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Research Paper

Unstructured Peer-to-Peer Systems: Towards Swift Routing

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Abstract

In this paper, we contribute to the enhancement of routing in unstructured Peer-to-Peer (P2P) systems. Our contribution aims to propose an alternative to the repetitive interactions between peers in discovery which waste considerable time. We propose a methodology that seeks effectiveness and swiftness. Contrary to classic and heuristic-based routing strategies, the main goal of our proposition is that every peer prepares a database at the integration phase. The database includes information about peers, locations, routes to every destination, etc. Every peer possesses its own database and is able to update it whenever a change occurs in the system. Changes refer to the integration of new peers and the dissociation of existing ones. Theoretically, the communication between peers will become significantly quicker since every peer knows enough information about the other peers forming the system. The application of our strategy demonstrates its fitness to the proposed system model in addition to its celerity and relevance.

Keywords: *Peer-to-Peer (P2P); Resource discovery; Routing, Simulation; Unstructured P2P system.*

1. Introduction

This Peer-to-Peer (P2P) systems continue to deliver a variety of services such as file sharing, video streaming, etc. The growing demand for such systems is due to their distributed, scalable and robust structure [1, 2, 3, 8, 10, 18]. Thus, P2P systems became an active research topic in computer science [2, 4, 5, 6].

Generally, we can categorize P2P systems into two broad categories: centralized and decentralized systems. This taxonomy is based on the availability of one or more central nodes, and to what extent the peers depend on the services provided by those central nodes [4, 7, 9, 15, 16].

Regarding topology, there are two classes of decentralized P2P systems: structured and unstructured systems. The difference between the two models lies in the manner adopted to forward queries to other nodes [11, 15].

In structured P2P systems, data is placed under the control of certain predefined strategies and the metadata that it is being inserted in the network. While in unstructured P2P systems, peers are autonomic and are responsible for their data and keep track of neighbours that they may forward queries to [12, 13, 14].

For unstructured peer-to-peer systems, there are two main approaches for routing strategies: classic and heuristic strategies. The problem with both of them is that they cause a lot of traffic when it comes to resource discovery [16, 17, 19, 20, 21].

Another major limitation in classic routing strategies' is the 'blind' search. When the search space is large the search performance becomes poor. Moreover, if the solution is far away, the searching process consumes time. In the worst scenario, the peer may stay waiting for a long period in vain [4]. In addition, they consume a great deal of communication resources and use a massive amount of messages [4, 5].

Heuristic routing strategies are created in order to overcome those problems. They reduce significantly the number of messages; however, they suffer low performance since the approaches are unable to adapt to different query loads with their random characteristics [4].

In this paper, we detail the proposed methodology for routing in unstructured P2P systems. The idea behind this work is that recently integrating peers discover the other peers at the integration phase. This will considerably ease the eventual routing of requests and responses within the systems.

The paper is organized as follows:

- We describe the system model that we adopted in order to conceive the proposed strategy (section 2).
- We detail the proposed methodology (section 3).
- In order to evaluate the performance of the proposed strategy, we simulate a system adopting it (section 4).

2. Page layout

The conception of the proposed approach is based on a selected set of criteria which refers the sought level of efficiency and effectiveness. Here are their definitions:

- Usability: it reflects the ease of use as well as the queries sequencing between peers.
- Scalability: it is important for large-scale environments. A measure of scalability is the quantity of messages that need to be routed in order to locate information.
- Decentralization: there is no reliance on a central peer for the distribution of queries.
- Availability management: a proactive process is adapted in order to update all peers' tables after the integration of new peers.
- Storage: each peer needs to store its metadata.
- Coverage: this refers to whether the search space contains the answers. A scheme with a higher coverage is certainly more useful.
- Response time: a system is efficient if it can locate the resource quickly.
- Survivability: the multiplication of routes for every peer increases the possibility of process continuity after a potential cataclysm that can cost the principal route of communication between two peers.
- Sustainability: in case of a peer's failure, peers spread information between them and notice each other.

3. The proposed methodology

In this section, we present our proposition for resource discovery in unstructured P2P systems as this step is very important for routing. We aim to reduce the time consumption by repetitive interactions between peers in the discovery phase. Every peer integrating the system collects information about the system's topology and creates its own dynamic routing table.

The routing tables include peers, locations, routes to every destination, etc. Each peer possesses its own table. They are dynamic because they change immediately when the system changes. The system changes by the integration of new peers or the dissociation of existing ones.

Correspondingly, every peer in the network updates its routing table and adds routes associated with the recently integrated peer. The same process occurs when a peer declares its intention to dissociate from the system.

Peers store in the previously mentioned table all possible routes to get to all other peers. A preferred route is chosen for every peer, in case of failure another route is chosen and becomes the first choice for the peer in all coming transactions. The routes' redundancy assures the survivability, availability and sustainability of the system.

In the following subsection, we present two essential steps in the proposed methodology: the integration process and the tables mixture.

3.1. The integration process

Fig. 1 illustrates the first step of the integration into the system. The new peer broadcasts a message of arrival. First, the message is sent to the directly neighbouring peers. Then, every peer broadcasts the received message to all its directly neighbouring peers except the sender. This behaviour persists until the whole system becomes aware of the integration.

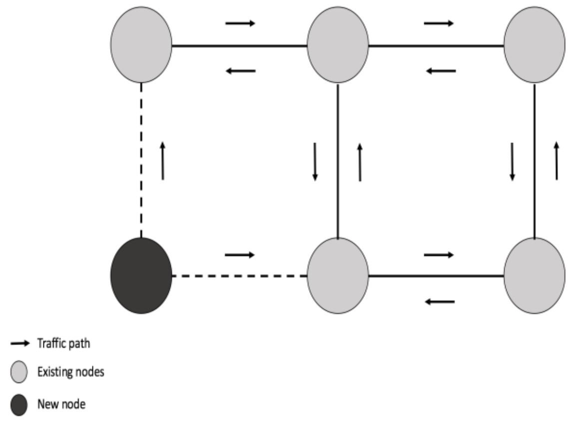

Fig. 1: Peer's integration: illustration of interactions and messages' paths

In a real context, the message may contain numerous information concerning the new peer such as its address, the TTL (Time to Live), etc. in addition to other information concerning system's properties such as the algorithm used to encipher data, the electronic signature, etc.

When a peer receives a notification of integration from another peer, the first thing it does is to verify the system's parameters if there is nothing wrong it verifies the information about the peer requesting to integrate the system.

If the information is also good the peer dissipates the notification to its neighboring peers, updates its routing table by adding routes to the new then sends it the routing table within the TTL duration. The process continues until all the system becomes notified and the new peer receives all routing tables.

Contrariwise, if there is something wrong with the information sent by the new peer, the request is rejected and no answer is sent to the peer. The latter waits until the TTL duration expires and if no answer is received then it can deduct that its request has been rejected.

3.2. The tables mixture

This step comes in the successful scenario where all peers assess the received message and send their routing tables to the newly integrating peer. The latter combines the received routing tables.

This step is crucial because it contributes in the standardization of the topology's perception for all peers forming the system. The composition of peers is simultaneously preserved and adapted to each peer's perspective and position.

The tables mixture process is intuitive. At the reception of every routing table the peer does as follows:

First, it verifies the existence of a road to the selected peer in his routing table, if no road exists, the peer adds himself to the road, changes the identifier of the road and increments peers number in the table. Then it selects another peer on the same table and does the same thing. The process continues until all the received tables are covered.

The updates affecting the routing tables are not exclusive to the integration process, they may also occur when peers request to exit the network or when they no longer respond to requests.

4. Simulation results

In order to evaluate the performance of the proposed methodology, we conduct our simulation in the academic version of the Riverbed modeller. Considering the parameter values shown in Table 1.

Table I: Simulation Parameters

Parameter	**Value**
Values per Statistic	1500
Background Traffic Start Delay (seconds)	150
Tracer Packets Per Interval (packets)	2
Traffic Scaling Factor	1.0
Traffic Scaling Mode	Background Traffic
Traffic from Link Loads	Included
Traffic from Link Flows	Included
Routing Activity Idle Timer (seconds)	20
Interface Buffer Congestion Threshold	0.8
Network medium	10Gbps - Ethernet
Number of peers	10

In the simulation environment, we create logical topologies containing 10 peers forming an unstructured P2P system. We simulate the integration of 'Peer 10' into the network. The integration is done by the exchange and mixture of routing tables with the rest of the peers.

Table II: Ethernet Delay Report

Object name	Minimum	Average	Maximum	Standard Deviation
Peer 10	0.050371	0.050371	0.050372	0.0000001940
Peer 1	0.035985	0.035985	0.035985	0.0000000000
Peer 2	0.032961	0.032961	0.032961	0.0000001946
Peer 3	0.032627	0.032627	0.032627	0.0000000000
Peer 4	0.027831	0.027831	0.027831	0.0000000000
Peer 5	0.027694	0.027694	0.027694	0.0000000000
Peer 6	0.025920	0.025920	0.025920	0.0000000000
Peer 7	0.025168	0.025168	0.025168	0.0000000000
Peer 8	0.024731	0.024731	0.024731	0.0000000000
Peer 9	0.021358	0.021358	0.021358	0.0000000000

In the networking context, latency is the time expended by the propagation through the network medium and adapter hardware. It impacts the time the application must wait for data to arrive at its destination. It represents the infrastructural latency. Table 2 illustrates the minimum, the maximum and the average values of the Ethernet delay in our network, as well as the standard deviation.

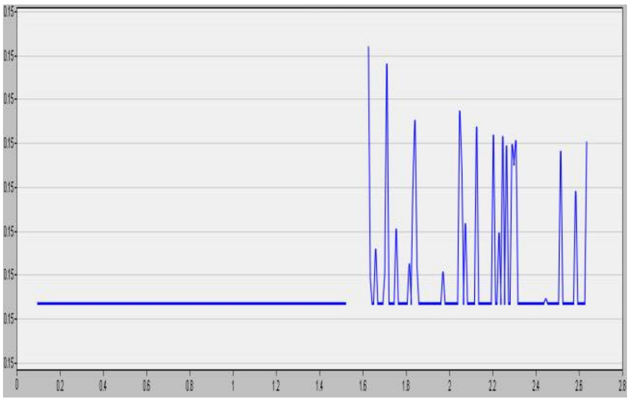

Fig. 2: TCP latency average for all peers

Correspondingly, the TCP latency represents the delay related to the transport protocol. Fig. 2 represents the average of TCP latency for the rest of the peers. The delay is bellow 0.6 seconds, that means that the integration process does not affect the network's health, which makes it a good result.

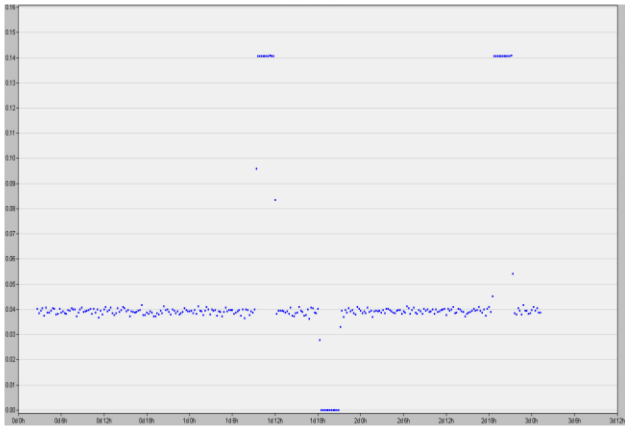

Fig. 3: Segmentation delays (sec)

The traffic received in the network increases, and that is totally normal since the integration process for the 'Peer 10' entails the exchange of integration messages with all the system. However, the segmentation delays are generally around 0.04 seconds. See Fig. 3.

5. Conclusions

The main purpose of this work is to conceive a methodology that accelerates the routing process for unstructured P2P systems. Our strategy is based on the creation of databases at the integration phase of each peer and their exploitation for effective resource discovery. Databases include information about peers, locations, routes to every destination for every peer, etc.

This process makes routing becomes faster since peers already know each other's location and don't need to do a preliminary research inside the system to localize the desired peer. Thus, the communication becomes instantaneous within the system.

The application of the proposed methodology validates the system model and shows that it overcomes the main limitations of existing solutions which are slowness and greediness in terms of time and resources.

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