SERVICE MANAGEMENT STRATEGIES FOR NEXT GENERATION NETWORKS

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ABSTRACT

Next Generation Computing Networks has a new paradigm that aims to provide seamless connectivity to users in distributed computations regardless of their location. To realize this aim, it is necessary to design distributed algorithms that explicitly account for host mobility in Next Generation Computing Networks and the mobility constraints associated with them. This paper proposes a distributed algorithm consists a token ring approach for managing services in Next Generation Network model. In addition, since the location of a mobile host could change after initiating a distributed computation and before receiving the result, service management strategies for mobile hosts has to be explicitly integrated with the proposed distributed algorithm.


1. INTRODUCTION

A wide spectrum of portable, personalized and smart computing devices ranging from laptops to smart phones and tablets has been introduced. Their explosive growth has sparked considerable interest in providing seamless services to Mobile Hosts (MHs) regardless of their location. MHs are not only used for calling, messaging and mailing but also they can be effectively utilized as dynamic computing devices. As the MHs are having high mobility, managing services and shared data for dynamic computation should be distributive. The objective of Service Management in Next Generation Networks (NGN) is to provide distributed algorithms or techniques that explicitly account for host mobility associated with NGN.

The design of distributed algorithms and protocols in the existing system model was traditionally based on an underlying network architecture consisting of Mobile Support Stations directly communicating MHs with limited geographical area. These Mobile support stations are...
connected to a wired network to the fixed host which is a static network. MHs are thereby able to connect to the static segment of the network from different locations at different times. However, this model is upgraded with the Core Network connect to the Fixed host, an IP based heterogeneous back-bone network augmented with Access Network Servers (ANSs) of different radio access technologies, that are capable of directly communicating with MHs seamlessly.

As the previous, in the proposed system model also MHs are able to connect the static segment of the network, but as the MH moves from one ANS to another the overall network technology changes. This implies that the distributed algorithms designing for dynamic mobile computing environment cannot assume that the host maintains in a fixed technology all the times; the MH must be first located (“searched”) with respect to the type of ANS before a message can be delivered to it. Further as the Hosts changes their locations, the physical connectivity and other protocols of the network changes which may be homogeneous or heterogeneous in nature. If it is homogeneous, there may be no change in the protocols and no tuning parameter is required except the status of updating of the MH which is minimal and less significant. Whereas in heterogeneous, change in the protocols and tuning parameters like bandwidth etc., are required and updating of status of the MH is more significant [1][2].

The core objective in design of distributed algorithm is achieved through a distributed execution amongst the fixed hosts while performing only those operations at the Mobile Hosts that are necessary for the desired overall functionality. In conjunction with the principle, we also need strategies to track the location of “migrant” MHs i.e., MHs that invoke a service from the host networks at one ANS but move between several ANSs before receiving the result. Therefore, to deliver the desired result to a migrant MH, a distributed algorithm must now explicitly incorporate Service Management strategies for migrant MHs in its design. This paper proposes various Service Management strategies like search, inform and proxy by structuring a token based logical ring for Mobile Hosts in distributed dynamic mobile computing systems.

2. THE SYSTEM MODEL

The term ‘mobile’ implies able to move while retaining its network connections [3]. A device that can move while retaining its network connections is a Mobile Host (MH). The infrastructure machines that communicate directly with the Mobile Hosts under a geographical coverage area are called Access Points. The set of similar Access Points with its MHs are grouped and connected to Access Network Server (ANS). All MHs that have identified themselves with similar Access points are considered to be local to the ANS. An MH can directly communicate with ANS (and vice versa), only if the MH is located physically within the region serviced by the ANS. At any given instance of time, an MH may logically belongs to only one ANS, but may be physically located by two or more ANSs of similar or different network technologies.

The system model consists of two distinct sets of entities: a large number of mobile hosts and relatively fewer ANSs. ANSs are built with technologies like 2G Cellular, 3G Cellular, Wi-Fi, Wi-Max. All ANSs and MHs and their communication paths between them constitute with dynamic network as shown in Figure 1. The overall network is backup with IP-based back-bone heterogeneous network called Core Network connected to the fixed host. Each ANS contains the list of ids of MHs that are currently local to it. When two or more ANSs of same or different type are available, then the MH can dynamically change its point of attachment to ANS of better connectivity for seamless services. Every ANS executes update() periodically which updates the list of ids of MHs.
When an MH invokes a service and sends the request to the fixed host network. The request received by the fixed host network executes the service by distributing among them and performs the necessary operations at the MH by sending a token. If the requested MH is migrant MH, the core system has to locate the migrant MH and sends the token to it, through its present ANS by using different service management strategies. Large number of migrant MHs requests services simultaneously leads to bottleneck and needs structuring \[4\][5][6]. This paper proposes a logical ring approach for handling multiple requests by different migrant MHs of different ANSs simultaneously.

3. STRUCTURING THE LOGICAL RING USING SERVICE MANAGEMENT STRATEGIES

The proposed algorithm in distributed systems consists of circulating a token amongst participants in a logical ring. Each participant executes as follows: (1) wait receipt of token from its predecessor in the ring, (2) enter the critical region, if desired, (3) send the token to its successor in the ring. This algorithm trivially satisfies two important properties: (1) mutual exclusion (2) allows fair access to the token by allowing each participant to access the token at most once in one traversal of the ring \[4][7][8].

The logical ring should be established within the Core Network that consists of all ANSs with the token visiting each ANS in a predefined sequence. A MH that wishes to access the token is required to submit a request to its local ANS. When the token visits this ANS, all pending requests are serially serviced. However, a MH may have changed its location since submitting its request, and therefore, the location of such migrant MHs need to be explicitly managed. Below, we present two Service Management strategies viz. search and inform, for the case when all ANSs constitute the logical ring.

An alternative method of structuring the ring is to partition the set of all ANSs into “areas” and associate a designated fixed host, called a proxy, with each area. The token now circulates only amongst the proxies, and each proxy is responsible for servicing token requests from ANSs within its area. A combination of search and inform strategies is used to manage the location of migrant MHs in this case.
SEARCH Strategy

Step 1: When the MH need to access the critical region, sends a request to its ANS. Then the ANS adds that request to the rear of its request queue.

Step 2: The ANS receives the token from its predecessor in the logical ring.

Step 3: The pending requests from ANS’s request queue are moved to grant queue.

Step 4: De-queue the request from the grant queue.
If the MH making the request is currently local to the ANS, then deliver the token to the MH. Now the MH accesses the critical region and returns the token to the same ANS.
Else, search and deliver the token to the MH in its current ANS.

Step 5: Repeat step 4, until the grant queue is empty.

Step 6: Forward the token to the successor ANS in the logical ring.

The above strategy assumes that a MH does not submit a second request if its previous request has not yet been serviced. Secondly, when a MH receives a token, it must return it to the sender ANS after accessing the critical region, i.e. it may not disconnect permanently after receiving the token. Mutual exclusion is trivially guaranteed by this strategy, since at most one MH may hold the token at any given time. In order to avoid starvation, when the token arrives at an ANS, request stored in request queue are transferred to the grant queue; new requests can be added to the request queue. Only those requests that are available in the grant queue are satisfied by the ANS. The below given Figure 2 is a sequence diagram for Search strategy, shows how the processes – MH, ANS, newANS, RQ and GQ interacts by exchanging messages and are arranged in time sequence.

Figure 3 – Sequence Diagram for Search strategy
INFORM Strategy

Inform strategy is an alternative to the search strategy to locate a migrant MH. Migrant MH has to notify the ANS after every change in its location till it receives the token. The ANS has to update() the information received from the migrant MH.

Step 1: When the MH need to access the critical region, sends a request to its ANS. Then the ANS adds that request to the rear of its request queue.

Step 2: When the requested local MH changes its connection from one ANS to another, the information is updated in the request queue.

Step 3: The ANS receives the token from its predecessor in the logical ring.

Step 4: The pending requests from ANS’s request queue are moved to grant queue along with the updates of the mobile current location.

Step 5: De-queue the request from the grant queue.

- Deliver the token to the MH through its current ANS.
- Else, forward the token to the present ANS that was updated in the grant queue.

Step 6: Repeat step 5, until the grant queue is empty.

Step 7: Forward the token to the successor ANS in the logical ring.

Mutual exclusion is trivially guaranteed by this strategy also, since at most one MH may hold the token at any given time. To avoid starvation, the same procedure, transferring all request from request queue to grant queue is applied even in inform strategy also. The sequence diagram for Inform strategy shown in Figure 3 explains how the processes – MH, ANS, newANS, RQ and GQ interacts by exchanging messages and are arranged in time sequence.

Figure 4 – Sequence Diagram for Inform strategy
PROXY Strategy

The third strategy that combines advantages of both search and inform strategies, and is tuned for a mobility pattern where a migrant MH moves between adjacent ANS frequently and moving between non-adjacent ANS rarely. The set of all ANSs are partitioned into areas and ANSs within the same area are associated with a common proxy. The proxy is a static host like ANS and also performs all activities related to service management as similar to ANS. In this strategy the token is circulated in a logical ring among the proxies. On receiving the token, each proxy is responsible for serving pending requests from its request queue. It is assumed that the MH is aware of the identity of the proxy associated with ANSs. Simply, this is an inform strategy for proxies.

Step 1: When the MH need to access the critical region, sends a request to its Proxy. Then the Proxy adds that request to the rear of its request queue.

Step 2: When the requested local MH changes its connection from one Proxy to another, the information is updated in the Proxy’s request queue.

Step 3: The Proxy receives the token from its predecessor in the logical ring.

Step 4: The pending requests from Proxy’s request queue are moved to grant queue in that Proxy along with the updates of the mobile current location.

Step 5: De-queue the request from the Proxy’s grant queue, Deliver the token to the MH through its current Proxy.

Else, forward the token to the present Proxy that was updated in the Proxy’s grant queue.

Step 6: Repeat step 5, until the Proxy’s grant queue is empty.

Step 7: Forward the token to the successor Proxy in the logical ring.

From the above three strategies it is obvious that the effort for circulating the token among the proxies is less than the effort for circulating the token among the ANSs. The below shown Figure 4 is a sequence diagram for Proxy strategy illustrating how the processes – MH, ANS, PROXY, newPROXY, RQ and GQ interacts by exchanging messages and are arranged in time sequence. The performance and efficiency of all the three strategies can be justified by identify measuring units calculating the overall computational workload among the static hosts.

![Sequence Diagram for Proxy strategy](image-url)

**Figure 5** – Sequence Diagram for Proxy strategy

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4. METRICS FOR SERVICE MANAGEMENT STRATEGIES

To evaluate the performance and efficiency of the different Service Management strategies two metrics are identified namely: (1) Communication Load Factor (2) Service Efficiency. The ratio of the number of requested services that are executed in a period of time and the average communication load of those services in that period is named as Communication Load Factor (CLF) and the ratio of the number of service requests executed in a period of time to the average waiting time of those services during that period is Service Efficiency (SE). Evaluation using these metrics can be done if all the three schemes service the same number of token requests in one traversal of the ring.

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\text{CLF} = \frac{\text{No of service requests executed in a period of time}}{\text{Average communication load of those services in that period of time}}
\]

\[
\text{SE} = \frac{\text{No of service requests executed in a period of time}}{\text{Average Waiting time of those services during that period of time}}
\]

5. PERFORMANCE ANALYSIS

By considering the metrics the performance and efficiency of the three strategies are evaluated for 4 different traversal of the ring. In each traversal, the token requests are randomly chosen and the same are applied for all the strategies. The communication load factor and service efficiency are calculated and are plotted with respect to time on X-axis scaling to (1:1000). The Figure 6 & 7 shown below are the performance analysis for the two metrics: CLF and SE plotted graphically. From the Figure 6, in all the traversals as the time increasing the proxy strategy gives better CLF than inform & search strategies. Similarly, from Figure 7 the SE for proxy & inform strategies are better than search and are almost equal for all traversals.

![Figure 6](image1)

![Figure 7](image2)

**Figure 6 – Metric 1: Communication Load Factor (for 4 traversals of the ring)**

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6. CONCLUSIONS

The design of algorithms for distributed dynamic mobile computing systems and their performance and efficiencies are evaluated based on the assumption that the location of ANSs & Proxies do not change and the connectivity amongst the ANSs & Proxies is static and fixed in the absence of failures. However, with the emerging mobile computing, these assumptions are no longer valid. This paper first presents a new system model for the dynamic mobile computing environment and then describes a general principle for structuring distributed algorithm for NGN. The proposed algorithm in distributed systems is a token circulating in a logical ring among MHs by presenting Service Management strategies: (1) search (2) inform (3) proxy.

The efficiency of search and inform strategies is determined by the number of moves made by the migrant MH. Search strategy is useful for migrant MHs that are frequently changing their ANSs, whereas the inform strategy is better for migrant MHs that change their locations less often. The proxy strategy is efficient where the migrant MH moves frequently between adjacent proxies, while rarely moving between non-adjacent proxies. Finally, it is concluded that proxy strategy gives better results as this strategy combines the advantages of both search and inform strategies.

REFERENCES


BIOGRAPHIES

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