Appendix A Pattern Matching

A

This appendix describes the pattern matching scheme used by the X.25 access list feature.

Regular Expression Pattern Matching

The X.121 address and CUD field used in the source of a **translate** configuration command and the X.121 addresses used in X.29 access lists can all be *regular expressions*.

Regular expressions provide a way to specify wide ranges of X.121 addresses and Call User Data fields by using just a few keystrokes. If you are familiar with regular expressions from UNIX programs such as *regexp*, then you are already familiar with much of Cisco System's regular expression implementation.

Writing regular expressions is simple once you see and try a few examples. A regular expression is a formula for generating a set of strings. If a particular string can be generated by a given regular expression, then that string and regular expression *match*. In many ways, a regular expression is a program, and the regular expression matches the strings it generates.

A regular expression is built up of different components, each of which is used to build the regular expression string-generating program. The simplest usable component is the *atom*, but first, you need to understand *ranges*, as atoms are built of these.

Ranges

A range is a sequence of characters contained within "[" and "]" (left and right square brackets). A character matches a range if that character is contained within the range, for example,

[aqcsbvd]

forms the range consisting of the characters "a," "q," "c," "s," "b," "v," and "d." The order of characters is usually not important; however, there are exceptions and these will be noted.

You can specify an ASCII sequence of characters by specifying the first and last characters in that sequence, and separating them with a "-" (hyphen).

[a-dqsv]

The above example could also be written so as to specify "]" (right square brackets) as a character in a range. To do so, enter the bracket as the *first* character after the initial left square bracket that starts the range.

This example matches "]" (right bracket) and the letter "d."

[]d]

To include a "-" (hyphen), enter it as either the first or the last character of the range.

You can reverse the matching of the range by including a wedge (caret) at the start of the range. This example matches any letter *except* the ones listed. When using the "wedge" (caret) with the special rules for including a bracket or hyphen, make the caret the very first character.

[^a-dqsv]

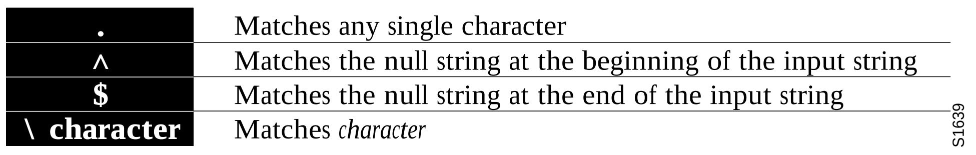
This example matches anything except a "]" (right square bracket) or the letter "d:"

[^]d]

Atoms

Atoms are the most primitive usable part of regular expressions. An atom can be as simple as a single character. The letter "a" is an atom, for example. It is also a very simple regular expression, that is, a program that generates only one string, which is the single-letter string made up of the letter "a." While this may seem trivial, it is important to understand the set of strings that your regular expression program generates. As will be seen in upcoming explanations and examples, much larger sets of strings can be generated from more complex regular expressions.

Table A-1 Special Symbols Used as Atoms



.	Matches any single character
^	Matches the null string at the beginning of the input string
$	Matches the null string at the end of the input string
\ character	Matches *character*

S1639

Certain characters have a special meaning when used as atoms; refer to Table A-1.

As an example, the regular expression matches “abcd” only if “abcd” *starts* the full string to be matched:

^abcd

Whereas

[^abcd]

is an atom that is a range that matches any single letter, as long as it is *not* the letters “a,” “b,” “c,” or “d.”

It was previously stated that a single character string such as the letter “a” is an atom. To remove the special meaning of a character, precede it with a “\” (backslash).

$

Whereas this atom matches a $ (dollar sign):

\$

Any character can be preceded with the backslash character with no adverse affect.

\a

Atoms are also full regular expressions surrounded by parentheses. For example, both “a” and “(a)” are atoms matching the letter “a.” This will be important later, as we see patterns to manipulate entire regular expressions.

Pieces

A piece is an atom optionally followed by one of the symbols listed in Table A-2:

Table A-2 Special Symbols Used with Pieces

*	Matches 0 or more sequences of the atom
+	Matches 1 or more sequences of the atom
?	Matches the atom or the null string

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For example:

a*

matches any number of occurrences of the letter “a,” including *none*.

This string requires there to be at least one letter “a” in the string to be matched:

a+

This string means that the letter “a” can be there *once*, but it doesn't have to be:

a?

This string matches any number of “*” (asterisks):

\**

Here is an example using parentheses. This string matches any number of the two-atom string “ab.”

(ab)*

As a more complex example, this string matches one or more instances of letter-digit pairs (but not none, that is, an *empty string* is not a match):

([A-Za-z][0-9])+

The order for matches using the optional *, +, or ? symbols is longest construct first. Nested constructs are matched from outside to inside. Concatenated constructs are matched beginning at the left side of the construct.

Branch

A branch is simply a set of zero or more concatenated pieces. The previous letter-digit example was an example of a branch as concatenated pieces. Branches are matched in the order normally read—from left to right. For example, in the previous example, the regular expression matches “A9b3,” but not “9Ab3” because the alphabet is given first in the two-atom branch of [A-Za-z][0-9].

Regular Expressions

A regular expression is a branch, or any number of branches separated by a “|” (vertical bar). A string is said to match the regular expression if it is generated by the “program” specified in any of the branches. Of course, a string can be generated by more than one branch. For example, “abc” is generated by all branches in the regular expression

abc|a*(bc)+|(ab)?c|.*

Also remember that if a regular expression can match two different parts of an input string, it will match the earliest part first.

The regular expression support and the technical information for this portion of the documentation is based on Henry Spencer’s public domain *regrep(3)* library package.