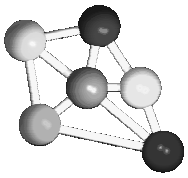
# Peer-to-peer under the hood



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# Peer-to-peer under the hood

- This talk will be about p2p algorithms. Not about specific p2p software.
- David has researched p2p algorithms since 1997 and full time since autumn 2000.
- David is making a p2p-programming library. So that other programmers can build advanced p2p applications easily, without having to spend years on research first.

Note that slides with a red X are not shown during talks but are added in printed and online versions to make the slides more comprehensible.

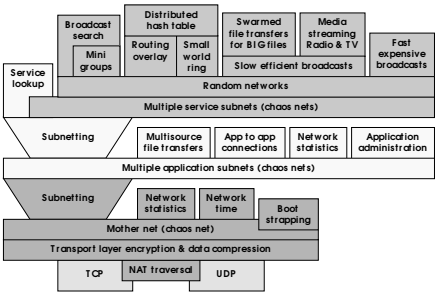
# Ideal p2p systems

- Fully distributed
- Totally serverless
- Fully scalable
- Globally searchable
- Bandwidth efficient
- Robust
- Encrypted
- Stealthy
- Preferably anonymous

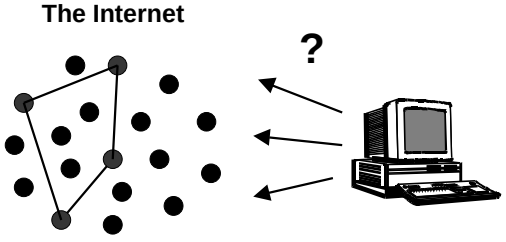
# Target applications

- File sharing
- Chat systems
- Instant messaging
- Internet telephoning
- Internet games
- Radio & TV (sent from home users computers)
- Distributed calculation systems
- And many more applications

# The Randpeer layer model




# Bootstrapping




How to find the other peers on the Internet?

## Bootstrapping 2

When a node joins a p2p network it needs some way to find the network.

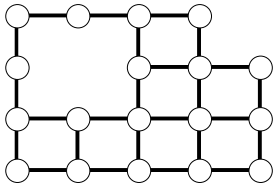
Centralised approach:

- Start servers / reflectors. Reachable at fixed IPs or fixed DNS names.

Distributed serverless approach:

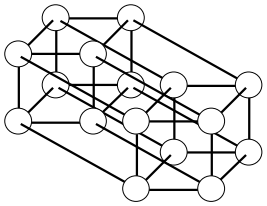
- Start lists: Nodes remember nodes that are online often and much with the same IP.
- Old nodes use their start list to find the network.
- New nodes get a start list in the install package.
- If the start list is too old, get a fresh one from the web or IRC or from a friend via email or diskette.

## Two dimensional grid



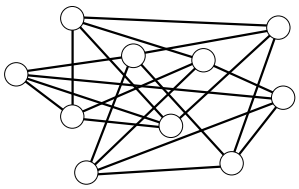
- Easy to understand
- Tricky to code and maintain
- Inefficient (Long jump distances)

## Hypercube



- Easy to understand
- Tricky to code and maintain
- Efficient (Short jump distances)

## Random network
### (Small world network)



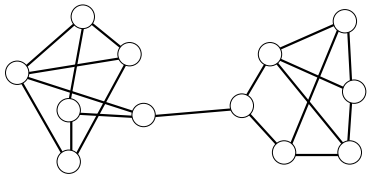
- Slightly tricky to understand
- Easy to code and maintain
- Efficient (Short jump distances)

## Internet problems

- High node churn = Home users often turn their computers off
- Erroneous ISP routers = All nodes can not reach each other
- Firewalls and NAT routers = All nodes can not reach each other

This means random networks are easier to maintain then “well organised” grids.

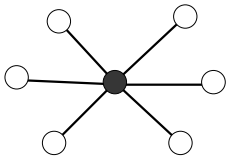
## Netsplit prevention



We need random (far away) node addresses:

- Node address announcements
- Random walkers
- Chaos nets (David’s own solution)

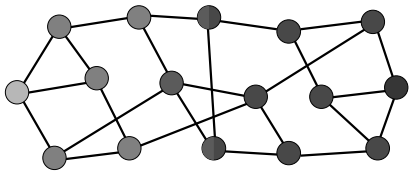
## Flooding / Overloading



**Methods to prevent overloading of nodes:**

- **Round based algorithms**
- **Throttling**
- **Randomised algorithms (to spread load evenly)**

## Throttled balanced broadcasts



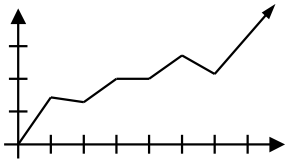
**Often a node doesn't need to see *all* broadcasted messages, only *enough* messages**

## Throttled balanced broadcasts 2

**Often nodes don't need to broadcast to all nodes, instead nodes need to receive enough messages:**

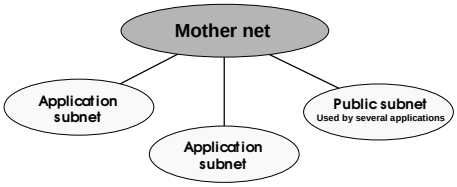
- **Jump counter instead of TTL (Time To Live) (Count up instead of down)**
- **Youngest message is forwarded**
- **Each originating node reaches about the same amount of nodes**
- **Forward some messages per link per round**
- **Different message types can / should be handled separately = "slotted broadcasting"**

## Network statistics



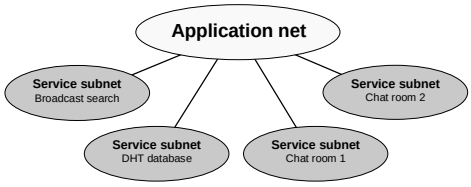
- **Number of nodes online**
- **Number of unique nodes per month**
- **Network averages, medians, max and min**
- **Network totals (sums)**
- **Network time**

## Application subnets



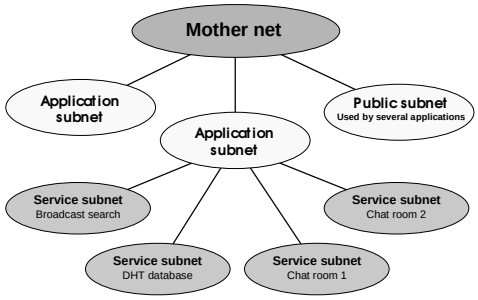

- **New nets can bootstrap off old nets**
- **Small nets help each other with bootstrapping**
- **Old shrinking nets can bootstrap of new big nets**
- **"Public subnets" for co-operating applications**

## Service subnets
### (Rendezvous service)




- **Chat rooms and file transfer swarms as subnets**
- **User IDs and servers as subnets**
- **Algorithms / protocols as subnets: Plug in new kinds of search databases later on!**

## Subnetting overview




## Subnetting

**If you don't know the name and the key you should not be able to "see" the subnet:**

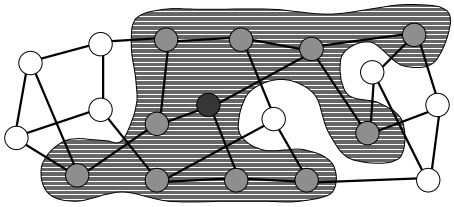
**subnet address = hash( subnet name + subnet key )**

**Huge subnets must be able to coexist with small subnets.**

**Ways to implement subnet lookup (rendezvous):**

- **Broadcast search**
- **Distributed Hash Table (DHT)**
- **Subnets under subnets**

## Broadcast search



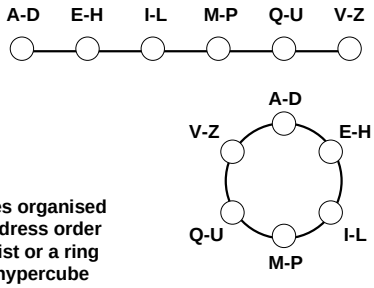
**Preferably uses throttled balanced broadcasts**

## Broadcast search 2

**Gnutella, Kazaa and many more:**

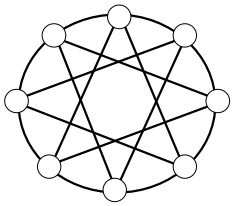
- **Uses a random network**
- **Search limited by a TTL or jump counter**
- **Search horizon = Only reaches the closest nodes**
- **Uses very much bandwidth**
- **Very good at handling complex searches such as "ccc AND video AND NOT Berlin"**
- **Width first or depth first search**
- **Some optimisations can increase the horizon: supernodes, search filters, mini groups**

## Distributed Hash Tables 1




**Nodes organised in address order in a list or a ring or a hypercube**

## Distributed Hash Tables 2



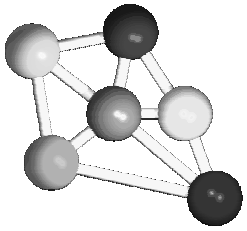
**Routing overlay = Shortcuts across the ring make lookups much faster.**

## Distributed Hash Tables 3

**Chord, Pastry, Kademlia and many more DHTs:**

- **Nodes often connected in a ring**
- **Shortcuts = Routing overlay**
- **Some DHTs are hypercubes instead of rings**
- **Item key = hash( item name )**
- **Search among millions of nodes = If one node has what you want, you find it**
- **Can not do complex searches, only key lookup**
- **Complex to implement and vulnerable to attacks**
- **Problems with unevenly distributed data (Hashing only partly fixes the problem)**

## The end



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