1. Overview:

Dynamic Circuit Networks [1] is used to create dynamic circuits of desired bandwidth between two endpoints. This virtual circuit can be created for a short duration from any start time to end time. This virtual circuit is more reliable and flexible in terms of bandwidth specification between a source node and destination node in the network. Scientific applications such as Large Hadron Collider and other projects which involve collaboration between researchers at distributed locations can create short and scheduled bandwidth connection over the backbone network.

Creation of virtual circuits across various domains requires coordination of the participant domains. A control plane software is used to achieve this coordination across domains along with required authentication and authorization mechanisms. Projects such as DRAGON (NSF) [6,7], OSCAR (ESnet) [9] and GEANT2 [5] AutoBAHN have developed their own control plane software for this purpose. GLIF is involved in a development of an inter-domain protocol along with various other research organizations.

ION [1] (Interoperable On-demand Network) is a new name to DCN after it went into production in fall 2009. It leverages the existing control plane work with a simplified web application to instantiate circuits on the Internet2 dynamic circuit fabric. In this document we use the term DCN/ION to refer to the same service.

2. DCN/ION in Internet2

The DCN can be used to create end-to-end virtual circuits across the Internet2 [2] backbone. This control plane software automates the setup and tear down of these dynamic circuits. DCN control plane software suite is an open source and it includes both the software developed by DRAGON and also the OSCAMS software developed by ESnet.

The DCN control plane software can also used by other institutions to use in their own network. An institution connecting to DCN is called an Internet2 Connector. An Internet2 connector connecting to DCN not only has the provision to create dynamic circuits across the Internet2 backbone but also to the other regional optical networks and other global and national networks such as GEANT2 in Europe and ESnet in USA.
An institution can connect to DCN using the following approach. A two-step approach is followed in which the first step is to create a data connection to DCN and the connector uses this static connection to enable its users to connect to the DCN. The second step is to have a DCN domain on its own and switching the users dynamically to Internet2 DCN. The following is the detailed explanation of the above two-step approach.

### 2.1 Stage 1

![Image](http://www.internet2.edu/pubs/DCN-howto.pdf)

Figure 1: Stage 1 of DCN in Internet2

In this stage an Ethernet switch is used at the Internet2 PoP to connect to DCN. Static VLANs are created in the Ethernet switch so that a user from the institution can create the DCN circuit using the predefined VLAN to the Internet2. In this case the virtual circuit originates from the edge of the Ethernet switch. If the user wishes to create multiple VLAN circuits to DCN from his/her institution, required VLANs are added to the Ethernet switch to facilitate this.
2.2 Stage 2

If the demand of circuits increase in the local institution it might not be possible to create that many static VLANs in the Ethernet switch. Hence, to meet the demand the local network might be converted to a local DCN domain using its own DCN software to create dynamic circuits within the domain. In this case the regional domain has its own IDC interacting with the IDC of the Internet2 to create circuits across the domain. The user interacts only with the IDC of his domain.

3. DCN in GpENI

The Ciena CoreDirector [8] Optical Switch in Kansas City PoP is connected to the Internet2 network infrastructure and hence this can act as a gateway for GpENI [4] to connect to the Internet2 infrastructure. This document just focuses on establishing the local or regional dynamic circuit domain in GpENI as mentioned in the stage 2 above. Later on it can further proceed to use the Ciena CoreDirector in Kansas City PoP to establish DCN circuit from GpENI to several sites in the Internet2. In the following document we first explain the current network infrastructure of the GpENI and the changes needed in the current infrastructure to establish DCN across GpENI.
3.1 Current GpENI Network Configuration

GpENI's basic connectivity currently is designed as a single Ethernet broadcast domain capable of transporting arbitrary VLANs. All the four GpENI universities (UNL, KSU, KU, UMKC) are connected to their own interface in GPN Cisco 6509 Ethernet switch (GPN Switch) in Kansas City PoP and all these interfaces are configured to the same VLAN number 125. UNL has direct fiber connection of capacity 1GigE to the GPN switch transported through Ekinops DWDM equipment. UMKC connects to the GPN switch using L2TP tunneling through MOREnet infrastructure. KSU and KU form a single MPLS domain in the KanREN network infrastructure and are connected to the GPN switch through VPLS. The CoreDirector CI switch connects to Internet2 is also connected to the GPN switch using a 10GigE link.

Each university has a Netgear GSM7224 switch and a node cluster connected to the switch. We have modified the DCN software suite to support the Netgear GSM7224 switch. Hence we can create dynamic circuits between the universities with DCN software running over these switches if the infrastructure in Kansas City PoP supports it. The limitation is that, as these Netgear switches do not have per-vlan bandwidth policing feature, they do not have the capability to create circuits of specific bandwidth as requested by the user.
3.2 Option 1: GpENI Network Connectivity with DCN (using GPN switch)

The GPN switch is a production switch that carries traffic between the four GpENI universities and is also not supported by the current DCN/ION software suite. This option analyses the possibility of using the GPN switch for creating DCN circuits between GpENI universities. There are two ways (1(a) and 1(b)) in which the GPN switch can be configured to enable DCN circuits between GpENI universities.

One way (1(a)) is to configure static VLANs over the GPN switch so that DCN circuits can be created between universities only with the pre-configured VLAN tags. Hence this involves creating a table of VLAN tags for all possible source and destination of DCN circuits between GpENI universities and configuring them appropriately in the GPN switch. In this case the IDC and two VLSRs: one for controlling the Ciena CoreDirector CI switch in UNL and another for controlling all the Netgear GSM7224 switches in all the GpENI universities, will be located in the UNL. Hence we will be able to create, delete and modify dynamic circuits over the web interface provided by the DCN/ION software suite between these universities.

Another way (1(b)) is to configure Q-in-Q cloud in the GPN 6509 switch with VLAN 125 so that it acts as a pass through for packets of any VLAN tag generated by any of the GpENI universities. Hence in this case also, the IDC and two VLSRs will be placed in the UNL, but the only difference is that we
will be able to create circuits of arbitrary VLAN tags between the GpENI universities. Though the advantage of this method over the previous is the freedom of choice of VLAN tags, the drawback is that, because of the Q-in-Q cloud the packet transmitted by any university will be broadcasted to all the 4 GpENI universities.

3.3 Option 2: GpENI Network Connectivity with DCN (using GpENI switch)

This option requires acquiring a new Ethernet switch (GpENI switch), which is already supported by the DCN/ION software suite and replacing the existing GPN switch with the GpENI switch. Hence this option requires all the 4 GpENI universities to have a layer 2 connectivity to the GpENI switch and one interface of the GpENI switch will be connected to the GPN switch. The dedicated switch at Kansas City for this option could also be a switch placed by the ProtoGENI group at this location. Funds are being sought for the deployment of a GpENI switch at Kansas City.

The IDC of the DCN/ION can be placed at UNL or Kansas City PoP and two VLSRs: one for controlling the CoreDirector CI and another for controlling the Netgear switches, can be placed in UNL or Kansas City PoP. Hence we will be able to create dynamic circuits of desired bandwidth of arbitrary VLAN tag between any of the GpENI universities with this network infrastructure. The Ciena
CoreDirector in Kansas City is shown as connected to the GpENI switch because this will be the Connector for GpENI universities to connect to the Internet2 infrastructure. This is still being investigated and will be explained in detail in our next investigation report about "GpENI connectivity to MAX".

4. References