Mobile Agent based Emigration Framework for 4G: MAEF

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Abstract This paper proposes an intelligent emigration framework which proactively migrate data from one network to another especially when the remaining time of current transaction is more the remaining battery life (RBL) of current device. However, if no suitable network is found then it gives an option of moving data from current device to other alternative device. The proposed is intelligent as it is assisted with mobile agents thus making it to be more robust. Mobile agent learns the behavior/pattern of transactions happening in the past and in turn computes RBL. It also acts as an adjunct support for the current device which is about to shutdown.

Keywords: Power-Conservation, Mobile Agent, Vertical Handover, Transaction Time Required, Remaining Battery Time.

1. Introduction

The success of 4G lies in the heterogeneity of networks and terminals and it shall not be considered as linear expansion of 3G [10]. Where network heterogeneity guarantees ubiquitous connection and provision of common services, terminal heterogeneity refers to the support of different types of terminals in terms of display size, complexity, energy consumption, portability, etc [1]. Thus future technology provides clear advantage in terms of network coverage; sharing of resources, power consumption etc. The mobile devices are constrained in terms of battery draining which is an unceasing problem. So it is important to minimize the power consumption for the application access.

The power consumption rate is dependent on the network with which the Mobile Node (MN) is associated, and also on the state of the MN, which may be transmitting, receiving or idle state [3]. Literature [17] indicates the rate of data transfer depending on the network, where as application specific power consumption is given in [11].

It has been argued that during the less RBL, either the application could be switched off or mode of application can be changed i.e. from GUI to CUI. However, authors of this work claims that a user might be in a midway of high priority task, would not be interested in any of the above two solutions. In fact, they may get annoyed. In such cases, it is more desirable to switch to high speed network so that task / data transfer could be completed well in time. This paper intends to facilitate the users by providing such a Mobile Agent based Emigration Framework (MAEF) which not only intelligently initiates network transfer but also provides an additional support for transferring the transaction to alternative device.

As reflected in literature [13, 14, 15, 16, 18] agents are now contributing to the growth of telecommunication and are proving to be intelligent staffers.
This works intends to exploit agent technology in 4G by proposing an agent oriented emigration framework as 4G is still looking for an intelligent paradigm. The paper has been organized in four sections. Section 2 gives the related

work. Section 3 explains the conceptual and working of proposed work along with algorithm. Finally conclusions and future scope are presented in section 4.

2. Related Work

This section discusses the literature pertaining the developments in 4G as well as the role of Mobile Agents in facilitating the mobile users. The survey of 3G & latest trends imply that 4G shall comprise of components shown in Figure1. A typical 4G mobile phone will consists of following components

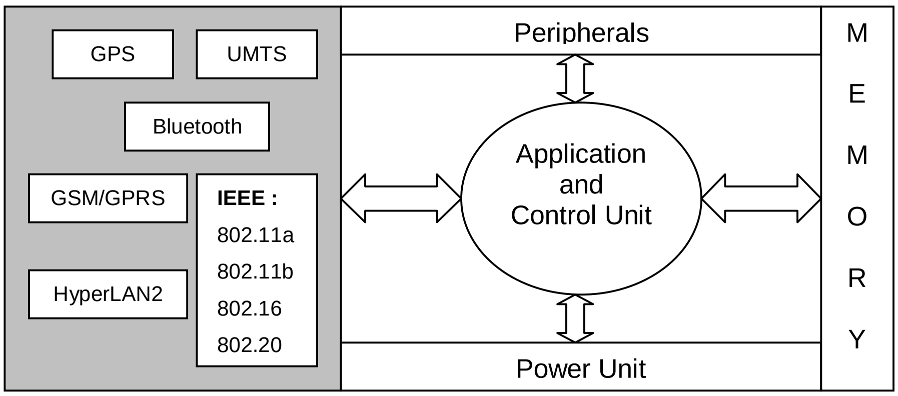

Figure 1: Future 4G Architecture

Literature [11] reflects that application and control unit shown in Figure 1 consumes 40% of the total energy and network unit consumes 20%, whereas rest 40% is used by memory and other peripherals. Researchers [6, 19] have contributed and proposed hardware solutions such as low power processors, mobile / cellular memories to reduce the consumption of power. In contrast, people may debate, if the battery's power capabilities cannot be improved, the other substitute is to locate ways to use less power. Various energy efficient methods and techniques in the environment of mobile computing are proposed. In [5], the authors presented an energy-efficient cache invalidation method, called Grouping with cold update-set retention (GCORE), that allows a mobile computer to operate in a disconnected mode to save battery while still retaining most of the caching benefits after a reconnection. GCORE can substantially improve mobile caching by reducing the communication bandwidth (or energy consumption) for query processing.

In [6], the authors aspire to use the modular architecture for achieving the goal of optimization of power consumption. Nanomaterials, new manufacturing solutions and energy sources together with increased memory and computing capacity, will enhance the capabilities of mobile devices. They presented a conceptual device called the Morph that illustrates use and benefits of nanotechnologies in real life applications. This device is different in many ways in terms of user interface, functionality and in appearance. It is capable of sensing its environment, then user can make decision based on this information. The only drawback is that it is not compatible with the existing technologies.

Another solution for the above problem is remote process execution [7]. It basically moves the new tasks from the portable machine to a server machine before the task start running. The server would execute the task and ship the results back to the portable computer. Since wireless cards themselves consume considerable amounts of power, there is no guarantee that migrating would actually save power.

Mobile Agents within the Mobile Data (MAMDAS) [8] is a technique to improve the performance of mobile node using mobile agents. The high performance, energy efficiency, scalability, and robustness of MAMDAS allow us to envision its application in a variety of fields such as military operations, emergency teams, and mobile E-business. The only limitation using MAMDAS is that it can not be used for large scale distributed information sharing system.

In [9] authors proposed an adaptive application-driven power management (AADPM) protocol for mobile agent-based applications with in the WLAN environment. The objective is to minimize energy while achieving low round trip time (RTT) delay. AADPM can suspend the Network Interface Card (NIC) when possible to maximize energy saving.

The above mentioned literature clearly reflects that there is need of a new framework which could switch the network during critical situations of draining battery without interrupting the ongoing task. In order to handle the above mentioned crises situations Mobile Agent based Emigration Framework for 4G (MAEF), is being proposed in the upcoming section.

3. Proposed Work:

MAEF comprises of four components namely Interface Agent, Networks, Computing Agent and Alternative Devices, which are being discussed briefly in the upcoming subsections.

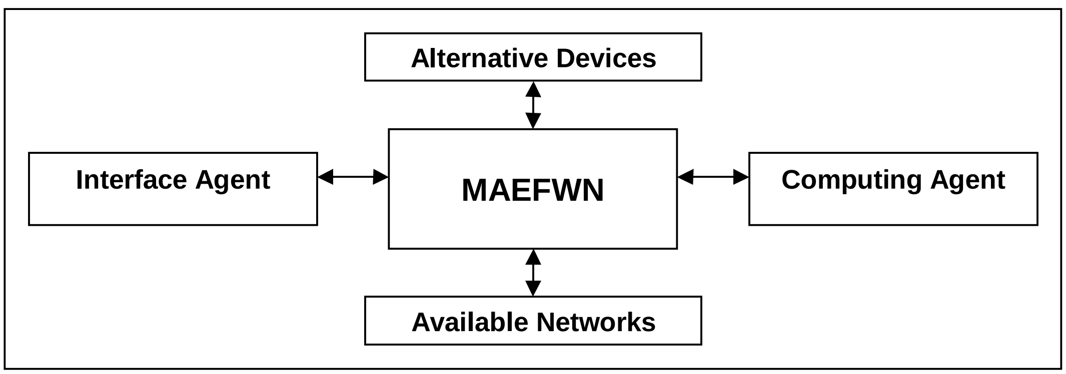

Figure 2: Mobile Agent based Emigration Framework for 4G

3.1 Conceptual View

- **Interface Agent**

An interface agent is an agent that can travel through the heterogeneous network autonomously, move around from host to host. In MAEF framework, the responsibility of this agent is to retrieve the present bandwidth of the available network, alternative devices and deliver the same to computing agent for further processing. The procedure is repeated periodically. The interface agent remains inactive or goes to sleep mode otherwise.

- **Computing Agent**

This agent retrieves the size of data to be transferred and computes the Remaining Transaction Time (RTT) depending upon the bandwidth being provided by interface agent. The intelligence of the framework is that computing agent computes RTT intelligently by learning from the pattern of data sizes utilized in past few cycles. RTT is computed dynamically by using the formula.

$$RTT = DataSize / Bandwidth \qquad \text{(i)}$$

- **Networks**

Here network include heterogeneous network which includes Satellite, GSM/GPRS, UMTS, IEEE 802.16a, IEEE 802.20, IEEE 802.11a, IEEE 802.11b, Bluetooth. All these networks are included so as to provide a seamless approach.

- **Alternative Devices**

These device may be a user alternative mobile device, personal data assistant (PDA), user's laptop and /or personal computer (PC).

3.2 Working

The proposed framework primarily focuses on the following two tasks.

- Handover of the MN to an available network which can transmit the current transaction and also has higher data transfer rate.
- If current available networks are unable to process the transaction within Remaining Battery Life (RBL) then remaining data should be migrated to an alternative device. So that transaction continues on that device.

Figure 3 represents the state diagram reflecting the working of the proposed framework and the algorithms are given as below:

Algorithm: Mobile Agent based Framework for 4G

```
begin
    Invoke Interface_agent
    Invoke Compute_agent
    if (RTT < RBL)
        if (change in network)
            Invoke MN_agent
        else
            Start Migration
        end if
    end if
end
```

Algorithm: Interface$_{agent}$

```
begin
    Invoke Interface_agent
    aN[ ] = <Available Networks>
    aD[ ] = <Alternative Devices>
    while (i <= aN[ ] )
        pb= getBandwidth()
    wend
    sort (aN[])
    return sorted aN[]
    while (i <= aD[ ] )
        pb= getBandwidth()
    wend
    sort (aD[])
    return sorted aD[]
end
```

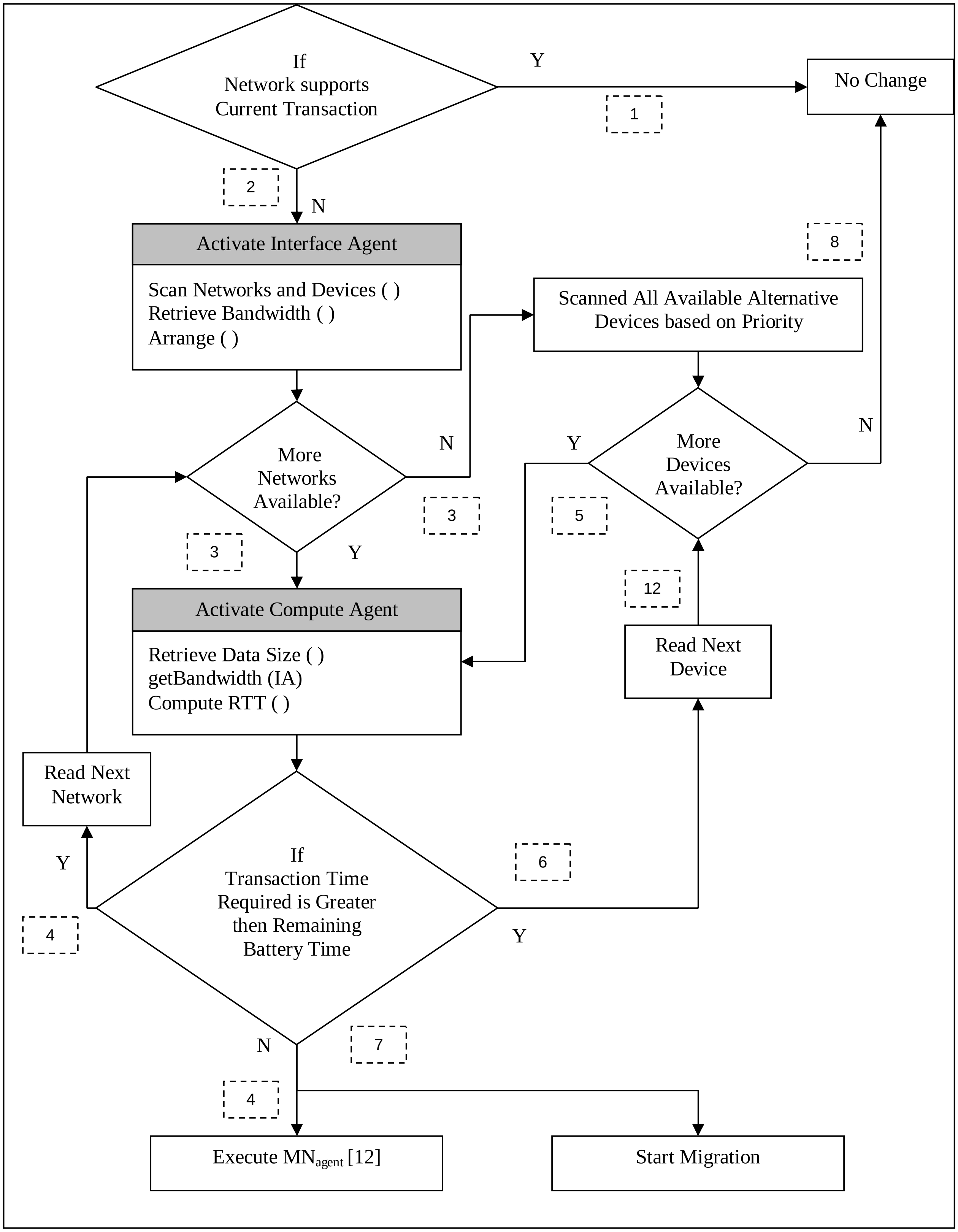

Figure 3: State Diagram of MAEF: The Proposed Work

Algorithm: Compute_{agent}

```
begin
    while (I <= aN[])
        ds = getDataSet()
        RTT = ds / pb (🡐 Interface_agent)
        return RTT
    wend
    while (i <= aD[ ] )
        ds = getDataSet()
        RTT = ds / pb (🡐 Interface_agent)
        return RTT
    wend
end
```

4. Conclusion and Future Work:

This work contributed a novel idea MAEF for 4G, which holds the promise of providing seamless data transfer even under critical situations. The work is under the primary stage of implementation and we believe that this shall be fruitful for the future 4G generation.

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