

# Next Generation Edge and Overlay Services



Internet2 Spring Members Mtg Tutorial

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# Outline

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- **Background: Edge and Overlay Services:**
- Content Delivery Networks
- Other Approaches
- Two important trends
- The Promise of the Grid
- Finding the future



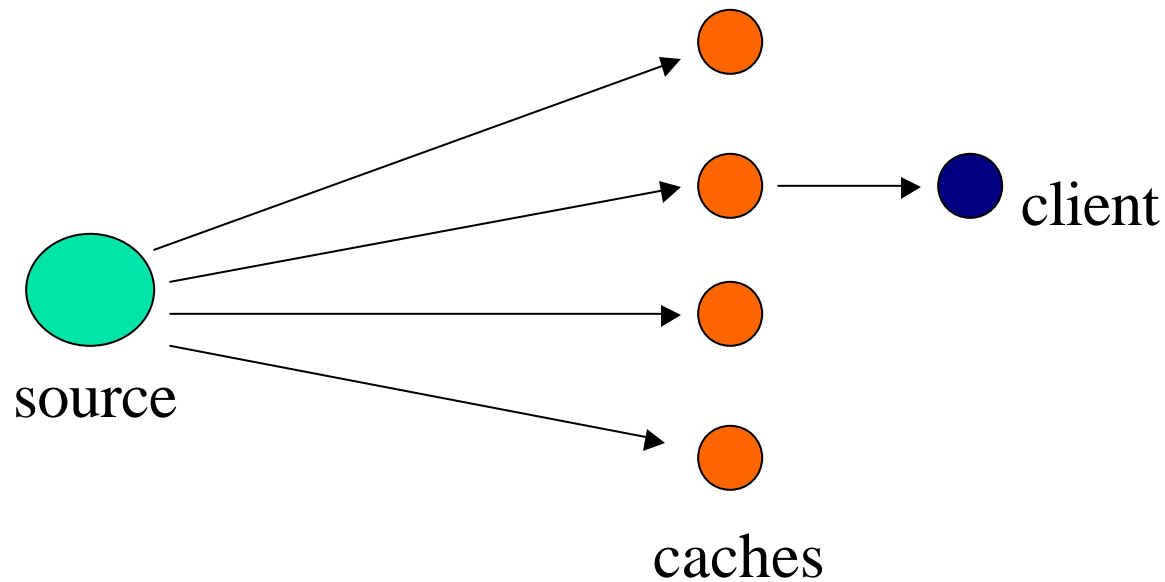
# What are Edge and Overlay Services?

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- IP services are defined in terms of end-to-end delivery of datagrams
- Stateful protocols only for control state
  - Multicast
  - QoS
- Edge and Overlay Services introduce application level protocol intermediaries

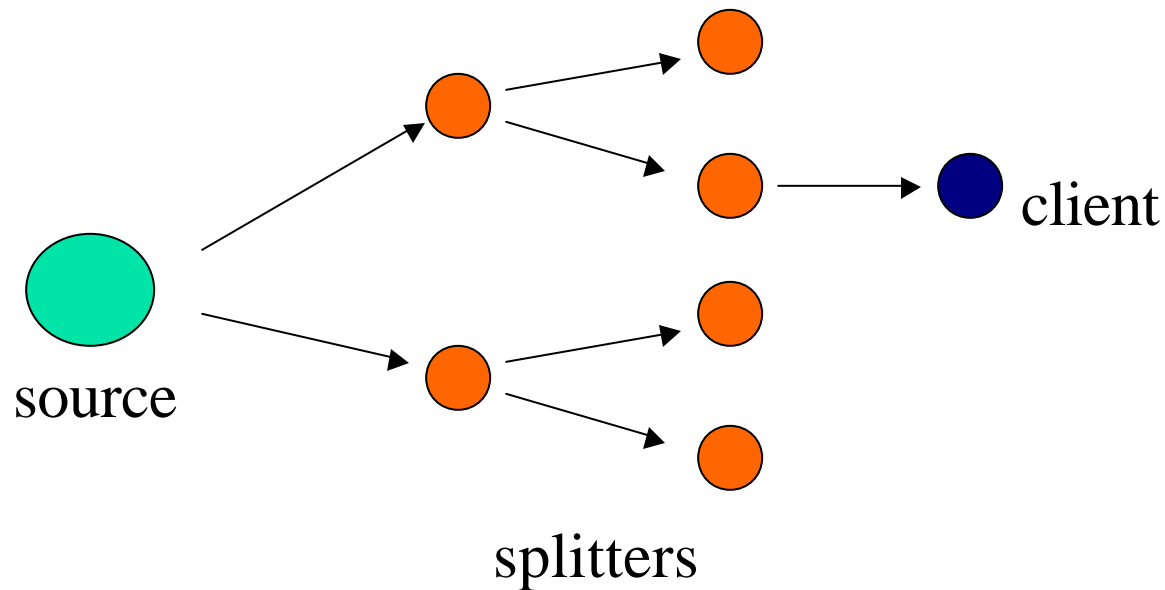
# The Prototypical Edge Service: Web Caching

- HTTP response capture and replay
- TCP proxy intermediaries



# The Prototypical Overlay Service: Application Level Multicast

- Streaming video splitters
- Statically configured UDP relays





# Why are Edge and Overlay Services Important Today?

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- Commodity backbone congestion
- Server overload
- Latency
- Flexibility/openness
- Deployability
- Resource scalability



# Issues with Edge Services

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- Request redirection
  - IP hijacking
  - unreliable DNS resolution hacks
- Non-standard protocols
  - proprietary streaming (Real, QT, MS)
  - proprietary edge/overlay services
- IETF Mantra:  
**Scalability, mangability, interoperability!**



# Edge Services and Advanced Networks

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- Edge networks are very capable
- Backbones support massive aggregate load
- High performance applications can overwhelm servers
- TCP problems at high bandwidth x delay
- Latency: Complaints to Prof. Einstein
- Flexibility, deployability, resources





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# Commodity CDNs

**Akamai, Digital Island, Mirror Image**

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- Content Delivery  $\approx$  Content Distribution
- Cache resources leased to content providers
  - disk space partitioned
  - bandwidth metered
- Colocation cheap or free
  - Local network saves bandwidth
  - Reselling outbound bandwidth
- Complex DNS redirection algorithms



# Infrastructure Vendors

## Inktomi, Cisco, Novell

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- Service providers have taken the lead
  - Service providers serve as content brokers
  - ISPs are not experienced at running CDNs
  - No interoperable infrastructure
- Infrastructure vendors serve enterprises
  - Self contained content provider and ISP
  - Single infrastructure provider
- Digital Island Uses Inktomi Caches



# If Knowledge is Power, What do you know?

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- Control of communication has always been mission critical for Universities
  - University Presses controlled their own printing for centuries
  - Campuses buy and operate telephony switches
  - Campuses control IP services through Internet<sup>2</sup>
- Why cede control of wide area publication to CDN service providers?



# IETF activities

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- Web Replication and Caching (WREC)
  - Taxonomy, requirements
- Content Delivery Internetworking (CDI)
  - Settlements, SLAs, property rights,
- Web Intermediaries (WEBI)
  - Content Invalidation Protocol
- Open Pluggable Edge Services (OPES)
  - Rules-based invocation of proxy services



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# Peer-to-Peer: Cooperative Overlay Services

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- Edge resources on client workstations
- Cooperative sharing of resources
- No (or minimal) settlements
- Very specific services
- High end-user value
- Whoever organizes a service takes responsibility for it (e.g., Napster)



# Application Service Providers: Data Centers at the Edge

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- Applications installed on servers in distributed data centers
  - semistatic installation
  - location transparency within cluster
- Flexibility & licensing advantages
  - usage fees enable business model
- Clients access via remote user interface
  - some OS specific mechanisms (Citrix)





# Rule-Based Active Edge Services

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- OPES distributes proxylets
  - Intermediary Rule Markup Language
  - Filtering, ad insertion, transcoding, translation
- Internet<sup>2</sup> Distributed Storage Infrastructure (I<sup>2</sup>-DSI) distributes static content and servelets Portable Channel Representation
  - Database access, high interactivity, localization
  - WWW10 paper with Lokomo Systems



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# Storage Will Rock Your World!

## New IBM Storage Products

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- **Ultrastar 36Z15**
- 35 GB, 4MB cache
- 52.8 MBs sustained xfer
- 2 ms average latency  
3.4 ms seek time
- 10.7 Gb/in<sup>2</sup> inch density
- 26H/102W/146D (mm), .75 kg
- 6 disks, 12 heads
- **Microdrive DSCM 11000**
- 1 GB, 128K buffer
- 2.6 MBs sustained xfer
- 8 ms avg latency  
12 ms avg seek time
- 15.2 Gb/in<sup>2</sup> areal density
- 5H, 43W, 36D (mm), 16 g
- 1 disks



# Reliance on Network Services

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- Critical services: Real Time Market Info.
- Workflow: Publishing, Graphics
- Organizational Coordination: Calendar, Directory, Scheduling, etc
- Distance Learning: Lectures, Exams
- Subscription Content: Law, Medicine, Porn
- Napster: I burned my CDs!



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# Computing Grids

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- Remote access to computational resources
- Operating system style: Legion
- Distributed Machine Room: Globus
- Other approaches:
  - Condor (UW)
  - NetSolve (UT)
- Standardization: Grid Forum



# Data Grids

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- Data Intensive Computing Environments
  - Digital Libraries and Large Data Sets
  - SDSC Storage Resource Storage Broker
- CERN Large Hadron Collider (Gryphon)
  - 1 PB/year data distribution
  - Continental/regional/campus centers
- Internet Backplane Protocol (UT)



# Access Grids

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- Advanced Telemedicine
- Remote Instrumentation
- You know the story...

Video's the one thing we **can** do!





# Logistical Computing and Internetworking (UT)

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- Logistical Internetworking: Flexible coscheduling of storage and bandwidth
- Logistical analogy: Movement of industrial materiel using trucking and warehouses
- LoCI: Add computational resources
- Middleware components
  - Internet Backplane Protocol
  - Network Weather Service
  - NetSolve
- Common resources for communities, campuses



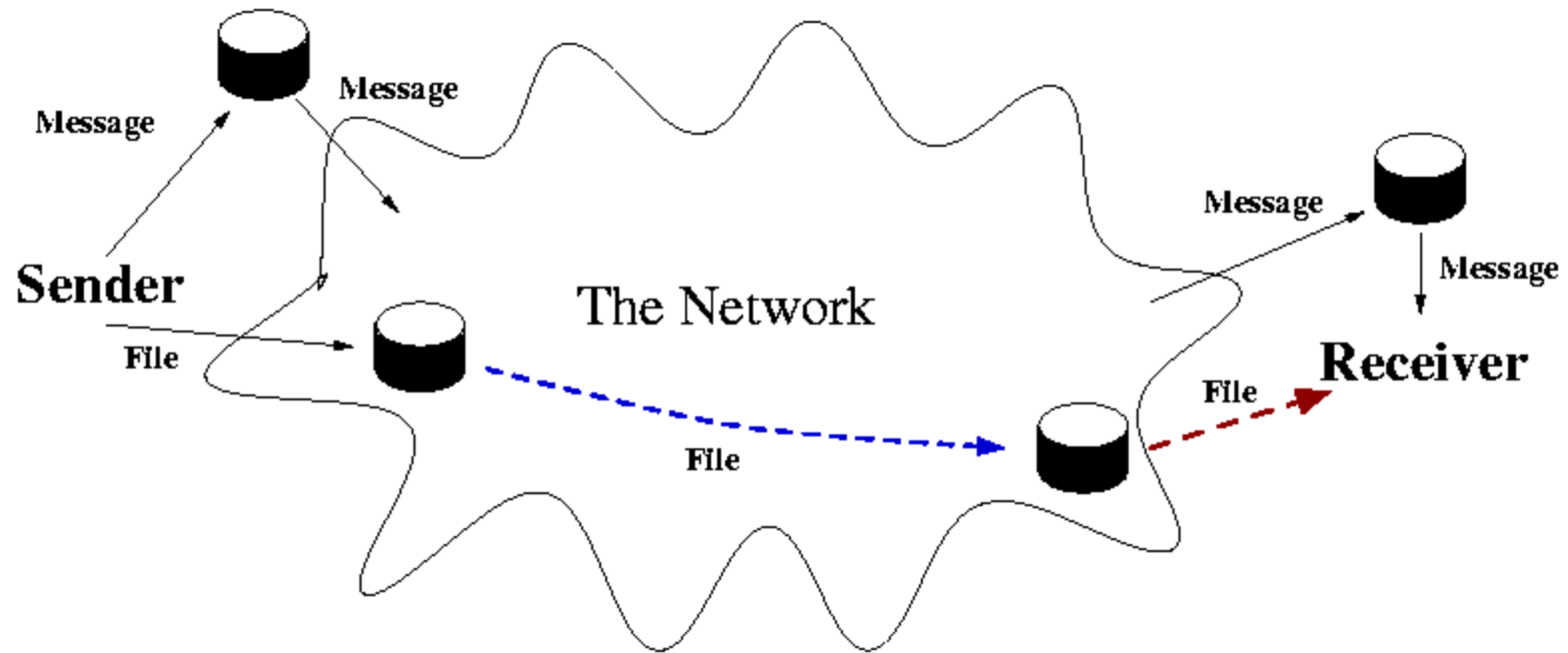
# Internet Backplane Protocol

<http://icl.cs.utk.edu/ibp>

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- Storage analogy to IP
- Lightweight allocation
- Weak semantics for a storage service
  - Unreliable
  - Time limited
  - Volatile
- Model close to physical resource
- Analogy: processor backplane

# IBP Mail





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# Searching Where the Light Is

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- Scene: Drunk on hands and knees under street light
- Cop: What's up?
- Drunk: Lost m' keys!
- Cop: I'll help you look. Did you drop 'em right here?
- Drunk: No, I dropped 'em over there (points to darkness in the middle of the block)
- Cop: So why are you looking over here?
- Drunk: The light's much better!



# The Loneliness of the Long Distance Fiber

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- Stateful, reliable, ubiquitous services are shaping the future of network apps (It's just not what Internet<sup>2</sup> does!)
- These attributes are not defined as “advanced”
- Exciting commercial apps are ruled out
- We've locked ourselves in our campuses and we won't come out!



# What we do: High bandwidth wide area TCP to the desktop

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- Without easy-to-use reliable, high bandwidth connections the application community will remain restricted
- High bandwidth x delay product makes TCP very hard to tune automatically
- Many valuable edge and overlay services do not require end-to-end connectivity
- Internet<sup>2</sup>'s Procrustean bed: **sleep tight!**



# A Vision of Inclusive Advanced Networking

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- Criterion: New uses of the network enabled by the Internet<sup>2</sup> project
- Criterion: Advance the mission of Internet<sup>2</sup> member universities
- View IP connectivity as a means, not an end
- Serve user communities, not router jockeys
- We belong to the future, not it to us