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United States Patent [19]

Varghese et al.

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[45] Date of Patent: Jan. 4, 2000

[54] **METHOD AND APPARATUS FOR FAST HIERARCHICAL ADDRESS LOOKUP USING CONTROLLED EXPANSION OF PREFIXES**

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[73] Assignee: **Washington University**, St. Louis, Mo.

[21] Appl. No.: **08/821,100**

[22] Filed: **Mar. 20, 1997**

[51] **Int. Cl.**[7] **H04L 12/46**

[52] **U.S. Cl.** **370/392**; 370/401; 395/200.75

[58] **Field of Search** 370/392, 393, 370/401, 402, 403, 404, 405, 466, 467; 395/200.68, 200.75

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Attorney, Agent, or Firm—Howell & Haferkamp, L.C.

[57] **ABSTRACT**

Many network protocols, including the Internet, have addresses that are structured hierarchically. The hierarchy is expressed by an address prefix P that represents all addresses in the given hierarchical level that starts with prefix P. The hierarchy is not strict and can be overridden by more inclusive hierarchies. This is achieved by having network routers find the longest prefix that matches a destination address in a message.

The disclosed invention describes a method and apparatus for implementing controlled expansion: for expanding a set of prefixes into an equivalent (possibly larger) set of prefixes that have a smaller set of prefix lengths. The new set of prefixes can then be looked up significantly faster using any technique whose speed improves by reducing the number of prefix lengths. Our invention also incorporates fast techniques to insert and delete new prefixes, and a technique of pointer hoisting to halve the memory READs needed for trie search. Our solution to longest matching prefix also applies to other routing protocols such as OSI Routing, call routing in telephone networks, and to string matching problems.

20 Claims, 10 Drawing Sheets

	Prefix	Link
P1	01*	L1
P2	1*	L2
P3	10*	L3
P4	101 *	L2
P5	100 *	L6
P6	10111 *	L2

Old Prefix	New Prefix	Link
P2	110*	L2
P2	111*	L2
P1	010*	L1
P1	011*	L1
P4	101*	L2
P5	100*	L6
P6	101110*	L7
P6	101111*	L7

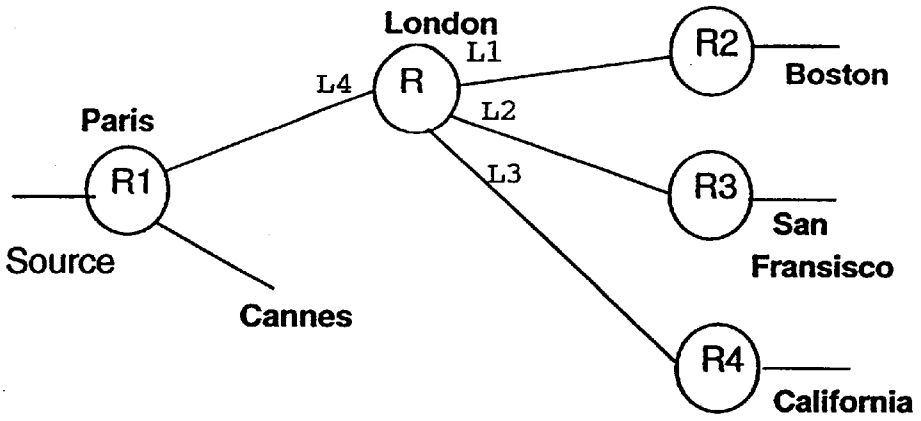

FIG. 1

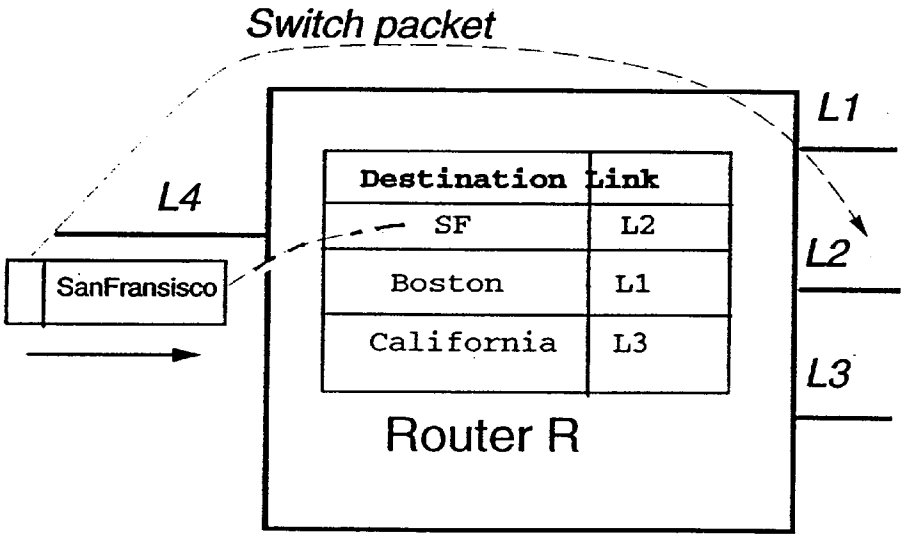

FIG. 2

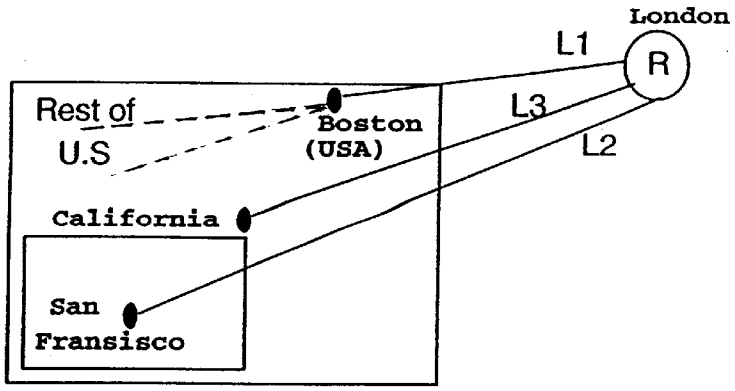

FIG. 3

Destination	Link
USA.CA.SF	L2
USA	L1
USA.CA	L3
USA.MA.Boston	L2

FIG. 4

	Prefix	Link
P1	01*	L1
P2	1*	L2
P3	10*	L3
P4	101 *	L2
P5	100 *	L6
P6	10111 *	L2

FIG. 5

Length 1	1* L2	
Length 2	10* L3	01* L1
Length 3	101* L2	100* L2
Length 5	10111* L7	

FIG. 6

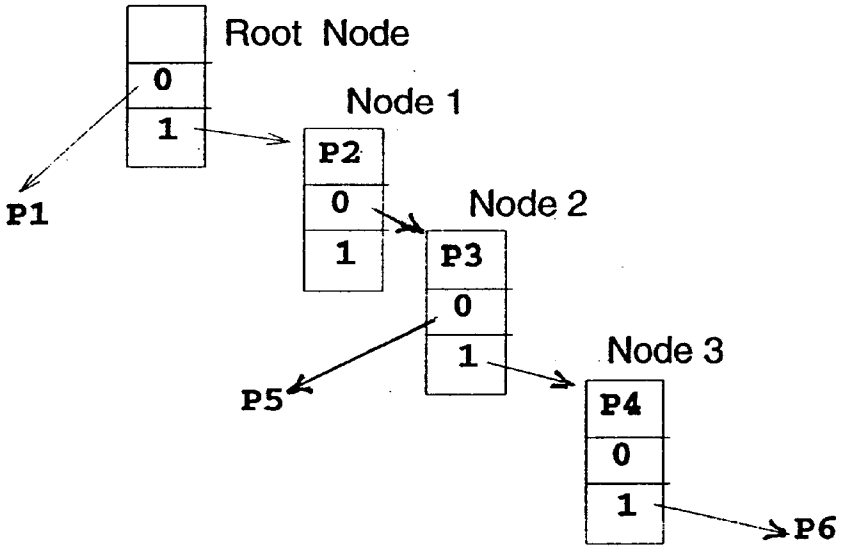

FIG. 7

Old Prefix	New Prefix	Link
P2	110*	L2
P2	111*	L2
P1	010*	L1
P1	011*	L1
P4	101*	L2
P5	100*	L6
P6	101110*	L7
P6	101111*	L7

FIG. 8

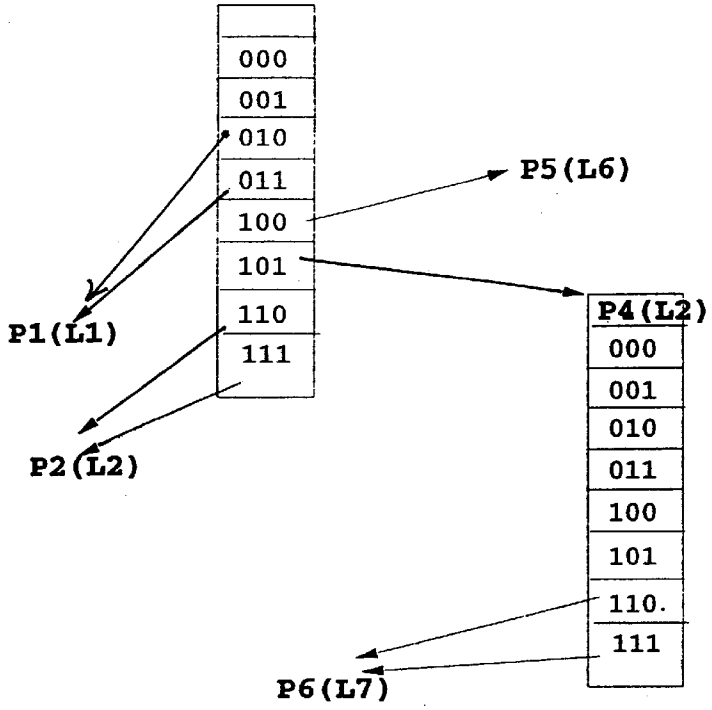

FIG. 9

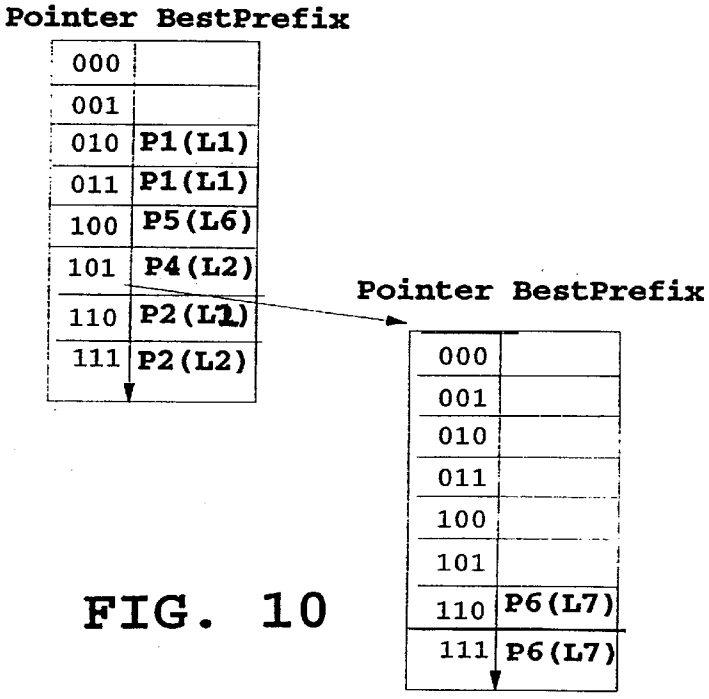

FIG. 10

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