MapReduce calculating model on mobile devices

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Abstract — **In this article explains the use of the newest programming model which makes a large number of calculating operations in parallel on mobile devices, where program runs in a sandbox without specific needs, and simulates mobile as powerful as PC. The following describes the steps of the method.**

Keywords — MapReduce; Cloud computing; Mobile technologies; Distributed calculations;

I. INTRODUCTION

The technology of distributed calculations has gained popularity over the last 5 years. It is caused by the global connection of a large number of computer devices to the Internet, that, in turn, allows the nodes to be connected with each other.

The idea is based on the statement, that modern electronic machines do not use the whole processor power of their core (RAM, main processor) and spend energy irrationally.

The vocation of such technology is the system's loading of various simple tasks during the downtime of the operating system, not blocking application software of root user at the same time.

MapReduce is useful in a wide range of applications, including distributed pattern-based searching, distributed sorting, web link-graph reversal, Singular Value Decomposition, web access log stats, inverted index construction, document clustering, machine learning, and statistical machine translation. Moreover, the MapReduce model has been adapted to several computing environments like multi-core and many-core systems, desktop grids, multi-cluster, volunteer computing environments, dynamic cloud environments, mobile environments, and high-performance computing environments.

MapReduce libraries have been written in many programming languages, with different levels of optimization, so it will help to easily implement this system to any mobile platform.

The reminder of this article is organized as follows: in Section II we will discuss the requirements to mobile devices. In Section III, we discuss the method developed, which allows us to increase the efficiency of the calculations, and, finally, we conclude with a profit of mobile calculations in section IV.

II. REQUIREMENTS TO MOBILE DEVICES

Smartphones become very popular nowadays. It will be true to say that every modern man has it and even not one.

Such smartphones have powerful CPUs (even not one) and good efficiency in calculating small operations with non-big numbers/data. Thanks to this, it become possible to use them as small computers, so it let modern developers to create powerful and PC`s like applications and games. So, it is possible to say, that mobile device for this system should have modern architecture of CPU and have multitasking OS on board such as Android or IOS.

Due to what is now on mobile devices installed, we have picture, when every mobile user should charge his phone every day or every 2 days and this charging period can longs up to 2 - 3 hours as minimum. So, mobile device should have long term battery, or user should manually setup application to work only when battery level is above a certain level or say application to work only when device is charging. This approach will help to safe battery life and give users a feel of freedom about what processes are running on their gadgets.

Of course, choosing a mobile platform (mobile phones, tablets, smart watches) as nodes of the distributed calculated system has several advantages:

- High performance for simple tasks

- Gadget Mobility

- Simplicity of application settings and creation

- Ability to use a large number of nodes

- Permanent online status due to widespread 3G connection

- Lots of downtime (in standby mode)

- Ability to uniquely identify the node by the gadget parameters (IMEI, GUID, Serial Number, mobile operator card number).

The other thing, is that mobile device should have enough storage space. It means, that all temporary and intermediate calculations will be uploaded to RAM, and if user want to run another application – it should be enough memory to store all needed data. And of course, it should be enough disk space on device, to store computed data before it will send to server.
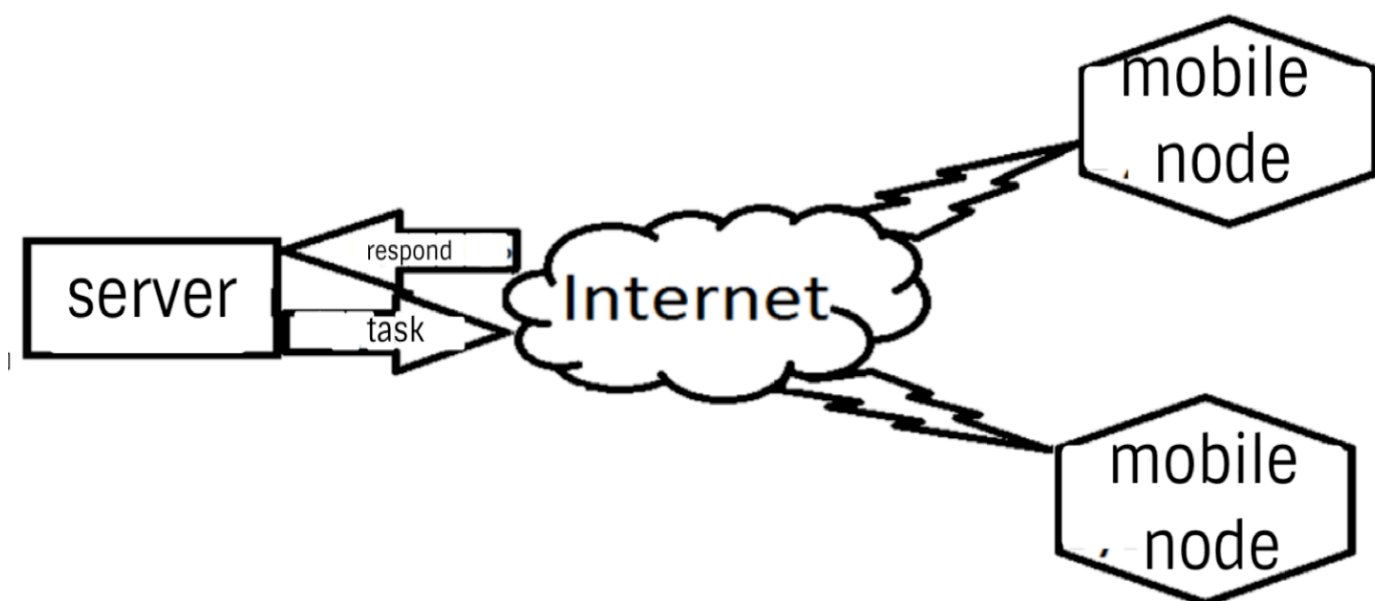
Fig.1 Distributed Calculating Network Scheme for mobile nodes

III. METHOD OF DISTRIBUTING TASKS

Schematically, the Distributed Calculation System is a network of linked nodes and a server in the Internet, using the popular HTTP protocol (figure 2). The system consists of a server, written and working on the Node.js technology, that simplifies the binding of nodes and work with the Internet protocols, and several nodes, connected via Wi-Fi and 3G with various mobile operating systems (iOS and Android). The server, responsible for dividing, mailing and bonding a task, must have a reliable access to the Internet, because it also has to monitor the state of the node and the progress of the calculation.

There is also a software snap-in on a mobile client, which carries out the acceptance of the task. Actually, for calculating purposes, such client should have a piece of computed algorithm, especially it is needed for Reduce phase, because it is important to build a logical chain of small pieces of calculated data to obtain whole correct result. So, it is important to build flexible client, that can load calculating algorithms on a par with other information. This client is responsible for processing and formatting the response for further sending to the main node.

The nodes, working within one project, receive tasks from the main server, which initially divides the complex task into parts, then sends it to the nodes for execution, and after a set time t_{exec}, begins to collect the processed information by nodes in a single response.

The task is performed as a low-priority background process, taking up to 10% of productivity at parallel work with processes on behalf of the user, and up to 45% when the operating system goes into standby mode.

The server itself is a unique link in the work of this technology and needs fine tuning. Unlike it, working units can be different configuration and even do not know about the existence of each other. This architecture feature allows using not only commonly accepted desktops, but also other gadgets, equipped with 32 or 64-bit processors.

After dispatching the tasks and processing them on the nodes, the gluing to the general answer by the method, reversed to division of a task is performed on the server.

The difference between these processes is that at the gluing stage the completeness and relevance of the data is also checked by the unique identifier of the device.

This stage includes an analysis of the node's operation (availability of the online status) and the need to re-send the lost part of the response repeatedly to another free working node in case of a sudden disconnection of the previous node, engaged in processing this part of the task.

For such a system there has been developed an application on popular mobile platforms - iOS and Android - which can be downloaded from the app store for each operating system, in accordance. It is to perform data receiving, processing, sending and formatting in the form of an answer for easy gluing by the server.

Thus, the use of mobile devices to carry out bulky and long-term calculations as small and medium-sized networks has several advantages over the use of stationary computers, namely: longer downtime of the operating system and standby time, an easy access to the Internet, easiness of platform configuration for tasks execution, centralized distribution system.

IV. Conclusion

This article proposes a solution to the problem of calculating big data. In contrast to the methods for solving the problem presented earlier in other papers, the described approach has the following advantages:

1. The chosen algorithm is well suited for implementation of the distributed system because it solves the problem of parallelizing the task between the working nodes; the separation of the scope of devices, that is, the establishment of independent communications between devices; management of the fractional division of a task, to achieve the performance of a mobile device for easiest operations, to reduce the load on the device battery and reduce the risk of loss of a large part of the calculation due to the sudden disconnection of the node from the Internet.

2. Client for a mobile device will be a simple application like others and it would not be difficult for user to install it. Thanks to it cross-platform architecture, it is not needed to make extra configurations from user.

3. An original method is presented that allows obtaining the processing time of the HTTP request with minimized noise introduced by the network delay, which in practice often has a wide range of values.

The big data calculations based on nodes which are mobile devices is really and can be reached in an automated way. An exception is that computing power of each mobile node is not so big as PC and there exists maximum limit of pieces in which each task can be divided on map phase. In general, the proposed method for solving problem of making big data calculations depends on devices, that should be working as nodes.

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