Data Portals

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Overview

• Science DMZ and Data Portals

• This assumes you already have a Science DMZ
  – If you don’t have one, we can chat about how you might build one
  – If it would be helpful, I can talk to your systems and networking folks
  – Or check out the fasterdata knowledgebase:
    • [http://fasterdata.es.net/science-dmz/](http://fasterdata.es.net/science-dmz/)
Science DMZ Design Pattern (Abstract)

- **Border Router**
  - 10G connection to WAN
  - 10GE connection to Enterprise Border Router/Firewall
  - Clean, High-bandwidth WAN path
  - Site / Campus access to Science DMZ resources
  - Per-service security policy control points

- **Science DMZ Switch/Router**
  - 10GE connection to Site / Campus LAN
  - High performance Data Transfer Node with high-speed storage
  - perfSONAR

- **Enterprise Border Router/Firewall**
  - 10GE connection to Science DMZ Switch/Router
  - perfSONAR

**PerfSONAR**

**ESnet**

**Science DMZ**

**WAN**

**Site / Campus**

**LAN**

High performance Data Transfer Node with high-speed storage

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HPC Center Data Path

Diagram showing the network paths:
- WAN
- Border Router
- Core Switch/Router
- Firewall
- Offices
- Supercomputer
- Parallel Filesystem
- Data Transfer Nodes
  - High Latency WAN Path
  - Low Latency LAN Path
Next Steps – Building On The Science DMZ

• Enhanced cyberinfrastructure substrate now exists
  – Wide area networks (ESnet, GEANT, Internet2, Regionals)
  – Science DMZs connected to those networks
  – DTNs in the Science DMZs

• What does the scientist see?
  – Scientist sees a science application
    • Data transfer
    • Data portal
    • Data analysis
  – Science applications are the user interface to networks and DMZs

• Large-scale data-intensive science requires that we build larger structures on top of those components
Science Data Portals

• Large repositories of scientific data
  – Climate data
  – Sky surveys (astronomy, cosmology)
  – Many others
  – Data search, browsing, access

• Many scientific data portals were designed 15+ years ago
  – Single-web-server design
  – Data browse/search, data access, user awareness all in a single system
  – All the data goes through the portal server
    • In many cases by design
    • E.g. embargo before publication (enforce access control)
Legacy Portal Design

- Very difficult to improve performance without architectural change
  - Software components all tangled together
  - Difficult to put the whole portal in a Science DMZ because of security
  - Even if you could put it in a DMZ, many components aren’t scalable
- What does architectural change mean?
Example of Architectural Change – CDN

- Let’s look at what Content Delivery Networks did for web applications
- CDNs are a well-deployed design pattern (Netflix, etc)
- What does a CDN do?
  - Store static content in a separate location from dynamic content
    - Complexity isn’t in the static content – it’s in the application dynamics
    - Web applications are complex, full-featured, and slow
    - Data service for static content is simple by comparison
  - Separation of application and data service allows each to be optimized
Classical Web Server Model

- Web browser fetches pages from web server
  - All content stored on the web server
  - Web applications run on the web server
  - Web server sends data to client browser over the network
- Perceived client performance changes with network conditions
  - Several problems in the general case
  - Latency increases time to page render
  - Packet loss + latency cause problems for large static objects
Solution: Place Large Static Objects Near Client

- CDN provides static content “close” to client
- Web server still manages complex behavior
- Latency goes down
  - Time to page render goes down
  - Static content performance goes up
- Load on web server goes down (no need to serve static content)
- Significant win for web application performance
Client Simply Sees Increased Performance

- Client doesn’t see the CDN as a separate thing
  - Web content is all still viewed in a browser
    - Browser fetches what the page tells it to fetch
    - Different content comes from different places
    - User doesn’t know/care
- CDNs provide an architectural solution to a performance problem
  - Not brute-force
  - Work smarter, not harder
Architectural Examination of Data Portals

• Common data portal functions (most portals have these)
  – Search/query/discovery
  – Data download method for data access
  – GUI for browsing by humans
  – API for machine access – ideally incorporates search/query + download

• Performance pain is primarily in the data handling piece
  – Rapid increase in data scale eclipsed legacy software stack capabilities
  – Portal servers often stuck in enterprise network

• Can we “disassemble” the portal and put the pieces back together better?
  – Use Science DMZ as a platform for the data piece
  – Avoid placing complex software in the Science DMZ
Legacy Portal Design

- **Border Router**
- **Firewall**

**WAN** to **Enterprise**

**Portal Server**

**Filesysterm**

Portal server applications:
- web server
- search
- database
- authentication
- data service

Browsing path
Query path
Data path
Next-Generation Portal Leverages Science DMZ

Portal server applications:
- web server
- search
- database
- authentication

Data Transfer Path
Portal Query/Browse Path

API DTNs (data access governed by portal)
Put The Data On Dedicated Infrastructure

• We have separated the data handling from the portal logic
• Portal is still its normal self, but enhanced
  – Portal GUI, database, search, etc. all function as they did before
  – Query returns pointers to data objects in the Science DMZ
  – Portal is now freed from ties to the data servers (run it on Amazon if you want!)
• Data handling is separate, and scalable
  – High-performance DTNs in the Science DMZ
  – Scale as much as you need to without modifying the portal software
• Outsource data handling to computing centers
  – Computing centers are set up for large-scale data
  – Let them handle the large-scale data, and let the portal do the orchestration of data placement
Scalability Example – Petascale DTN Project

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L380 Data Set

Data set: L380
Files: 19260
Directories: 211
Other files: 0
Total bytes: 4442781786482 (4.4T bytes)
Smallest file: 0 bytes (0 bytes)
Largest file: 11313896248 bytes (11G bytes)
Size distribution:
- 1 - 10 bytes: 7 files
- 10 - 100 bytes: 1 files
- 100 - 1K bytes: 59 files
- 1K - 10K bytes: 3170 files
- 10K - 100K bytes: 1560 files
- 100K - 1M bytes: 2817 files
- 1M - 10M bytes: 3901 files
- 10M - 100M bytes: 3800 files
- 100M - 1G bytes: 2295 files
- 1G - 10G bytes: 1647 files
- 10G - 100G bytes: 3 files
Links and Lists

- ESnet fasterdata knowledge base
  - http://fasterdata.es.net/
- Science DMZ paper
- Science DMZ email list
  - Send mail to sympa@lists.lbl.gov with subject "subscribe esnet-sciencedmz"
- perfSONAR
  - http://fasterdata.es.net/performance-testing/perfsonar/
  - http://www.perfsonar.net
- Globus
  - https://www.globus.org/
Thanks!

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http://fasterdata.es.net/
http://my.es.net/
http://www.es.net/
Extra Slides
DTN Cluster Detail

Configure as DTN Cluster

"Sealed" DTNs (Globus only, no shell access)
DTN Cluster Design

• Configure all four DTNs as a single Globus endpoint
  – Globus has docs on how to do this

• Recent options for increased performance
  – Use additional parallel connections
  – Distribute transfers across multiple DTNs (Globus I/O Nodes)
  – Critical – only do this when all DTNs in the endpoint mount the same shared filesystem

• Use the Globus CLI command `endpoint-modify`
  – Use the `--network-use` option
  – Adjusts concurrency and parallelism