Using the Dynamic Circuit Network: A Brief Tutorial

John Vollbrecht
Brian Cashman
Andy Lake
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Overview

• What is DCN?
• How does my computer or network connect to DCN?
• How do I request circuits?
• How do hosts link into DCN?
• How do I write my own DCN application?
• How do I deploy DCN?
• Where can I learn more?
What is DCN?

First, some definitions:

- **Control Plane**
  The part of the architecture that is concerned with the information that defines what to do with incoming data.

- **Data Plane**
  The part of the architecture that is concerned with actually forwarding data between interfaces.
What is DCN?
Functional Overview

Creates point-to-point VLAN circuits between devices connected to DCN
Parallels to telephone network
What is DCN?
Parallels to the Telephone Network

Making a telephone call

Dial the other number

SS7 = Control Plane
Connection Path = Data Plane
What is DCN?

Functional Overview

Creates point-to-point VLAN circuits between devices connected to DCN
What is DCN?

Making a DCN “call”

Initiate the connection

IDC = Control Plane
Connection Path = Data Plane
DCN On-Ramp Examples

Hosts are linked to the DCN network.
They can connect to each other.
Each typically has an IP address known to the other.

Used by LIGO and other applications.
DCN On-Ramp Examples

Routers are interconnected with a dynamic connection.
Each router is set to send a particular flow to the other.
Requires setup at both ends.
Routers typically use unrouted IP addresses for DCN connections.
Lambda Station and TeraPaths use this approach.
DCN On-Ramp Examples

Phoebus Gateways connect to DCN
Host sessions connect to Phoebus Gateways
Gateways create connection between each other
Phoebus may use DCN for part of session between Gateways
What is DCN?

Functional Overview

• Creates point-to-point VLAN circuits between devices connected to DCN
  • Parallel to telephone network
• The user or application sends a connection request to the DCN control plane
• The control plane software automates the authorization, reservation, set up, and tear down of connections
• Connections crossing multiple domains is coordinated using an internationally developed IDC protocol
What is DCN?
Internet2 DCN Footprint
Global Dynamic Circuit Network

InterDomain Controller
Control Plane Connections
GOLE
What is DCN?

Network Control Plane

- Two logical parts of Control Plane for each network
- Interdomain Controller (IDC)
  - Accepts circuit requests
  - Coordinates requests with other domains
- Domain Controller (DC)
  - Manages local resources
  - Set-up/tear-down circuits in local domain
What is DCN?

Multidomain Control Plane

[Diagram of network architecture with IDCs and domain controllers]
Connecting to DCN
Infrastructure Overview

1. Link connectivity within DCN
   • Internet2 model
     campus links to regional
     regionals link to national
     National networks interconnect
     Exchange points facilitate national network interconnects

2. Control plane connections
   • Control plane connect to control plane of Link neighbors
   • Users make requests to Control plane
   • Some networks may have no control plane as describe in the following
Connecting to DCN

Physical Data Connection

• Internet2 Regional Connectors
  • Physical Link to Internet2 DCN at DCN POP
  • Link is ethernet supporting VLANS, Looking into SONET and OTN carrying encoded VLANs

• Universities and campuses
  • Physical Link to Internet2 Regional
  • Typically connection is Ethernet w/VLANs
Connecting to DCN
Linking to DCN

• Option 1:
  • Create Static VLAN from user to Internet2 DCN
    • Static VLAN from user to edge of Internet2
    • Dynamic VLAN from edge of Internet2 to remote DCN connected User
    • Users request connection from Internet2 IDC
  • Option 2: Campus/regional creates own DCN
    • Static connection from user to local DCN
    • Local DCN has its own IDC
    • Users request circuit over DCN from local IDC
Connecting to DCN
Statically connect users to DCN
Connecting to DCN
Creating Local DCN

- Option 2: Install local IDC
What is DCN?

DCN Software Suite

• DCNSS contains two open source software packages

• OSCARS (IDC)
  • Open source project maintained by Internet2 and ESNet

• DRAGON (DC)
  • NSF-funded
  • Open source project maintained by MAX, USC ISI EAST, and George Mason University

• Version 0.5 released March 23, 2009
# Use of the DCN Software Suite

<table>
<thead>
<tr>
<th>Connectors</th>
<th>Running IDC</th>
<th>Using DCN SS</th>
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<tbody>
<tr>
<td>CENIC</td>
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<tr>
<td>Merit</td>
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<tr>
<td>NOX</td>
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<td>Yes</td>
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<td>PNWGP</td>
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## Use of the DCN Software Suite (cont.)

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<td>ESnet</td>
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<td>NetherLight</td>
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<td>JGN</td>
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<td>USLHHCnet</td>
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</table>

<table>
<thead>
<tr>
<th>Local/ Campus</th>
<th>Running IDC</th>
<th>Using DCN SS</th>
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<tbody>
<tr>
<td>Northrop Grumman</td>
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<tr>
<td>University of Amsterdam</td>
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<td>CalTech</td>
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<td>University of Houston</td>
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<tr>
<td>Texas A&amp;M University</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Campus Connections to DCN

• Campuses connect through their connector
  • Connector may use static vlans through their switch

• Two types of connections are used currently:
  • Direct fiber to connector DCN switch
    • e.g., Boston U, U Nebraska-Lincoln, Caltech, U Wisconsin-Milwaukee
  • DCN “enabled” campus-connector infrastructure
    • e.g., Syracuse, Texas A&M
Making Circuit through DCN

How are circuits requested

• User-initiated
  • OSCARS Web Page
  • Simple command-line tools
    • User must authenticate

• Program-initiated
  • Program requests circuit to support data transfer
  • Program must have cert to authenticate itself
  • Examples – Phoebus, LambdaStation, TeraPaths, CoUniverse
  • API can be built into applications or scripts
Requesting a circuit

Required Info in request

• Minimum set of required information
  • Endpoints
  • Start and End Time
  • Bandwidth
  • Description

• Additional fields available
  • VLAN range
  • Path
  • more…
How do I request a circuit? - Interfaces

- **Web User Interface (WBUI)**
  - Java servlet interface used by OSCARS web page
  - Not intended for use by other applications

- **Web Service API**
  - XML-based API intended for use by applications
  - E.g. Phoebus, LambdaStation, TeraPaths, CoUniverse
How do I request a circuit? - WBUI

• You may test the WBUI on Internet2’s test IDC
  • Go to http://test-idc.internet2.edu
  • Login with guest/guest
  • Click “Create Reservations” and enter:
    • Source: test-newy.dcn.internet2.edu
    • Destination: test-chic.dcn.internet2.edu
    • Bandwidth: 100
    • Purpose of Reservation: [your name] testing
How do I request a circuit? – WS API

• Used by applications to contact IDC
  • In programs like LambdaStation, Phoebus, TeraPaths, CoUniverse or future applications
  • Script shown next illustrates this

• Authenticate using an X.509 certificate
  • Generate with command-line tools
  • Have CA sign (Internet2 has test CA)

• Message format defined in DICE Control Plane group

• Custom applications should use this interface
WS API - sample
How do I write my own DCN application?

- Java library for making DCN calls
- Can call simple command-line client directly from application
- Libraries for other languages in future…
Summary

• User needs
  • physical data connection to DCN
  • control plane access to DCN
• Connector needs
  • physical connection to DCN
  • MAY have control plane connection
• Networks can create local DCN using available open source software
• Users and applications can use API to request circuits
Where can you learn more?

- Internet2 DCN Working Group
  - https://spaces.internet2.edu/display/DCN/Home
- DCN Software Suite
  - https://wiki.internet2.edu/confluence/display/DCNSS/Home
- Java Client API
  - https://wiki.internet2.edu/confluence/display/DCNSS/Java+Client+API
- Test IDC Guide
  - https://wiki.internet2.edu/confluence/display/DCNSS/Internet2%27s+Test+IDC
- Obtaining a Test Certificate
  - https://wiki.internet2.edu/confluence/display/CPD/How+to+Request+an+IDC+User+Certificate
Connecting to DCN
Software Configuration

• **Option 1: Static Data Connection to Internet2 DCN**
  
  • Statically configure network to connect between user device and Internet2
    
    • This typically requires static connection thru Regional net
  
  • Applications/Users dynamically request circuits from the Internet2 IDC
How do I connect? – Software Configuration

• Option 2: Install local IDC
  • i.e. DCN Software Suite
DCN Access by Connectors

- CENIC
- CIC OmniPoP
- GPN
- LEARN
- MAX
- Merit
- NOX
- NYSERNet
- PNWGP
- LONI

All connections to DCN are through a connector’s Ethernet switch
Definitions

• Control Plane

"Infrastructure and distributed intelligence that controls the establishment and maintenance of connections in the network, including protocols and mechanisms to disseminate this information; and algorithms for engineering an optimal path between end points."

Source: Global Grid Forum
Definitions

• Data Plane

Source:
DCN On-Ramp Examples

Host linked to the DCN network connect to each other. Each typically has an IP address known to the other. Used by LIGO and other applications.

Routers interconnected with dynamic connection. Each router is set to send a particular flow to the other. Routers typically use unrouted IP addresses. Lambda Station and TeraPants use this approach.

Phoebus Gateways connect to DCN. Host sessions connect to Phoebus Gateways. Gateways create a connection between each other. Gateways direct sessions over DCN connections.