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EXPLORING CLOUD COMPUTING FOR MOBILE WORLD ON ARM2

PATNAIK P.D.R.[1]*, GUNDALE A.S.[2]

Electronics Dept., Walchand Institute of Technology Solapur, Maharashtra, India.
*Corresponding Author: Email- pdrpatnaik1@gmail.com, pdrpatnaik@gmail.com

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Abstract- With the rise of the smartphones and dependencies on web applications and the cloud, there has been one processor architecture that has taken the charge: ARM. Processors based on the ARM architecture have found their way into Apple iPhone, iPad and iPod Touch devices, Android smartphones and tablets, upcoming Chrome OS netbooks and tablets, home network routers and home multimedia hubs. Some of the reasons for the proliferation of ARM-based processors include: low cost, low-to-very-low power consumption, decent processing power, and open development environment. In this paper we first try to understand some concepts of cloud computing and then present some more details on why ARM became so popular and a way of implementing the concept of cloud computing on ARM based mobile platform.
Keywords- ARM, Cloud Computing, Eucalyptus, OMAP, Openstack, Cloud.

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Introduction

Cloud computing in mobile platforms has invoked a new wave of evolution in the rapidly developing mobile world also known as Mobile Cloud Computing (MCC)[1]. Although several striking research work has been conducted in the high computing counterparts of mobile technology, the field of cloud computing for mobile world is vastly unexplored.

Head of NVIDIA's Jen-Hsun Huang mentioned a number of interesting moments at the annual conference, which she spends. According to him, such major handset manufacturers like Motorola, Samsung Electronics and LG Electronics are very important for NVIDIA in the case of issuance of successful graphics products will be its main customers. It is not clear whether Hwang expressed a hope for future fruitful cooperation, or meant something specific[2]. It is likely that these companies may soon begin to use in their products (such as smartphones, and tablet), chipset NVIDIA Tegra, and, as Tegra 2, and the next generation. Samsung now prefers a 1 GHz chip Hummingbird, and Motorola for its high quality smartphone applies mainly chipset TI OMAP. In addition, Huang believes that in future ARM processor will win a complete victory over the chip x86, as has already happened in the segment of smartphones, and tablets.

As the need for additional web applications and cloud resources increases and the need for hosting providers and datacenters to make better use of power and cooling, I think it is time for the ARM architecture to be a formidable competitor in the server market. Granted, I am not alone in thinking about this, as various server builders are already considering options. For the past several years, the IT marching orders have been all about consolidation and virtualization. Virtualization has been a hot topic, as it allows workloads running on under-utilized servers to be pooled together on to fewer servers that provide more I/O and higher availability. Hypervisors, such as VMware ESXi, Xen and Hyper-V, have also improved dramatically over the years, mostly in terms of efficiency and manageability. The prsoblem with virtualization in a very large cloud environment is the cost of management tools, lack of network visibility or the cost of exposing network visibility (VN-Link, VMware Virtual Distributed Switching, etc.), and the dependence of relatively expensive servers. Another consideration is that you are generally currently limited to 24

cores/48 threads for every unit of rack space (twin-node 1U server with dual six-core Xeon processors), while each twin-node server can draw more than 500W of power.
Another option would be to purchase an UltraSPARC-T3 server with 16 cores and 128 threads filled with 128GB of RAM, running Solaris 10 with numerous zones or virtual partitions. For many applications, this option would work out quite fine and would allow for a fully supported Java stack top to bottom. Unfortunately, it comes at a cost of moderately-high power consumption, the requirement of FBD modules (something that Intel moved away from with the Nehalem-based Xeon processors), potential floating point bottlenecks, and, a deal-breaker for some, it is an Oracle product. Therefore the people are always in search of a better and cheaper solution that would best suit their needs.
Thus there is always a clever mind solution to adopt an equivalent system hardware with less consumption of power and source needs as in the case of ARM processors. Hence it would always be a good solution to adopt ARM based mobile systems for many reasons with the above mentioned reason being one despite other difficulties[4].
Therefore the war like situation in today's market between ARM and x86 regarding issues like processing power, power consumption, portability are becoming the major advertising policy to gain strength in the market. ARM seems to have higher potential as compared to x86 and others like AMD too. The most probable reason is that they are a kind of dedicated servers with some specific task to perform. Most often many users of a computer either use a whole lot power which may look like its not sufficient or don't at all use it which may prove the processing power of that computer useless.So there is a need to think on to buy and use the computer's processing power as per ones needs, and here is where the origin of cloud computing.

Understanding Cloud Computing

Understanding The Private Cloud Concept

In most cases, a private cloud is a shared IT infrastructure set up in your corporate data center and dedicated to just your company. Let's break down the cloud computing definition to better understand its implications to IT operations:

Standardized capability

The value of a cloud comes in the flexibility it brings to the business how rapidly and predictably you can deploy applications to this infrastructure. That value comes from provisioning and managing the environment in a consistent manner every time. You do that by standardizing what you deploy which means prioritizing user options and by automating as many processes as possible. It's not customized or configured uniquely for each client, each time that raises complexity, slows down processes, and is much harder to make repeatable. There may be options for consumers to choose some lightweight customizations they can apply atop the service, but the capability delivered is repeated, religiously.

Pay-per-use

A second core tenet is that the cloud is a shared environment where customers "pay" for the resources they use only when they use them. Efficiencies come from how much sharing takes place and how high you can drive the utilization of cloud resources as often as possible. A big reason clouds invoke pay-per-use costing is to keep the cloud efficient by incenting resource efficiency from the customer themselves. While many enterprises won't implement this model the same way public clouds do, they should account for and either show back or chargeback cloud consumption to maximize the overall cloud investment.

Self-service

For cloud services, self-service doesn't mean a web page where you request the service. Self-service is about providing self-service access through a portal to request services that have been defined in a service catalog. Thus it provides automation that requires minimal IT interaction so that the IT team can focus on more strategic business needs rather than routine tasks. The Storage Infrastructure For The Cloud Must Be Standardized And Efficient Nearly every successful cloud is built atop standardized, virtualized server infrastructures tightly integrated with consistent network and storage architectures that help achieve holistic economic advantage.
This means standardization and automation don't stop at the server. Storage must be provisioned with each new virtual machine and shared volumes must be easily integrated into the configuration. Standardization of the storage also means creating a service catalog of storage services attached to service-level agreements (SLAs) that satisfy the majority of infrastructure requests from your internal customers, introduce consistency, and streamline the IT request and delivery process. This is critical to delivering the time-to-market and economic advantages of the cloud. This study and other Forrester research show that most IT organizations focus on the server parts of their private cloud instead of optimizing each component to achieve maximum cost benefits. The storage architecture is commonly overlooked, leaving lots of efficiencies out of reach. Ideally, cloud storage should handle both latency-sensitive and latency-insensitive applications at minimal cost, while taking advantage of thin provisioning, life cycle management, automated tiering, and live migration.

How It Works?

A cloud user needs a client device such as a laptop or desktop computer, pad computer, smart phone, or other computing resource with a web browser (or other approved access route) to access a cloud system via the World Wide Web(Fig.[1]). Typically the user will log into the cloud at a service provider or private company, such as their employer[5]. Cloud computing works on a client-server basis, using web browser protocols. The cloud provides server-based applications and all data services to the user, with output displayed on the client device. If the user wishes to create a document using a word processor, for example, the cloud provides a suitable application running on the server which displays work done by the user on the client web browser display. Memory allocated to the client system's web browser is used to make the application data appear on the client system display, but all computations and changes are recorded by the server, and final results including files created or altered are permanently stored on the cloud servers. Performance of the cloud application is dependent upon the network access, speed and reliability as well as the processing speed of the client device.
Since cloud services are web-based, they work on multiple plat-

forms, including Linux, Macintosh, and Windows computers. Smart phones, pads and tablet devices with Internet and World Wide Web access also provide cloud services to telecommuting and mobile users[6].

A service provider may pool the processing power of multiple remote computers in a cloud to achieve routine tasks such as backing up of large amounts of data, word processing, or computationally intensive work. These tasks might normally be difficult, time consuming, or expensive for an individual user or a small company to accomplish, especially with limited computing resources and funds. With cloud computing, clients require only a simple computer, such as netbooks, designed with cloud computing in mind, or even a Smartphone, with a connection to the Internet, or a company network, in order to make requests to and receive data from the cloud, hence the term "software as a service" (SaaS). Computation and storage is divided among the remote computers in order to handle large volumes of both, thus the client need not purchase expensive hardware or software to handle the task[7]. The outcome of the processing task is returned to the client over the network, dependent on the speed of the Internet connection[8][9].

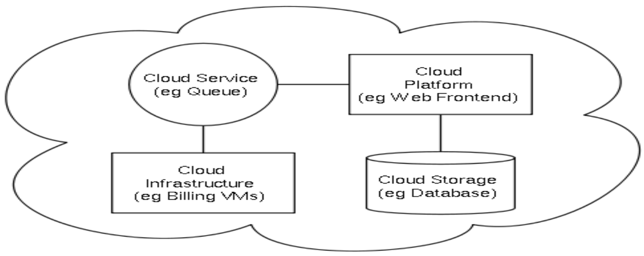

Fig. 1- Cloud computing sample architecture

Exploring Mobile Cloud Computing

Architecture for Mobile Apps in Cloud Environment

We will look at a open source project for mobile cloud platform called openmobster [3]. Its architecture is as given in the Fig(2).

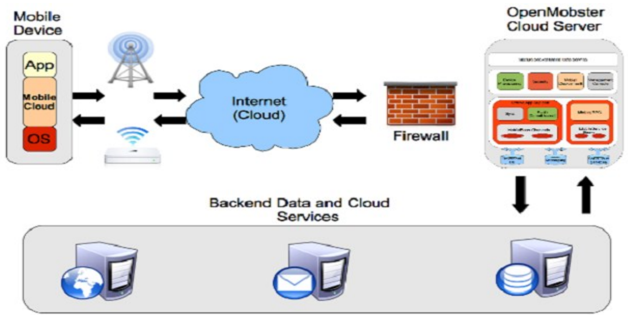

Fig. 2- The openmobster architecture for MCC

Typical services needed by a mobile cloud client

The most essential services include[2]:

- **Sync:** This service synchronizes all state changes made to the mobile or its applications back with the Cloud Server.
- **Push:** It manages any state updates being sent as a notifications from the cloud server. This improves the user's experience as it does not require the user to proactively check for new information.
- **OfflineApp:** It is a service which carries the management capabilities to create smart coordination between low level services like Sync and Push. It frees the programmer from the burden of writing code to actually perform synchronization as it is this service which decides synchronization management and mechanism which is best for the current state. The moment the data channel for any mobile application is established, all synchronizations and push notifications are automatically handled by OfflineApp service.
- **Network:** It manages the communication channel needed to receive Push notifications from the server. It carries the ability to establish proper connections automatically. It is a very low-level service and it shields any low level connection establishment, security protocol details by providing a high level interfacing framework.
- **Database:** It manages the local data storage for the mobile applications. Depending on the platform it uses the corresponding storage facilities. It must support storage among the various mobile applications and must ensure thread safe concurrent access. Just like Network service it is also a low-level service.
- **InterApp Bus:** This service provides low-level coordi nation/ communication between the suite of applications installed on the device. Fig(3) shows the client cloud stack using the most essential apps of the mobile stack.

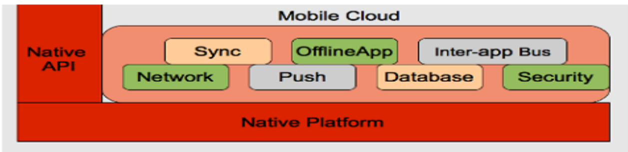

Fig. 3- The Client Cloud Stack.

Typical services needed by a mobile cloud server

These are the essential services that must be provided to the mobile apps by the server.

- **Sync:** Server Sync service synchronizes device side App state changes with the backend services where the data actually originates. It also must provides a plugin framework to mobilize the backend data.
- **Push:** Server Push service monitors data channels (from backend) for updates. The moment updates are detected, corresponding notifications are sent back to the device. If the device is out of coverage for some reason, it waits in a queue, and delivers the push the moment the device connects back to the network.
- **Secure Socket-Based Data Service:** Depending on the security requirements of the Apps this server side service must provide plain socket server or a SSL-based socket server or both.
- **Security:** Security component provides authentication and authorization services to make sure mobile devices connecting to the Cloud Server are in fact allowed to access the system. Every device must be first securely provisioned with the system before it can be used. After the device is registered, it is challenged for proper credentials when the device itself needs to be activated. Once the device is activated, all Cloud requests are properly authenticated.
- **Management Console:** Every instance of a Cloud Server

must have a Command Line application such as the Fig(4).[3] Mobile server cloud stack.

Management Console as it provides user and device provisioning functionalities. In the future, this same component will have more device management features like remote data wipe, remote locking, remote tracking, etc.

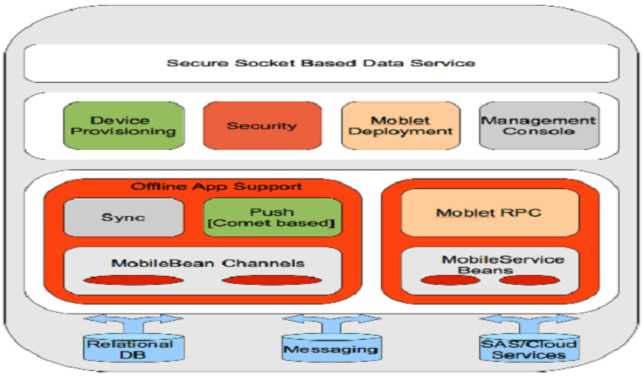

Fig. 4- The Mobile Server Cloud Stack.

The Arm Based Cloud Architecture Using OMAP

Texas Instruments' (TI) Open Multimedia Application Processor-4 (OMAP™ 4) mobile applications platform will redefine the mobile phone of tomorrow with new, innovative user experiences driven by PC-like web browsing, 1080p full HD video record and playback, intuitive user interfaces, location-based services and next-generation social networking applications. The OMAP 4 platform includes applications processors, a comprehensive software suite, power management technology and supporting components to bring next generation Smartphones and Mobile Internet Devices (MIDs) to market quickly. It OMAP 4 platform supports development of planned features for the Smartphones and MIDs of tomorrow with tremendous performance and programmability to support new applications yet to be imagined.

An architecture based on OMAP4 which is an ARM version 7 is used to propose a model for cloud computing platform on mobile devices. The proposed architecture is shown in Fig(5).

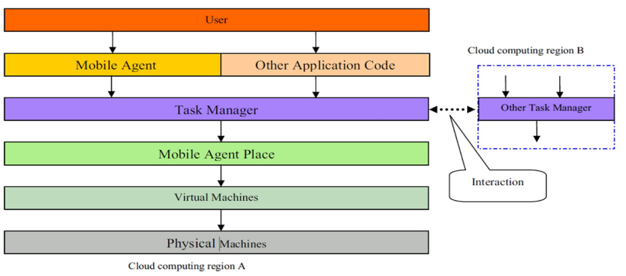

Fig. 5- Architecture for cloud computingmodel based on OMAP4.

Results

Since OMAP4 processor boards like Beagleboard, BeagleboardXM and Pandaboard come with full set of features like multiple OS support like Android, Windows Compact, Ubuntu, CentOS, Meego and many more its difficult to test all the possible OS performance with ARM based machines and hence we adopted an opensource emulator called QEMU which is processor emulator using a portable dynamic translator. The screenshot is shown in Fig(6). This emulator is first used to emulate ARM architecture on x86 machine and then the kernel images with appropriate bootloader is mounted on this ARM system to emulate the ultimate OMAP4 architecture. This provides very good results as far as the issues related to delay and text mode handling is concerned.

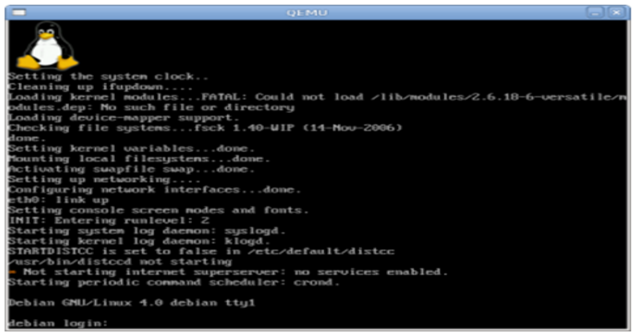

Fig. 6- ARM on Qemu.

But later when we tested the same on a specific ARM processor i.e. on Panda Board, OMAP4430 open-source ARM Cortex-A9 development board we found the results satisfactory proving the ARM's winning performance against as compared to x86. We used Eucalyptus to form a cloud with three OMAP 4430 processor boards and configured them to act as a cloud. All the three machines were loaded with ubuntu netbook images each of which were acting as a Cloud, Cluster Controller and a Node respectively.

These performance results when compared with x86 proved that ARM based machines are stunningly fast with performance when it comes to deal with issues like Cloud Computing.

Conclusion

A The concept of cloud computing provides a brand new opportunity for the development of mobile applications since it allows the mobile devices to maintain a very thin layer for user applications and shift the computation and processing overhead to the virtual environment. A cloud application needs a constant connection that might prove to be an Achilles heel for the cloud computing movement. However as mobile internet capabilities continue to get better, it is likely that solutions to this particular problem will become apparent. New programming languages such as HTML-5 already provide a solution by enabling data caching through a mobile device, and this allows a cloud application to continue working if connection has been momentarily lost. Some of the reasons for the proliferation of ARM-based processors include: low cost, low-to-very-low power consumption, decent processing power, and open development environment.

The ARM is very prevalent in low power embedded applications such as Ipods, Palm Pilots, and network routers. They are designed for low power consumption, meaning a laptop using an ARM processor is going to possibly have much better battery life than an x86 based laptop. Thus it would be a very good choice for ARM based cloud computing platforms similar to PANDABOARD. Also other aspect like better utilization and performance issues proves ARM as a better alternative for x86 and AMD processors too.

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