in the same order as the template, all data may be selected and copied in one operation. If the field order is not the same, copy the data from each column and paste it into the rate schedule.

LCR Internal Database Updates

The LCR internal database is built from the content of the *.csv files located in the $PLCR_CONFIG_DIR directory during system initialization. By default, this environment variable is not defined. LCR uses the $MPSHOME/common/etc/lcrd/ directory, which is where the configuration *.csv files must be located if $PLCR_CONFIG_DIR is undefined. If you prefer to have the configuration files located in another directory, add the following line to your /opt/home/<username>/.cshrc file (and source the file):

```
setenv PLCR_CONFIG_DIR <directory path>
```

This command may also be entered at the command line to define the LCR configuration for the current session, or until it is changed again. This can be useful in testing or testing different LCR configurations.

This command may also be entered at the command line to define the LCR configuration for the current session, or until it is changed again. This can be useful in testing or testing different LCR configurations.

```
lcrd lcrreadconfig
```

Chapter 4: Application Programming

This chapter covers:

1. MPS Developer Tool Kit
2. Operation in a Call Application
3. Route Request
4. Route Response
5. Route Update

LCR Application Programming

MPS Developer Tool Kit

The LCR functions are supported by tool containers included in the PERItlkt tool kit. The LCR tools used in Media Processing Server (MPS) Developer applications are the Lcr Request Block on page 50 and the Lcr Update Block on page 57. A thorough understanding of MPS Developer and its use in application development is a prerequisite to this section. Refer to the MPS Developer User Guide.

Installing the PERItlkt Tool Kit

To develop applications that use the LCR feature, the PERItlkt tool kit must be installed so that MPS Developer has access to it.

The lcrToolkit is part of PERItlkt. For MPS Developer to access lcrToolkit, the lcr.pprotoolkit file must be located in a directory that is defined in the MPS Developer path environment variable, $PPROPATH.

To install the PERItlkt refer to Installing MPS Software on the Solaris Platform or Installing MPS Software on the Windows Platform.

To set the MPS Developer path environment variable:

1. The path of the lcrToolkit directory must be set in the $PPROPATH environment variable. If not, add the following lines to the /etc/vpsrc.csh file. (A logical place would be immediately after the $PPROHOME definition.)

```
#
# PPROPATH
#
if ( ${?PPROPATH} == 0 ) then
setenv PPROPATH ${PPROHOME}
endif
setenv PPROPATH $MPSHOME/PERItlkt/lcrToolkit:${PPROPATH}
```

Note:

Adding these statements to the /etc/vpsrc.csh file makes the lcrToolkit available to all users. To make the tool kit available to an individual user, add the lines to the user's /home/<username>/.cshrc file instead.

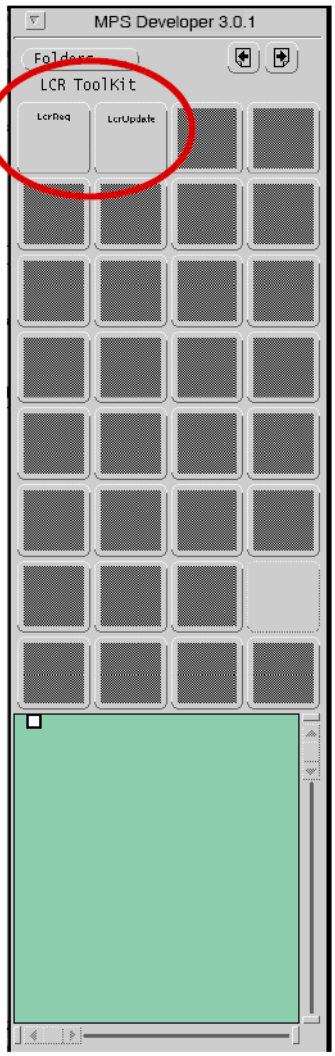
2. To invoke the environment variable, source your .cshrc file:

```
cd ~ source .cshrc
```

The LCR MPS Developer tool kit package consists of the following files and directories:

File or Directory	Description
ILcr.folder file	LCR data folder definition
lcr.pprotoolkit file	CTX tool kit definition file
icons directory	Tool kit icon files
pprs directory	Tool kit container programs
samples directory	Sample programs

When MPS Developer is started after installation of the lcrToolkit, the tool kit is available as an additional accessory tool kit in the tools window. The following illustration shows the tool kit.



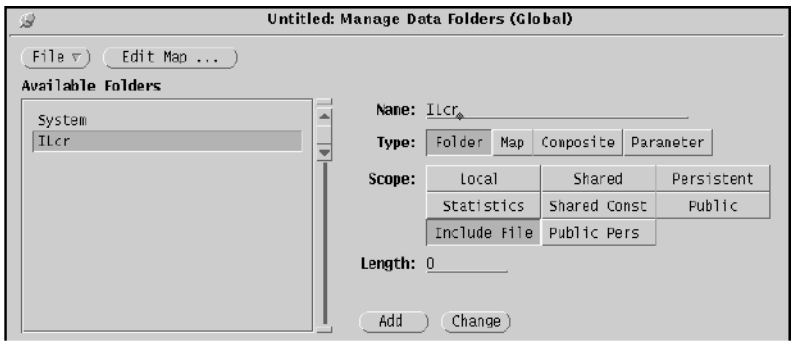
Including LCR Data Folders in an Application

The lcrToolkit includes the LCR data folder definition that is used to create the output data folders and cards that must be available to the application for the LCR tools. These data folders are discussed later in this chapter under each tool block's description.

The include folder definition must be loaded before building an application that will use the LCR tools. Additionally, it must be loaded as an include folder and not as local variables. The include folder definition is contained the file named ILcr.folder.

To load the tool kit include folder definition, perform the following when starting to build an LCR application in MPS Developer:

1. In the MPS Developer Tool Kit window, click on the Folders… button.
2. In the Manage Data Folders window:
    a. In the folders (top) Name field, enter ILcr (do not include the .folder extension).
    b. Under Scope, select Include File.
    c. Click on the Add button.



Important:

Do not load the folder definitions using the File > Load… menu option in the Manage Data Folders window. This loads the definitions as local folders and not as include folders (that is, they can be modified from within the MPS Developer application). To ensure the data folder definition is loaded properly, check that ILcr is listed under Available Folders, as shown in the image above.

Operation of LCR in a Call Application

Requesting Least Cost Route

During a call, the application uses two tool kit containers for LCR.

- The Lcr Request container is used before placing an outbound call, to request the ordered list of telephony routes satisfying the cost, and quota requirements for that call.
- The Lcr Update container is used after the outbound call has been hung up, to update LCR with call information.

Four data folders are required for LCR.

- The Lcr Request parameters folder (PLcrRequest) is used to hold the destination number and other data required to request a least cost route. (See Route Request on page 49.)
- The LCR request response data folder (GRspLcrRequest) is used to hold the route selection list. This folder includes an array subfolder (GaRoute) containing up to eight array elements, each a returned route. (See Route Response on page 53.)
- The Lcr Update parameters folder (PLcrUpdate) is used to hold end of call information required by LCR. (See Route Update on page 57.)
- The LCR update response data folder (GRspLcrUpdate) holds the return status of LCR update. (See Update Failure on page 58.)

Important:

Parameters folders PLcrRequest and PLcrUpdate are used to create the action windows for the Lcr Request and Lcr Update tool blocks, respectively. These folders are hidden, and loaded only if the respective MPS Developer application (LcrRequest.ppr or LcrUpdate.ppr) for the tool is opened in MPS Developer. If LCR is to be used in an application, only the ILcr.folder needs to be loaded.

When building an application that will employ the LCR service, the LCR include folder (ILcr.folder) must be loaded into the application via the MPS Developer Folders window. (See Including LCR Data Folders in an Application on page 45.)

All LCR data folders contain a Request ID field that is used by LCR to track the consistency of the message flow between the call application and LCR. This ensures that LCR is always synchronized with the application.

After filling in the LCR request data folder with the relevant data, the application uses the Lcr Request container in the tool kit to request the least cost route. This container generates a Send Resource message containing all the data in the LCR request data folder.

The application must be sure to select the Wait option when making an LCR request. The request message is sent to the LCR engine through the MX library that creates an IPC connection between MX and LCR. LCR returns a response by the same path, whether success or failure.

If the route request is successful then an output complete (“oc”) condition will be returned to the application with condition data containing a response data string with a valid route list.

If the route request cannot be satisfied, an output failure (“of”) condition will be returned to the application with condition data containing a response data string with a failure reason and a null route list.

LCR Response Format

LCR returns its response stored in the LCR response data folder. The response parameters identify the selected routes, the dialable strings to be used with the routes, and additional information needed by the application to process the call. An overall selection status will also be returned (success or failure, with the reason for failure).

The selected routes will be returned as a list of eligible routes in order of preference. Each route will have its own dialable string, carrier name, service type, and cost associated with it. These fields are defined in more detail under Route Response on page 53.

Handling LCR Response

If the LCR response indicates a failure, the application will typically use a default route to place the outbound call.

If the response is successful, the application will start at the top of the returned route list and use a container from the MPS Developer tool kit (that is, Line Operations) to obtain the Connection ID of an outbound line and give the poolname. If a line is not available in the telephony pool represented by the first route, the application will try the next route on the list.

After the application has obtained an outbound line it will use the Connection ID to make the call, again using the MPS Developer tool kit (Originate).

If the call fails to go through because of a network failure (fast busy condition), the application may try again with the next route on the list. In some cases, the next route may be the same device pool (route name) but have a different prefix in the dialable digits to select a different network path. In most cases, the next route will be a different device pool using a different carrier.

If a call is successfully presented to the network, the final route selection is recorded by the application in the LCR Update Data Folder. If the call is not answered, the length of call will be zero, otherwise the total call time is also recorded in the Update Data Folder.

End of Call Update to LCR

After filling in the LCR Update Data Folder with the required end of call data, the application uses the Lcr Update container in the tool kit to send the data to LCR. This container generates a Send Resource message with an attribute-value string containing all the data in the LCR

Update Data Folder. This message is sent to the LCR engine by the same path used for route requests.

An output complete (oc) condition is returned to the application with no condition data.

The call application cannot send an end-of-call update without first requesting a route. All end-of-call updates must be preceded by a route request with the same Request ID.

The latest LCR_Request message received from an application line defines that line's current valid Request ID. Any LCR_Response to, or LCR_Update message from, that application line that does not have that Request ID will be discarded, and an error message generated. In this way LCR will always be in sync with the call application.

Consistent Usage

It is possible to program the call application with both the route and the dialable number of the outbound call. However the application should always proceed with requesting a route and returning an end-of-call update. This verifies the validity of the route and keeps LCR up to date on carrier usage for the purpose of satisfying quotas and statistical report requirements.

Route Request

Processing Destination Number

In a typical call application, the destination phone number is a raw, unpunctuated sequence of digits, input by the caller, that must be parsed and interpreted by LCR. The PCCP application is an example of the way LCR can be used to flexibly and efficiently support a call application.

For call billing purposes, the PCCP application parses the destination number enough to determine whether it represents an international or national call. If it is an international call, the PCCP application extracts the country code and the remaining national number. In this case, LCR needs only to extract the NPA code that should correspond to a key in the carriers' service and rate schedule tables. Therefore, the PCCP must present LCR with the destination country code, if any, and the national number. To implement this within the canonical phone number format of the LCR request data folder, the PCCP application will store the destination country code in the COUNTRYCODE field, and the national number in the SUBSCRIBERN field. To indicate this to LCR, the PCCP application will put the text "PCCP1" in the DIALPLAN field.

The PCCP application may also know the country of origin of the card holder's call through the ANI digits it received with the call. Although LCR may not need this information, it can be

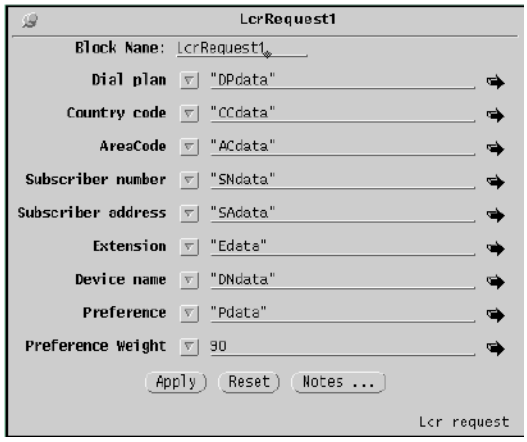
included in the data as part of the DIALPLAN field, by adding another “rule” defined as “CC:<country code of call origin>”, separated from the “PCCP1” rule by a comma (,). Any other required special information could be passed to LCR through this mechanism.

The destination number is assumed to be valid if it is consistent with the country and area code entries in the LCR rate schedule database. If the number is not consistent with the database, LCR will return a failure status in its request response and the application will take appropriate action.

Lcr Request Block

The Lcr Request block is used before placing an outbound call to request the ordered list of telephony routes satisfying the cost and quota requirements for that call. For more information, see Route Request on page 49 and Route Response on page 53.

To request a list of routes from LCR, the application must fill in an LCR request data folder. The application uses an Lcr Request container in the tool kit to fill in the request folder and send an LCR_REQUEST message to LCR. The following parameters are associated with the Lcr Request block and displayed in the action window:



Field Name	Description	Data Type	Max # of chars.
Dial Plan	List of dial plan rule strings (DPR1, DPR2, ..., DPRn).	C	32
Country code	Identifies country for international calls.	C	32
Area Code	Area code within country (leave blank).	C	32
Subscriber number	The telephony address required for all calls (area code may be included).	C	32
Subscriber address	Special purpose code.	C	32

Field Name	Description	Data Type	Max # of chars.
Extension	Extension number.	C	32
Device name	Name of device or subscriber being referenced by the destination number.	C	32
Preference	Modifies the selection logic in favor of the named object for this particular route request. The preference can be a ROUTENAME, a CARRIERNAME, or a SERVICETYPE.	C	32
Preference Weight	Required if preference is specified. Tells Least Cost Routing service how much weight to give to the selection named in Preference. This is a numerical (percentage) value between 1 and 100. A value of 100 means the application wants only this selection.	N	3

The following condition data is provided.

Table 7: GLcr.GrspLcrRequest

Field Name	Description	Data Type	Max # of chars.
gnRouteCnt	Count of routes in GaRoute.	N	2
gnReqId	Request Id.	N	12
gcStatus	Status of operation.	C	32
GaRoute	Array of selected routes. (See table Table 8: GLcr.GRspLcrRequest.GaRoute on page 51.)	F	212

The GaRoute folder contains an array of up to eight selected routes. The following data is provided for each instance in the array.

Table 8: GLcr.GRspLcrRequest.GaRoute

Field Name	Description	Data Type	Max # of chars.
gnIndex	Index of this entry (1 to 8).	N	2
gnRouteId	First route IDin the returned route list .	N	8

Field Name	Description	Data Type	Max # of chars.
gcPoolName	Outbound pool name providing connection to carrier.	C	40
gcDialString	Dial string.	C	40
gcCarrierName	Carrier name.	C	40
gcServiceType	Service type.	C	40
gnServiceRate	Service rate.	N	10
gcReason	Reason for selection.	C	40

The fields in the request folder are described below. The destination number fields are designed to match the canonical phone number elements. Unless otherwise noted, the parameter values are all character strings of arbitrary size. A length of 32 characters per value is allowed by LCR. Unused optional elements should contain blanks.

- Dial plan — List of dial plan rule strings (DPR1, DPR2, …, DPRn; required or optional depending on application). Within the list, multiple rule strings are separated by commas and spaces are ignored. Dial plan is used to supply rules for interpreting the other data elements, or if special rules need to be applied to construct the dialable number string. Some of these rules are dependent on carrier, especially for private networks, and could be included in the call router's carrier data base, however the application has the ability to specify special cases.

  Example for PCCP: For the PCCP application the value of Dial plan will be the string “PCCP1, CC:<country code of call origin>”. This identifies an internal dial plan and the country from which the call originated. The plan name “PCCP1” specifies that the value of Country code will be the country code of the call destination, that the remaining unparsed part of the destination number will be in the value of Subscriber number, and that he other fields are to be ignored.

- Country code — Country code (CC; required for all international calls to identify the country, otherwise optional).

  Example for PCCP: For the PCCP application Country code will always contain the country code of the call destination even if it is not an international call.

- AreaCode — Area code (NPA; may or may not be required depending on the call application and the destination country).

  Example for PCCP: Not currently used for PCCP, but available if any special service code needs to be passed to LCR.

- Subscriber number — Subscriber number (SN; the telephony address normally required for all calls).

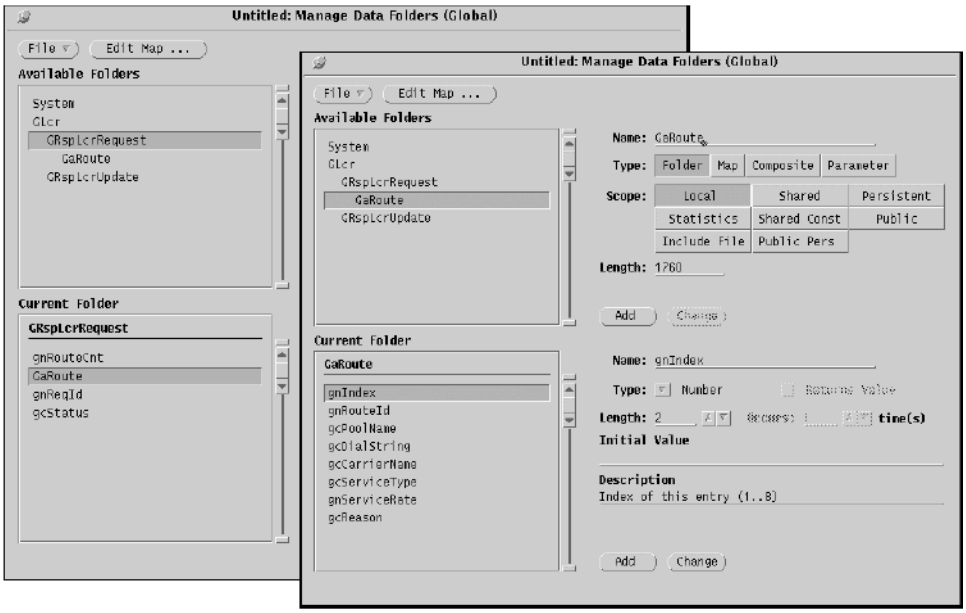
  Example for PCCP: Contains the part of the destination number not parsed by the PCCP application. That is, Subscriber number will not contain any country code but may contain an area code. The LCR engine will need to search for and extract any area code.

- Subscriber address — Subscriber address (SA; optional). This field could be interpreted as a special purpose code if required by the call application, selectable using Dial plan.
- Extension — Extension number (EXT; optional).
- Device name — Name of device or subscriber being referenced by the destination number (optional). This would be used as a substitute for part or all of the other destination number elements and would have to be defined in the call router's data base.
- Preference — Selection preference (optional). This is a name recognizable by LCR that will be used to modify the selection logic in favor of the named object for this particular route request. The Preference may be a PoolName, a CarrierName, or a ServiceType. (See LCR Response Data Folder on page 53.)
- Preference Weight — Preference weight (required if Preference is specified, otherwise ignored). This value tells LCR how much weight is to be given to the selection named in Preference. This is numerical (percentage) value of 1 to 100. A value of 100 means that the application wants only this selection (this is also useful for test purposes). The meaning of other values will depend on the particular requirements of the application service provider.

Route Response

LCR Response Data Folder

In response to a route request the following data is returned to the call application by LCR. This data is stored in the LCR response data folder (GRspLcrRequest). Unless otherwise noted, the parameter values are all character strings of arbitrary size. A length of 32 characters per value is allowed by LCR. The illustration below shows the data items in the response data folder (GRspLcrRequest), including the items in the route array (GaRoute).



- RouteCnt — Number of routes returned in GaRoute.
- ReqId — Request identification.
- Status — Request status. This indicates the overall status of the route request, either success (SUCCESS) or failure (FAILURE-<reason for failure>). (See Failure Status on page 55.)
- Route — The route list is returned as an array. Each row in the route list is a route record with eight fields. There may be up to eight records, although typically fewer. The first record gives the most preferred route, and so on in order of decreasing preference. The eight fields of the route record are defined as follows.
  - Index — Index number of this route record (1 to 8).
  - RouteId — First route ID in the returned route list
  - PoolName — Route name. This name identifies the pool of telephony devices providing an outbound connection to the selected carrier.
  - DialString — Dialable string. The call application passes this string to the selected telephony device.
  - CarrierName — Carrier identification. This field contains the Carrier Identification Code (CIC) for the telephony provider servicing this route.
  - ServiceType — Service type (SS7, ISDN, and so on). This identifies the type of service supported by the selected pool of telephony devices. The application needs this information to initiate the call and satisfy telephony protocols.
  - ServiceRate — Service cost. This is the cost determined by LCR for this carrier. It is numerical value from 0 to 9999999999 (ten characters) in whatever units are used in the rate schedules, typically cents per minute or the local equivalent. This may not

actually be the least cost because other factors such as quota and preference are taken into account.

- Reason — Reason for selection (available when supported). This might consist, for example, of a list of three-letter codes that provide insight into LCR's reasoning path used to find this selection and its place in the route list. This would be generated by the LCR search engine as it makes decisions.

Making an Outbound Call

After receiving the list of routes from LCR the call application will select the first (most preferred) route record. At this point the application can still reject a route based on restrictions that might apply for this particular call or caller.

The application must pass the pool name to the Line Operations tool to obtain the call connection Id (CID) of an outbound line. The application then uses this call CID and the DialString for the selected route to place the outbound call using the Originate tool.

Overflow and Redundancy

If the outbound call cannot be presented through the selected route, the application tries again with the next Route in the array. The routes provided by LCR can represent overflow to a less preferred carrier or redundant (alternate non-local) routes to the preferred carriers.

If no routes are available, the application has the option of providing a queuing function by retrying routes until one is available.

If this call is to be bridged to an inbound call on hold, the application can play music (or other message) to the inbound caller while the outbound routes are tried.

Failure Status

When LCR is unable to return a route list in the response data folder, the REQSTATUS field will contain the text FAILURE-<reason for failure>. The two classes of failure are selection failure and administrative errors.

Selection Failures

Selection failures indicate a problem with a particular destination number. These failures include the following <reason for failure> condition data:

- Bad destination number — A fatal inconsistency was found while parsing the destination number supplied by the application.
- Country code not found — The value in the Country code field of the request data folder could not be found in the CAC Table.
- Area code not found - An Area Code match was not found in the CAC Table and there is no blank area code entry to use as the default.
- No available routes — The destination was found in the CAC Table but all routes were disallowed during subsequent processing.

Administrative Errors

Administrative errors indicate more internal and possibly more serious problems. These errors include the following <reason for failure> condition data:

- LCR failed — Generic failure of the LCR software.
- Not ready — The LCR_REQUEST message was received while LCR was not fully initialized.
- Bad data — The request data folder contained some invalid data.
- Admin error — Other administrative errors.

LCR does not consider it to be an error if a Route Request is received while a Route Update was expected. Although this should not normally happen, LCR is programmed this way so it will synchronize automatically to the application state.

Route Update

End of Call Processing

LCR needs to log which route from the original list was finally used for the outbound call, and the length of the call. This information is used by LCR to satisfy traffic volume quota requirements and to maintain route selection statistics.

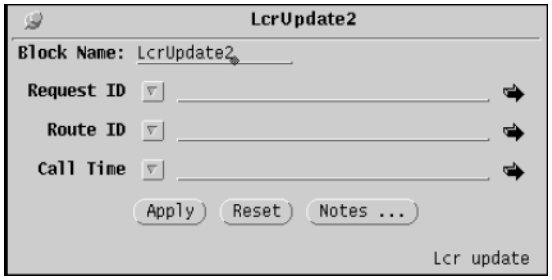
It will also be useful for diagnostic purposes for the application to return its call connection ID (CID) of the outbound line.

The application must update the end of call information by filling in a LCR Update Data Folder. When the outbound call has terminated the application uses the Lcr Update container to fill in the update folder and send a LCR_UPDATE message to LCR.

Lcr Update Block

The Lcr Update block is used after the outbound call has been hung up, in order to update the Least Cost Routing service with call information.

The LCR Update Data Folder contains the following parameter fields. Unless otherwise noted, the parameter values are all character strings of arbitrary size. A length of 32 characters per value is allowed by LCR. Unused optional elements should contain blanks. The following parameters are associated with the Lcr Update block and displayed in the action window:



Field Name	Description	Data Type	Max # of chars.
Request ID	This field contains the request ID returned from LCR request call.	N	12

Field Name	Description	Data Type	Max # of chars.
Route ID	A numerical value that identifies the route that was used to place the call. The associated “Call Time” field must contain a numerical value. The call route field refers to the route list in the Least Cost Routing Response Data Folder which identifies the position of the selected route within the list (0 for first choice, 1 for second, and so on).	N	8
Call Time	A numerical value in seconds from 0 to 9999999999 (ten characters). A value of 0 means the call was presented but not answered (busy or no answer), and the call attempt was then abandoned either by the system or by the original inbound caller.	N	12

- Request ID — Request identification (required).
- Route ID — Number of the route used from the Route array in the LCR response data folder (required if an outbound call was successfully presented to the network, otherwise blank or omitted). This is a numerical value that identifies the route used to place the call. The associated Call Time field must contain a numerical value (may be 0). The Route ID refers to the route list in the LCR response data folder and identifies the position of the selected route within that list (0 for first choice, 1 for second, and so on). This scheme allows for multiple list entries with the same PoolName.
- Call Time — Length of outbound call (required if an outbound call was successfully presented to the network, otherwise blank or omitted). This is a numerical value in seconds from 0 to 9999999999 (ten characters). A value of zero (0) means that the call was presented but not answered (busy or no answer), and that the call attempt was then abandoned either by the system or by the original inbound caller (the card holder in the case of PCCP).

Update Failure

Normally, LCR will return an Output Complete (“oc”) condition in response to an LCR_UPDATE message.

If the LCR is unable to process the update, an Output Fail (“of”) condition will be returned. These failures include the following condition data:

- No route request — LCR was not expecting an LCR_UPDATE message.
- ID mismatch — LCR was expecting an LCR_UPDATE message but the Request ID field did not match that of the last LCR_REQUEST message.

Chapter 5: Selection Quotas and Statistics

This chapter covers:

1. Overview
2. Route Quota Specifications
3. Route Ordering for Quota Fulfillment
4. Quota and Selection Statistics
5. Statistics Update Mechanism
6. Statistics Reports

Selection Quotas and Statistics

Overview

Traffic Volume Quotas

LCR targets a certain level of traffic volume for each carrier route based on business rules implemented in the LCR selection algorithm. These rules may be defined independently for each route. The traffic volume may be measured in one of three ways, defining the Quota Type:

- Total number of calls placed to the route.
- Total connection time (duration) of the calls placed to the route.
- Total cost (rate times duration of call) of calls placed to the route.

This Quota Type is specified as part of the LCR route parameters along with a corresponding Quota Value that defines the quota fulfillment target.

The traffic volume quota applies to certain specified periods of time, including per peak rate period, per day, or per month. This Quota Period is also specified as part of the LCR route parameters.

Quota Fulfillment

The LCR software maintains traffic volume statistics for each route. For each route request, LCR first builds a route list based on least cost using the carrier rate schedules. The traffic volume statistics are then retrieved and compared against the quota requirements for each route on the cost-based route list.

Routes that have quota remaining to be satisfied are given priority over routes with no quota remaining. The route list is reordered accordingly, based on the business rules implemented in the LCR algorithm. After the outbound call is terminated the traffic volume statistics are updated.

Configuration Maintenance

Traffic volume quotas for each carrier are part of the LCR database controlled by configuration files. (See LCR Administration on page 31.) These files may be updated by authorized system administrators using standard worksheet tools. LCR may then be reconfigured dynamically by entering the following command in a Vshell:

```
lcrd lcrreadconfig
```

This command causes LCR to reinitialize itself and apply the updated configuration data. This configuration update is transparent to the call application and does not interfere with application performance. (See LCR Internal Database Updates on page 41.)

Selection Statistics

In addition to the traffic volume statistics needed for quota fulfillment, detailed route selection statistics are also kept for route usage and cost analysis and for selection diagnostic purposes. These statistics are written to daily log files whenever LCR receives the following command:

```
lcrd lcrupdate
```

This command defines the statistics period and should be generated periodically by the system cron task. This statistics update is transparent to the call application and does not interfere with application performance. (See Statistics Reports on page 77.)

Route Quota Specifications

Configuration Table

The parameters LCR uses to control the quota mechanism are listed in the Route Configuration Table. (See Route Configuration Table on page 36.) The Route Configuration Table contains three fields (columns) which define the quota metric type, the quota fulfillment value, and the quota time period. These parameters are specified for each route, so that different quota mechanisms may be specified for different routes independently.

Quota Type

The Quota Type field specifies the metric used to satisfy the quota requirement. This field may contain one of the following characters designating a Quota Type:

- Blank — No quota defined for this route.
- N — Quota based on the total number of calls successfully completed.
- T — Quota based on the total duration of calls successfully completed.
- C — Quota based on the total cost of calls successfully completed.

Quota Value

The Quota Value field specifies the value that will satisfy the quota requirement. This value is a number given in units that corresponds to the Quota Type:

- N — Quota Value is the total number of calls.
- T — Quota Value is the total duration of calls in minutes.
- C — Quota Value is the total cost (rate x call duration / 100) of calls in the same monetary units (for example, pence) used in the carrier rate schedules (for example, pence/minute), divided by 100 (as a reasonable scale factor). It is assumed that all rates in the rate schedules are given per minute.

Quota Period

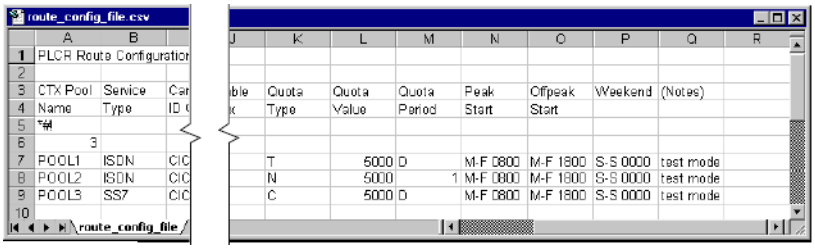
The Quota Period field specifies the period of time over which the Quota Value is to be met. LCR supports three Quota Periods: per month, per day, and per one defined Rate Period (typically the peak period). This field may contain one of the following characters designating a Quota Period:

- M — Quota Period is the current month and resets at the beginning of each month.
- D — Quota Period is the current day and resets at the beginning of each day.
- 1 — Quota Period is the first defined Rate Period (typically peak).
- 2 — Quota Period is the second defined Rate Period (typically off peak).
- 3 — Quota Period is the third defined Rate Period (typically weekend).
- And so on, if more than three Rate Periods are defined.

The Rate Periods are defined in the Route Configuration Table on page 36. If a defined Rate Period is used to specify the Quota Period, the quota mechanism will be active only while the current time falls within the specified rate period. In this case, the mechanism resets at the beginning of the next specified rate period.

Example

The following is part of a sample Route Configuration Table. The quota for POOL1 is 5000 minutes per day, the quota for POOL2 is 5000 calls during the peak period (period 1) of each weekday (Monday through Friday), and the quota for POOL3 is a total cost of 500,000 pence per day (for rate schedules in pence per minute).



Route Ordering for Quota Fulfillment

Quota Fulfillment Mechanism

The quota fulfillment mechanism used in LCR is very straightforward. The mechanism depends only on whether or not a route's quota has been fulfilled.

No Route Quotas Fulfilled

When none of the route quotas have been fulfilled, the cost-based route list will not be effected by the quota mechanism. In other words, all routes will be given the same priority with respect to quotas, regardless of how close each route may be to their quota fulfillment. The lower cost routes will continue to be preferred and will therefore tend to fill their quotas sooner than will higher cost routes.

Some Route Quotas Fulfilled

When one or more routes have fulfilled their quota and others have not, the quota mechanism causes the cost-based route list to be reordered, giving priority to those routes which have not yet fulfilled their quota. Specifically, all routes which have not fulfilled their quota will be moved ahead of all routes which have fulfilled their quota. However, within each of these groups (fulfilled and not fulfilled), the original cost-based ordering will be preserved. The preferred route will now be the lowest-cost route which has not yet fulfilled its quota.

All Route Quotas Fulfilled

When all routes have fulfilled their traffic volume quotas for the current Quota Period, the quota mechanism will have no effect on the cost-based route list. When the current Quota Period expires, the quota statistics will be reset and the quota mechanism will become active again.

Procedure

When a Route Request is received from the call application, the LCR will first analyze the call destination and determine a Working Route List based on costs taken from the carrier's rate schedules. This cost-based Working Route List is then reordered according to the quota fulfillment mechanism discussed previously.

Example

Three routes POOL1, POOL2, and POOL3 are determined on the basis of their rate schedules to have the following route list order:

POOL2 POOL1 POOL3

If none of these routes have fulfilled their quotas, or if they all have fulfilled their quotas, the priority order remains the same. However, if POOL1 and POOL2 have fulfilled their quotas and POOL3 has not, the route list order will be changed to:

POOL3 POOL2 POOL1

Quota and Selection Statistics

Overview

A Route Quota Fulfillment Statistic is required to support the quota fulfillment mechanism. This statistic is maintained separately for each route. In addition, LCR maintains route request and selection statistics that are useful for analyzing route usage and monitoring the selection mechanism. These include Route Request, Route Response, and Route Update (end-of-call) statistics.

The statistics fall into two categories: Overall Statistics that are independent of the routes and Route Statistics that apply to each route.

Route Quota Fulfillment Statistic

This statistic is maintained as part of each Route Control data structure. The value of the Route Quota Fulfillment Statistic depends on the Quota Type defined under Destination Number on page 21, and is handled separately for each route. This value is one of the following:

- The number of successful outbound calls. (See Successful Outbound Calls Per Route on page 71.)
- The total duration of those calls. (See Duration of Outbound Calls Per Route on page 71.)
- The total cost of those calls. (See Cost of Outbound Calls Per Route on page 71.)

When this value becomes equal to or greater than the specified Quota Value (see Quota Value on page 63), the quota for this route is fulfilled for the current Quota Period. The Route Quota Fulfillment Statistic is reset when a new Quota Period starts. Note that the corresponding Route Statistics discussed in Successful Outbound Calls Per Route on page 71, Duration of Outbound Calls Per Route on page 71, Cost of Outbound Calls Per Route on page 71and have the same criteria but are collected over separately-defined time periods.

Overall Statistics

These statistics are maintained as part of the LCR Control data structure.

Route Requests to LCR

The number of Route Requests to LCR is the total number of valid Route Request messages received by LCR, whether or not a successful response was returned to the application. This statistic is referred to as Total Requests.

Successful Route Responses

The number of Successful Route Responses is the total number of successful Route Response messages returned to the application which included a route list containing at least one route. These responses will have a request status of “Ok”. This statistic is referred to as Success Responses.

Selection Failure Responses

The number of Selection Failure Responses is the total number of failed Route Response messages returned to the application for which all routes were rejected by the selection rules. This happens if none of the routes support the destination number requested (blank rate field or destination deselected), but also includes cases where the destination number cannot be parsed or the country code or area code is invalid. These responses will have a request status such as “No available routes”, “Area code not found”, “Country code not found”, or “Bad destination number”. This statistic is referred to as Failure Responses.

Software Error Responses

The number of Software Error Responses is the total number of failed Route Response messages returned to the application for which a processing error was encountered. This happens if the Route Request message contained invalid data or if the software encountered a logic or state error. These responses will have a request status such as “Admin error”, “ID mismatch”, “Bad data”, “Not ready”, and “Wrong state”. This statistic is referred to as Error Responses.

Successful Outbound Calls

The number of Successful Outbound Calls is the total number of valid Route Update messages received by LCR for which the call time is greater than zero, regardless of the route used. This statistic is referred to as Successful Calls.

Duration of Outbound Calls

The duration of successful Outbound Calls is sum of all the call times reported in valid Route Update messages received by LCR. Call durations are reported to LCR with a resolution of 1 second. These duration times are converted to decimal minutes for the Total Time statistic. This statistic is referred to as Total Time.

Cost of Outbound Calls

The cost of successful Outbound Calls is computed from the call times reported in valid Route Update messages received by LCR. The call cost is the call time multiplied by the call rate reported by LCR to the application in the Route Response message, divided by 100 as a convenient scale factor. The selected call route reported to LCR by the application in the Route Update message determines which call rate is used for this calculation. This statistic is referred to as the Total Cost. If the rate schedules are in US cents per minute, for example, the Total Cost will have units of US dollars.

Failed Outbound Calls

The number of Failed Outbound Calls is the total number of valid Route Update messages received by LCR for which the call time is equal to zero. This means that a route was selected and the call was attempted but did not connect (i.e., the selected route is known but there is no associated call duration or cost). This statistic is referred to as Failed Call

Missing Calls - Unacknowledged Responses

The number of Missing Calls is the number of instances when a successful Route Response message to the application was not followed by a valid (same request ID) Route Update message to LCR. This is detected when the next valid message is a new Route Request. This condition means that either the application could not use the returned route list, the original caller hung up, or some other error was encountered by the application. This statistic is referred to as Missing Calls.

Cost Adjustment for Overflow Mechanism

An application will sometimes place an outbound call which does not use LCR's First Route Choice. This is LCR's overflow mechanism. When such a call is reported to LCR in the Route Update message, the cost for the selected route is subtracted from that for the first route choice. This difference is summed over all calls. The Overflow Adjustment has the same units as Total Cost. This statistic is referred to as Overflow Adjustment.

Note:

If the Overflow Adjustment is negative, a cost penalty was incurred by the overflow mechanism. The sum of the actual Total Cost and the (usually negative) Overflow Adjustment yields the total cost that would have been incurred if LCR's first route choice had always been used.

Route Statistics

These statistics are maintained as part of each Route Control data structure.

Responses as First Route Choice

The per route number of First Choice Responses is the number of successful Route Response messages returned to the application which included this route as first on the route list. This statistic is referred to as First Route Choice.

Responses as Second Route Choice

The per route number of Second Choice Responses is the number of successful Route Response messages returned to the application which included this route as second on the route list. This statistic is referred to as Second Route Choice.

Responses as Third Route Choice

The per route number of Third Choice Responses is the number of successful Route Response messages returned to the application which included this route as third on the route list. This statistic is referred to as Third Route Choice.

Responses with Route Rejected

The per route number of Rejected Responses is the number of successful Route Response messages returned to the application which did not include this route on the route list. This statistic is referred to as Route Rejected.

Successful Outbound Calls Per Route

The per route number of Successful Outbound Calls is the number of valid Route Update messages identifying this as the selected call route for which the call time is greater than zero. This statistic is referred to as Successful Calls per route. The sum of all the route Successful Calls yields the overall Successful Calls.

Duration of Outbound Calls Per Route

The per route duration of successful Outbound Calls is sum of all the call times reported in valid Route Update messages identifying this as the selected call route. This statistic is referred to as Total Time per route. Call durations are reported to LCR with a resolution of 1 second. These duration times are converted to decimal minutes for the Total Time statistic. The sum of all the route Total Times yields the overall Total Time.

Cost of Outbound Calls Per Route

The per route cost of successful Outbound Calls is computed from the call times reported in valid Route Update messages identifying this as the selected call route. The call cost is the call time multiplied by the call rate reported to the application in the Route Response message, divided by 100 as a convenient scale factor. The selected call route reported to LCR by the application in the Route Update message determines which call rate is used for this calculation. This statistic is referred to as Total Cost per route. If the rate schedules are in US cents per minute, for example, the Total Cost will have units of US dollars. The sum of all the route Total Costs yields the overall Total Cost.

Failed Outbound Calls Per Route

The per route number of Failed Outbound Calls is the number of valid Route Update messages identifying this call route for which the call time is equal to zero. This means that this route was selected and the call was attempted but did not connect (that is, the selected route is known but there is no associated call duration or cost). This statistic is referred to as Failed Calls per route. The sum of all the route Failed Calls yields the overall Failed Calls.

Hypothetical Cost of Exclusive Route

Each time a successful outbound call is reported to LCR, the hypothetical cost that would have been incurred by the use of each route is calculated for that call. For a given route, the total of these costs is the Hypothetical Cost of placing all the outbound calls through that route exclusively. The Hypothetical Cost has the same units as Total Cost. There is no corresponding overall statistic. This statistic is referred to as Hypothetical Cost per route.

Note:

This statistic helps to evaluate the cost savings realized with LCR. If the least cost route is always used then the actual overall Total Cost will be less than any of these Hypothetical Costs. However the Route Quota mechanism and the occasional selection of a second or third choice route (the overflow mechanism) will tend to lower the actual cost savings and must be taken into account when evaluating this statistic.

Cost Adjustment for Overflow Mechanism

When a successful outbound call which did not use LCR's First Route Choice is reported to LCR, the cost for the selected route is subtracted from that for the first route choice. The difference is summed with calls per selected route. The Overflow Adjustment has the same units as Total Cost. If the Overflow Adjustment is negative, a net cost penalty was incurred by the overflow mechanism having selected this route. The sum of all the route Overflow Adjustments yields the overall Overflow Adjustment. This statistic is referred to as the Overflow Adjustment per route.

Data Collection Periods

Current Quota Period

The Route Quota Fulfillment Statistic is kept for the current Quota Period as defined under Traffic Volume Quotas on page 27. This statistic is reset when the Quota Period rolls over, whether that is a defined Rate Period, a day, or a month, as specified in the Route Control Table for each route. If the Quota Period rolls over between the Route Response and the Route Update, there will be some ambiguity with how to handle the quota fulfillment. LCR resolves this by using the current time when the Route Update message is processed, since this is when the Route Quota Fulfillment Statistic is updated.

Current Statistic Period

All route statistics (except for the quota fulfillment statistic) and overall statistics are kept for the current statistics period. This period is determined by the frequency of Statistics Report Update commands to LCR. The statistics are written to the current daily log file whenever LCR receives the following command:

```
lcrd lcrupdate
```

This command terminates the current statistics period and resets the per route and overall statistics. The system cron task should be configured to generate the lcrupdate command periodically (for example, hourly) as required by the application service site.

Statistics Update Mechanism

Route Request Message

Overall Statistics

All of the LCR statistics are event driven. When LCR receives a valid Route Request message, the number of Total Requests will be incremented. (See Route Requests to LCR on page 67.)

Route Response Message

Overall Statistics

When LCR is ready to send a Route Response message, one of the following Overall Statistics will be incremented:

- The number of Success Responses. (See Successful Route Responses on page 67.)
- The number of Failure Responses. (See Selection Failure Responses on page 68.)
- The number of Error Responses. (See Software Error Responses on page 68.)

Route Statistics

When LCR sends a successful Route Response message, one of the following Route Statistics will be incremented for each route known to LCR:

- The number of First Route Choice responses. (See Responses as First Route Choice on page 70.)
- The number of Second Route Choice responses. (See Responses as Second Route Choice on page 70.)
- The number of Third Route Choice responses. (See Responses as Third Route Choice on page 70.)
- The number of Route Rejected responses. (See Responses with Route Rejected on page 71.)

Route Update Message

Overall Statistics

When LCR receives a valid Route Update message, one of the following Overall Statistics will be incremented, either the number of Successful Calls (see Successful Outbound Calls on page 68) or the number of Failed Calls (see Failed Outbound Calls on page 69).

If the number of Successful Calls is incremented, all of the following are also computed and incremented:

- The Total Time duration of calls. (See Duration of Outbound Calls on page 68.)
- The Total Cost of calls. (See Cost of Outbound Calls on page 69.)
- The Overflow Adjustment, if any. (See Cost Adjustment for Overflow Mechanism on page 69 .)

Route Statistics

When LCR receives a valid Route Update message, one of the following Route Statistics will be incremented for the call route identified in the Route Update message:

- The number of Successful Calls per Route. (See Successful Outbound Calls Per Route on page 71.)
- The number of Failed Calls per Route. (See Failed Outbound Calls Per Route on page 72.)

If the number of Successful Calls per Route is incremented, all of the following will also be computed and incremented:

- The Total Time duration of calls per Route. (See Duration of Outbound Calls Per Route on page 71.)
- The Total Cost of calls per Route. (See Cost of Outbound Calls Per Route on page 71.)
- The Hypothetical Cost per Route. (See Hypothetical Cost of Exclusive Route on page 72.)
- The Overflow Adjustment per Route, if any. (See Cost Adjustment for Overflow Mechanism on page 72.)

Route Quota Update

When LCR receives a valid Route Update message for a successful outbound call, one of the Route Statistics (number, duration, or cost) will also contribute to the Route Quota Fulfillment Statistic. See Route Quota Fulfillment Statistic on page 67.

The Quota Type and Quota Period are checked and the Route Quota Fulfillment Statistic is incremented accordingly. The Quota Periods may not be contiguous (for example, if the Quota Period is only the peak rate period), so the Route Quota Fulfillment Statistic increments only if the current time is within the Quota Period.

No Route Update Message

Overall Statistics

When LCR receives a new Route Request message without having received a Route Update message from the previous Route Response, it increments the number of Missing Calls (unacknowledged responses). See Missing Calls - Unacknowledged Responses on page 69.

Statistics Reports

Daily Log Files

The Overall and Route Statistics discussed in Overall Statistics on page 67and Route Statistics on page 70are written into LCR daily statistics log files. At the beginning of each day, a new file is automatically generated with the file name:

```
ccyymmddhh
```

This file is placed by LCR in $MPSHOME/common/lcrstats and in Comma Separated Variable format.

A statistics table is written to the current daily log file whenever LCR receives the following command:

```
lcrd lcrupdate
```

This command defines the statistics period. If the vsh command is generated hourly by the system cron task, each daily log file will contain 24 tables of hourly records. This vsh command may also be entered manually for the purpose of system testing.

The statistics update process is transparent to the call application and does not interfere with application performance.

Important:
It is the system administrator's responsibility to periodically back up or remove the daily log files from the system disks.

Statistics Tables

Data Format

The daily log files contain the statistics data in Comma Separated Variable (*.csv) format for convenient viewing and manipulation with common worksheet programs. Each daily log file contains a series of statistics tables generated by the lcrupdate command. Each table contains the data collected since the last lcrupdate command. Each statistics table contains a Table Identification Record (Table Identification Record on page 78), an Overall Statistics Record (Overall Statistics Record on page 78) and a series of Route Statistics Records, one for each route (Route Statistics Records on page 79). A blank record separates successive tables. Each of these records corresponds to a worksheet row and each statistic field to a worksheet column. See Sample Statistics Data on page 80.

Table Identification Record

The first record of each statistics table is the Table Identification Record containing two fields, the site identification string and the current date stamp in the following format:

```
<Site-ID> <ccyymmddhhmm-day_of_week>
```

The site ID is taken from the current Local Configuration Table read in from the LCR configuration files. The time stamp gives the end of the time period over which the statistics data were collected. The beginning of the time period is given by the time stamp of the preceding statistics table, or 0000 hours if this is the first statistics table of this daily log file.

Overall Statistics Record

The second record of each statistics table contains the Overall Statistics data in the following fields (columns):

1. The text “all” to identify an Overall Statistics record.
2. The time stamp of the last modification to any data in this record (this time may be within a previous period if there has been no recent activity).
3. Total Requests, see Route Requests to LCR on page 67.

4. Success Responses, see Successful Route Responses on page 67.
5. Failure Responses, see Selection Failure Responses on page 68.
6. Error Responses, see Software Error Responses on page 68.
7. Successful Calls, see Successful Outbound Calls on page 68.
8. Total Time in minutes, see Duration of Outbound Calls on page 68.
9. Total Cost (rate x time/100), see Cost of Outbound Calls on page 69.
10. Failed Calls, see Failed Outbound Calls on page 69.
11. Missing Calls, see Missing Calls - Unacknowledged Responses on page 69.
12. Overflow Adjustment in cost units, see Cost Adjustment for Overflow Mechanism on page 69.

Route Statistics Records

The third and following records of each statistics table contain the Route Statistics data in the following fields (columns):

1. The Carrier Identification Code (CIC) to identify the route.
2. The time stamp of the last modification to any data in this record (this time may be within a previous period if there has been no recent activity).
3. First Route Choice, see Responses as First Route Choice on page 70.
4. Second Route Choice, see Responses as Second Route Choice on page 70.
5. Third Route Choice, see Responses as Third Route Choice on page 70.
6. Route Rejected, see Responses with Route Rejected on page 71.
7. Successful Calls per route, see Successful Outbound Calls Per Route on page 71.
8. Total Time per route, in minutes, see Duration of Outbound Calls Per Route on page 71.
9. Total Cost per route (rate x time/100), see Cost of Outbound Calls Per Route on page 71.
10. Failed Calls per route, see Failed Outbound Calls Per Route on page 72.
11. Hypothetical Cost per route, see Hypothetical Cost of Exclusive Route on page 72.
12. Overflow Adjustment per route, in cost units, see Cost Adjustment for Overflow Mechanism on page 72.

Sample Statistics Data

Sample Log File

The following data was taken from a LCR statistics log file (ccyymmddhh) generated during a test run. In this case, the lcrupdate command was issued twice, two minutes apart. This is the raw log data in plain text format.

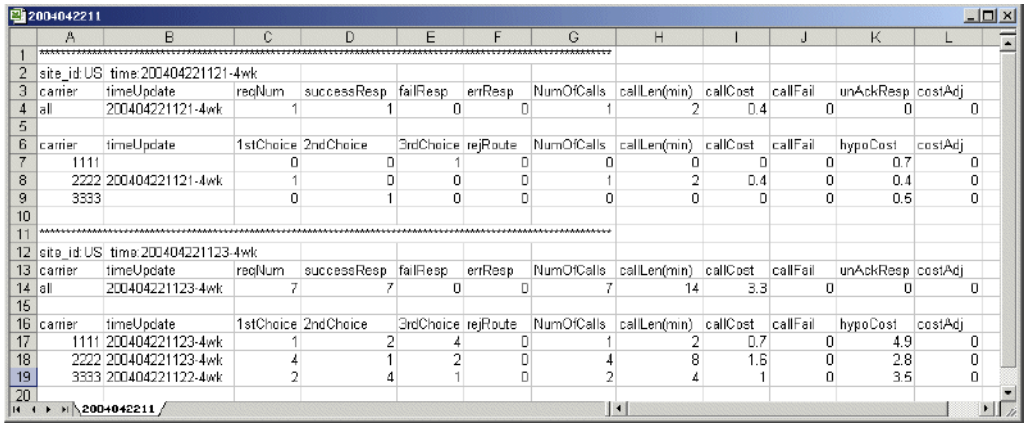
```
**********************************************************************************************
site_id:US1, time:200404221121-4wk
carrier,timeUpdate,reqNum,successResp,failResp,errResp,NumOfCalls,callLen(min),callCost,callFail,
unAckResp,costAdj
all,200404221121-4wk,1,1,0,0,1,2.00,0.40,0,0,0.00

carrier,timeUpdate,1stChoice,2ndChoice,3rdChoice,rejRoute,NumOfCalls,callLen(min),callCost,
callFail,hypoCost,costAdj
1111,,0,0,1,0,0,0.00,0.00,0,0.70,0.00
2222,200404221121-4wk,1,0,0,0,1,2.00,0.40,0,0.40,0.00
3333,,0,1,0,0,0,0.00,0.00,0,0.50,0.00

**********************************************************************************************
site_id:US1, time:200404221123-4wk
carrier,timeUpdate,reqNum,successResp,failResp,errResp,NumOfCalls,callLen(min),callCost,callFail,
unAckResp,costAdj
all,200404221123-4wk,7,7,0,0,7,14.00,3.30,0,0,0.00

carrier,timeUpdate,1stChoice,2ndChoice,3rdChoice,rejRoute,NumOfCalls,callLen(min),callCost,
callFail,hypoCost,costAdj
1111,200404221123-4wk,1,2,4,0,1,2.00,0.70,0,4.90,0.00
2222,200404221123-4wk,4,1,2,0,4,8.00,1.60,0,2.80,0.00
3333,200404221122-4wk,2,4,1,0,2,4.00,1.00,0,3.50,0.00
```

The same file, when opened in Excel, looks like this:



	A	B	C	D	E	F	G	H	I	J	K	L
1	**********											
2	site_id:US	time:200404221121-4wk										
3	carrier	timeUpdate	reqNum	successResp	failResp	errResp	NumOfCalls	callLen(min)	callCost	callFail	unAckResp	costAdj
4	all	200404221121-4wk	1	1	0	0	1	2	0.4	0	0	0
5												
6	carrier	timeUpdate	1stChoice	2ndChoice	3rdChoice	rejRoute	NumOfCalls	callLen(min)	callCost	callFail	hypoCost	costAdj
7	1111		0	0	1	0	0	0	0	0	0.7	0
8	2222	200404221121-4wk	1	0	0	0	1	2	0.4	0	0.4	0
9	3333		0	1	0	0	0	0	0	0	0.5	0
10												
11	**********											
12	site_id:US	time:200404221123-4wk										
13	carrier	timeUpdate	reqNum	successResp	failResp	errResp	NumOfCalls	callLen(min)	callCost	callFail	unAckResp	costAdj
14	all	200404221123-4wk	7	7	0	0	7	14	3.3	0	0	0
15												
16	carrier	timeUpdate	1stChoice	2ndChoice	3rdChoice	rejRoute	NumOfCalls	callLen(min)	callCost	callFail	hypoCost	costAdj
17	1111	200404221123-4wk	1	2	4	0	1	2	0.7	0	4.9	0
18	2222	200404221123-4wk	4	1	2	0	4	8	1.6	0	2.8	0
19	3333	200404221122-4wk	2	4	1	0	2	4	1	0	3.5	0
20												

Chapter 6: Route Preferences, Rate Adders, and Multipliers

This chapter covers:

1. Overview
2. LCR Preference Algorithm
3. Global Preferences
4. Dynamic Preferences

Route Preferences, Rate Adders and Multipliers

Overview

Route Preferences

Application service provider preferences, or tilts, are selection criteria that may modify or override rate schedules and traffic volume quotas. These preferences may usually refer to service carrier but might also refer either to telephony device pool (route) or to service type (ISDN, SS7, T1, E1). Preferences are implemented in two ways: Global Preferences and Dynamic Preferences.

Adders and Multipliers

Rate adders or multipliers can modify the base cost of a route. These modifiers allow a carrier's published rates to be conveniently adjusted by the application service provider for special

purposes. These adjustments apply globally to all route requests and will be implemented as a form of Global Preference.

Maintenance

Route preferences and rate adders or multipliers for each carrier are part of the LCR database controlled by configuration files. These files may be updated by authorized system administrators using standard worksheet tools. LCR may then be reconfigured dynamically at any time to apply the updated configuration data. See LCR Internal Database Updates on page 41.

LCR Preference Algorithm

Global Preferences

Global Preferences are applied, depending on the preference mechanism described below.

Cost Differential

Global Preferences, defined as a cost differential (rate adder or multiplier), are applied when the initial cost-based Working Route List is being determined. The rate adder or multiplier is applied to the rate found in the rate schedule, then the Working Route List is ordered according to cost in the normal manner.

Quota Modification

Global Preferences, defined as a quota modification, are applied when the cost-based Working Route List is being adjusted according to quota fulfillment requirements, using the Quota Value specified in the Preference Configuration Table rather than that specified in the Route Configuration Table.

Selection Weight

Global Preferences, defined as a selection weight, are applied to the quota-adjusted Working Route List according the same rules that apply to Dynamic Preferences. If a particular Route Request specifies a Dynamic Preference, that override any Global Preference selection weight that may otherwise apply.

Dynamic Preferences

Dynamic Preferences are applied to the quota-adjusted Working Route List. If a preferred route is not on the Route List, it cannot be accommodated and the Dynamic Preference specification is ignored. If the preferred route (or, when implemented, class of routes) is on the list, it is moved to a higher priority according to the Preference Weight.

A preference weight of 100 leaves the preferred route as the only selection on the Route List, all others will be removed.

A preference weight of 90 moves the preferred route to the top of the Route List, leaving the rest unchanged. In this case, the state of quota fulfillment for a preferred route will be overridden.

A preference weight of 80 moves the preferred route to the top of its quota group, leaving the rest unchanged. There are two quota groups: those routes which have fulfilled their traffic volume quotas and those which have not. In this case, those routes which have not fulfilled their quotas will remain higher on the Route List. If the preferred route has not fulfilled its quota, it moves to the top of the Route List.

Final Route List

When all Global and Dynamic Preferences have been applied, the resulting preference-adjusted Working Route List becomes the final Route List returned to the call application in the LCR Route Response message.

Global Preferences

Specification

Global preferences are specified in the LCR database and selection algorithm. These preferences will be taken into account by the selection algorithm for each route request. Global preferences are defined in terms of the parameters on which the rates depend, including the following:

- The destination Country/Area/City Code, for any rate period.
- A particular rate period, for all destinations.
- The rate for a specific destination and rate period.

Preference Mechanism

The form of the global preferences may be specified by the application service provider's business rules and incorporated into the LCR selection algorithm, but this requires special development effort. To allow the most flexibility, three preference mechanisms are built in as LCR options. These options are selected on a per route basis.

Cost Differential

The Global Preference may be a cost differential treated as an adder (positive or negative) or a multiplier applied to the cost determined from the rate schedule for a particular route.

Quota Modification

The Global Preference may be treated as a quota modification or override for a particular route. The Quota Type must be the same as that specified in the Route Configuration Table but the Quota Value may be modified for particular destinations or rate periods by the data in the Preference Configuration Table.

Selection Weight

The Global Preference may be treated as a weight or percentage interpreted by the LCR software as a special route selection criterion. When defined this way, the Global Preference is treated the same way as a Dynamic Preference except that it is applied globally to all route requests. For a particular Route Request, a Dynamic Preference specified by the application in the Route Request will override any Global Preference weight that may otherwise apply.

Dynamic Preferences

Specification

Preferences may be implemented in a dynamic fashion, applying only to a particular Route Request. In this case, the call application specifies the Preference Object and Preference Weight as part of its Route Request data.

Preference Object

The dynamic preference mechanism is specified by the application by identifying one of the following objects to be given selection preference.

Carrier Name

The application may specify that a particular telephony service provider is preferred or required for this call. The preference will apply to any route that uses this carrier.

Route Name

The application may specify that a particular telephony device pool (route) is preferred or required for this call. The preference will apply only to the specified route.

Service Type

The application may specify that a particular type of service (ISDN, SS7, T1, E1, and so on) is preferred or required for this call. The preference will apply to any route that provides this type of service.

Preference Weight

Along with a dynamic preference, the application must specify a percentage weight (1 to 100) that is interpreted by the LCR engine according to the rules of its algorithm. The Preference Weight options are discussed under Dynamic Preferences on page 83.

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