Context Information based Fault Tolerant Technique in Mobile Grid*

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Abstract. Mobile grids extend the concepts of grid computing through performance improvement of mobile devices and the development of wireless communication and offer mobility to grid service user. But mobile devices have various problems such as instability of wireless communication, intermittent connection, limit of power supply, and low communication bandwidth. These problems cause unreliable communication and many faults happened by unpredictable characteristics. In this paper, through taking checkpoints to local node and proxy server using context information such as mobility and communication information, we propose fault tolerant techniques to perform jobs continuously when the faults occur in mobile devices.

Keywords: Context Information, Mobile Grid, Fault Tolerance, Checkpoint

1 Introduction

Grid computing has studied primarily in wired communication networks; however, as wireless communication networks are gradually developed and mobile devices become better functioning, studies on grid computing are extended to mobile grid environments which support mobility and use the mobile devices as a resource provider. But mobile devices have various problems such as instability of wireless communication, intermittent connection, limit of power supply, and low communication bandwidth[1]. In order to reduce these problems, fault tolerance techniques such as checkpoint and replication, have been studied in mobile grids. [2] proposes a proxy based coordinated checkpoint technique in mobile grids. However, due to an unpredictable status like intermittent connections, it is difficult to tolerate faults of mobile devices in mobile grids. Therefore, according to context information of devices, fault tolerance techniques are required to solve the various faults that can be occurred. Context information denotes user's status information such as user's current location and connection status[3].

This paper proposes the fault tolerance technique that is based on analyzing mobile devices' status using context information such as mobility information of mobile devices and communication information, and takes a checkpoint.

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2 System Architecture

Mobile grid environment has a system structure that connects an existent wired grid and a wireless grid. However, due to problems such as heterogeneity between mobile devices, low network bandwidth, and high intermittent connection, it is difficult to directly integrate mobile devices with grid environments. To mediate between mobile devices and wired grids, a proxy is used. The roles of the proxy are to supplement insufficient performance of mobile device, to connect mobile devices with wired grids, and to manage mobile devices.

As shown in figure 1, the proxy consists of Discovery Service Manager, Mobile Grid Job Scheduler, Fault Tolerance Manager, Context Information Manager, Mobile Grid Job Manager, and Communication Module. Mobile devices consist of Communication Module, Lightweight Context Provider, Lightweight Job Manager, and Job Execution Module.

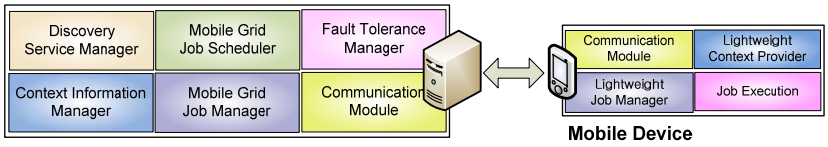

Figure 1 System architecture

3 Context Information based Fault Tolerant Technique

3.1 Flow of context information

Context information such as location information of mobile device and network status information (bandwidth), is transmitted to a proxy and is analyzed. And then, the proxy informs the mobile device of the time to take a checkpoint to using the analyzed information. Figure 2 shows the flow of context information.

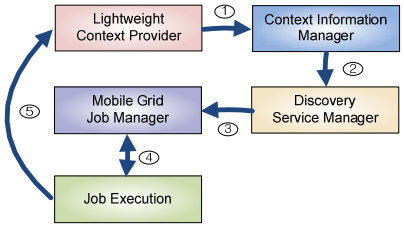

Figure 2 Flow of context information

(1) Context Provider collects context information of the mobile device, and transmits it to Context Information Manager. Context Information Manager analyzes the information and stores necessary information in context database. (2) The analyzed information is transmitted to Discovery Service Manager. And Discovery Service Manager searches resources suitable to the analyzed information. (3) The

information of discovered resources is transmitted to Job Manager and the resources are allocated to tasks managed by Job Manager. (4) After the processing of the tasks at Job Execution stage, the results of completed tasks are transmitted to Job Manager. (5) Context Provider receives and updates the information of devices.

3.2 Fault tolerance technique

Fault tolerance technique uses context information of the mobile device and determines the time to take a checkpoint, depending upon mobility and communication status. Moreover, when a fault occurs, it discovers a resource that is similar functionally to the device with a fault, and enables to be continued the interrupted operation by the resource. Each of the context information is received, analyzed and computed in real time. There is context information such as mobility information and communication information.

Firstly, mobility information denotes GPS information of mobile device such as location, speed and direction, and is used to compute the time when hand-off occurs using the GPS information.

```
struct MobileInfo {    /* Mobile Portability information */
    locationInfor ;      /* Location information */
    speedInfor ;         /* Speed information */
    directionInfor ;     /* Direction information */
}
do {
   foreach(mobile device) {
      get MobileInfo from Context Provider ;
      calculate handoff point ;
      send MobileInfo and handoff point to PROXY ;
   }
} while(true) ;
```

Figure 3 Mobility information algorithm

Secondly, communication information denotes network bandwidth and wireless signal strength. Network bandwidth is changed, depending on signal strength and network usage. According to this result, available bandwidth is computed. The value denotes the difference between maximum available bandwidth and background traffic and, is changed depending upon background traffic.

```
struct CommInfo {       /* Communication information */
   bandwidthInfor ;      /* Bandwidth information */
   signalInfor ;          /* Current AP signal information */
   AP_signalInfor ;      /* Duplicate AP signal information */
}
do {
  foreach(mobile device) {
      get CommInfo from Context Provider ;
      calculate available bandwidth ;
      send CommInfo and available bandwidth to PROXY ;
   }
} while(true) ;
```

Figure 4 Communication information algorithm

Taking a checkpoint has the following two stages. Stage 1 is to take a checkpoint on local storage of mobile device when the available bandwidth is under the first

boundary, that is one tenth of bandwidth. Stage 2 is to take a checkpoint on storage of the proxy when the available bandwidth is under the second boundary, that is one twentieth of bandwidth. However, if available bandwidth becomes the second boundary and the occurrence of hand-off of mobile device is anticipated through context information like mobility, this stage doesn't take a checkpoint to proxy and restarts from the checkpoint which is saved in the local. Then, if the mobile device is out of boundary of the proxy, the proxy finds other resources to restart from the checkpoint on the proxy.

```
checkdevice( ) {
   do {
     call Devicestate( ) ;        /* Device State Information */
     if (device's state is empty) task_migration( ) ;
     else del proxy_checkpoint ;
   } while(true) ;
}

checkpoint( ) {
   do {
    call MobileInfo( ) ;
    call CommInfo( ) ;
   if (handoff point ≠ 0) checkpointing on the local ;
   if (available bandwidth <= 1/20)
       if (AP_signalInfor == 0) {
          checkpointing on proxy ;
          call checkdevice( ) ;
       } else checkpointing on proxy;
   else (available bandwidth <= 1/10) checkpointing on the local ;
  } while (true) ;
}
```

Figure 5 Checkpoint algorithm

4 Conclusion

This paper proposes the fault tolerance technique based on context information such as mobility information of mobile devices and communication information. It can tolerate faults that can be occurred according to context of mobile device through method that overcomes restriction of mobile device in mobile grid environment. Future work studies adaptive fault tolerance technique using various context information.

References

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