Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Bistro

a Platform for Building Scalable Wide-Area *Upload* Applications

Prof. Leana Golubchik

Email: leana@cs.usc.edu
URL: http://cs.usc.edu/~leana

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Scalable Data Transfer Applications

End-system / Application-level

		# of Receivers	
		One	Many
# of Senders	One	*ftp* *traditional apps* *...*	*web downloads* *software distribution* *video-on-demand* *server push* *...*
	Many	*Bistro!!*	*chat rooms* *video conferencing* *multiplayer games* *...*

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Who Is Working on Uploads?

- To the best of our knowledge, there is no existing work on making *many-to-one* communication at the *application* layer *scalable* and *efficient*

USC IML
Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

What Are *Upload* Applications?

- ***Hard deadlines***
  - IRS income tax submission
  - paper submission
  - ***real-life events***
- ***No hard deadlines***
  - Internet-based storage
  - Data warehousing

Digital Government

Digital Democracy

Distance Education

E-commerce

Internet-based Computing

Internet-based Storage

Data Warehousing

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Why is *Upload* Different?

- many-to-one data transfer
- read vs. *write*
  - traditional solution such as replication of data (caching), replacement of data, etc. won't help
  - fault tolerance, *security*
- contention for service rather than data
- data consumed later *(will exploit this)*

- replication of services and resources for a single event is expensive, inflexible, & not scalable

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Traditional Approaches

(at the application layer)

- Increase capacity
- Spread the load ... over time, space, or both
- Change the workload

- Examples
  - data replication *ftp mirroring, web caching*
  - data replacement *multi-resolution images, video*
  - service replication *DNS lookup, NTP*
  - server push *news download, software distribution*

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

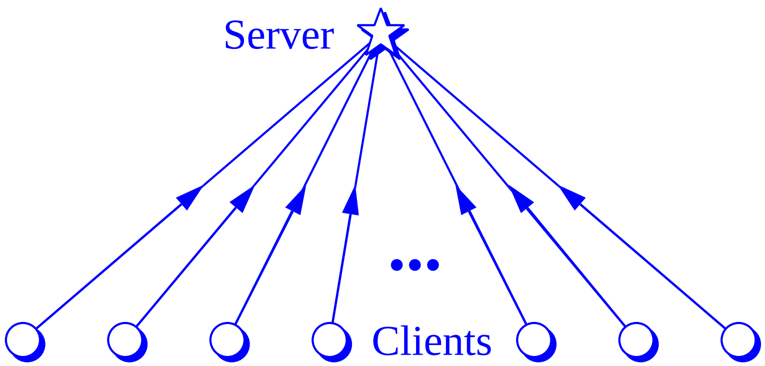
Our Goals

- **A single infrastructure (termed *Bistro*) for all *data collection* needs**
  - **good performance (for both service providers and users)**
  - **scalable (shares resources among all service providers)**
  - **secure (one service provider does not have to trust another)**

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Current State

- **Independent data transfers over the Internet, i.e., TCP/IP**
  - **TCP/IP shares bandwidth fairly**
  - **individual clients experience poor performance when number of clients is large (if transfer time is long enough to *see* other connections)**
  - **TCP/IP is here to stay**



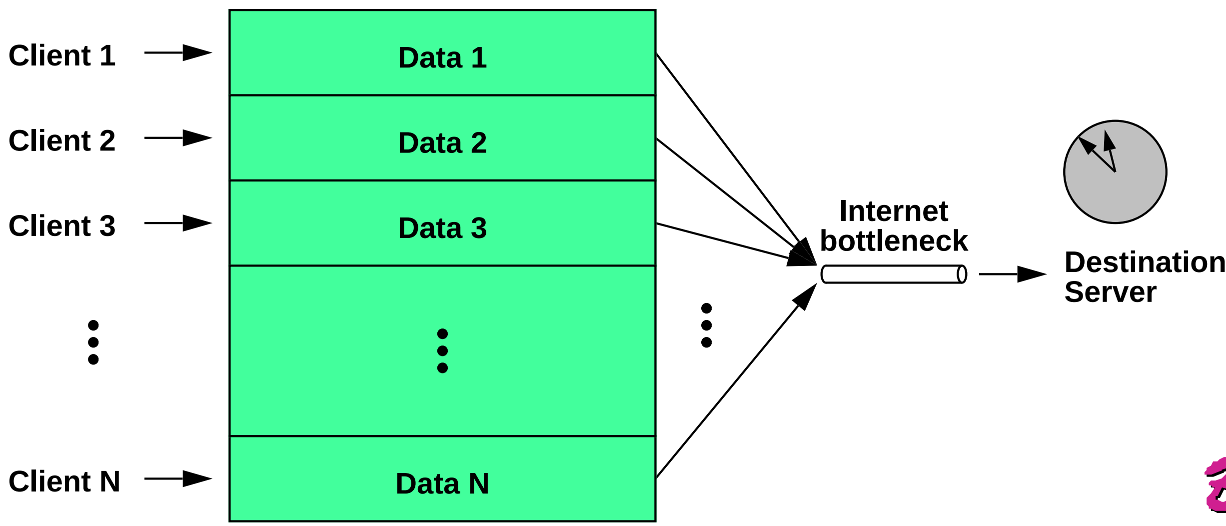
- ***Not scalable!***

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Key Observations

(applications with deadlines)

- Existence of hot spots in uploads is largely due to *approaching deadlines*
- Exacerbated by *long transfer times*
- Problem: too much data ... too little time ...



Key Observations (Cont...)

(applications with deadlines)

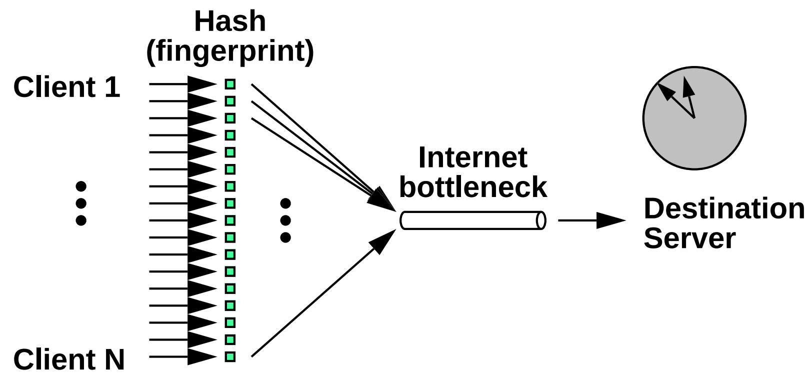
- **What is actually needed is an *assurance* that specific data was submitted before a specific time; then the transfer of that data needs to be done in a timely manner, but does *not* have to occur by the deadline**

the data may not be consumed by the server right away

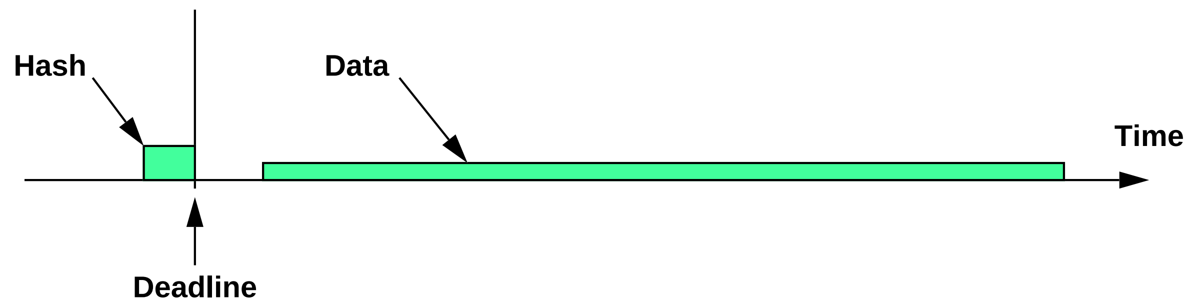
USC IML
Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Solution with *Bistro*

- Before deadline:

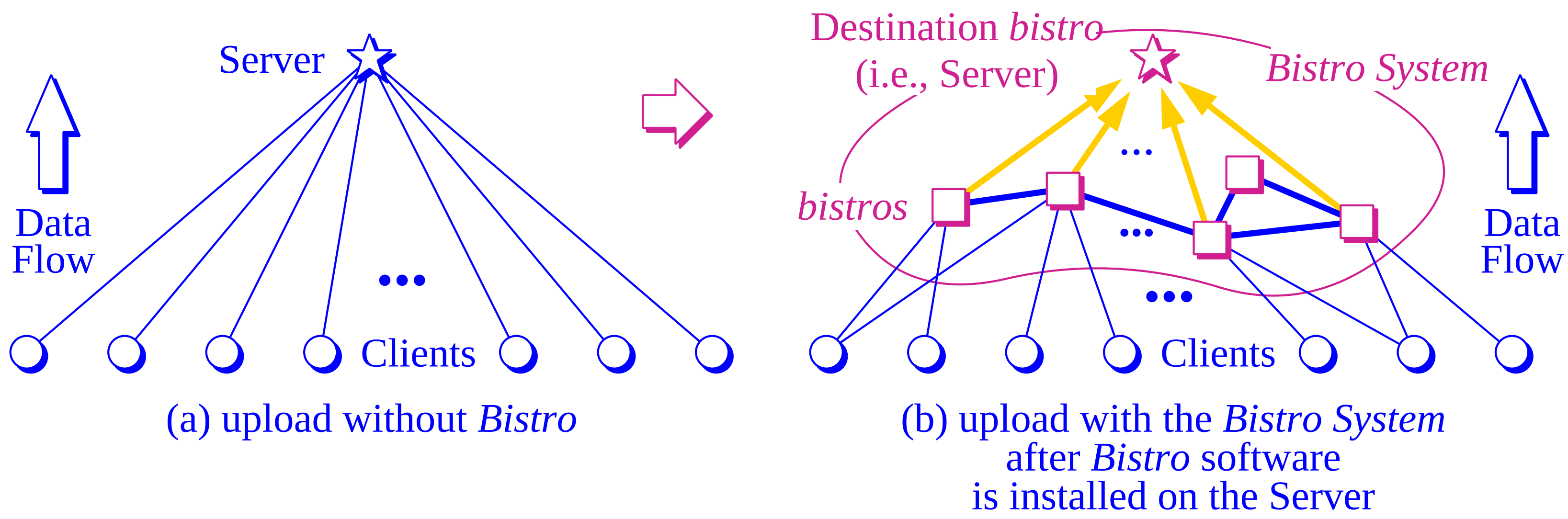


- Traffic at/near *Destination Server:*



Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

A Solution to *Upload* with *Deadlines*



- **Real-time timestamp**
- **Low-latency upload to *any* intermediary (*commit*)**
- **Timely transfer to final destination (large scale *data transfer*)**

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

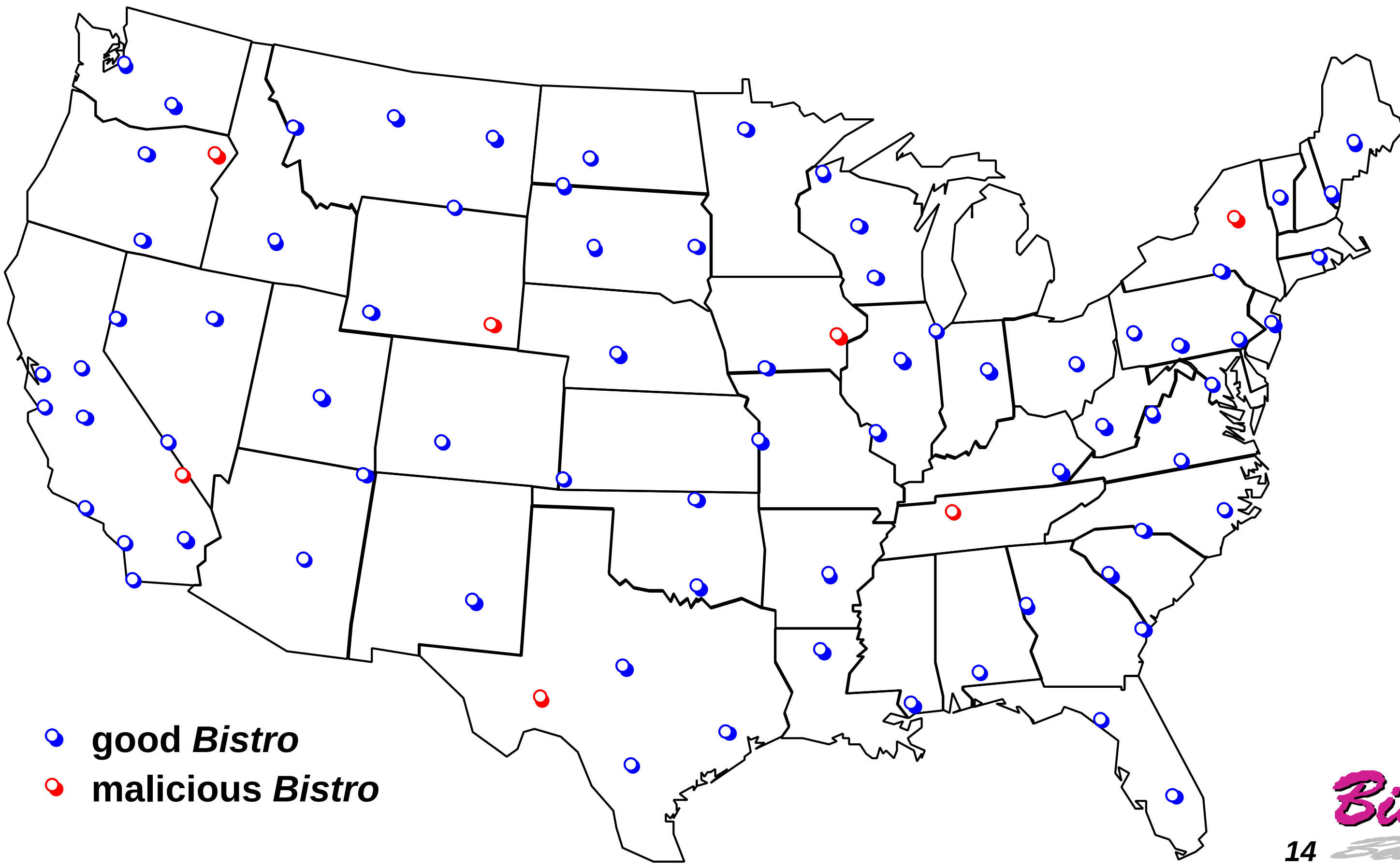
Advantages of Bistro

- **Shares resources and a *single* infrastructure**
- **Replaces a traditionally *synchronized client push* solution with a *non-synchronized* combination of *client-push* and *server-pull***
- **Eliminates hot spots by spreading most of the demand on the server *over time*, by making the actual data transfer *independent* of the deadline**
- **Deployable *today*, i.e., no change required inside the network**
- ***Gradual* deployment over a public, private, or mixed infrastructure of hosts**
- **More *dynamic* and therefore more *adaptive* to system and network conditions**

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Deployment Issues

- **Public vs. private infrastructure**

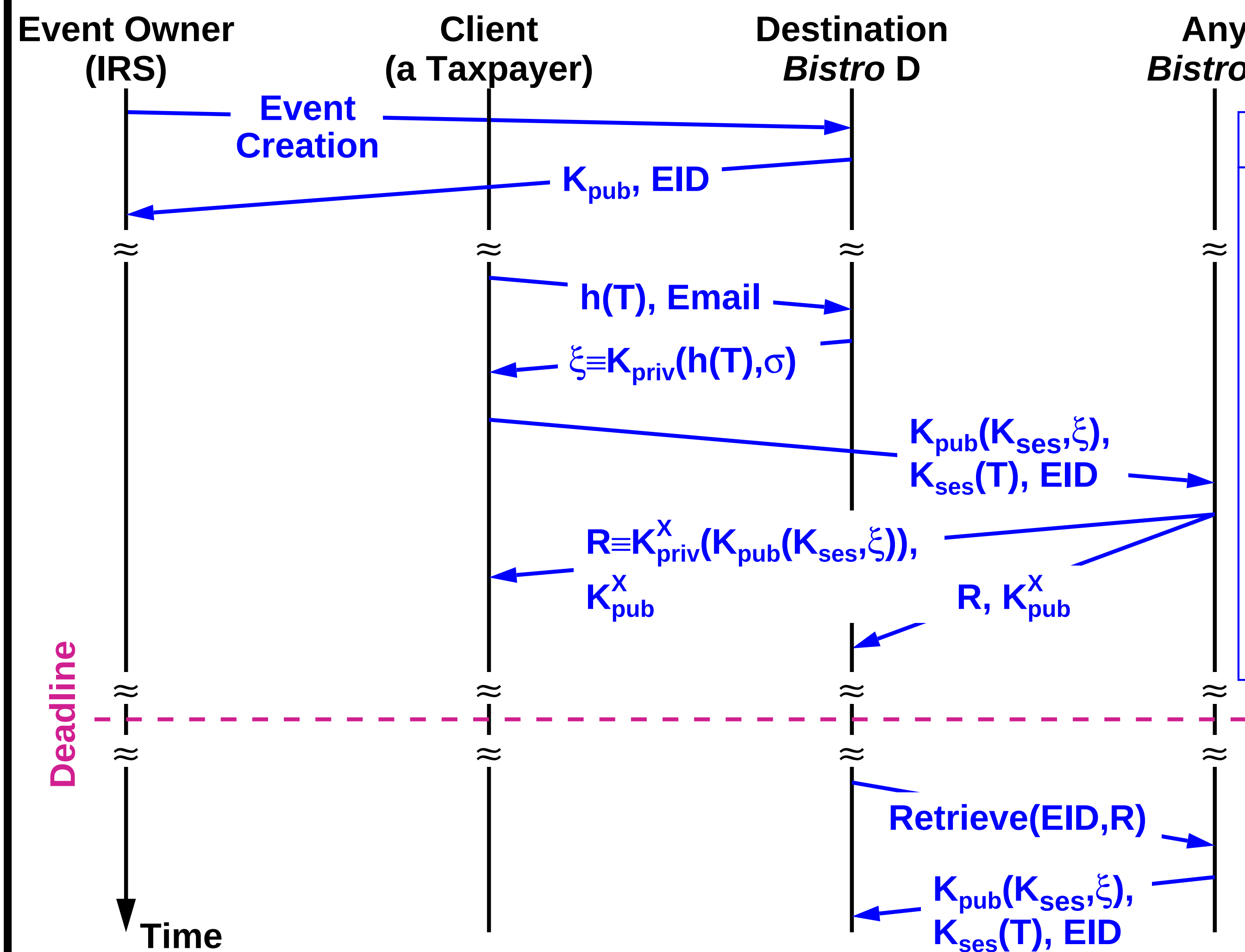


Bistro

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

over public infrastructure
trust issues (e.g., IRS)

Bistro



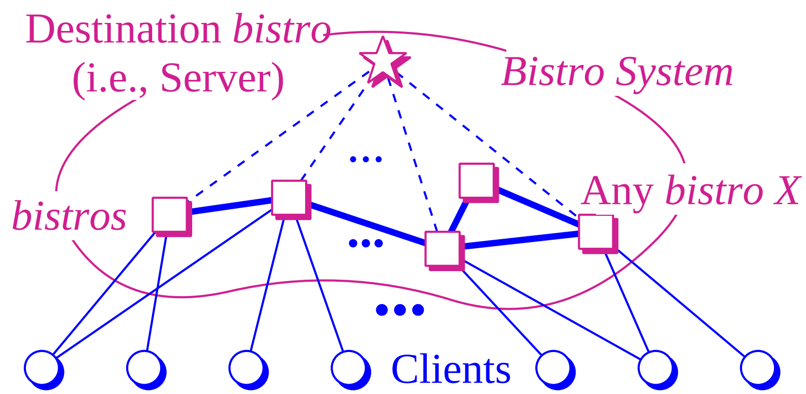
Legend:

EID :	Event ID
K_{pub} :	Event Public Key
K_{priv} :	Event Private Key
K^X_{pub} :	*Bistro* X Public Key
K^X_{priv} :	*Bistro* X Private Key
T :	Data to upload
h() :	Message Digest
σ :	Timestamp
ξ :	Ticket
R :	Receipt

USC IML
Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Who is Trusted with What?

- **Event Owner**
  - **trusts the Destination *Bistro* for *this* event**
- **End User**
  - **trusts its Client software**
  - **trusts the Destination *Bistro* for *this* event**
- **Destination *Bistro***
  - **generates (K_{pub}, K_{priv}) for *this* event**
- **Any *Bistro* X**
  - **generates (K^{X}_{pub}, K^{X}_{priv}) for *any* event (only once)**

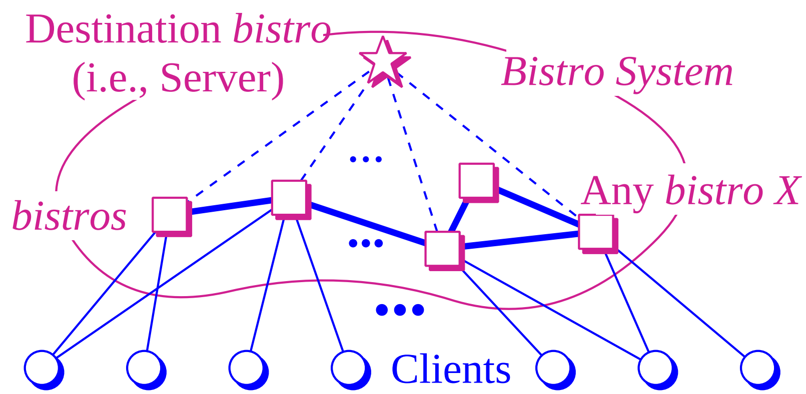


analog to certified mail with untrusted post-office

USC IML
Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Some Issues

- **Mirroring**
- **The Destination *bistro* can also be Any *bistro* X**



- **Issues**
  - **the usual *public key distribution* problem**
  - **no client authentication (e.g., multiple submissions from the same user)**
  - **single point of attack**
  - **event owner doesn't want to use the Destination *bistro*'s public key crypto system**

Leana Golubchik
Internet Multimedia Lab
CS / EE-S / IMSC / ISI
University of Southern California

Contributions Thus Far

- **First effort to study many-to-one communication problem at the *application* layer & attempt at stating fundamental obstacles**
- **Proposed a reasonably general framework**
- **Proposed solutions to all parts of the problem**
- **Suggested some open problems**

Related Work

- Akamai and other content distribution networks
- Napster
- A variety of server selection problems
- Internet security

Related Work (Cont...)

- Many-to-one communication at IP level & within Active network framework
  - Gathercast [Badrinath & Sudame 98]
  - Concast [Calvert et al. 00]
- Wide area applications
  - wide-area download applications: e.g., Akamai [Karger et al. 97]
  - Napster type systems, e.g., [Kong & Ghosal 99]
  - application layer multicast: e.g., [Chu et al. 00]
- Client-side server selection
  - statistical: e.g., [Seshnm et al. 97]
  - dynamic: e.g., [Carter & Crovella 97] [Sayal et al. 98] [Dykes et al. 00]

Related Work (Cont...)

- Application level re-routing
  - alternate paths [Savage et al. 99]
  - Detour [Savage et al. 99]
  - RON: resilient overlay network [Andersen et al. 01]

- Online batch-based digital signature schemes
  - modification on cryptographic algorithm [A. Fiat 89]
  - one-time signatures used in secret key system [Lamport 79, Merkle 88]

Vision

- **A *bistro* in every administrative domain e.g., co-located with web servers**
- **Entire network of *bistros* collects data for one application one day and for another application the next day**
- **Use the *Bistro* infrastructure for other large scale data gathering, transfer, and storage needs**

Participants

- Faculty Members:
  - Leana Golubchik
  - Samir Khuller (UMD)
  - Cheng-Fu Chou (NTU)
- Research Staff:
  - William C. Cheng
- Students:
  - Leslie Cheung
  - Yung-Chun Wan (UMD)
  - Yan Yang

Contact Information

Prof. Leana Golubchik

CS / EE-S / IMSC / ISI
University of Southern California
Los Angeles, CA 90089

Email: leana@cs.usc.edu
Voice: (213) 740-4524
Fax: (213) 740-7285
URL: http://cs.usc.edu/~leana

Project URL: http://bourbon.usc.edu/iml/bistro
Lab URL: http://bourbon.usc.edu/iml