Application Case Studies of Logistical Networking

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What Do Network Users Want?

» Old view of networking: What people want is to transfer of bits: FTP, Telnet, e-mail, static Web content, net news

» Today people want services: Dynamic web content, streaming media, video conferencing services, Internet2 commons

» Tomorrow people will want *high value* services: Computing utilities (the Grid) Telepresence, Nomadic computing, etc.
What Can Network Users Get?

» You can get services across the network, but what about having the network do more for you?
» Problem: Scalability is the nature of the network
» The high value services (e.g. Grid computing, telepresence) won’t scale, so networking people leave them to application people
» But is there some form of these services that can support advanced applications and can be made to scale?
» That’s what Logistical Networking is about: Creating scalable forms of advanced services
It Starts with Storage

» The first task of Logistical Networking: Provide a scalable storage service that is part of the network

» Core technology: *Internet Backplane Protocol (IBP)*

» It’s called “Logistical” by analogy with military and industrial logistics, which also combine storage and transport lines to move materiel

» What if putting even huge amounts of data at a set of locations were as simple as sending large amounts of data is today because the network is massively provisioned to support that?

» What would that take? 100TB on each campus? Today that costs under $500K!
What We Have Today

A Global storage infrastructure and the tools to use it

» IBP depot code V 1.3.1 now in widespread use
  • Over 250 publicly advertised on L-Bone
  • Additional DOE Laboratory sites
  • Deployed in more 29 countries

» L-Bone: over 20+ TB advertised
  • half available for “hard” allocation
  • remainder is idle storage

» Cross platform user tools
  • Windows, Mac OS, Linux, Unix
  • GUI interface
  • Complete user manual

» Developers API
Current and Future Developments

» Network supplies computational cycles
» Performance improvements to the infrastructure being described today
» Compatibility with legacy file systems interfaces
» Integration with optical and other heterogeneous network technologies
» Applications in hard to network parts of the world
» Disconnected networks
» Programming construct to support app developers
» Integration with distributed indexing and data management
Application Overview

Describe a range of current, concrete applications, from simple to complex

- Simple Content Delivery
- Individuals sharing big files
- Bulk data transport
- Video Delivery
- Content Delivery Networks
- Remote visualization
- State management in Grid and Cluster computing
Basic Jargon of LN

- Internet Backplane Protocol (IBP)
  - IBP storage server = depot
  - Generic, best-effort storage service
  - Stronger services on top, end to end
- Logistical Backbone (L-Bone)
  - Resource discovery/Resources deployed
- Logistical Runtime System (LoRS)
  - Basic tools: upload, download, augment, refresh
  - E2E services: checksums, encryption, etc.
- exNode
  - Metadata for IBP allocations in XML
LoRS interface: User view of LN
Simple Content Delivery

» First application: Linux Distribution
» Legacy of Internet2 Distributed Storage Infrastructure (I2-DSI) project
» Method is simple
  • We spread multiple copies of Linux ISO’s across the L-bone
  • Link the exNodes to a web page
  • Users get the LoRS tools and download
User Testimonials

» “These IBP and LoRS tools of yours are *AWESOME*. I got the mandrake CD1 in under 3 minutes! OMG i am impressed to say the least." - Suvrit Sra, Univ. of Texas

» "It allowed me to get a Mandrake CD in less than 6 minutes from the Univ. of Colorado network - excellent!" - N. McBurnett
Researchers at UT (Computer Science) and Indiana St. (Phylogenomics) share 2G files of Terapeptide sequences
IBPvo: PVR Meets Internet2

• Uses the same tools as LoRS mail in the same way
IBPvo Scheduling Interface

utkscott
Wednesday, 10/15/2003
Record your favorite TV show and watch it when you have time

Schedule the TV program you wish to record.

TV Program:  
Starting Time (hh:mm): 10:00
Starting Date (mm/dd/yyyy): 10/15/2003
Program Duration: Hour: 0 Min: 00
Channel: ABC (WATE)

Submit

Advanced Options
Augment file to:
- State
  - Indiana
- Zip 60611
- Country Code

Encoding Bitrate (kbps)
About Bitrates
- 1500

Encryption Type:
- Strong (DES)
- Weak (XOR)

Show Listing:
- Yes
- No
Digital Video CDN in Brazil

- Leader: Guido Lemos de Souza Filho
- LoCI alum Hunter Hagewood
- RNP DVWG Phase 2
- A CDN for Digital Video, e.g. huge video archive for K-12 education
- IBP running at some POPs
- Staged implementation
  - Very long-term depots at primary nodes
  - Secondary depots cache
  - Deploy lots of depots
LN Research & Apps in the Czech Republic

» Leader: Ludek Matyska, Masaryk Univ.
» DiDaS is a nationwide network for research and applications of LN
» Completely independent initiative
» Depot resources:
  • 7 depots ≈1.5 TB each
  • Total capacity ≈ 10 TB
» Connected directly to backbone at 100 Mb/s or 1 Gb/sh
» Both IBP (70%) and GridFTP (30%); comparison forthcoming
Czech Logistical Research Network
Applications on the Czech Research LN

» Research on network performance
» National Technical Library
  • Access to digitize content on tape
  • Model data: old cartographic maps, and video
  • Need to load balance to avoid overload
» DiDaS role: Caching, load balancing, reliability
» Nonspecific Users: Temp Data, load balancing, transfer outside the core
» Access reliability: automated replication, multi-access, fail over
TSI Logistical Networking Infrastructure

- 5 Depots, 1.6 TB at each collaborating location
- Dell Servers
  - Dual 1.7 GHz processors
  - 2GB RAM memory
  - Dual Gig-E NICs
- SAN connected enclosure, IDE drives
  - Integrated RAID controller
  - Point-to-point SAN, QLogic HBA
  - 2 Gbps Fiber Channel
- Expandable with multiple HBAs, daisy chained enclosures, or switched SAN Fabric
Terascale Supernova Initiative (TSI)

- Lead by Tony Mezzacappa, ORNL Physics
- Massive output from supercomputer simulations at ORNL and NERSC
  - 10-100 GB currently
  - 100-1 TB this year
  - 1-10 TB next year
- Long term data archive: HPSS
- Remote visualization at collaborating sites
  - NCSU, UCSD, SUNY Stony Brook
- Data access: localization of full datasets
Remote Image Databases
with exNodes & IBP
Logistical QoS for Remote Visualization

Aggressive two-stage prefetching. A is the server depot, while B is the client agent. C is a depot on the local area network of the client agent, B.

Aggressive staging of all viewsets to a local depot, ordered by proximity to cursor.

Staged viewsets available in LAN

When cursor movement triggers prefetch of viewsets to the client agent, they are available locally.
Latency Hiding Through Aggressive Prestaging

Remote database

Wide Area Network

Prestaging

Data in WAN

Data in LAN

Data in WAN with LAN Depot

Interactive Browser

client cache

request

response
User Latency, 300x300 Resolution

Case 1: Data in LAN
Case 2: Data in WAN
Case 3: With LAN Depot
Integration with NetSolve/GridSolve

No knowledge of the grid required, RPC like.
LAPACK for Clusters

USER PERSPECTIVE:
- SEQUENTIAL INTERFACE
- ALGORITHMIC SCOPE - FACTORIZATIONS: CHOLESKY, LU, QR
  [LAPACK ROUTINES DPOSV(), DGESV(), AND DGELS()]

INTERNAL DESIGN AND FUNCTIONALITY:
- SYSTEM BENCHMARKING
- USES EXISTING BLAS AND MPI LIBRARIES
- PERFORMANCE MODELING OF THE APPLICATION KERNELS
- MULTI-CLUSTER SCHEDULING OPTIMIZATION
- DISCOVERY OF OPTIMAL PARALLEL EXECUTION PARAMETERS

PARALLEL EXECUTION SERVICES:
- RESOURCE ACQUISITION AND RELEASE
- PARALLEL COMPUTATION LAUNCHING
- PROBLEM DATA DISTRIBUTION
- SOLUTION DATA DELIVERY

1. SEQUENTIAL CALL TO LFC
2. PARALLEL CALL TO ScALAPACK
3. RETURN THE SOLUTION

LoCi
The Vision of Logistical Networking

» In other sessions at this meeting, you’ll hear what you can do with big, fast pipes if you have the know-how, the staff, the institutional support, the collaborations, etc.

» That is, these services are the services that the IP network *can* provide, whether or not it’s what you need.

» The vision of Logistical Networking is of a network *that provides every member of the community with every resource and service it can.*

» There are technical and financial limits to what the network can do.
More on Logistical Networking

» Logistical Networking software & documents available now
  • http://loci.cs.utk.edu

» Publications
  • Logistical Networking for Digital Video on Internet2 (2 page flyer)
  • “An End-to-End Approach to Globally Scalable Network Storage,” ACM SIGCOMM 2002 Conference, Pittsburgh, PA, USA, August 19-23