The Learning Network of Minnesota
Blueprint for Higher Education

Introduction

From its beginning in 1993 as an effort to provide network connectivity for public post-secondary institutions, the Learning Network of Minnesota (LNM) is the educational component of Minnesota’s integrated statewide network. In 1995 this effort was linked to an initiative to provide network connectivity for public school districts and libraries. In 2000 a joint powers agreement entered into by the University of Minnesota, the Minnesota State Colleges and Universities (MnSCU), and the Minnesota Office of Enterprise Technology formalized the needed cooperative efforts for building, maintaining, and managing the integrated state network. The three cooperating entities developed the original Blueprint document to serve as a source of awareness and as a guide as they engaged in collaborative efforts. The document summarizes current technology standards, outlines network goals, and establishes standards for ongoing participation in the network.

The higher education portion of the Learning Network of Minnesota has two primary parts:

- **Campus Networks**, which are developed and managed by the individual institutions with support from their respective systems.

- **The Statewide Network**, which is developed and managed in partnership with University of Minnesota, Minnesota State Colleges & Universities, private higher educational institutions, the six higher educational telecommunications regions, and the Minnesota Office of Enterprise Technology.

The six telecommunications regions provide for institutional and campus-based decisions within their region. Each region is governed by a board made up of individuals from the region’s member institutions. Regional representatives, together with representation from the University of Minnesota, Minnesota State Colleges & Universities, and representation chosen at large make up the Learning Network of Minnesota (LNM) Board of Directors. This Board, operating within the scope of its Charter, provides administrative and fiscal oversight of funds appropriated by the Legislature in support of the LNM,
establishes policies concerning the overall Learning Network, and advocates for the LNM in the Legislature and in other public policy making forums.

As part of its responsibility to establish policies for the LNM, the LNM Board, working with the statewide network partners, has incorporated the Blueprint for Higher Education as a part of its governing documents.

**Principles**

Through increased collaboration and cooperative efforts among its core members and with various public and private partners, the LNM is committed to providing lifelong learning opportunities through access to broadband networked services and applications to all public higher education locations within the State of Minnesota. Through public and private partnerships, the LNM leverages its available funding to improve not only its ability to deliver quality distance learning but also aids other organizations in their missions. Its member contracts with the Minnesota Office of Enterprise Technology and with telecommunications companies often set the LNM as the anchor tenant for new high bandwidth connectivity. These contracts provide the incentive for improvements in bandwidth and connectivity throughout the State, including previously underserved regions. The LNM believes that high bandwidth data communications is essential to the delivery of classroom content to students and it is essential to the economic and social wellbeing of our society.

**Goals**

The principles of the LNM shall be realized by working toward the following goals:

- The LNM shall enable and support the delivery of academic content on demand without regard to the traditional limits of place and time.
- The LNM bandwidth shall be maximized and a minimum data speed of 1 Gbps shall be delivered to all sites when practicable.
- The LNM shall be fully integrated and all technologies deployed shall be complementary and interoperable.
- The LNM will continue to press for full integration and interoperability, while recognizing the organizational autonomy of individual institutions.
• The LNM will encourage cooperation and collaboration with all E-12, public, non-profit, academic, and research organizations when these partnerships are of mutual benefit and comply with goals of the LNM.

• The LNM will encourage application and network peering with other national and international education and research networks (such as Internet 2), including regional commercial and non-profit organizations when such arrangements are of benefit and comply with its other stated goals.

• The LNM will encourage the advancement of technology by funding pilot projects and experimentation, as funding allows.

• The LNM will support the State of Minnesota’s Broadband initiative as defined by Minnesota Statute 237.012 as it leverages its resources through partnerships within its membership and with the Office of Enterprise Technology and private entities.

• The LNM resources shall either be shared among members or controlled and used solely by an individual member, but in all cases the disposition and acquisition of resources shall provide optimal service and support to members and students while taking advantage of the economies of scale.

Outcomes

The following outcomes shall be achieved upon the successful pursuit of the LNM goals:

• There shall be a standardization of technology within the LNM, as well as a commitment to universal access to network services and to leading edge technologies.

• LNM contracts shall be coordinated as follows:
  o Contract specifications shall be written to ensure that the goals of full integration and interoperability are met.
  o Contracts shall be coordinated to minimize cost.
  o Contract term lengths shall be coordinated to allow the orderly transition to new technologies.
  o Contracts for circuits and broadband services shall be reviewed by the LNM regional coordinators and the system CIO’s prior to commitment.
  o The Joint Powers Technical Committee shall be given adequate advance notice of pending contracts and requests for proposals (RFP) and consulted.

• All funds appropriated for use by the LNM shall be expended in a coordinated manner to ensure maximum efficiency and to minimize the duplication of effort.

• The LNM regional and system networks shall be integrated by sharing transport facilities, hardware, and common technologies when and where practicable.

• All LNM systems, appliances, and applications shall be interoperable and integrate seamlessly.

• Directory and authentication systems within the LNM shall be integrated.

• All new LNM systems, appliances, and applications shall be tested for interoperability.
To ensure that the LNM remains current and viable, IP version 6 shall be implemented within the appropriate timeframe and method as required.

**Future**

The Learning Network of Minnesota is not static. It is a dynamic and growing entity whose existence is not dependent on the present. Rather, it is a creature of the future. The outcomes noted above may provide the services we need today, but the LNM must to be constantly aware of future needs, of the technology changes which will meet these needs, and of the need to be nimble enough to exploit these new technologies. When addressing issues of the future, the following criteria shall be employed:

- The Joint Powers Technical Committee and the LNM Board of Directors shall review and approve the deployment of future technologies and/or standards.
- Future technologies will be tested and analyzed for their ability to interoperate and integrate with existing technologies prior to deployment on the LNM.
- The Joint Powers Technical Committee and the LNM Board of Directors shall insure that all future technologies being deployed on the LNM adhere to the published standards of the various internationally recognized standard setting bodies, including but not limited to the following: the IETF, IEEE, ITU, DIN, and OSI.
- Future technologies deployed on the LNM will fully support location independent service delivery.

**Responsibilities**

The responsibility for technologies deployed in the LNM is shared among all associated members as follows:

- The **LNM Board of Directors**, in accordance with its Charter, shall be responsible for approving the Blueprint, monitoring changes made to it, and overseeing the implementation of the Blueprint.
- The **LNM Administrator**, as the executive representing the LNM Board of Directors, shall be responsible for communicating to the LNM members the Board’s will regarding the implementation of the Blueprint.
- The **LNM Fiscal Agent** shall have the responsibility of monitoring the expenditures of LMN funds to ensure that such expenditures conform to the desired outcomes of this Blueprint.
- The **LNM Regions**, as governed by their individual boards of directors, shall adhere to the outcomes as described in the Blueprint.
• The **Regional Directors** shall be charged with the individual responsibility to inform their Boards of Directors of the contents of the Blueprint, the impact the Blueprint will have on the requirements of a particular region, and how best to proceed with the development and deployment of technologies within the region.

• The **Joint Powers Technical Committee** is made up of representatives from the University of Minnesota, MnSCU, the Office of Enterprise Technology, and from the LNM regions. In addition to its responsibilities already outlined, the Joint Powers Technical Committee shall be an advisory resource to the LNM Board of Directors and to the LNM members.

### Summary

The Blue Print document was written for the purpose of serving as a source of awareness regarding the technology construct of the Learning Network of Minnesota. It is meant to be used as a guide for the continuous development and future design upgrades for the LNM network. The document summarizes current technology standards, outlines network goals and anticipated outcomes, and establishes standards for ongoing participation and further development of the network. The Blue Print is adopted by the Learning Network of Minnesota Board of Directors, the six regional Boards of Directors, and the three-way partnership among the University of Minnesota, the Minnesota State Colleges & Universities, and the Office of Enterprise technology as the primary reference for the ongoing development of the LNM network. These entities require a continuous review of the standards and guides put forth in this document in order to address on-going changes in the technology frontier.
Appendix A

Definitions

- **BGP** refers to the Border Gateway Protocol version 4 routing protocol defined by RFC 4271 of the Internet Engineering Task Force (IETF).

- **Data frame** refers to the sequence of bits forming the data network’s transmission unit as defined by the various standards employed.

- **Ethernet** is the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) network standard as defined by IEEE 802.3; operating at data rates of 10 and 100 Mbps and 1 Gbps.

- **HD-Video or HD** refers to high definition video which provides video resolutions in excess of the NSTC standard; these would include VGA, SVGA, XGA, 780p, and 1080i/1080p.

- **IP** or Internet Protocol is the address control protocol within the TCP/IP suite, IPv4 (IP version 4) is designed around a 32 bit address scheme, IPv6 (IP version 6) is designed around a 128 bit address scheme; each protocol is implemented using its own routing and data frame characteristics as defined by their own unique design.

- **ITV or Interactive Television** refers to an interactive video/audio delivery application employing high or standard definition cameras and displays and a single data stream to give participants an interactive video and audio experience with others who are present at a remote location or at several remote locations.

- **MPLS** or Multiprotocol Label Switching refers to a scheme by which multiple virtual networks can be provisioned and routed across a single high bandwidth connection.

- **Telepresence** refers to an interactive video/audio delivery application employing high definition cameras and displays, specific facility design, and multiple independent data streams to give the participants an enhanced video and audio experience allowing the sense that they are in the presence with participants at a remote location or at several remote locations.

- **TCP/IP** is that evolved suite of communications protocols now prevalently in use on nearly all local, campus wide, and wide area networks.

- **TCP** or Transmission Control Protocol is the transport protocol in use within the TCP/IP suite used for the normal transmission of most data in non-real-time applications and where reliable data frame delivery is required; the protocol design of TCP itself provides for transport reliability.

- **UDP** or User Datagram Protocol is the transport protocol in use within the TCP/IP suite most often used for the transmission of real-time data streams (such as in voice and video applications); rather than relying on the transport protocol itself for reliable transmission of data, UDP streams are often prioritized on the network.

- **VLAN** or Virtual Local Area Network refers to an overarching technology defined by the IEEE 802.1q and IEEE 802.1p standards. These standards allow the configuration of multiple logical networks to exist on a single physical network. Logical networks are defined by a “tag” or bit sequence inserted into the data frame in accordance with the 802.1q standard. The defined logical network’s traffic is prioritized in accordance with the 802.1p standard by setting bits within the tag to define a priority level relative to that of other logical networks defined within the single physical network.
Appendix B:

Current Technology Standards

- Public higher education presently shares a common wide area network backbone managed primarily by the Minnesota Office of Enterprise Technology under the advisement of the Joint Powers Technical Committee.

- The current wide area network backbone supports an integrated selection of voice, video, and data applications.

- The wide area network transport is based on a MPLS scheme and the TCP/IP protocol over a largely 1Gbps Ethernet backbone.

- The wide area network employs IP version 4, migrating toward IP version 6, employs BGP routing between autonomous networks, and is multicast capable.

- The wide area network has many redundant paths and hubs within its core and also has power and hardware redundancy where practicable.

- The local area networks are the responsibility of individual learning network members and are based on Ethernet with TCP/IP network and transport support for applications.

- Real-time applications such as video and voice based on H.323 and SIP standards and proprietary schemes are supported.

- QoS on the wide area network is provided via DSCP and priority queuing.

- QoS is extended to the local area network via prioritized VLANs trunked across the network or via a separate physical infrastructure.
Appendix C:

Peering Standards

- The peering requirements apply to all organizations who wish to peer with the organizations operating under the joint powers agreement; therefore, by definition, the organizations within the joint powers agreement are exempt from these requirements.

- The organizations operating under the joint power agreement have peered with Internet 2 under the requirements of Internet 2 and therefore as an organization these peering requirements are waived for Internet 2.

- The Joint Powers Technical Committee shall be responsible for the specification, overseeing the implementation of, enforcing, and modifying these requirements.

- The requirements for peering are as follows:
  - All peering must include the IP version 4 protocol and should be capable of implementing IP version 6.
  - All IP version 4 addresses will be public and be of network blocks of size /24 or larger.
  - Private address spaces as defined by IETF RFC 1918 may not be used.
  - IP version 6 addressing may be used, but coordinated by the Joint Powers Technical Committee.
  - Peering via non-IP protocols will not be done.
  - Traffic filtering may not occur at the peering point; however filtering may occur elsewhere on an organization’s network.
  - Peering partners must have their own Internet service, the LNM does not provide non-members with commodity Internet service.
  - Peering partners must connect at DS3 speeds or higher.
  - Peering partners must use BGP as the routing protocol.
  - Peering partners will be responsible for all setup costs incurred.
  - Peering partners must have a 24x7 support solution, reviewed and approved by the Joint Powers Technical Committee, for trouble report and resolution procedures.

- If an organization would like to peer with the joint powers organizations at the application level, the organization shall coordinate such peering with the Joint Powers Technical Committee. The Joint Powers Technical Committee may decline such a peering request should it jeopardize the overall performance of the Learning Network. One example of application level peering would be to provide QoS for real-time applications across a peering point.