Content Distribution Mechanism in Mobile P2P Network

Zeng Degui
1. Luzhou Vocational and Technical College, Sichuan, China

Yishuang Geng
2. Center of Wireless Information Network Studies (CWINS), Worcester Polytechnic Institute, Worcester, MA, 01609, USA
Email: yugeng@wpi.edu

***Abstract*—As content distribution in mobile P2P network facing architecture instability, the limited ability of a single node, low efficiency of content distribution and other problems, this paper proposes a new mobile network structure and content distribution mechanism strategy, the new mobile network structure will be divided into multiple subnets network for partition management. Each subnet manages information routing and dissemination strategies through a super-node. The transfer of information between subnets can be achieved by transitional node in cross region. Thus the information transfer is achieved in the entire network. Content distribution strategies using part of network coding mechanism for data compression, improve the efficiency of information transmission and download success rate. Finally, experimental verification, the experimental results show that: the proposed new mobile network structure and content distribution mechanisms strategies can reduce the disturbance of download success rate caused by fixed point, reduce the data transmission delay, and effectively improve the hit rate.**

***Index Terms*—Mobile P2P; Content Distribution; Selection Strategy; Network Node**

I. INTRODUCTION

As the mobile terminal device performance gradually improved, mobile networks rapidly developed, and the inter-network resource transfer mechanism is different from traditional networks which have fixed infrastructure supported, entirely relying on mobile terminals to complete tasks. MP2P (mobile peer-to-peer) is the combination of mobile computing products and P2P (peer-to-peer) networks [1-3]. It has get rid of the shackles of fixed base stations, and opened up a new direction for the network market.

Resource distribution is the study of how the mobile P2P network based on limited resources changes and the ability of different nodes, to distribute dynamic, efficient, low-cost land resource. Resource distribution mechanism will directly affect the efficiency of the whole system. Therefore, a critical approach for successful network resources application is to reasonably design distributed applications [4-5]. Current resource distribution methods generally specifically refer to redundancy dissemination of data information. Redundancy dissemination of data information is currently one of the hot issues of MP2P study.

University of Illinois proposed method to achieve distributing data in selective distribution way under MP2P. Thomas Repantis and others in University of California proposed content-driven routing mechanisms and adaptive data distribution algorithm that can support large-scale, unstructured MP2P network intelligent routing queries [6-8].

Ouri Wolfsonv, who studied new data distribution method in the mobile node bandwidth and energy and storage resources (B, E, S) under limited conditions MP2P. He proposed distribution mechanism RANDI based on level values. Song Junde et al did more detailed analysis on MP2P current data distribution technology [9]. Mainly in the field of a number of key technologies such as network coding, error correction code, Gossip algorithm, and in terms of reliability, transmission speed and scalability aspects of them were analyzed. They designed and implemented with a certain universally, performative effective MP2P resource distribution methods. It becomes an important requirement in MP2P applied research [10-11].

GOLDENBERG DK and others countering plurality of nodes connected to ISP, by way of intelligent routing it optimize the flow distribution to multiple ISP links to reduce the peak on a single link, thereby reducing the link rates: WANG J and others delay part of flow transmission, and use flow optimization plan to solve the trade-offs between the tariff benefits brought by reduced peak flow and penalties incurred by the different delay [12]. However, these strategies for optimal rates are aimed at individual transmissional nodes, and under the ideal content distribution case, to both the source and destination nodes to reduce the peak value, that means between the nodes, there should be the joint optimal scheduling for perceiving each other up and down the line on idle bandwidth. GOLDENBERG DK and other systems put forward two data centers' nodes utilizing idle bandwidth to achieve data transmission delay tolerant approach. LAOUTARIS N and others put forward "bulk delay tolerant data" under the case of a small time

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difference between nodes at both sides of the idle bandwidth overlap time transmission [13]. By deploying extra intermediate node if there exists large time difference between the nodes, by storing and forwarding strategy to solve the source and destination address nodes' problem of idle bandwidth can not be used caused by time window overlap, however, it gives only a single simple case of additional intermediate nodes. LAOUTARIS N worked furthermore, when transmit data between two nodes which have a large time difference, firstly, collect data center nodes (including a plurality of intermediate nodes) of the idle bandwidth, free memory and other related information, based on these, to predict future values for these information, by focusing on the optimal schedule to obtain best optimalization, and then to store and forward transport so that a single destination node's distribution problem, however, there are often plurality of target nodes in the content distribution, although through the literature [5] similar model we can get global optimization schedule, but this requires mass focused scheduling operations, when the deviation between the predicted value and the actual value it needs constantly recalculation, especially with the number of the target nodes growth (currently Akamai globally has a plurality of network nodes more than 1000) , the rapid expansion of computing makes centralized optimization not feasible in practice, but need to find a scalable distributed optimization scheduling method [14-15].

MP2P network inherited the traditional peer network's many advantages such as resource load balancing, no centralized, reciprocal nodes, and easy extension framework. In the affected areas, the battlefield and other complex environment need to minimize personnel involved, and other places which are not suitable for wired devices and base stations to build facilities in, MP2P, with temporary and flexibility, will be more practical application value and advantages because it does not need to set up a wireless base station.

However, multi-hop wireless networks MP2P also facing a series of instability caused by frequent node join and leave, constantly moving nodes within the network. In this paper, based on conditions that without the support of the fixed base stations, set self-organizing wireless network is as background for research. Therefore, MP2P content distribution network will face major issues such as network architecture instability, limited ability of single nodes, the low efficiency of content distribution.

For the existing problems, this paper proposes new mobile network architecture: the network is divided into multiple subnets for partition management; each subnet manages information routing and dissemination strategies through a super-node. The transfer of information between subnets can be achieved by transitional node in cross region. Thus the information transfer is achieved in the entire network. Content distribution strategies using part of network coding mechanism for data compression, improve the efficiency of information transmission and download success rate. The experimental results show that: the proposed strategy can improve the content distribution efficiency of the dynamic networks. Thus enhanced MP2P network has the robustness.

This paper mainly made in the following areas to expand and innovation work:

(1) For mobile P2P network's content distribution network architecture, limited ability of single nodes, low content distribution efficiency problem, this paper proposes a new mobile network structure and content distribution mechanism strategy, which calculated weights according to node performance, to assign different functions for nodes. In order to build efficient mobile P2P content distribution networks, the nodes are divided according to their different functions, and adopting different data transmission methods in the subnet and between subnets. The super node is responsible for its content distribution in the subnet and achieves information exchange through routing mechanism between subnets. Part of the network coding strategy using the data "compression" process, the seed node backup cache contents and decoding operation simplification timely, reducing its complicated calculation process during transition, and thus can improve the bandwidth utilization, speed data transfer rate.

(2) In order to further validate correctness and validity of the proposed new mobile network structure and content distribution mechanism, we did experimental verification for the impact of the content distribution strategy's average latency, node density and speed on the success rate of resources downloading and the relation between reservoir data blocks and the success downloading rate. The experiment use of mobile P2P network node's mobility characteristics, structure of the network with anti-disturbance framework, divide two kinds of functional super-nodes and transition nodes which are responsible for content distribution between inter-subnets and subsets. And use part of the network coding data processing, and storage. In this paper proposed network structure, the super node of the data cache strategy to extend its presence time in the network and location relative stability time, so as to effectively alleviate the phenomenon that hit rate sharply declined. Simulation experiments results show that: this strategy can effectively improve the success rate of resources downloading and hit rate, reduce resource transmission delay and improve the mobile P2P networks content distribution efficiency, but also enhances the system Robusting.

II. Network Topology

For a highly dynamic mobile network, the loose unstructured network frame design will reduce the transmission accuracy of the information; the structured frame design will have large cost of routing updates caused by frequent node join in and leave. Learn the advantages and defects of existing framework, this article will divide added mobile network nodes into super node, common node and the transition node. Each node performs their duties to play their own features and to build MP2P content distribution network in an effective collaborative manner.

Definition 1 (subnet): by the super-node, the transition nodes, and common nodes consisting of triples. Can be expressed as the following:

Subnet $= \prec$ super node Common node Transition node $\succ$ MP2P network topology model is shown in Figure 1.

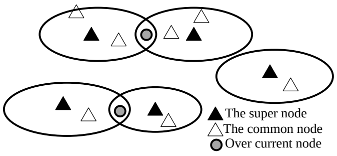

Figure 1. MP2P network topology model

A. Subnet Topology

A non-empty set of V and ordered pairs set E denote a network diagram G, and $G=(V,E)$, where, V is the set of network nodes, E is the logical link set of linked nodes $E=\{(i,j)|i,jV\}$.

Definition 2 Let V be a set of nodes, $p:v^x v^{\rightarrow} R$, for any $i,j,k^{\in}v$

$$st.\begin{cases} p(i,j)=0, when\ only\ i=j \\ p(i,j)=p(j,i) \\ p(i,j)\le p(i,k)+p(k,j) \end{cases}$$

Then V is called a measure of ρ.

Definition 3 Let (V, ρ) is a metric space, oV, for any given real number $\sigma \succ 0$, set $B(o,\sigma)=\{jv|p(o,j)\prec\delta\}$ is called a subnet space sphere of o as the center, δ radius.

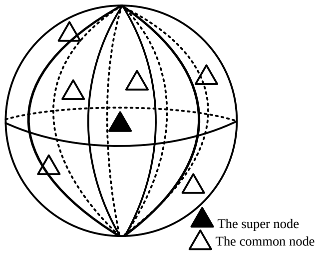

Figure 2. Subnet topology model

Super-node as its center in the subnet, safeguard δ covered sphere radius range. In a new subnet inception, the spherical space using the default setting radius r, and $r \le \varpi R$, R is the subnet super-node communication radius, and the default constant values, and $\varpi \succ 1$. After each cycle according to the change in the number of nodes within the subnet to change the size of the radius subnet:

$$\delta = \min\{1+(\Delta r_t)/R_t)r, \varpi R\} \quad (1)$$

Formula (1) represents after each ΔT time period, change the rules of radius, and the maximum radius of the subnet is subject to super-node in the subnet's communication radius constraint. Where, Δr_t is the number of changes during the time period, R_t is the total time the node index records. Subnet topology model is shown in Figure 2.

B. Sub-network Management

In each subnet, has a super node managing content distribution of the subnet, therefore, the super-node in accordance with storage space (M), computing capacity (C), the residence time in the network (T), node speed (V) and other performance standards select comprehensive measure. Wherein, in addition to hardware conditions impact for the mobile device, the node stability in the network is also very important: the longer the retention time, the more comprehensive and more stable the average speed of the slower moving node stores resources, the more valuable the node kept the data.

Storage space and computing capacity can be measured by the node ability Cap. Retention time and node's speed can be measured by dynamic D_{yn}.

Formula (2) given the failure rate of node i

$$lose_i = 2 - \frac{R_i}{M_i \Delta T + V_i} \quad (2)$$

where in, R_i represents the communication radius of node i; V_i denotes the moving velocity of node i; T represents information update cycle, therefore, the smaller the radius communication node i is, the greater the speed, the higher the failure rate of node i.

Processing capacity of node i Cap_i and dynamic Dyn_i formula is as follows:

$$\begin{cases} Cap_i = \kappa M_i + \lambda C_i \\ Dyn_i = \dfrac{1}{lose_i} T_i \end{cases} \quad (3)$$

where, and γ denote the weight of Mi and C_i, and $\varpi + \gamma = 1$. The larger M_i and C_i are, the higher Cap_i is, means the stronger the processing nodes are. The smaller $lose_i$ is, the longer T_i is, the larger the Dyn_i is (smaller dynamic).

Therefore, the combination of the node $i's$ weight calculation formula is

$$w_i = \delta_i Cap_i + \lambda_2 Dyn_i \quad (4)$$

where, λ_i is the weighting factor, and $\lambda_1 + \lambda_2 = 1$.

Definition 4

$$S_{super-node} = \begin{Bmatrix} R_i \,|w_i = \max_x (\varpi_1, \varpi_2, ..., \varpi_n) and \\ R_i \in R_{\varpi}, i = 1,2,...,n \end{Bmatrix} \quad (5)$$

Super nodes not only maintain their routing information on the subnet, but also perform processing and storage capabilities of caching policy on the part of information. Formula (6) indicates that the remaining qualified node as the backup super-node into the "candidate list":

$$O_{optional-nodes} = \left\{ R_{\varpi} \left| R_{\varpi} \in \left(\varpi_i - S_{super-node} \right) \right. \right\} \quad (6)$$

Node in "Candidate List" backup subnet resources where super-node maintaining the routing tables prevent current super node's non-normal leave, or the loss of resources from failures, avoiding the possibility of M P2P network collapse.

Within the subnet, super-node, through the "heartbeat mechanism", maintain routing nodes, delete nodes lapsed, and polls out the highest comprehensive weight node as the new super-node. If in the agreed period of time, does not receive super node's "heartbeat" message, then it may be considered that the super node has lapsed. When the subnet super node fails, the following ways can be adopted to communicate with other nodes and restore subnet nodes: 1) Enable the Subnet candidates super-node from the "short list" as the new super-node; 2) For the nodes that new super-node can not override (distance between node and new super node is greater than ϖ_i), then the node is a candidate to join neighboring anchored subnet.

Therefore, the network nodes are generally divided into four states: common state, that is, as a network node in a normal state; optional state, the common node into the "optional list", the node's optional state before an alternative to super node; super state, elected as the super-node of the subnet and play the role of maintenance; leave state, the node normally or abnormally off the network connection. Node state transition is shown in Figure 3.

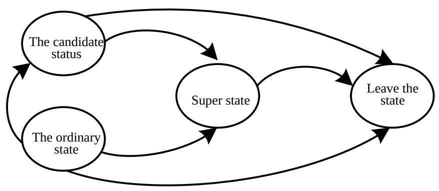

Figure 3. Node state transitions

Definition 5 (Node Management): if the ID of subnet which new node added to is the same with the ID of the subnet which other nodes belong to, then anchor the subnet, while the newly added node will register the subnet neighboring subnets (as a candidate affiliated sub-network); if no anchored subnets exist, then it becomes the new super nodes.

When a new node joins the MP2P network, it will get the ID of the subnet where the node most likely belongs to. Newly added node can visit and communicate with any node in the subnet. From the existing node routing table to find the subnet super node ID, if the new node holding $ID = ID'$, then it can successfully anchor in this super- node, they are recognized as ordinary nodes of the subnet, while the node registered to the nearest anchored subnet, when the original subnet can not overwrite the node, then the node can be added to the candidate anchoring subnet, thus to maintain the communication with other nodes ; If $ID \neq ID'$, then the node is not a part of the subnet, and so on, if the node do not belong to any of the existing subnets , the node becomes a super node, and maintain a new subnet .

III. Content Distribution Strategy

In mobile networks, nodes frequently joining, leaving, and changing positions, will make data uploading, downloading stability difficult. The traditional P2P network widely adopted structured network model and hash table (DHT) and other mature mainstream technology, in order to speed up the search efficiency of resources and the disturbance of mobile networks will lead to too much DHT maintenance overhead. Therefore, a simple structured network architecture and DHT mainstream technology is no longer applicable MP2P networks. To build efficient content distribution network MP2P, the paper will divided nodes according to different functions, and adopt different data transmission method between subnet and subnet.

A. Data Distribution Strategy in Subnet

Super-node as the management central node of data distribution in subnet, mainly maintain the local resources routing table. Therefore, when a node query resources, the query node will first visit the super-node of the subnet, if the resources required route exists, then distribute content in the local subnet; if the required resources route do not exist, then put a copy requests for resources stored in the super-node, waits for the super node query and request other subnets through the transitional node.

Taking into account the dynamic nature of the query node and resource distribution efficiency, when the super node obtain the necessary information resources from other subnets, whether replies query node, the node can thus check the stability period decision. Node stabilization period can be calculated as formula (7):

$$S_i = \frac{\left| p\left(S_{super-node,} C_i\right) - \gamma \right|}{\left(Velocity_S + Velocity_{C_i}\right)} \quad (7)$$

where in, $p\left(S_{super-node,} C_i\right)$ is communication metrics of a super node S query node C_i, $\left(Velocity_S + Velocity_{C_i}\right)$ is the sum of relative velocity of the super node and the query node, δ is the radius of the subnets.

Theorem 1 (node stabilization period): within node stable T_i period, the node will not leave on the same subnet. It provided that at time t_1, node send out a query information includes its own stable period, if the super-node receives the query message, and before reply message, calculated out time t_2 the query node may arrive at, during the time period $t_2 - t_1$, the distance change between the two is

$$p_{\max} = \left(Velocity_S + Velocity_{C_i}\right)\left(t_2 - t_1\right) \quad (8)$$

At time t_2, when $\Delta t = t_2 - t_1 \le T$ node, the distance between the query node and the super-node is:

$$D_{distance} = p_{\max} + p\left(S_{super-node,} C_i\right)$$
$$= \left(Velocity_S + Velocity_{C_i}\right)\left(t_2 - t_1\right) + p\left(S_{super-node,} C_i\right)$$
$$\le \gamma - p\left(S_{super-node,} C_i\right) + p\left(S_{super-node,} C_i\right) \le \gamma$$

Since the node will not leave the subnet during the stable cycle period, therefore, the super node not only reduced information sending and waiting time in establishing communication channels, but also improves bilateral communication success rate of the node in cycle stability period Ti.

B. Part of the Network Coding Strategy

Part of the data and information will be copied and stored. This will help improve the reliability and load balancing of resources, given the mobile device's own storage capacity is limited, adopted part of the network coding technology to process data and increased storage capacity under limited buffer space. Not only compressed data but also facilitate the replacement of old and new data.

$$t = \partial c = \left[\partial_0, \partial_1, \partial_2, ..., \partial_{m-1}\right].\left[c_0, c_1, c_2, ..., c_{m-1}\right]^{-1}$$

Ere, α is from the domain t_q (q of size 29) in the randomly selected code vector.

Data is finally stored in the form of the coded block; each coded block occupies a unit of storage space, so it should meet the condition that the number of coded blocks for storage should not more than the buffer space.

$$capacity\left(\sum T_i^j\right) \prec N$$

i is the coded block storage order , and i is non-negative ; j is the firstly obtained data block number of the original coded block data, $j = \min(n)$.

$$p_x = \left\{T_1^1 = t\left(c_3, c_2, c_1, c_0\right), t_1^2 = t\left(c_3, c_2\right)\right.$$

Therefore, when p_x node receives the arrival order c_3, c_2, c_1, c_0's source data, the encoding and storage conditions may be expressed as Having N storage units in the case of buffer space , this paper will receive the source data is identified as c_0, c_1, c_2, c_{m-1}, wherein the data c_{m-2} on the arrival time is earlier in c_{m-1}. Subsequently, the data will be coded as follows:

1) Lookkup_new $data(C_n)$
2) If capacity $i\left(\sum F_i^j\right) \prec N$
3) Encoding $\left(F_i^j, C_n\right)$
4) Else
5) Discard $\left(F_i^{\min(j)}\right)$
6) For $\left(i = 0; i \prec m-1, i++\right)$
7) DO
8) Sort $\left(F_i^j\right)$
9) $F_{(m-1)}^n = a_n.c_n$
10) Done
11) End if

When new data C4 again arrives, it whether can be stored needs to be judged by the " algorithm data storage (C_n):

$$p_x = \left\{T_0^2 = t\left(c_4, c_3, c_2\right)\right.$$
$$\left.T_1^3 = t\left(c_4, c_3\right), T_2^4 = t\left(c_4\right)\right\}$$

Strategy that coding part of the network processing data according to the data block arriving time, not only can "compress" the original total data space, but also bring convenience to the decoder, the early data storage's timeliness character and value will continue decreased over time. Such as for new data (c_4, c_0, c_1) are early data. Thus, in a limited storage space, for the timely stored new data c4, then encoded packet that the old data occupied can be discarded, to free the cache space. The coding result after data replacing is expressed as

$$p_x = \left\{T_1^3 = t\left(c_1, c_2, c_3\right)\right.$$
$$\left.T_2^3 = t\left(c_4, c_3\right), T_3^4 = t\left(c_4\right)\right\}$$

Strategy that coding part of the network will directly discard data coding block that contained old data, receive, encode, storage new data, thus saving the limited computing capacity.

C. Cross-Subnet Information Transmission Strategy

Based on MP2P network characteristics and the method this paper divide networks, management strategies, each subnet will randomly appear overlapping areas. Therefore, we can use transition node to achieve communication with multiple super-node, and create opportunities for interaction between subnets resources, to achieve connectivity throughout the network.

Formula (9) is used to determine whether the node is the "transitional Node" collection.

$$D = \left\{\left(U, SN_i\right) \middle| \sum_{k=1}^{i} C_{ij} \succ 1, i = 1, 2, ..., n\right\} \quad (9)$$

$\left(U, SN_i\right)$ is a binary group, U is belongs zone (subnet) time for the node i in. SN_i is the number of nodes that super node i queried. B_{ij} is 0-1 variable, indicating whether the node i belongs super node j. Assuming the current number of super nodes is k. When a node get super-node more than 1 in its query cycle, then it is the transition nodes.

"Transitional node" will notify "Cross-Subnet" information to super-nodes within the original subnet (U), this time, super-node will timely pass requests that not found within the subnet through this "transitional node", and send it to its cross-subnet to another super-node, and query and request resource. Opportunity forwarding mechanism schematically is shown in Figure 4.

Therefore, this paper uses storage forwarding thinking, proposed cross-subnet algorithm to achieve information interaction between subnets. First, the query node will submit query information to the super nodes; super-node will save no query routing table information on the results to be saved. When crossing region between subnets occurred, the super node will copy information to n transitional nodes in the cross region. N-transition node forwards this information to its own neighbors in the metric space, neighbor nodes pass information to their super-node for query, query information in order to distribute and locate resources. If there is no resources the neighbor needed within the subnet, because position again across the network resource efficiency is too low, the super node in neighbor subnet will no longer stored this query message. Therefore, cross-subnet positional resources can be reached within five hops.

Assuming that the node moves independently, the probability rate of encounter other nodes is p_{meet}, the cross-subnet transmission success rate can be present by the algorithm (10):

$$p_{ts} = 1-\left(1-p_{meet}\right)^{n+1} \tag{10}$$

When the transition node's appear probability is too small or fail to locate resources, and considering that storage space for super node is greatly limited, super-node based TTL (time to live) survival time, will discard the query information which failed transmitted for a long time.

As mobile node in the sub-edge join or leave the subnet will bring greater disturbance to resources storage conditions, therefore, super nodes within the subnet will update information by periodically broadcasting the node. Information update period T is calculated by formula (11):

$$\begin{aligned} &\Delta T = \partial / \left\{ 2\left[\left(\frac{1}{n}\right)\sum_{i=1}^{n} Velocity_i\right]\right\} \\ &st. \\ &0 \prec \partial \ell \\ &\Delta p \prec 2\left(\Delta T' - \Delta T\right)\left[\left(\frac{1}{n}\right)\sum_{i=1}^{k} Velocity_i\right] \end{aligned} \tag{11}$$

Theorem 2 (update cycle): after every T period, need to update massage of the nodes in the subnet.

Proof Suppose the interval of sending information two times is $\Delta T', \Delta T' = t_2 - t_1$ and $\Delta T \succ \Delta T, p_t\left(s,c_i\right)$ is the measure of super node in time t1 and the node c_i in outer edge of the subnet, therefore, it can be written as $p_t\left(s,c_i\right) = \varphi + \Delta p$, and in time t2, measure of both is:

$$p_{t_2}(s,c_i) = p_{t_i}\left(s,c_i\right) - 2\left(\frac{1}{n}\sum_{i=1}^{k} Velocity_i\right)\Delta T'$$

$$because\, 0 \prec \Delta p \prec 2\left(\Delta T' - \Delta T\right)\left(\frac{1}{n}\sum_{i=1}^{k} Velocity_i\right),$$

$$so\; p_{t_2}\left(s,c_i\right) \prec p_{t_1}\left(s,c_i\right) - 2\left(\frac{1}{n}\sum_{i=1}^{k} Velocity_i\right)\Delta T$$

$$-\Delta p \prec \delta + \Delta p - a - \Delta p \prec \delta - a$$

Therefore, after ΔT, the node in the subnet's outside edge goes into subnet.

When $\Delta T' = \Delta T$

$$p_{t_2}(s,c_i) = p_{t_i}\left(s,c_i\right) - 2\left(\frac{1}{n}\sum_{i=1}^{k} Velocity_i\right)\Delta T'$$

$$= \delta + \Delta P - A \succ \delta$$

It can be obtained through the ΔT period; nodes outside subnet edge are still outside the subnet.

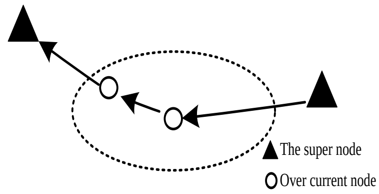

Figure 4. Opportunity Forwarding Mechanisms

IV. EXPERIMENTAL RESULTS AND ANALYSIS

A. Experimental Environment

For MP2P network characteristics, this paper used $Inet + Oversim + OMNeT{++}$ simulation combination platform to simulate and comprehensively evaluate indicators of content distribution efficiency of the mobile network framework. Experimental platform required hardware software environment shown in Table 1. To more appropriately describe and simulate the actual mobile network features, and Table 2 lists several major parameter settings of the MP2P simulation environment.

TABLE I. EXPERIMENTAL PLATFORM HARDWARE / SOFTWARE ENVIRONMENT

Hardware environment	Software environment
CPU P4 3.0GB	OverSi2011
Memory 1GB	OMNet++4.0
Hard disk 160GB	Inet2011, Linux Fedora 10

TABLE II. EXPERIMENTAL DATA CONFIGURATION PARAMETERS

Simulation parameter	Parameter value
Network Range	3000m×3000m
Number of nodes	400
Node	20m/s
Node	0m/s
Bandwidth	250kbit/s
Data block size	512kbit
TTL	**7**

B. Results and Analysis

This paper counter characteristics of MP2P mobile nodes in the network, structure the network framework with anti-disturbance traits, divided two kinds of functional super nodes and transition nodes to charge content distribution inter subnet and cross-subnets, and use part of the network coding strategy to process and storage data, to improve the stability of the network resources.

Figure 5 shows contrast between unstructured spherical subnet (SS, spherical subnet) Structure and structured Chord network, frame-less Gnutella network structure. It can be obtained from the experimental data, the average delay of the proposed content distribution strategy is far less than Chord structured network, and with the data blocks increase in the net, it is slightly lower than Gnutella network.

In MP2P network, the nodes constantly move and rapidly change route, resulting in serious loss of data packets, routing information to be updated frequently, thereby increasing the average delay of data transmission in Chord structure. Gnutella network, transmission delay will be less when the data block is less, but due to the gossip algorithms, as data block required in the network transmission increases. It will gradually leads to a large number of duplicate information, and thus network congestion occurred, data transmission delay increased.

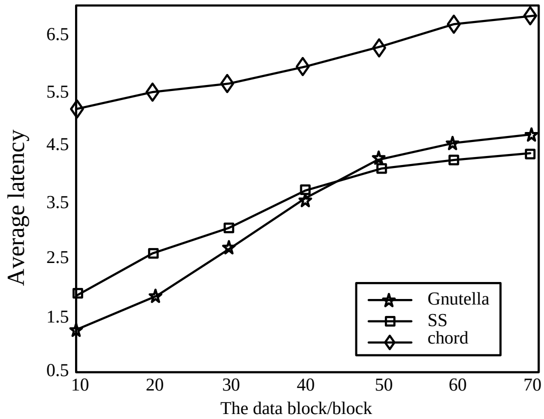

Figure 5. Comparing for the average delay of 3 kinds of networks framework

This paper proposed content distribution strategy to achieve exchange of information through transition nodes, so the transition node latency and processing time for data encoding is an important part of the average delay.

Figure 6 shows in the mobile environment, comparing the hit rate changed with speed between structured Chord network topology, unstructured Gnutella network structure, and SS network structure which is proposed in this paper, in which, hit rate = (hits number) / (visit number). Considering the actual handheld equipments average moving speed, in the simulation environment, set the node speed at range of 0 ~ 20 m / s.

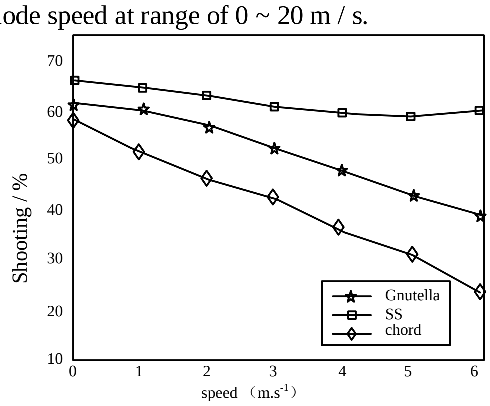

Figure 6. Node averages moving speed and hit rate relation

In structured Chord network, in the face of the mobile node, the routing information is no longer reliable, the information packet loss rate increased, resulting in hit rate continues to drop. Unstructured Gnutella network uses the spread information technology such as flooding, making excessive information redundancy, resulting in network congestion. This paper proposed SS network structure, super-node data caching strategy extend its presence in the network, during the location relatively stable time, and effectively alleviate the hit rate sharply declining phenomenon.

Relation between the node density, average moving speed and resources downloading success rate shown in Figure 7, based on content distribution strategy proposed in this paper, to increase the number of nodes within the network, improve network node density, it can effectively improve the success download rate of resources. Meanwhile, as the network node average speed increases, the downloading success rate can maintained at a certain range. This is the network dividing the sub-network management advantages: the node's low average speed is good for transfer of information within the subnet; increase in the average speed of nodes, increasing the transition node ability, good for the transmission of information between subnets.

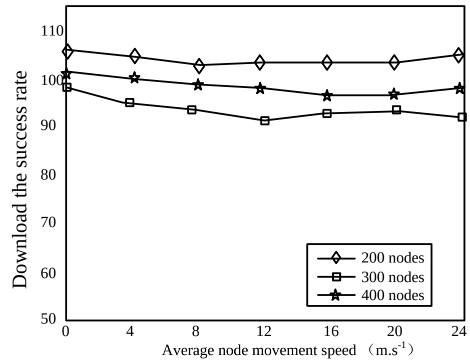

Figure 7. Impact of node density and speed on the resources success download rate

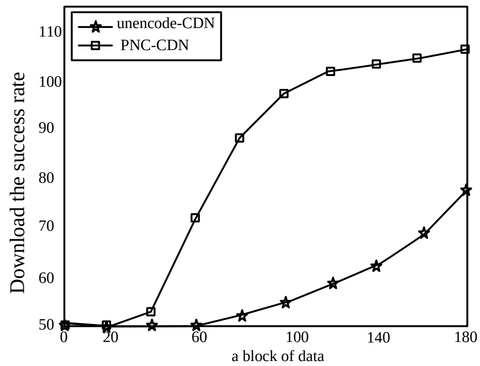

Figure 8. The relation between storage data blocks and the success downloading rate

Using network coding to process data is "compress" multiple sets of data in a data space unit, thereby reducing the amount of data transmission, to improve the transmission efficiency and the utilization of storage space, to provide more stable data for the subnet, and to improve the success downloading rate of resources. As shown in Figure 8, the use of part of the network coding technology strategy to store more data blocks in a limited space. According to the priority for replacement of old data, to save the most valuable information, comparing to traditional non-encoding operation storage technology, the success downloading rate of resources has significantly improved.

V. Conclusion

Based on the calculation of the weight of node performance, this paper proposes the node different functions. The super node is responsible for its content distribution in the subnet, and to achieve information exchange across mobile networks through subnet routing mechanism. By using part of the network coding strategy to complete "compression" process, the seed node timely backup cache contents, and simplistically decode operation, reducing complicated calculation process during its transition, and thus can improve the bandwidth utilization, speed up data transfer rate. Experimental results show that the proposed framework MP2P network can reduce the disturbance caused by fixed point's download success rate, reduce the data transmission delay, and effectively improve the hit rate. Therefore, unstable status of nodes in MP2P network, memory, limited computing power and other issues, made out a better solution, at the expense of less energy consumption and improve the efficiency of MP2P content distribution, and improve overall network robustness.

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