Mobille Resource Availability Modeling in Mobile Grid System

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ABSTRACT

Mobile grid system supports the integration mobile devices as grid resources. Availability of mobile resources changes dynamically in mobile grid system. Stochastic reward nets (SRN) is an extension of stochastic Petri nets and provides compact modeling facilities for system analysis. We build the SRN model to represent availability of mobile resources with disconnected operation service.

Ⅰ. Introduction

Mobile Grid, in relevance to both Grid and Mobile Computing, is a full inheritor of Grid with the additional feature of supporting mobile users and resources in a seamless, transparent, secure and efficient way [1]. Mobile computing brings changes and challenges, such as intermittent connectivity, device heterogeneity, battery constraints, weak security and so on to the general Grid concept. These limitations and constraints should be dealt with accordingly before mobile grid integration is fully enabled[2]. Mobile resources are prone to disconnections due to their confined communication range and device mobility. This paper mainly focuses on the availability of mobility resources changing dynamically in mobile grid system. We build SRN model which is constructed based on job queuing service and executing process on intermittent connectivity mobile nodes. Some measurements are taken to get numerical results of total around time and execution time to start availability analysis.

Ⅱ. System Modeling

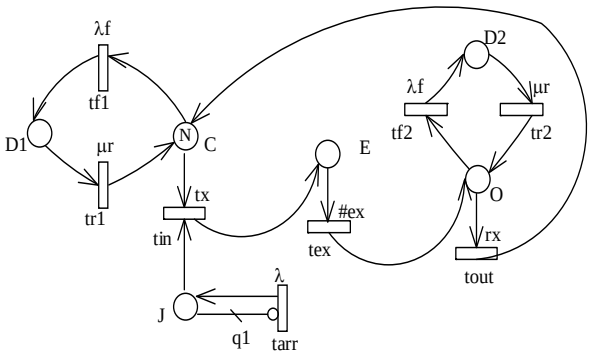
SRN is an extension of stochastic Petri nets and provides compact modeling facilities for system analysis. SRN has the ability to allow extensive marking dependency. It also has one important feature of expressing complex enabling/disabling conditions through guard functions. To get the performance and reliability/availability measures of a system, appropriate reward rates associated with the markings are assigned to its SRN[3,4].

Due to the unreliable connectivity of mobile devices, the job performance of each mobilenode affected heavily. We model the job execution process on mobile nodes taking the frequent disconnections of each node into account, and get the corresponding execution time. The SRN model is shown in Figure. 1. The N tokens in places C represent the number of connected mobile nodes.

The firing of transition ***tarr*** represents arrival of jobs with initial firing rateλ . Then jobs go to the job queue—place ***J***. With some job scheduling methods which we do not concern in this paper, the transition ***tin*** gets fired which means that the job is transmitted and allocated to an available mobile node. Then the token is moved to place ***E*** (execution state). The firing of transition ***tex*** represents that the mobile node processes the job. The '#ex' of transition ***tex*** means that the actual rate is dependent on the number of tokens in place ***E***, the rate is multiplied by the number of tokens in place ***E***. After execution tokens are moved to place ***O*** which means ready to output the finished jobs. This may make transition ***tout*** get fired with the firing rateγ .Jobs are output to the clients and one token is moved to place C represents that a mobile node is ready to accept new job.

The firing of transition ***tf1*** represents failure (disconnection) of a mobile node. When transition ***tf1*** fires with the firing rateλ , one token moves to the place ***D1***(disconnection state). After transition ***tr1*** (reconnected again) fires one token is moved from place ***D1*** to place ***C***, which means the mobile node are reconnected. So it's the same meaning to transition ***tf2***, ***tr2*** and place ***D2***. The node will wait for reconnection while it's in disconnected state. When the job is processed and the node is in connected state, it sends result data back and the free mobile node is returned back to place ***C***.

In order to perform steady-state analysis, we put a multiple inhibitor arc from place ***J*** to transition ***tarr*** with value q1 to construct a circle.



▶▶ Fig.1 SRN model of a Mobile Grid System

Ⅲ. Measures of Interest

In order to obtain the performance measures numerically from the SRN model, underlying CTMC is generated and solved through the use of the software package SPNP. We assume that all transition firing rates in our SRN models are exponentially distributed, so we perform the steady-state analysis of the model we have constructed[4].

• Mobile Execution Time(MET)

MET is the mean response time which mobile takes to execute the job. We calculate MET according to Little's Law:

N=λ *T Mean number tasks in system = mean arrival rate * mean response time

We take the input, execution and output parts of the node level as one queue, and calculate the average queue length, N:

N= #C+#D1+#E+#O+#D2 , Λ= rate(tarr), where #C = average number of tokens in place C, rate(tarr) = real throughput of transition ***tarr***. MET= N/Λ

• Total Around Time(TAT)

TAT is a total time the system takes to serve a job. To calculate TAT, the average queue length includes job place ***J***.

● Job Waiting Time(JWT)

JWT is the time job waits for execution and is obtained from following equation: JWT=TAT − MET

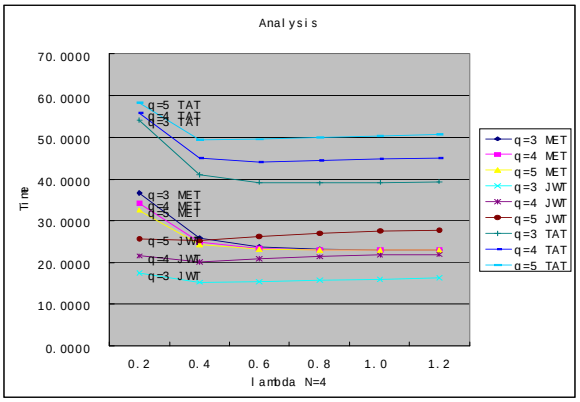
Ⅳ. Numerical Results

1. Input data

Input data are given for solving the SRN model. We assign the initial job input rate tx and output rate rx equal to 1, job execution rate is dependent on the number of tokens in place ***E***, the initial node disconnected rate 0.08, and node reconnected rate 0.02.

2. Numerical results

We collect the results of MET, TAT, and JWT for different number of nodes N and different arriving rateλ . Figure.2. shows the changes of MET, TAT and JWT in one combined graph.



▶▶ Fig.2 MET, TAT and JWT from increasing the arriving rate λ and queue size.

V. Conclusion and Future Works

In this paper, we built SRN model to analyze the availability of mobile grid system under the condition of intermittent connectivity. We only focus on the node level about job execution with unreliable mobile nodes.

There are still lots of work to do with that system, such as taking the job scheduler side into account and other special situations. We will tackle on these situations in our future work and get more deep and complicated analysis.

▌References ▐

[1] Zeng Wenying1, Zhao Yuelong, Song Wei and Wang Wenfeng. " Mobile grid architecture and resource selection mechanism," International Journal of Modelling, Identification and Control, 9(1−2):15−23, 2010.

[2] Sang−Min Park, Young−Bae Ko, and Jai−Hoon K. " Disconnected Operation Service in Mobile Grid Computing*," First International Confer −ence on Service Oriented Computing(ICSOC '2003).

[3]. Cheul Woo Ro, Kyung Min Kim. " Stochastic Petri Nets Modeling Methods of Channel Allocation in Wireless Networks," IJOC (International Journal of Contents) Vol. 4, No.3, 2008.9

[4].Ciardo, K.S. Trivedi, SPNP Users Manual Version 6, Duke University, 1999.9