DTN – Data Transfer Node

Xavier JEANNIN, RENATER
Damir REGVART, CARNET

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GÉANT 4-3 WP6 Task1: Network Technology Evolution

- Data Plane Programming

- **Data Transfer Node Stimulation**

- LoLa

- Optical Time & Frequency Network

- Quantum Key Distribution

- White-Box for research and education

- Router for Academia, Research and Education (RARE)

- By its nature, this task assesses the interest in different topics, and during GN4-3 some of these could be stopped and new ones, if proposed or identified, and if there is evidence of end users, can be started

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Data Transfer Node Stimulation in WP6 Task1

- Milestone 6.4, review of DTN Activities in the Community

- Initially there was not a strong engagement from the NRENs
  - There was a proposal for work put forward in the project preparation phase
  - But there were very few applications from NRENs to do the work, including the NREN that proposed it

- Data Infrastructure survey, Oct. 2019 in order to identify NREN interest in supporting large scale data transfers, especially using a DTN solution

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Why large scale data transfers matter for NRENs?

- It is a very common use case for the NRENs, supporting data-intensive science
  - Short distance transfer
  - Long distance transfer
    - Very sensitive to packet loss
    - Even a fraction of 1% packet loss leads to poor performance
  - Congestion / provisioning
  - Optimize network (Optimize network path, MTU, …)
  - Deploy Science DMZ at the end sites / campuses - https://fasterdata.es.net/science-dmz/

- Other providers have the same concern, e.g., Google created an algorithm "Bottleneck Bandwidth and Round-trip time (BBR)", which is far less sensitive to packet loss
- Established data-intensive transfer users (mainly the CERN community and WLCG) have already addressed this concern (File Transfer Service, and the same principles as Science DMZ).
- Long tail science, and emerging science disciplines, are subject to a poor experience

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What is a DTN?

- Mission: Move (BIG) data fast
- DTNs are custom made servers (Linux), optimized for data transfer
- Maximize utilization of network capacity
- DTNs sit at campus edge (Science DMZ model); outside campus firewall
- Day-to-day campus traffic handled differently to "big science" traffic
- Forward large amount of data **from** and **to** the site resources (fast and efficient transport)
- Now supports 100 Gbps flows, tomorrow 1 Tbps
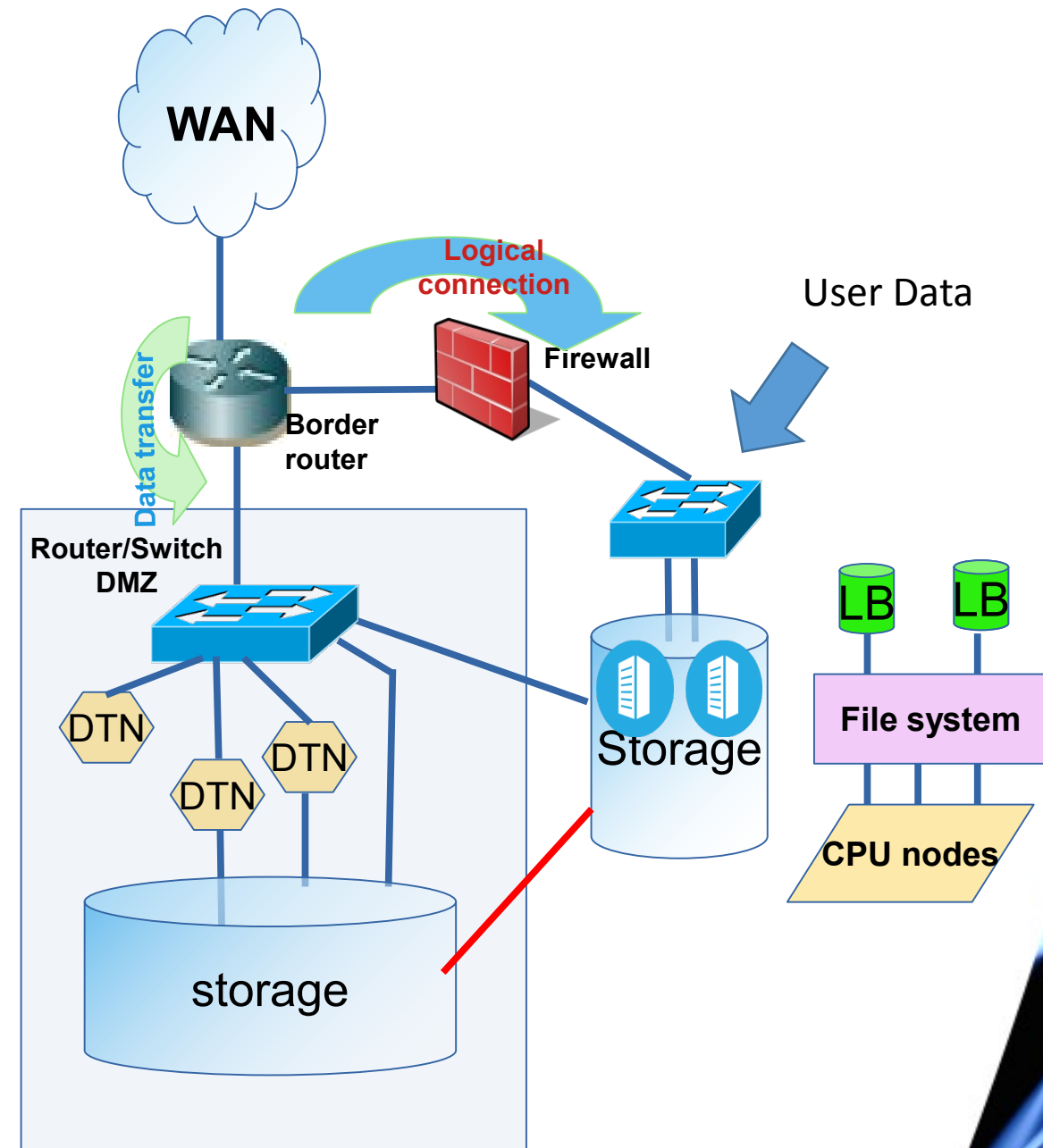
DTN explained

- Speaking about DTN you can find multiple definitions
    - Hardware – physical machine and its specification
    - Software – the transfer tools used
    - Orchestration – managing the flows, possibly configuring bandwidth on demand

- All functions must be « *tuned* »
    - CPU is dedicated for data transfer
    - File transfer (large buffers/chunks of data), tuning TCP parameters
    - Logical (sequential) order in sending data

READ DATA (I/O) → **TRANSPORT NETWORK (Data transfer)** → **WRITE DATA (I/O)**

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Example of DTN server (Caltech)

Design options for High Throughput DTN Server

1U SuperMicro Server (Single CPU)
Single 40/100GE NIC
Dual NVME Storage (LIQID 3.2TB each)
~90 Gbps disk I/O using NVME over Fabrics

2U SuperMicro Server (Dual CPU)
Single 40/100GE NIC
Three NVME Storage (LIQID 3.2TB each)
~100 Gbps disk I/O using FDT/NVME over Fabrics

2U SuperMicro (Dual CPU)
Single/Dual 40/100GE NICs
24 NVME front loaded 2.5" drives (U.2)
~200Gbps of disk I/O using FDT/NVME over Fabrics

http://supercomputing.caltech.edu/

DTN implementation challenges

- Performance
  - Troubleshooting
  - Tuning

- Monitoring
  - perfSONAR – network measurements
  - Application logs – disk to disk measurements

- Authentication

- Authorisation

- Important that the tools are easy-to-use for end users
  - Needs to be intuitive, not require specialist knowledge
  - Software development

Examples of data transfer projects

- AENEAS project (https://www.aeneas2020.eu/)
  - Federated European Science Data Center (ESDC) to support the astronomical community in achieving the scientific goals of the Square Kilometer Array (SKA)
- Process (https://www.process-project.eu/)
  - Creating data applications for collaborative research (Exascale learning on medical image data, SKA/LOFAR, Ancillary pricing for airline revenue management, Agricultural Analysis based on Copernicus data)
- Big Data Express (https://bigdataexpress.fnal.gov/
- Pacific Research Pplatform (https://prp.ucsd.edu/); Petascale DTN Project
  - Uses FIONA devices; SSD disk with GPU compute built in. Effort to improve data transfer performance between the DOE ASCR HPC facilities at ANL, LBNL, ORNL, NCSA
  - 4.4TB of cosmology simulation data
- Others …

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Existing data transfer tools

- Amazon Web Services - Amazon S3 or Amazon Simple Storage Service (https://aws.amazon.com/s3)
  - Object storage service
  - API control/management, batch operations
- Globus Online (https://www.globus.org)
  - Non-profit group within the University of Chicago
  - SaaS (Software as a Service) principle. It allows users to move data between two GridFTP servers or between a GridFTP server and a user's machine
  - "DTN Orchestrator"
  - User has "Agent application" that controls and monitors flow of data
- Others…

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Survey results 1/4

- 29 NREN responses (from the APM contacts)

- User groups that move data intensively thanks to the NRENs/GÉANT networks:
  - Physics : (HEP) LHCONE, Astro-physics, LOFAR | HPC: PRACE | Astronomy | Biology: human brain, ELIXIR ... | Environment and climate research: CMIP6, Copernicus
  - Some are more established than others
- NRENs identified well-known big projects

- Some NRENs see their role as transport capacity providers

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Survey results 2/4

- Success stories:
  - Same well-known projects: LHCONE (CMS, ATLAS), LOFAR, PRACE, Astro-physics, HPC, Astronomy, Biology ...
  - Tuning the campus/LAN (Science DMZ)
  - GÉANT and AARnet - demonstration that NREN networks provide better performance than commercial networks for long haul data transfers
- Issues
  - Network
    - Long distance transfers, firewalls, last mile network, bandwidth capacity
    - Poor network performance and difficulty to troubleshoot
  - Tune campus, LAN and local systems
  - Difficult to implement Science DMZ and security – need to apply security policy differently for day-to-day and "big science" traffic
  - IAAS usage without coordination of NREN
  - Low expectation – so see transport of large volumes of data transfer using hard drives!

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Survey results 3/4

- Performance tools
  - perfSONAR, Netflow, Iperf
- Ways in which NRENs can help users move data
  - Traffic engineering (dedicated circuits, VRFs, dynamic provisioning, etc)
  - FileSender service
- Other forms of assistance
  - Support, advice, collaboration
  - Promoting Science DMZ – 3 NRENs
- Large scale data transfers with international organisations
  - Same well-known projects

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Survey results 4/4

- Would you be willing to work with us (GN4-3 WP6) on improving data transfer infrastructures for the community? - 11 = Yes
    - The big question is – doing what? What collaborative work would be most beneficial?

- Other comments
    - The problem is often due to local network capacity, the last mile
    - Need more documentation of best practices

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Conclusions

- There is some evidence that NRENs already work with their users, but that this can also be improved

- How can GTN4-3 WP6 T1 help NRENs?
  - **What would be the best things to focus on for our work in Year 2 of the project? (Jan – Dec 2020)**
  - Perhaps maintain a wiki of best practices, data transfer projects, DTN configuration examples?

- From WP6 T3 we have tools to detect and localise performance issues
  - Provide training on performance troubleshooting using those tools?

- Is there any software development that would add value?

- Your thoughts?

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Thank you

Any questions?