

Peer-to-Peer Systems

What's behind the buzzword?

Uwe Schmidt

Un-Distinguished Lecture Series

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What is it?

- What does Peer-to-Peer (P2P) mean to you?
- What does “peer” mean?
 - Merriam-Webster:
one that is of equal standing with another :
EQUAL; especially : **one belonging to the same societal group** especially based on age, grade, or status

P2P Principle

- Organizational principle, core concepts:
 - Self-organizing, no central management
 - Resource sharing, exploits resources at the edge of the network
 - Peers in P2P are all equal (more or less)
 - Large number of peers in the network

Properties of P2P

- Unreliable, uncoordinated, unmanaged
- Resilient to attacks, heterogeneous
- Large collection of resources

When to use it?

- Budget
- Resource relevance
- Trust
- Rate of system change
- Criticality

P2P Vision

No More Dedicated Servers,
Everything in Internet Served by Peers

P2P File-sharing

- The most popular application of the P2P principle
- Made P2P popular
- We will look at the “evolution” of P2P file-sharing in the following...

Filename	File Size	User	Status	Speed	Progress	Rate	Time Left
Comedy - Maclean & Maclean - The Gross Manual (14 Sure Fire Jo...	299,200 of 2,220,560	ldhull	Downloading...	Unknown	13 %	5.06 k/s	00:06:19
(Comedy) Maclean & Maclean - Johnny Marijuana Seed .mp3	270,048 of 7,381,800	mbrin	Downloading...	Cable	3 %	6.50 k/s	00:18:13
Comedy - Maclean & Maclean - The Gross Manual (14 Sure Fire Jo...	539,936 of 2,220,560	big_bang_	Downloading...	Cable	24 %	7.33 k/s	00:03:49
MacLean and Maclean - Bowser and Blue.mp3	5,606,005	adie_m	Getting Info...				
Andrews Sisters - Little Toot.mp3	375,392 of 8,528,129	F4phantom_...	Downloading...	DSL	4 %	4.14 k/s	00:32:50
78's CHILDREN'S STORY RECORD -- LITTLE TOOT.mp3	89,512 of 5,840,561	dude_way	Downloading...	14.4	1 %	1.10 k/s	01:26:59
Disney Parks Toontown-Little Toot.mp3	64,608 of 2,354,597	hitteimerbitter	Downloading...	Cable	2 %	1.28 k/s	00:29:47
Maclean & Maclean - Little Toot.MP3	12,288 of 602,112	KASDJFLKJ...	Downloading...	Cable	3 %	0.24 k/s	00:41:39
Disney Parks Toontown-Little Toot.mp3	185,648 of 2,354,597	Creano1	Downloading...	56K	8 %	5.82 k/s	00:06:12
Maclean & Maclean - Little Toot.mp3	210,944 of 882,688	stearch	Downloading...	56K	24 %	4.44 k/s	00:02:31
Big Tiny Little & Mickey Finn - Toot Toot Tootsi.mp3	40,128 of 2,888,844	albear69	Downloading...	Cable	1 %	1.89 k/s	00:25:08
Comedy - Maclean & Maclean - Little Toot.mp3	6,816 of 882,688	catalina2136	Downloading...	DSL	0 %	0.55 k/s	00:26:45
Brenda Lee - Toot Toot Tootsie Goodbye (Little Miss Dynamite, CD...	44,368 of 2,250,710	angel3339	Downloading...	Unknown	1 %	1.10 k/s	00:33:26
MacLean & MacLean - Little Toot (edit).mp3	115,600 of 1,180,444	123412341...	Downloading...	14.4	9 %	4.68 k/s	00:03:47
Maclean & Maclean - Little Toot.mp3	882,688	raybauduc	Getting Info...				

Filename	File Size	User	Status	Speed	Progress	Rate	Time Left
Crosby, Stills, Nash And Young - Ohio.Mp3	2,725,888 of 3,709,496	cybermoose	Uploading...	56K	73 %	1.55 k/s	00:10:33
lollipop lust kill - jesus chrysler.mp3	3,339,493	4StringMF	File Complete!				
Simpsons - The Life Of Homer Simpson.mp3	1,406,976 of 2,756,736	aoldude67	Uploading...	56K	51 %	1.45 k/s	00:15:30
Fear Factory - Cars.mp3	3,921,141	tubbedbird	File Complete!				
Comedy - Richard Pryor - New Niggers.mp3	3,796,451	tubbedbird	File Complete!				
Unknown - Mopar (Chrysler) 440 6-pak V8 race-buit - real men don't...	859,049	TYLERSEX...	File Complete!				
Comedy - Jerky Boys - Fanning My Balls.mp3	675,840 of 1,784,264	tubbedbird	Uploading...	14.4	38 %	7.33 k/s	00:02:31
Ben Stiller & Andy Dick - Can We Get It Together Again.mp3	1,230,600	fluidpockets...	Waiting...				

Concurrent Downloads: 25 Concurrent Uploads: 1

Clear Finished

Cancel

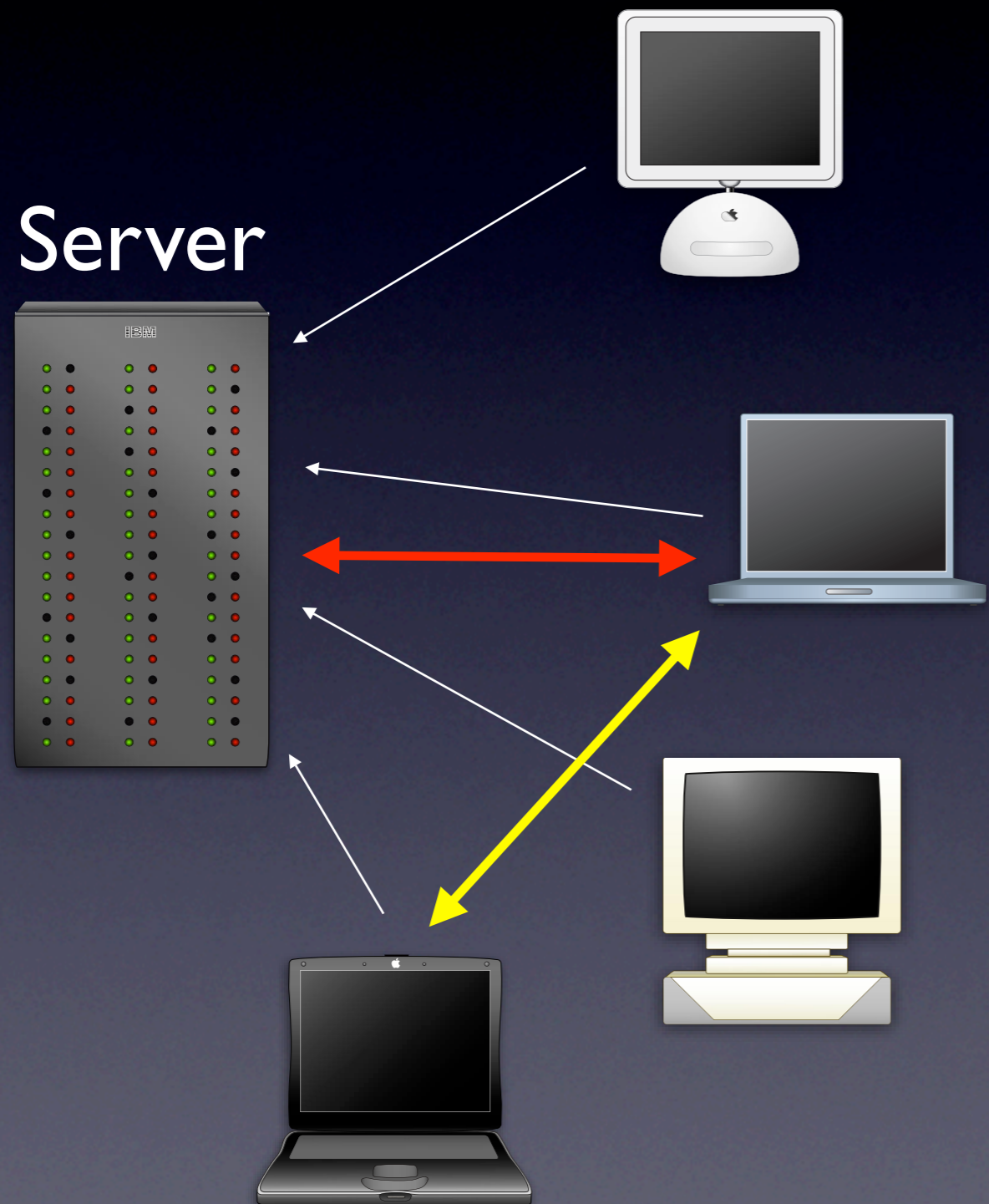
Napster

- First P2P file-sharing application (June 1999)
- Only MP3 sharing possible
- Made the term “P2P” known
- Created by Shawn Fanning (nickname “Napster”)

How Napster worked

- Based on central index server (farm)
- User register and give list of files to share
- Searching based on keywords
 - Results: List of files with additional information, e.g. peer's bandwidth, encoding rate, file size

Napster Diagram



- Peers log in
- Send list of files to share

- Peer queries server
- Server responds

- File transfer directly

Strengths & Weaknesses

Strength	Weakness
Fast, efficient and overall search	Central server is a single point of failure
Consistent view of the network	Expensive to maintain central server (farm)

atk-gnutella 0.80 beta

gnutellaNet
 Uploads
 Downloads
Search
 Monitor
 Config

Active searches: lebowski

120 items found Minimum connection speed (kbps)

lebowski (120) | smashing pumpkins gish (59, 24)

File	Size	Speed	Host	Info
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	256	192.168.0.118:6346	Bear, push
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	1000	141.2.176.46:6346	urn:sha1:B2TT9ZRP6UD3Z
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	512	65.13.50.220:6346	urn:sha1:QH9D3USUT9NXT
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	1000	213.100.46.202:634	urn:sha1:ENP978Q43WN2C
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	256	43.227.212.129:634	urn:sha1:ENP978Q43WN2C
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	512	24.67.117.44:6346	Bear, busy
The.Big.Lebowski.DVDRip.DivX-DVL.avi	727.6 MB	512	24.229.125.35:6346	Bear, busy
Gypsy Kings - Hotel California (Big Lebow	5.3 MB	10000	152.42.124.123:634	Bear, stable
Gypsy Kings - Hotel California (Big Lebow	5.3 MB	512	12.254.196.195:634	Bear, busy, stable
Gypsy Kings - Hotel California (Big Lebow	5.3 MB	512	24.126.142.28:6346	Bear, stable, push
Gypsy Kings_Hotel California_Big Lebows	5.3 MB	256	66.32.149.191:6346	Bear, push
Gypsy Kings - Hotel California (Big Lebow	5.3 MB	512	24.131.208.111:634	Bear, busy, stable
Gypsy Kings_Hotel California_Big Lebows	5.3 MB	256	66.32.149.191:6346	Bear
Gypsy Kings- Hotel California (Big Lebow	5.3 MB	512	24.126.142.28:6346	Bear, stable, push
Gypsy Kings- Hotel California (Big Lebow	5.3 MB	512	165.123.149.147:63	Bear, busy, stable

gnutellaNet sta
 1 hosts
 1 files
 13.9 MB
 134 ms avg p

Jump to downloads Automatic Download Retry search every (seconds, 0=never):

<http://gtk-gnutella.sourceforge.net/>

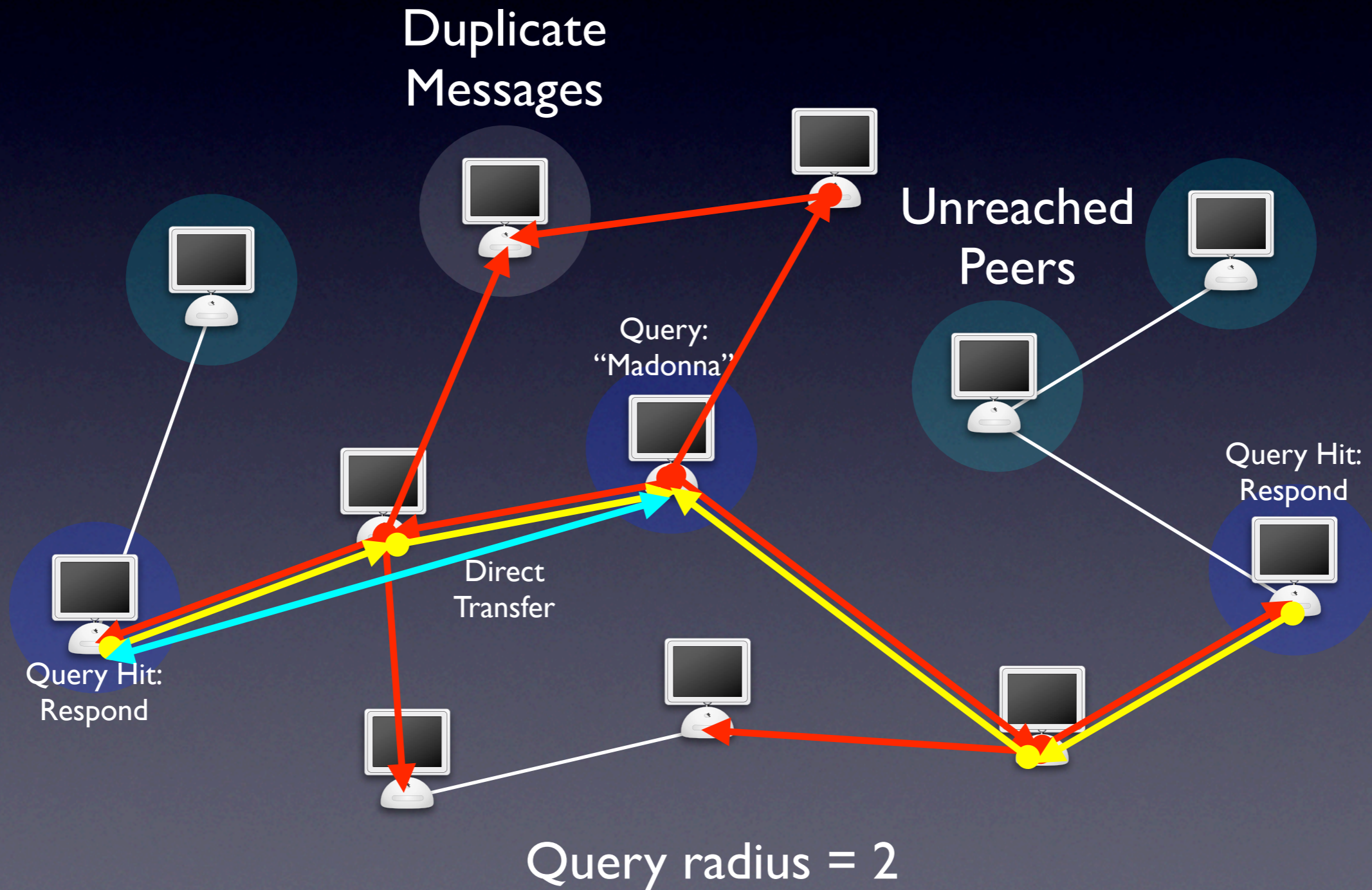
Gnutella

- Addresses some of Napster's weaknesses and introduces its own problems
- Originally developed at Nullsoft (AOL)
 - Accidentally released on their website
- Open protocol specifications
- Fully distributed

How Gnutella works


- Based on an overlay network
- All peers are fully equal
- A peer needs to know another peer, that is already in the network, to join
- Searching based on flooding
- Direct downloads

Gnutella Diagram



Strengths & Weaknesses

Strength	Weakness
Fully distributed, no attack points?	Flooding a query is extremely inefficient
Open protocol	Search only reaches a subset of peers due to limited query radius

Search	Title	Artist	Album	Category	ETA	User	Quality	Length	
 Search for Audio Files									
Search for:									
<input type="text" value="Linkin park"/>									
<input checked="" type="radio"/> All <input type="radio"/> Title <input type="radio"/> Artist									
<input type="button" value="Search Now"/> <input type="button" value="Stop Search"/>									
« Back									
More Search Options »									
Search Filter									
Search Tip									
Type in what you are looking for. If you are looking for an artist or a title, check the corresponding button. If you want to refine your search click on "More Search Options". To go back to the general search page click "Back".									
	It's Going Down (Fea...	Linkin Park	Built From ...	Rap	0:06:34	klfhkhjgf@K...			4,
	Runaway	Linkin Park	Hybrid Theo..	Rock	0:03:47	cheekyfella...	128	0:03:...	2,
	In the End	Linkin Park	Hybrid Theo..	Rock	10:07:41	cheekyfella...	128	0:04:...	4,
	Crawling	Linkin Park	Hybrid Theo..	Alternative	0:04:23	cheekyfella...	128	0:03:...	3,
	In The End	Linkin Park	Hybrid Theo..	Other	0:04:27	faraz@KaZa...	128	0:03:...	3,
	Break	Linkin Park	Unknown	Metal	0:03:33	elmasio@Ka...	128	0:02:...	2,
	High Voltage	Linkin Park	Hybrid Theo..	Hard Rock	5:45:45	cheekyfella...	128	0:02:...	2,
	Paranoia	Linkin Park	Unknown	Other	6:26:08	cheekyfella...	128	0:03:...	2,
	Cure for the Itch	Linkin Park	Unknown	Alternative	0:03:14	klfhkhjgf@K...	128	0:02:...	2,
	With You	Linkin Park	Unknown	Alternative	0:04:23	cheekyfella...	128	0:03:...	3,
	SuperXero	Linkin Park	title	genre	0:03:21	elmasio@Ka...	96	0:03:...	2,
	One Step Closer	Linkin Park	Hybrid Theo..	AlternRock	0:04:49	cheekyfella...	128	0:03:...	3,
	Point of Authority	Linkin Park	Unknown	Alternative	0:04:07	klfhkhjgf@K...	128	0:03:...	3,
	Part Of Me	Linkin Park	Unknown		8:00:33	cheekyfella...	128	0:03:...	3,
	Pushing Me Away	Linkin Park	Hybrid Theo..	AlternRock	9:57:53	cheekyfella...			4,
	Runaway	Linkin Park	Unknown		4:47:34	cheekyfella...	96	0:03:...	2,
	One Step Closer	Linkin Park	Hybrid Theo..	Other	0:03:12	cheekyfella...	128	0:02:...	2,
	Forgotten	Linkin Park	Unknown		6:45:11	cheekyfella...	128	0:03:...	3,
	Pushing Me Away	Linkin Park	Hybrid Theo..		6:39:34	cheekyfella...	128	0:03:...	2,
	live what you've lear...	linkin park	Unknown		7:11:47	cheekyfella...	128	0:03:...	3,
	My December	Linkin Park	Hybrid Theo..	AlternRock	0:04:45	elmasio@Ka...	128	0:03:...	3,
	Esal	Linkin Park	Unreleased	AlternRock	0:04:18	elmasio@Ka...	128	0:03:...	2,
	Crawling	Linkin Park	Hybrid Theo..	Rock	1:49:52	cheekyfella...	32	0:03:...	
	Points Of Authority [...	Linkin Park	Hybrid Theo..		0:06:38	faraz@KaZaA	128	0:03:...	3,
	Crawling	Linkin Park	Hybrid Theo..	Rock	5:26:40	cheekyfella...	96	0:03:...	2,
	A Place for my Head	Linkin Park	Unknown	Alternative	0:03:48	klfhkhjgf@K...	128	0:03:...	2,
	By Myself	Hybrid Theory	Unknown	Alternative	0:03:59	cheekyfella...	128	0:03:...	3,
	Forgotten	10_	Unknown	Blues	5:54:28	cheekyfella...	112	0:03:...	2,
	one step closer (1)	3	Unknown	Blues	4:06:26	cheekyfella...	96	0:02:...	1,
	Points Of Authority	3	Unknown	Blues	7:11:46	cheekyfella...	128	0:03:...	3,


What good is a cloned sheep?

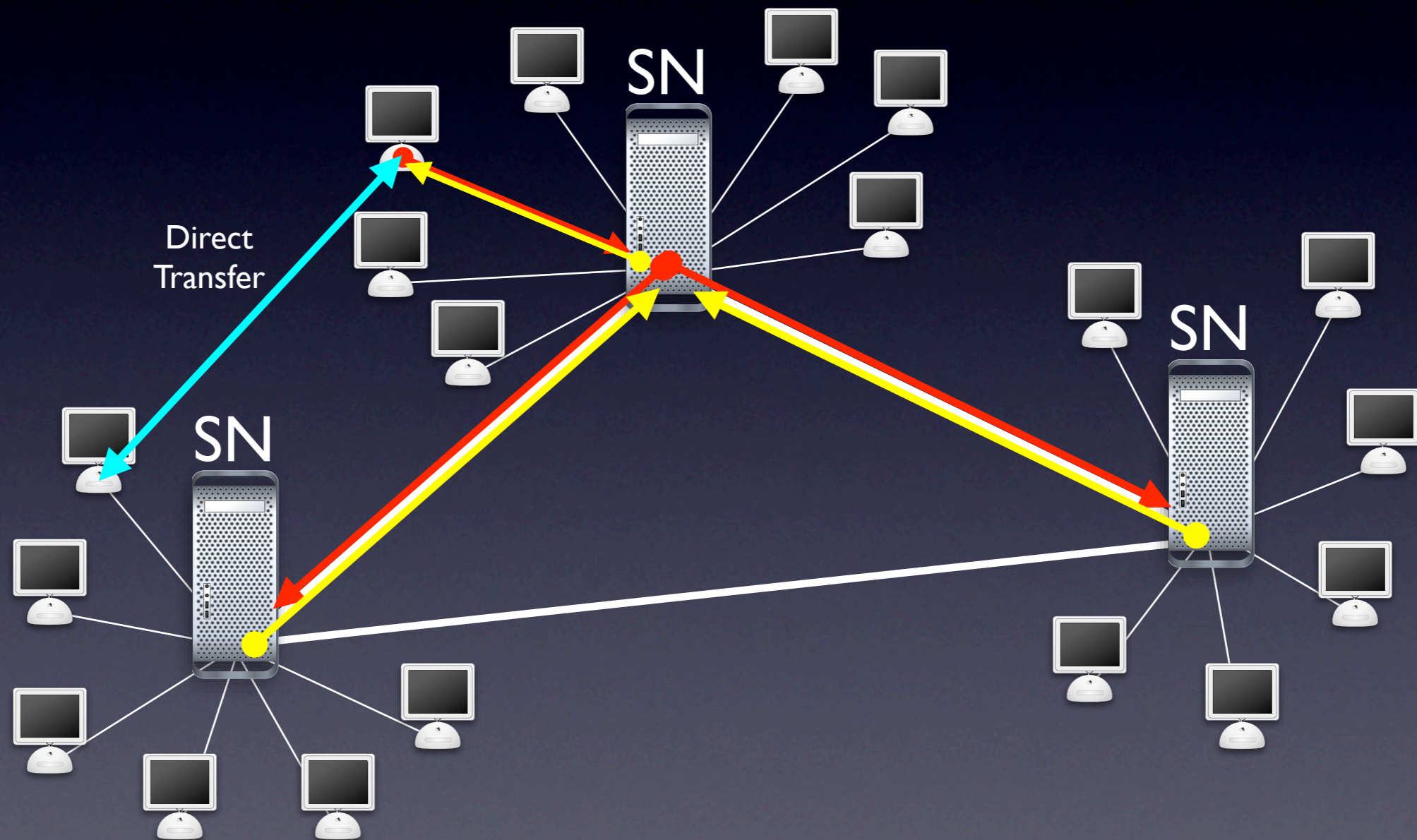
KaZaA

- Created in March 2001 (Niklas Zennström)
- Combines strengths of Napster and Gnutella
- Based on “supernode architecture”
- Exploits heterogeneity of peers
- Organize peers into a hierarchy

How KaZaA works

- Two-tier hierarchy
- Two kinds of nodes
 - Ordinary nodes (ON)
 - Supernodes (SN)
- ON belongs to SN

KaZaA Diagram



Strengths & Weaknesses

Strength	Weakness
Combines good points from Napster and Gnutella	Still no overall search
	Easier to attack?

Comparison

	Napster	Gnutella	KaZaA
Type of network	Centralized	Distributed	Hybrid
Efficient searching	+++	---	+
Resilience to attacks	---	++?	+

Current State

- Most bigger file-sharing systems sued into submission (e.g. Napster and KaZaA)
- Although many still running because of open clients
- User who share copyrighted content are sued as well...
 - e.g. by the RIAA

Non-direct file-sharing

- People try to be anonymous by disguising their identity, i.e. IP-address
- Idea: Non-direct file transfer, i.e. route traffic through intermediate peers
- Have currently too much overhead
 - slow and not very efficient

BitTorrent

- Developed by Bram Cohen in 2001
- New approach for sharing large files
- Goal: Quickly replicate one file to a large number of clients
- More appropriately called P2P content distribution instead of file-sharing

How BitTorrent works

- Build a network for each file to distribute
- Each file has unique “link”
 - “torrent” file holds metadata about a file
- Tracker is a server to manage active clients
- Files are broken into chunks

BitTorrent Download

- Client gets “torrent” file from somewhere
- Client contacts tracker, gets lists of peers
- Client contacts other peers directly for download of specific chunks

Tit-for-Tat policy

- Encourages cooperation, discourages free-riding
- A peer serves peers that serve it
- Peers download rarest chunks first
 - makes them attractive to other peers, they can then download in return
 - also prevents chunks from disappearing

Strengths & Weaknesses

Strength	Weakness
Works quite well, only slow in the beginning	Files have to be large
Efficient distribution mechanism	No searching
Enforces contribution, discourages free-riding	Everyone must contribute

Other P2P applications

- P2P Communications
 - Email, IM, VoIP
- P2P Computation
 - SETI@Home
- P2P Collaboration
 - Wikipedia

Skype™ (BETA) - screenshot...

File View Contacts Tools Call Help

Add Contact Search Call Phones Conference

Jason Wilson 5 new events € 1,26

Contacts Dial Live History

Cathy Black

Jagsemash!

Tallinn, EE 15:11 (GMT+3)

- Cy Burnett \o/ http://share.skype.com/si...
- Ella Vator
- Frederico Maximus free klonies today at skyp...
- Heather Anderson Parik - Kalale!
- Heather Jordan Jesus has two dadies.
- Kenneth Anderson 2.6.0.64
- Mary Carter
- Mom and Dad w0rk
- Thule Cus-Tutaya FILM JAM / TONIGHT /...
- Amy Stake
- Earl E. Bird
- Ike Entell On vacation. Back September 4.
- John Anderson Chuck Norris actually built the...

Enter Skype Name or United Kingdom phone numbe

Online 6 089 554 Users Online

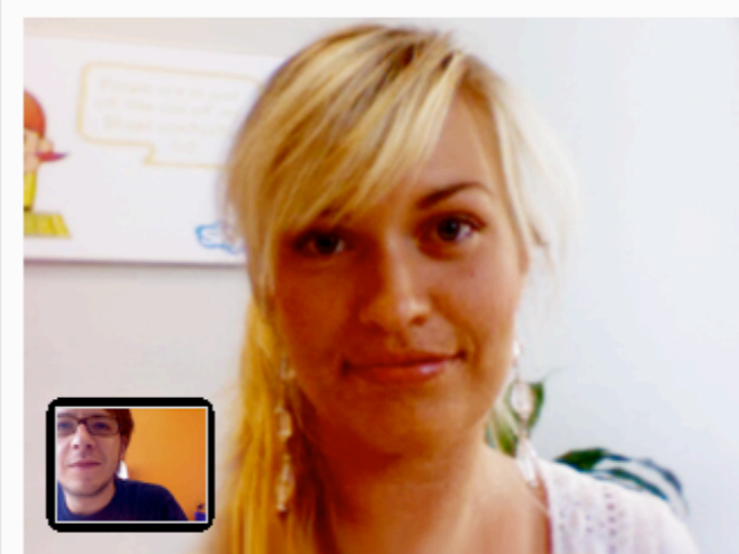
Skype™

File View Contacts Tools Call Help

Add Contact Search Call Phones Conference Chat Send File Profile

Martin Anderson sun is shining! No new events € 1.52

Contacts Dial History Kenneth Anderson



Barbara Anderson
(barbaraander4s)

Stop My Video Call Duration 01:39

Call with Kenneth Anderson 5,855,215 Users Online

Skype

- Developed by the same people as KaZaA
- 9 Million concurrent users (Jan. 29 2007)
- Very similar to KaZaA's architecture
 - Supernodes and ordinary nodes
- Central server for login and billing

Skype

- Proprietary and encrypted protocol
- Source code is closed
- Executable uses a lot of mechanisms to protect against reverse engineering
 - Anti-debugger code
 - Partly encrypted

How Skype goes through Firewalls

- Skype server plays mediator
 - takes IP addresses and UDP ports
 - forwards them to other side
- Both clients start connections
- Firewalls think that packets from the other side are responses to started connections

Joost

- Brought to you by the guys who made KaZaA and Skype
- Uses P2P video streaming technology
- Tries to merge the best of TV with the best of the Internet
- Beta test is running right now
- Advertisement based, View on demand

+ My Joost™ Plugins

Instant Messaging

Offline

Username

Password

Remember my password

Sign in using your Jabber or
Gmail account

Sign in

Notice Board

Happy new year everyone - and once again, a big thank you for helping us test the system.

This is our plugin section, where you can find (and soon, create!) all sorts of interactive applications and community tools. We are continually working on

Rate It

Stereophonics - Dakota



Very good! (3.84)

19 Ratings

Channel Chat

Netwerk (1 person)

Actions

Started talking in the 'Red Hot Chili Peppers' chatroom as guest-678db2fa

Started talking in the 'Paris Hilton' chatroom as guest-678db2fa

Started talking in the 'Netwerk' chatroom as guest-678db2fa

guest-678db2fa: Man, I was at one of their concerts last year! They rock

That's it

Let's get some beer...

References

Most slides are based and copied in large part from Jussi Kangasharju's lecture on "Peer-to-Peer and Grid Computing", chapter 1 and 2.

<http://elara.tk.informatik.tu-darmstadt.de/LectureNotes/ws0607/P2P/>

Other References:

1. "File sharing." Wikipedia, The Free Encyclopedia.
http://en.wikipedia.org/wiki/File_sharing
2. "Skype." Wikipedia, The Free Encyclopedia.
<http://en.wikipedia.org/wiki/Skype>
3. "Napster." Wikipedia, The Free Encyclopedia.
<http://en.wikipedia.org/wiki/Napster>
4. Joost.
<http://www.joost.com>

References

5. **The hole trick: How Skype & Co. get round firewalls**
<http://www.heise-security.co.uk/articles/82481>
6. **Silver Needle in the Skype**
http://www.secdev.org/conf/skype_BHEU06.handout.pdf
7. **Picture of Gtk-Gnutella**
<http://impressive.net/people/gerald/2002/01/21/gtk-gnutella.png>
8. **Picture of KaZaA**
http://www.lagranepoca.com/news_images/2006-7-28-kazaa.gif
9. **Pictures of Skype**
<http://about.skype.com/pictures.html>