

# A Distributed and Measurement-Based Framework Against Free Riding in Peer-to-Peer Networks

Murat Karakaya, Ibrahim Korpeoglu, Özgür Ulusoy  
Bilkent University  
Department of Computer Engineering  
Ankara, Turkey

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## P2P Network Features

- Application Level Networks

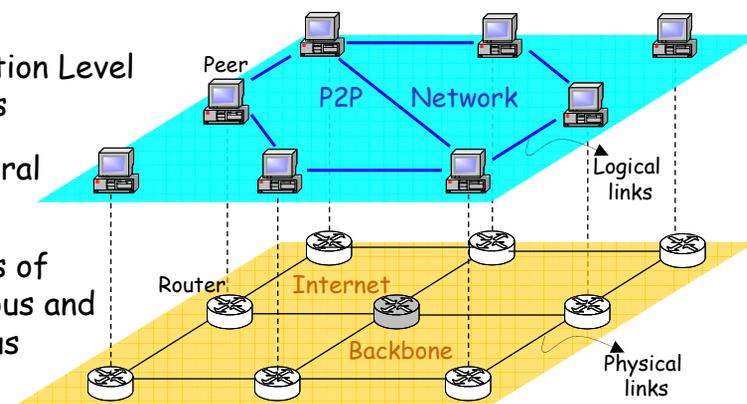
- No central control

- Consists of autonomous and anonymous peers

- A peer can be both a client and a server

- A peer may be connected to one or more other peers

- Cooperation between peers is expected.



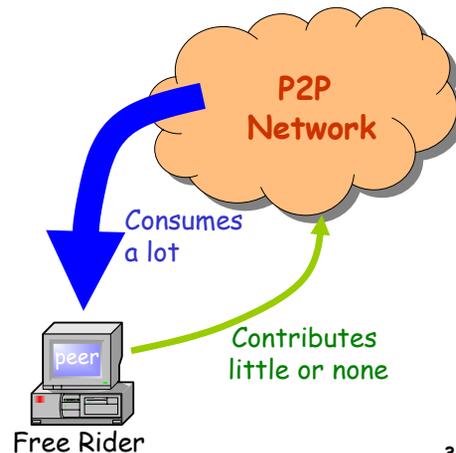
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# Free Riding

Free riding means exploiting P2P network resources, but not contributing to the P2P Network at desirable levels.

- A free rider may do search and download operations, but:
  - May not share any content
  - May not share any interesting content.
  - May not forward protocol messages.
  - etc.



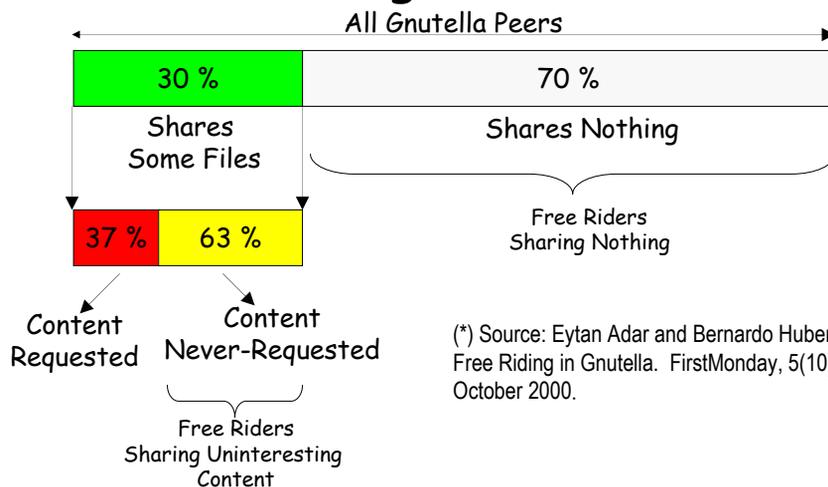
# Why Free Riding

- The peer may not want to share and contribute because of:
  - **Security** concerns
  - not consuming network **connection bandwidth**
  - not consuming **local storage and processing resources**

## Why Free Riding is not Desired

- Good peers will be **overloaded**.
- **Available content** will decrease in time if nobody shares.
- **Fault tolerance** will degrade
  - If good peers get down, content will not be reachable.
- **Search horizon will effectively shrink** if too many free riders exist in the network.

## Free Riding in Gnutella\*



(\*) Source: Eytan Adar and Bernardo Huberman, Free Riding in Gnutella. FirstMonday, 5(10), October 2000.

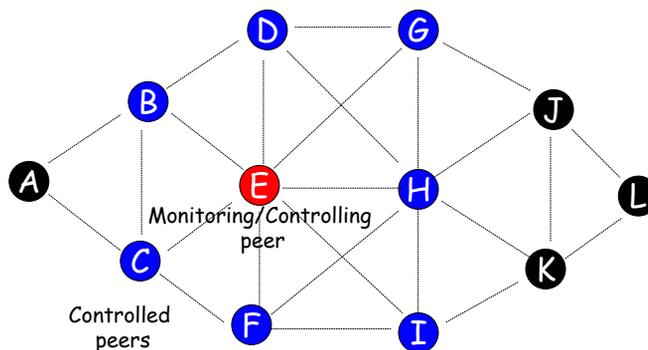
About 10 % of peers provide content that is searched and downloaded.

# Our approach

- Designed for **Gnutella**, an unstructured P2P network.
- Works in a **distributed** manner. No central control and management
- Based on **monitoring** protocol messages and updating counters.
- A proposal for:
  - **Detecting** free riders.
  - Applying **discouraging counter-actions** against free riders.

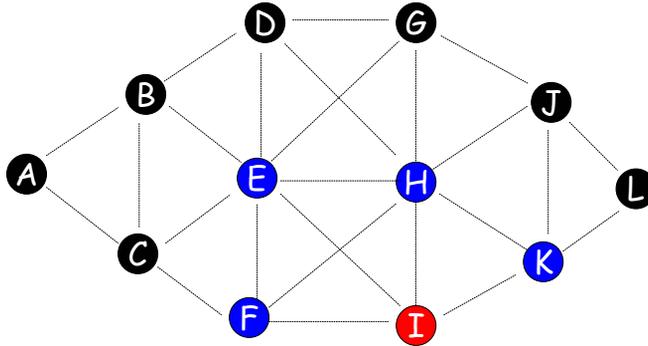
# Our Approach

- Our approach is based on having **each peer control its direct neighbors**.



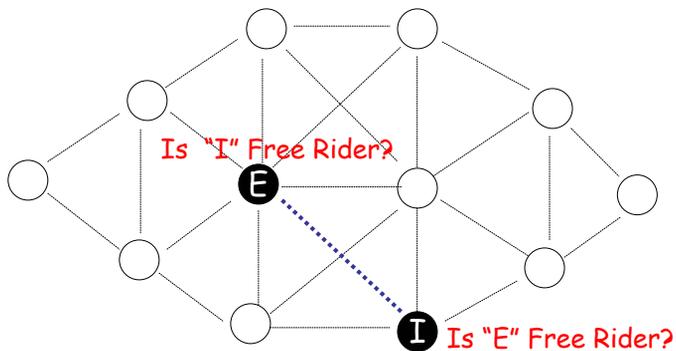
Peer E will control its neighboring peers B, C, D, F, G, H, and I.

# Our Approach



Peer I will control its neighboring peers E, F, H, and K.

# Our Approach



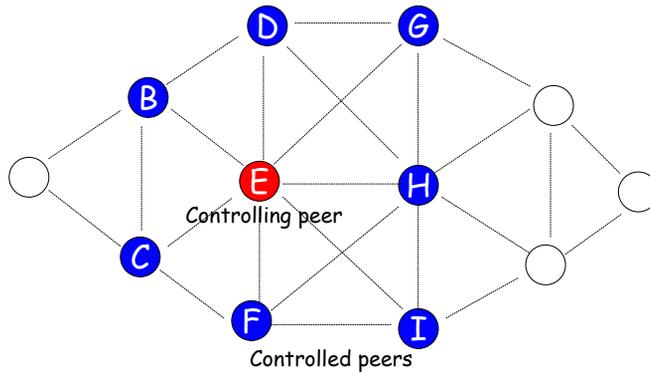
So, E will control I and I will control E.

Neighboring peers will control each other.

No central authority required.

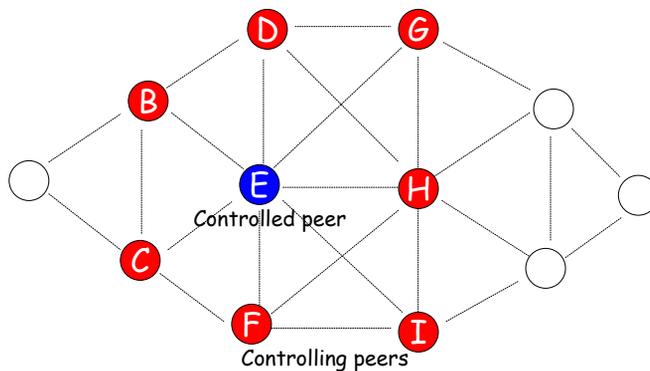
Each peer will control and get controlled.

# Our Approach



A peer may control one or more other peers.

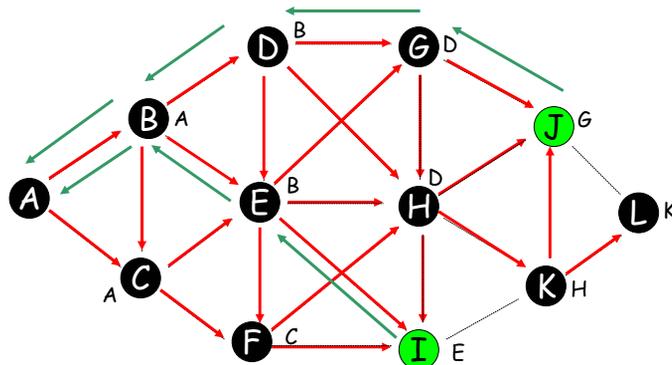
# Our Approach



A peer may get controlled by one or more other peers.

# Gnutella Overview

Example: Peer "A" starts a search for a file that exists on peers I and J.



QUERY →

QUERY HIT →

A will get two replies: one from I and the other from J.

A will download from one of them

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## Gnutella Overview - Messages

- **Query**
  - String (sequence of keywords) to search
  - Hopcount: incremented at every hop
  - TTL (time-to-live): decremented at every hop
    - "TTL + Hopcount" is constant
- **Query Hit**
  - Result Set (set of filenames that matches the query)
  - IP Address of host originating Query Hit
  - Port Number through which download can happen
- There are other types of messages; but our solution is based on just monitoring and counting these two types of Gnutella messages.

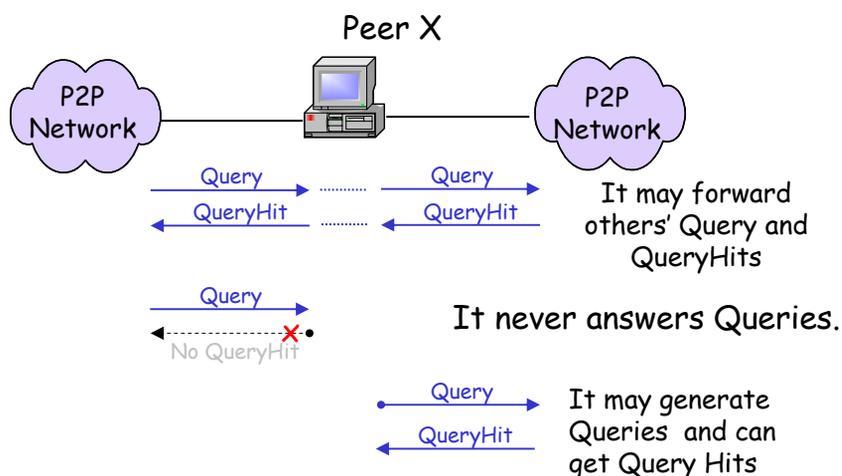
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## Free Riding Types

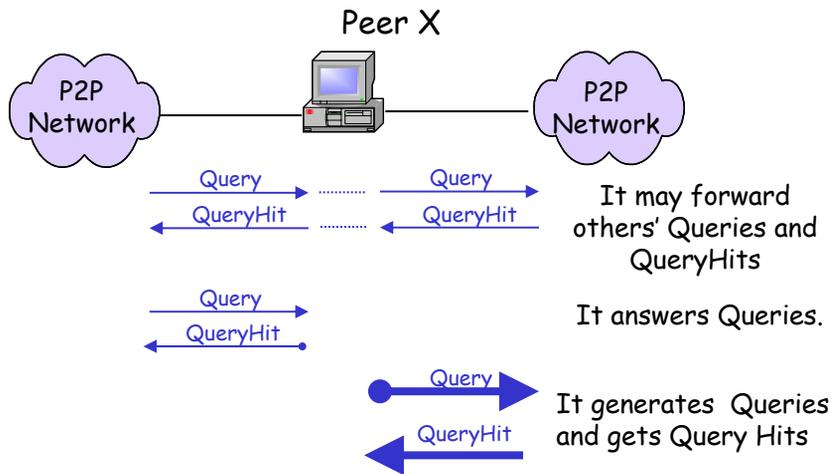
- We classify free riding behavior in **three** groups.
  - A free rider peer can behave as a:
    - 1) **Non-Contributor**
    - 2) **Consumer**
    - 3) **Dropper**
- A free rider may exhibit **one or more** of these behaviors.

## Who is a **NonContributor**?



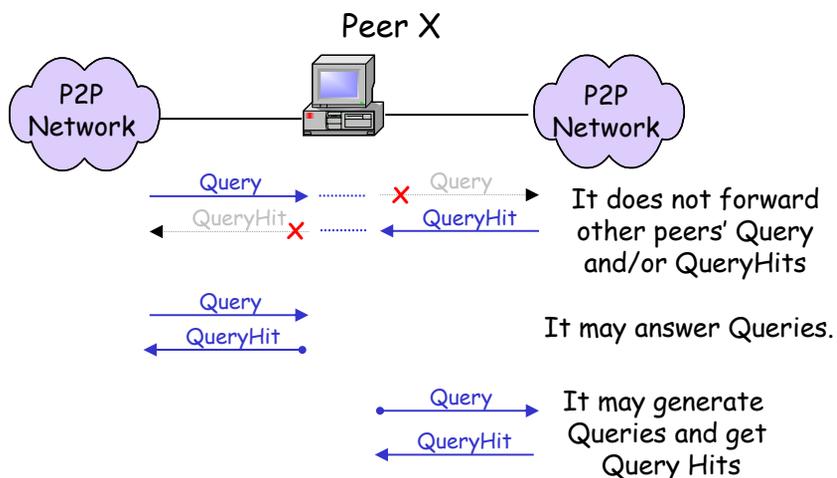
**Peer shares nothing or shares uninteresting content that is never searched.**

# Who is a Consumer?



Peer consumes more than it contributes.

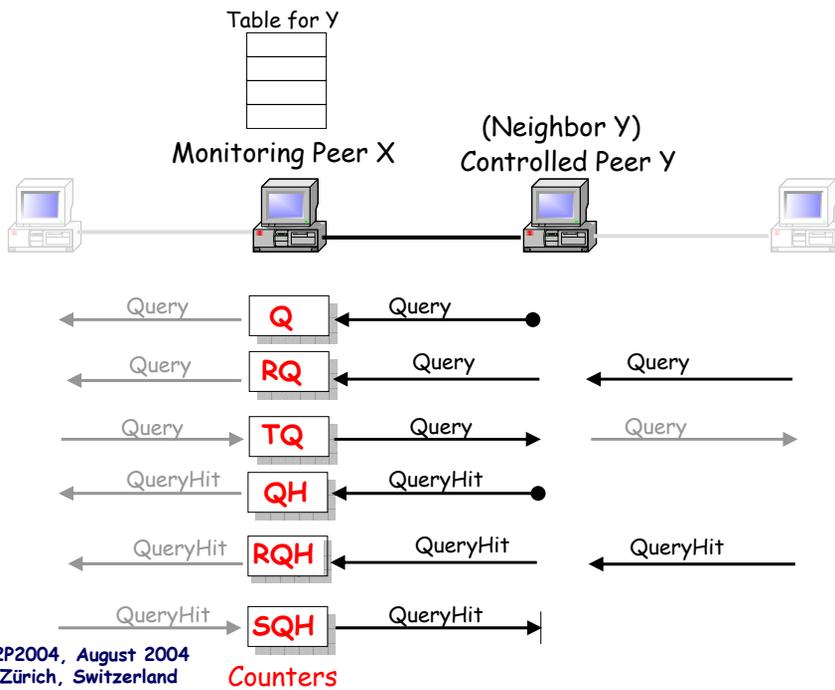
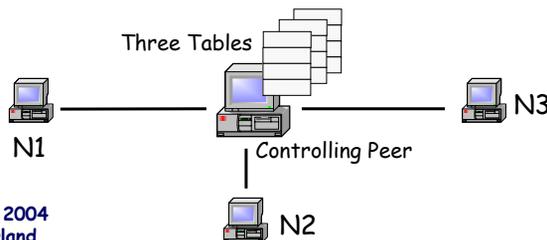
# Who is a Dropper?

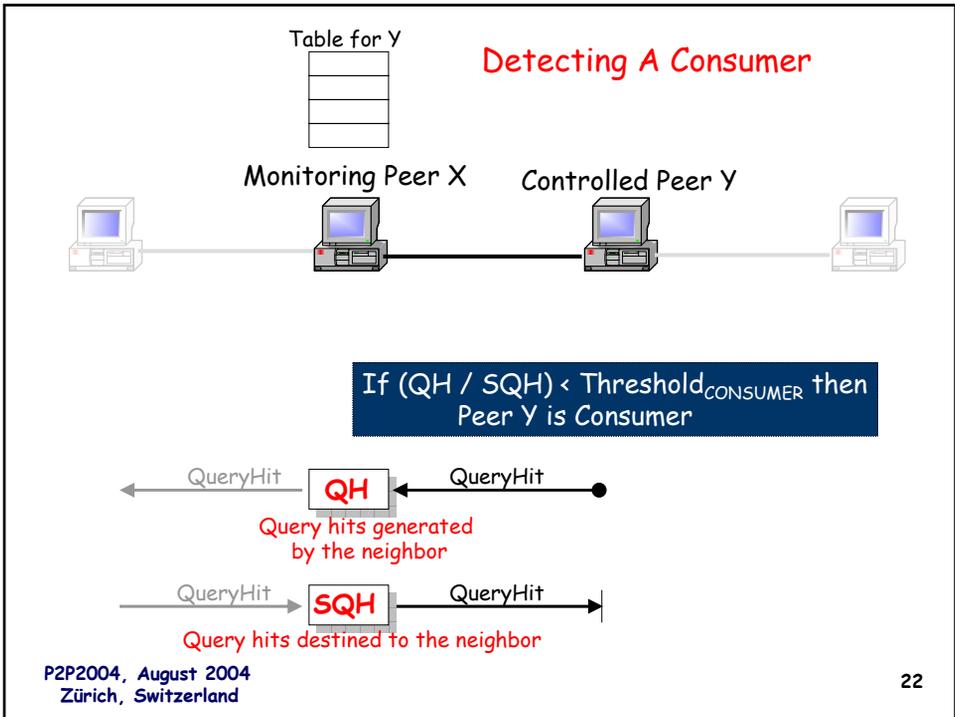
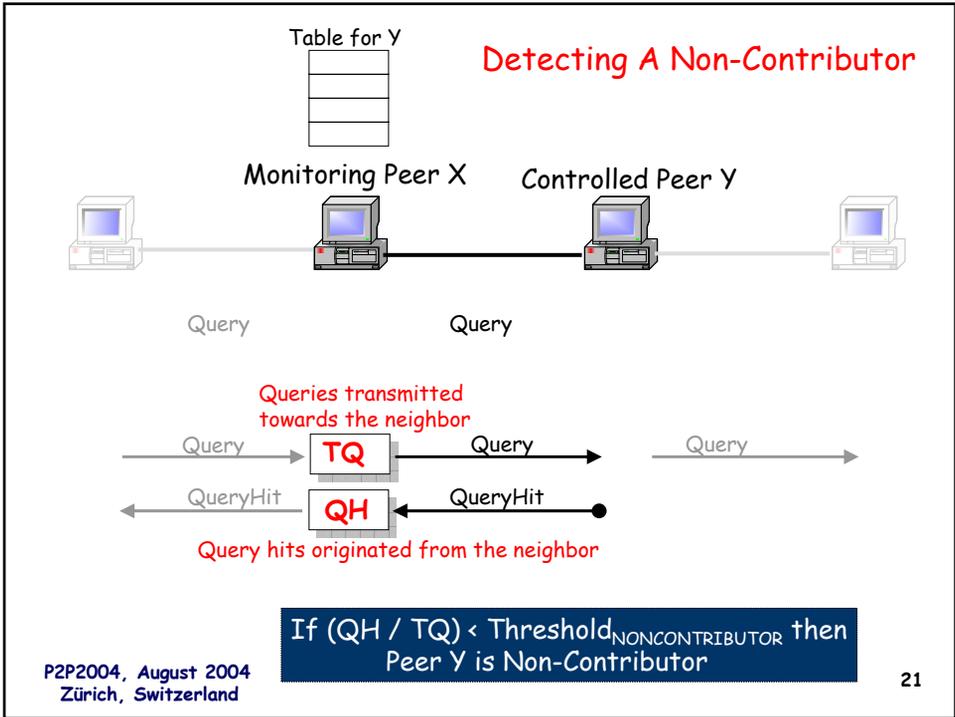


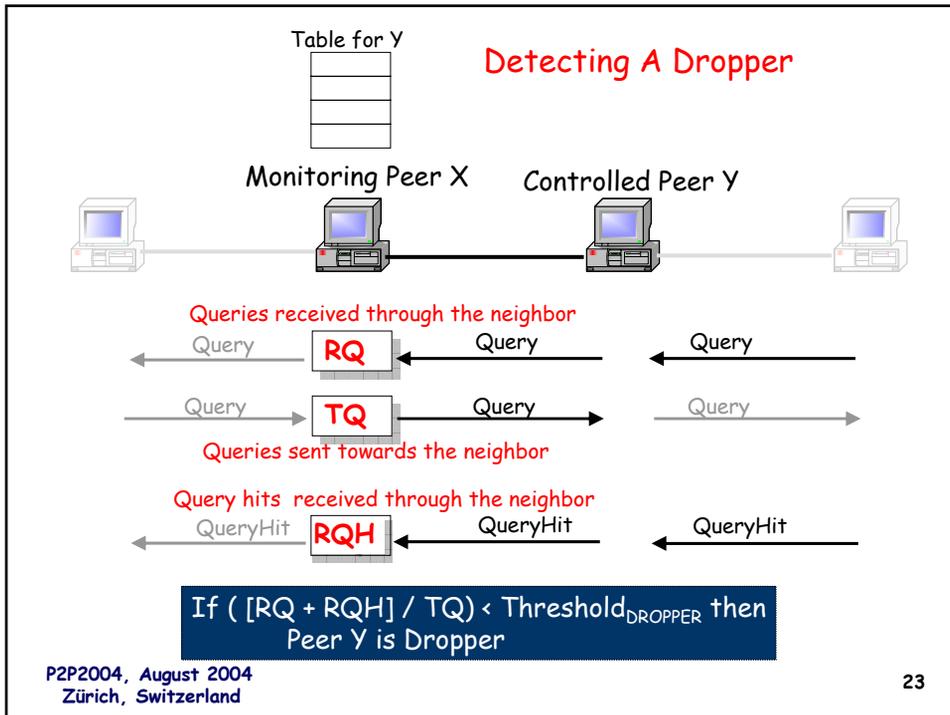
Peer does not act as an intermediate P2P network node.

# How do we decide about free riding and its type in the context of Gnutella?

- First, **count the protocol messages** received from and sent to a neighboring peer.
  - Update **counters in a table** maintained for the neighbor.
  - We will have a different table for each neighbor.

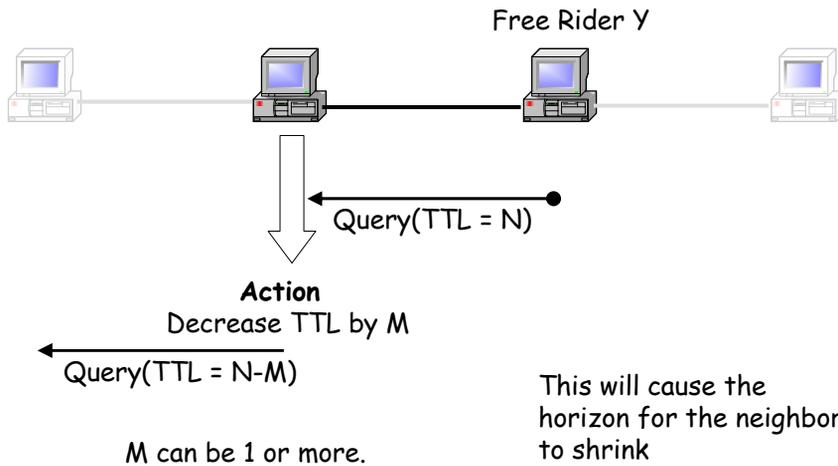




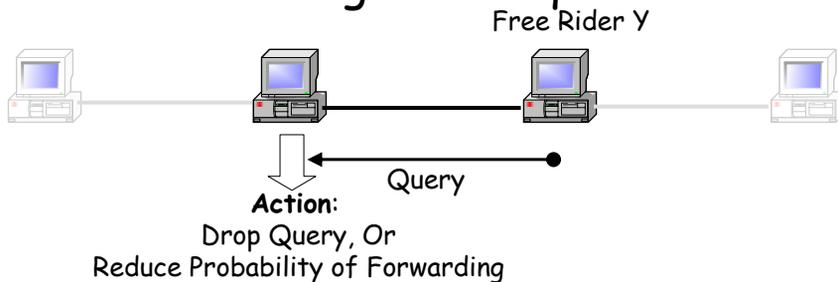


- ## Actions
- We define three levels of **discouraging counter-actions** that can be applied against neighboring free riders.
  - Level 1: **Decrement the TTL value in Queries**
    - Decrease the search horizon of the free rider
  - Level 2: **Ignore Queries partially**
    - Free rider will not be able to search through this neighbor
  - Level 3 actions: **Disconnect the peer.**
    - Free rider has to try to connect through another peer if it still wants to use the P2P network.
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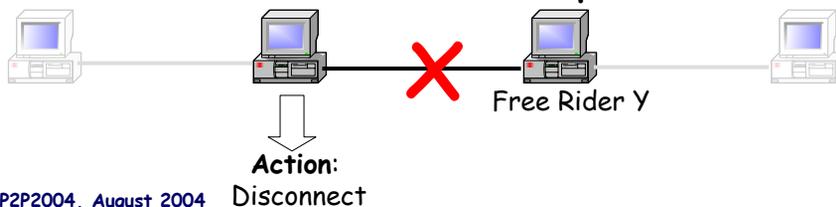
# Level 1: Decrement TTL

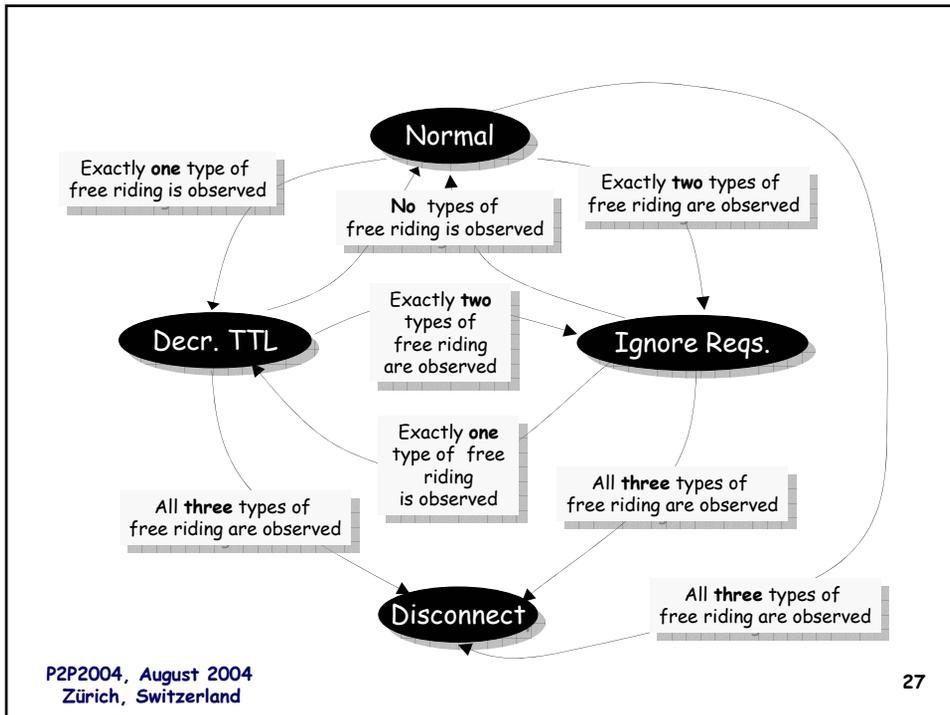


# Level 2: Ignore Request



# Level 3: Disconnect peer





## Summary and Future Work

- **Great amount of free riding** exists in Gnutella
- Free riding has **adverse affects** on the proper operation of P2P networks.
- We **proposed** a distributed and measurement based scheme to:
  - **Detect free riders** in a Gnutella Network
  - Take **discouraging actions** against free riders in Gnutella Network.
- We are currently working on a **simulation tool** that will simulate free riding in Gnutella and that will be used to evaluate our proposal.