Peer To Peer Trading for Storage Space

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Tutorial Overview

- Introduction
- Data Archiving Systems and Information Replication:
  - Basics on Data Preservation
  - Traditional Data Management Schemes & Peer To Peer Trading Systems
  - Data Trading
- Trading Process:
  - Deeper into the Trading Process
  - Bid Trading
- Conclusions
Introduction

- Preserving Data Motivations:
  - Maximize information reliability
  - Protect important data collections from failure by making multiple copies

- Autonomous Organizations or Archiving Networks?

- Digital Archives Sites Tasks:
  - Making multiple data copies
  - Trading for storage space
  - Providing on-line access to stored information
Data Archiving Systems and Information Replication:
Basics on Data Preservation

- **Archiving Sites:**
  - Storage Space
  - Collections
  - Clients

- **Reliability:**
  - Site Reliability
  - Local Data Reliability
  - Global Data Reliability

```
  1, 3    2,3    1,2,3
   A      B      C
```
Data Archiving Systems and Information Replication:
Traditional Data Management Schemes & Peer To Peer Trading System

1. Replicated DBMS
2. RAID
3. Replicated FileSystems
4. P2P: gnutella, freenet
5. Archival Intermemory, Offsites Backup
6. Community Preservation Approach
Hi, Have you got a 3Gb storage space?

Hi, yes I could give you if you pay 1 Gb of yours...!!

OK.....Thank You

You're Welcome

Sites “trade” space when each site contributes storage resources to others and uses storage at others.
Data Archiving Systems and Information Replication:
Data Trading

- **G**: replication goal
- **R**: retry policy followed by a site
  - ACTIVE: in which it initiates tradings
  - PASSIVE: in which it waits to be contacted by other sites to make further copies.
- **C**: collection copy policy
- **A**: storage space advertising policy
- **S**: trading strategy
Collections or Deeds Trading?

Looking for space...getting deeds
- D: deed size policy
- U: deed use policy
- T: deed transfer policy
- St: third party trading strategy.

FRAGMENTATION
COMPLEXITY
FAIRNESS
Trading Process:
Deeper into the Trading Process

- **Storage space:**
  - Public portion
  - Local portion

- **Advertising policies:**
  - SPACE FRACTIONAL
  - DATA PROPORTIONAL

How much storage space should I offer???
Trading Process: Deeper into the Trading Process

• **Trading Strategy:** Specifies how to select trading partners
• Broadcasting state information \ maintaining a central information repository

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>Trade with sites in random order</td>
</tr>
<tr>
<td>First fit</td>
<td>Trade with sites according to a globally defined order</td>
</tr>
<tr>
<td>Neighbors</td>
<td>Trade with sites according to a locally defined order</td>
</tr>
<tr>
<td>Clustering</td>
<td>Trade preferentially with sites that we have traded with before</td>
</tr>
<tr>
<td>Best deed</td>
<td>Trade first with sites for which we have the smallest deed</td>
</tr>
<tr>
<td>Worst deed</td>
<td>Trade first with sites for which we have the largest deed</td>
</tr>
<tr>
<td>Best fit</td>
<td>Trade first with sites that have the least free space</td>
</tr>
<tr>
<td>Worst fit</td>
<td>Trade first with sites that have the most free space</td>
</tr>
<tr>
<td>Neediest</td>
<td>Trade first with sites that have the rarest collections</td>
</tr>
</tbody>
</table>

Table 1: Trading strategies (<S>).
The trading negotiation must determine a price for the trade.

- BIDDING POLICIES SCENARIO
- TRADING:
  - Calling an auction
  - Making a bid
  - Choosing the trading partner
Trading Process:
Bid Trading 2

(a)

(b)

(trade)
Trading Process:
Bid Trading \3

- **SCENARIO:**

  - **Fixed-Price Bids:** All sites follow the same fixed-price policy, a bid must be the same as the amount of space requested
  - **Adaptive Bids:** All sites follow the same policy, but the policy takes into account local conditions
  - **Multiple Policies:** Sites are partitioned into classes, depending on factors such as their free space
  - **Maverick Site:** Site that follows its own policy trying to improve its own reliability even at the expense of the overall reliability
  - **Free Market:** Sites that follow their own policy to maximize their reliability
  - **Malevolent Sites:** sites that break the basic trading rules and try to subvert the system.
Trading Process: Bid Trading

A wants to replicate a collection C:

- **SC=C.Size()**

  - **Sc-Scedes**
    - **DEEDS?**
      - **Y**
      - **N**

- Solicits bids from sites where C isn’t stored

  - **Pick Winner**
    - **BIDS?**
      - **Y**
      - **N**

- **End trading**

WHAT CAN GO WRONG ??????

1. Each remote site stores C
2. Sites do not have Sc Space
3. Sites do not want to trade

- Using deeds A already holds
- Finding remote sites not storing C
- Choosing a space management policy
- Picking the winner
Trading Process:
Bid Trading \5

- **SCENARIOS:**
  - ADAPTIVE BIDS
  - MULTIPLE POLICIES
  - MAVERICK SITE

- We’re going to see for each of them…..
  1. AUCTION CALLING POLICIES
  2. BID POLICIES
ADAPTIVE BIDS

1. **Auction Calling policies:** A site can call an auction periodically or when it is really in need
   - *CallForAll*: call auctions for all of the collections
   - *CallForRare*: call auctions only for the rarest collections.

2. **Bid Policies:** set of rules for automatically calculating the bid for each auction.
   - *FreeSpace*: A site bids more when it has more free space
   - *UsedSpace*: A site bids more when more of its space is used
   - *AbundantCollection*: A site bids more when its collections are abundant
   - *RareCollection*: A site bids more when its collections are rare
Figure 9: Best bid policy for (a) high capacity and (b) mid capacity sites.
Trading Process: 
Bid Trading \7

MULTIPLE POLICIES

- Different sites have different resources and resource requirements
- Partitioning the sites into distinct classes
- For each class we define the auction call and bid policy that provides the best reliability
- Less restrictive than the Adaptive Bids scenario, where all sites must use the same policy regardless of needs or resources
Trading Process:  
Bid Trading \8

MAVERICK SITES

1. Auction Calling policies:
   - \textit{AlwaysCall}: a site calls auctions constantly.
   - \textit{NeverCall}: a site never calls auctions.

2. Bid Policies:
   - \textit{BidHigh}: a site consistently bids high;
   - \textit{BidLow}: a site consistently bids low;
   - \textit{NeverBid}: a site never submits a bid to an auction.
Figure 11: Maverick behaviors: (a) BidHigh and (b) NeverCall.
Conclusions

- Collections replication
- *Bid trading*: a mechanism for allowing sites to conduct peer-to-peer data trading
- Determining how much space to ask at the remote site for giving in return a deed of a certain size

We have described:

- How the auction and bidding process works
- The policies to decide when to call an auction and how much to bid
The arguments treated in this tutorial are described in the following articles:

- Cooper, Molina “Peer to Peer data trading to preserve information”
- Cooper, Molina “Bidding for Storage Space in a Peer to Peer data preservation system”
THANKS