1. Introduction

This document defines the NetWare® Link Services Protocol™ (NLSP™) specification, which provides link state routing for Internetwork Packet Exchange™ (IPX™) networks. Routing is the function in network computing that accomplishes two objectives:

- End-to-end delivery of data traffic over an internetwork; an internetwork contains disjoint media segments, so traffic must be relayed from segment to segment to reach its destination.
- Accommodation to the characteristics of the diverse underlying data-link transmission media; the links used in modern networks vary dramatically, and routing smoothes over the differences for the benefit of more general-purpose software components.

Routing is a software function. In this document, a *router* refers to a specialized network node, but a multipurpose system can offer both routing functionality and other kinds of service simultaneously. For example, file service, electronic mail, gateway to mainframe systems, hub, and network management. For brevity, the term *router* indicates a network node that runs routing software, even if it is a multipurpose system.

A router attaches to two or more disjoint segments and forwards data traffic as needed from one segment to another. It exchanges information with other routers to acquire sufficient information to make the best forwarding choices.

NLSP is (essentially) a protocol for information exchange among routers geared to the needs of large IPX internetworks. IPX is the Network-Layer protocol used by the Novell® NetWare network operating system, and by the compatible products of other system providers.

NLSP incorporates the *link state* approach to network-layer routing that is being adopted broadly in the industry. Link state routing can be hierarchical; networked systems are grouped into routing areas and areas are grouped into routing domains. Hierarchy promotes scalability. This specification covers the first level, Level 1 of the hierarchy—the protocol for operation within a routing area. Subsequent specifications will expand the scope to cover hierarchical operation.

1.1. Document Organization

This document is for network software developers who build implementations compatible with Novell's NLSP products.

Section 2 provides an overview of the NLSP design. Reading it provides necessary background for the details covered later.

The subsequent sections specify the protocol and procedures in sufficient detail for implementation. Each contains a *Database* subsection (where applicable), describing constants, configurable parameters, and dynamic values pertinent to that part of the design. The specification in each chapter uses the database items defined not only in

that chapter but in previous chapters—the databases are cumulative. Where relevant, each concludes with a *Packet Structures* subsection specifying the formats of messages exchanged among routers.

Section 3 documents the IPX WAN version 2 (IW2) protocol, which specifies initial connection setup methods for various WAN media. It has relevance not only to NLSP, but also to other IPX routing protocols.

Section 4 covers the local database each router maintains to describe the router's immediate neighborhood, and covers the protocol exchanges that take place with neighboring routers to keep the information current.

Section 5 describes methods for the “immediate neighborhood” information to be disseminated throughout a routing area. The routers cooperate to ensure that they keep a consistent, up-to-date representation of the state of all routers and links in the area; hence the name “link state.” From the representation, they can make informed decisions about how to forward data traffic.

Section 6 describes the Decision Process, which uses the link state representation to decide the best paths for forwarding data traffic to all destinations accessible in a routing area.

Section 7 covers compatibility with the previously existing RIP and SAP protocols. These two protocols have been used pervasively in IPX internetworks for routing and resource location. With NLSP, they continue to be the protocol used for communication between end nodes and routers. Moreover, for communication among routers, there is a compatibility specification enabling NLSP routers and RIP routers to coexist constructively.

Section 8 itemizes the network management aspects of NLSP operation. The specification there identifies Management Information Base (MIB) variables accessible to management stations from NLSP routers. The MIB supports configuration, monitoring, and troubleshooting.

Section 9 lists design differences between NLSP and the ISO 10589 IS-IS Standard. The core design of NLSP is based on IS-IS, which is familiar in the industry.

Section 10 describes the framing of IPX packets on LANs. It covers the three most common standard media: CSMA/CD, token ring, and FDDI.

Section 11 is a bibliography. References cited in the body of the specification are listed there.

1.2. Typographic Conventions

In this specification, new and important terms and concepts appear in *italic* type when introduced for the first time.

Protocol constants and management parameters appear in sansSerif type with multiple words run together. The first word is lowercase. The first character of each subsequent word is uppercase.

Protocol field names appear in Sans Serif type with embedded spaces and with the first character of each word uppercase.

Descriptive values of constants, parameters, and protocol fields appear enclosed in "double quotation marks." For example, with electric switches:

0 = "Off"
1 = "On"

Patches of pseudocode are in `monospace type`. Unless otherwise specified, arithmetic is performed using non-negative integers, with remainders truncated on division.

Hexadecimal values are preceded by "0x". Numbers appearing without such qualification are decimal. For example, 17 = 0x11.

In diagrams, this document uses a diamond-shaped symbol to represent a router, a horizontal or vertical line to represent a LAN, an oblique line to represent a WAN, and a cloud to represent a collection of networks whose internal organization is not applicable to the immediate discussion. See Figure 1-1.

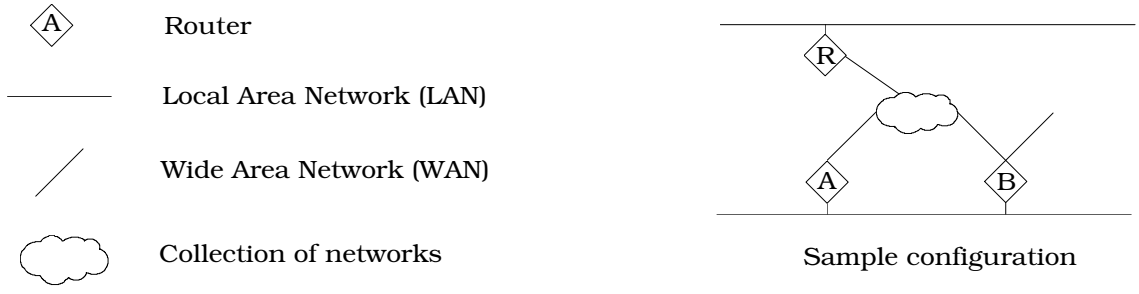

Figure 1-1: Diagram Conventions