

# **Connecticut Education Network**

## **Network Architecture Policy**

### **Architecture Policy Preface**

This network policy is written to address the fundamental goal of C.G.S. §4d-80 in creating a Commission for Educational Technology is to enhance significantly the learning environment in Connecticut by identifying and deploying opportune network-based technology.

The primary emphasis is on a developing pedagogy: everything done at the network level is in support of educational applications and new learning paradigms. It should be stressed that the work of the Network Committee is derivative in nature. The driver is the educational requirement. For CEN (the Connecticut Education Network) to realize its full potential an aggressive examination of what it means to learn and to educate in a technologically-rich, networked environment is critical. The Network Committee needs to understand what educators require and educators need to understand the gestalt of learning in a networked environment.

For this reason CEN should be conceived and developed as a single entity through all layers of the network stack from physical fiber through end-user application.

### **Connecticut Education Network Architecture**

Network architecture is defined as the underlying design upon which engineering implementation is based. The architecture is meant to be stable and relatively long lasting. Network engineering, in contradistinction, is meant to be implemented on a just-when-needed basis and will be a constantly evolving process.

CEN architectural requirements form a matrix derived from its multiple constituent classes and, in turn, their requirements. Physically, the traffic from K-12, the libraries and Higher-Education all benefit economically from transmission across the same converged network, but each must be separable logically in order to respond to differing application demands and security needs. In addition, the architecture needs to allow for scalable engineering capable of transmitting applications as yet not even conceived.

VOD or video-on-demand is often cited as an example of a new pedagogic tool. A potentially immense amount of previously broadcast or supplementary material not originally broadcast or even primary research material is available for streaming into the classroom at the teacher's demand. Each of the major network constituencies may have different filtering requirements and each may have widely varying technical aims. K-12 may wish to emphasize appropriate material. The libraries may want to ensure compatibility with their global peers in ways not yet even known. Higher-Education may want very high data rates for extreme visual fidelity. What may seem to be very high bandwidth today will likely be common place in a few years and applications soon to come will almost certainly consume significantly more bandwidth. The engineering implemented today needs to be capable of a many-fold bandwidth increase with a minimum of disruption. This argues for a geometrically simple layout using modular network electronics such that cards can be updated without replacing entire devices. It also argues for long term compatibility with a two-tier transmission model of IP/Optical or Internet Protocol for global logical connectivity and Optical multiplexing at local logical and physical levels.

Beyond simple bandwidth growth it is expected that network electronics will increasingly prioritize and shape traffic. Applications with no tolerance for delay such

as interactive video or voice over the network will be transmitted first while email may be buffered briefly without negative impact. In the long term it is expected that all transmission will be shaped automatically based on policy directives entered into policy servers queried by routers at sensitive intersections. Given the early development state of enabling software, usually referred to as middleware, we will likely start with a network requiring some manual intervention to support real-time applications and move as quickly as the market allows toward a completely converged and dynamically prioritized data, voice and video configuration. The rapid evolution of network applications and middleware serve to highlight the dynamic nature of contemporary networks. For this reason CEN will be an ongoing project. Educational technology and new learning paradigms have only begun to be explored. Moreover finding a reasonable path through the plethora of new technologies will require that some portion of the Network be designated for testing and development. The goal of testing and development is to minimize the number of technology direction changes that are required and still make cutting edge applications available for classroom and home use.

Time is also an architectural dimension. The intention of the Network Committee is to extend the learning opportunity effectively to 24 by 7. Whenever a student wants to learn, the network will be available. Remote access will therefore be necessary. The goal is to provide a single authentication/authorization step that will allow the user to access all of the resources to which she is entitled, wherever they may be located on the Connecticut EdNet. For example, this would potentially allow learners online access to all of the 1,200 journals available through the Connecticut library system.

### **Architectural Policy**

- 1) The Department of Information Technology will create a well-ordered and stable long term design.
- 2) The Department of Information Technology will implement an engineering plan derived from the architecture on a just-when-needed basis.
- 3) The Department of Information Technology will design and create a test-and-develop sub-network on which emerging network-based software enabling applications can be implemented safely.
- 4) The State Department of Information Technology will purchase will develop a secure user authentication and authorization system which in turn will enable 24X7 remote usage.

### **PERFORMANCE**

In any finite system some resource will be a limiting factor. In this network, it should not be the core. The center of the network should be constraint-free. The practical consequence of such architecture is that the core should be engineered for peak usage and not the more common average usage. It should also be engineered such that the inevitable increases in bandwidth demand can be accommodated without major re-design and in a timely manner.

The engineering reality today is that district-core access connections will need to be accomplished on a best practical effort basis. Experience shows that this is a likely place for congestion to occur. Minimum standard connection guidelines will be

published to help assure that anticipated applications will function as expected and the Network will be monitored to identify and correct problems as they occur.

### **Performance Policy**

1. The Department of Information Technology will engineer the core network for peak usage.
2. The Department of Information Technology will publish Best Current Practice connection guidelines.

### **OPERATIONS**

NOC (Network Operations Center) functions will be maintained by the State Department of Information Technology. Typically, NOCs are responsible for connection installation, monitoring, maintenance and reliability. Conventionally, they configure, and upgrade as appropriate, network electronics. NOCs also commonly maintain help desks, which users with problems can call.

To facilitate stability on the Network connecting locations will be asked to sign a cooperative bilateral agreement assuring reliable service and will be expected to comply with NOC requests affecting network performance and reliability.

It is intended that core network performance will be openly available in realtime to the user community via the web. Connecting locations are encouraged to make similar information available at their discretion. The NOC and/or members of the Network Committee will provide technical assistance if requested.

Reports reflecting the state of the Network will be made available periodically in written form. Such reports will include unscheduled outages, average and peak usage, and changes of note but will also focus on how the Network is meeting its original charge from the Commission. Simply put, reports will describe the state of the network.

### **Operations Policy**

1. The State Department of Information Technology will build and maintain a Network Operations Center and help desk.
2. The State Department of Information Technology will purchase and/or The Department of Information Technology will develop a publicly available system showing network performance.
3. The State Department of Information Technology will publish periodically a report on the state of the network.

NOTE: Responsibility for all of the tasks in the Operations section has been accepted by the State Department of Information Technology.

### **TECHNOLOGY**

In order for a network to function there needs to be conformity at the basic protocol levels. On CEN the bearer protocol will be IP. Routers will not be configured to bridge local protocols. Distributed locations may tunnel such protocols with the consent of the NOC and the Network Committee.

Network traffic will be routed dynamically both internally and externally via one of the major routing protocols such as Border Gateway Protocol and Open Shortest Path First. Additional routing protocols will be adopted as necessary Applications, however, do not necessarily need to be uniformly adopted. Even so, to promote maximum interoperability, locations are encouraged to utilize products based on standards supported by a major sanctioning body such as the International Telecommunications Union or the Internet Engineering Task Force.

While we expect locations to explore new and creative uses of CEN, the NOC should be notified of and permission requested for any application that might interfere with overall network stability or transmission. To minimize the potential for disruption locations might be asked to locate experimental applications on the test and development overlay segment. Should the NOC determine that an application is interfering with network reliability or transmission it may require that a location stop transmitting an application across the network core until the problems are corrected. Every reasonable effort will be made to accommodate new applications and help resolve problems.

Applications intended for general use should be located at the core of the Network with the consent of the NOC and the Network Committee.

Multi-homed locations are defined as networks with more than one wide area network connection. In general locations will not be permitted to multi-home their networks because of the complexity in troubleshooting and the high risk of routing errors. Exceptions may be made in extreme circumstances at the discretion of the NOC and the Network Committee.

The Network Committee will undertake to write and update "Best Current Practice" documents as it deems necessary and at the request of the community where practical.

## **Technology Policy**

- 1) The Internet Protocol (IP) will be the bearer protocol.
- 2) The network routing electronics will employ dynamic, standards-based routing protocols.
- 3) The Network Committee encourages software based on open standards.
- 4) The Network Committee encourages innovative application development in cooperation with The Department of Information Technology and the State Department of Information Technology.
- 5) The Network Committee discourages the practice of multi-homing.
- 6) The Department of Information Technology will publish Best Current Practice documents as necessary.

## **SECURITY**

The State Department of Information Technology will take appropriate measures to keep the network secure. These include providing protection from computer viruses, unauthorized viewing or altering of data/sites, and other internal and external attacks.

### **Security Policy**

1. The State Department of Information Technology will purchase software develop strategies which defend successfully against attacks on the network.

2. The NOC is explicitly given the authority to maintain an orderly flow of traffic on CEN. In an emergency circumstance the NOC is empowered to isolate offending traffic temporarily at the most local feasible point. Any such action shall be reported to competent authority promptly.
3. The State Department of Technology and the Network Committee will jointly form a Security Group and charge it with direct oversight of active security issues and investigations.

### **ACCEPTABLE USE**

The State of Connecticut's Acceptable Use Policy will prevail as the default for all persons using the Network.

The State Department of Information Technology is responsible for providing a content screening mechanism that can be configured to permit individual locations to limit traffic or usage based on local preference.

Individual locations are free to create their own AUPs by adding to the State of Connecticut's AUP whatever further clarifications or restrictions they deem proper.

The Network Committee will make available sample versions of AUPs with age-appropriate language for elementary and secondary school students. Schools are strongly encouraged to distribute an age-appropriate AUP to all students and obtain student and/or parental signatures as agreement for AUP compliance.

### **Acceptable Use Policy**

- 1) The State Department of Information Technology will provide content screening software capable of implementing the Connecticut State Acceptable Use Policy and also giving further control to individual districts for all traffic entering CEN from external source
- 2) DOIT will create age-appropriate versions of the State Acceptable Use Policy.
- 3) Directly connected members of CEN are expected to provide class-appropriate content. Same class internal traffic (e.g., K12 to K12 or Higher Ed to Higher Ed) will not be screened by CEN. Inter-class internal traffic (e.g., Higher Ed to K12) may be screened for content acceptability by CEN and all traffic can always be screened by the involved districts, at their discretion.
- 4) The Department of Information Technology and the NOC will limit traffic on CEN to those protocols which can be screened effectively.