Evaluation of Mobile-Based Cloud Computing Using Destination-Sequenced Distance-Vector Routing Technique

Ms.P. Ananthi[1], Mr. M. Praveen Kumar[2], Mr. S.P.Santhoshkumar[3]
[1, 3] Assistant Professor, Dept of Computer Science and Engineering
[2]Assistant Professor, Department of Information Technology
[1, 2, 3] Rathinam Technical Campus, Coimbatore.

Abstract- *In this paper, a cloudlet-based approach for a new ad hoc model for mobile-based cloud computing is proposed. The performance of the model is evaluated using destination-sequenced distance-vector (DSDV) for routing protocol and random way point (RWP) mechanism for mobility fashion. The important parameters used to evaluate the model are end-to-end (e2e) packet delay, system scalability and mobility management. The performance of the model has been studied using various workload sizes that are offloaded to cloudlets and for different node speeds. The variation of hand-off delay as well as workload size gives significant impact on the e2e delay results. Even with the maximum hand-off delay, passing various workloads through multiple cloudlets is still quicker than using an enterprise cloud unless offloading small workload size.*

Keywords- mobile cloud computing; cloudlet; ad hoc model; performance evaluation.

I. INTRODUCTION

Cloud computing with mobile devices, such as mobile phones, smart phones, laptops, etc. have come together to form a new emerging field called mobile cloud computing. Nowadays, mobile cloud computing has become one of the most popular technologies, while cloud computing itself has vast importance in enterprises due to its cost and computational advantages. The first challenge in cloud computing is service availability as considered in Marinelli (2009) and Jararweh et al. (2014a). The critical point that makes users that need to access the cloud services smoothly is mobility support. The proposal of this research is to study the behavior of a mobile cloud computing model in terms of performance to find out the benefits and drawbacks in order to achieve a most appropriate solution for the mobility problem.

We proposed a mobile cloud infrastructure as a service for mobile cloud applications consists of an enterprise cloud in addition to cloudlets that mobile nodes are connected to this cloudlet by WiFi in high bandwidth which we called AMCC (Mohammad et al., 2015). In this paper, we evaluate the proposed new model by simulation. The model enables ad hoc mobile users to exploit cloudlets network over using enterprise cloud to solve the mobility problem by utilising the context aware technique (consumer's mobile devices can sense and monitor their context such as location), in addition to measure the ability of the proposed model to react to the network topology change as ongoing to effectively transport data packets to their destination in terms of data transfer delay, system throughput and system overhead by studying the performance of the proposed model using simulation. We create our own simulator to the experimentation phase in addition to propose a new routing protocol by modifying the destination-sequenced distance-vector (DSDV) ad hoc routing protocol. The cloudlet-based system is being used widely in many applications such as data streaming, sharing and health applications (Quwaider and Jararweh, 2016; Jararweh et al., 2014b; Kostantos et al., 2015). The rest of this paper is organised as follows. Section 2 presents the related work. Section 3 explains and discusses our proposed model for mobile cloud computing. The experimental setup is presented in Section 4. Section 5 discusses the experimental results, and finally, Section 6 concludes by summarising the findings and presenting future research.

II. RELATED WORK

Mobile cloud computing is defined in many ways aspresented in many literatures (Fan et al., 2011; Kovachev et al., 2010; Satyanarayanan et al., 2009). Fan et al. (2011) defines that mobile cloud computing expands cloud computing with mobility through providing the ability ofstoring data and processing services on demand by using a cloud computing platform to the mobile device users. Mobile cloud computing is still in its early stage. So, several problems might be faced when delivering cloud service in mobile environment. Mobile devices native characters resulting in that mobile devices cannot execute complicated applications. In addition, these devices cannot be always online (Kovachev et al., 2010). Various literatures in this field are analysed and taken into account to get more understanding, and by realising their ideas in order to create our own idea. The papers in Jararweh et al. (2013, 2014a), Kovachev et al. (2010), Quwaider and Jararweh (2015) and Bajad et al. (2012) analysed running an application for mobile on a remote resource rich server, while the mobile device acts as a vein of a thin client connecting over to the distant (enterprise) server through 3G (e.g., Facebook's location aware services, Twitter for mobiles). A new approach of mobile cloud computing that utilises mobile devices to act as resources provider is presented in Marinelli (2009) and Fernando et al. (2013). The approach builds up a cloud environment in a peer-to-peer network. Therefore, the shared resources of the various mobile devices locality are utilised by offloading jobs to local mobile resources (Bajad et al., 2012). A cloudlet concept presented in Satyanarayanan et al. (2009), Bajad et al. (2012), Fernando et al. (2013), Guan et al. (2011), Altamimi and Naik (2011), and Quwaider and Jararweh (2013) shows that the mobile device's workload is offloaded to a nearby cloudlet. Each cloudlet consists of a number of multi core computers that would be placed in common regions such as universities and airports so that mobile devices can benefit from the low latency offered by connecting as a thin client to the cloudlet (Jararweh et al., 2013). Hong et al. (2013) explored energy efficiency of mobile devices when transferring data securely over various communication networks including high-speed 4G networks such as LTE and Wibro. Our proposed model is based on the Bench bee speed measurement of Galaxy S2 LTE (Hong et al., 2013) to get parameters for calculating the time need to transmit a file either via WiFi or via 3G.Even though a number of researches in wireless networks (Bajad et al., 2012; Fernando et al., 2013; Altamimi and Naik, 2011) have been done in location management, we want to focus on managing and supporting mobility in mobile cloud computing systems. To achieve this, we need to have proper information about the mobile device to find out the device's recent location, whether it is moving away from or on the way to the range of the cloud. A possible technique could be the infrastructure-based methods that use technology such as Wi-Fi with GPS.

III. MOBILE-BASED CLOUD COMPUTING MODELING

Mobile cloud computing has not been separated from other areas such as application partitioning, peer-to-peer computing and context-aware computing. Mobile cloud computing is still in its early development stages, new mobile applications can be enabled in mobile cloud framework when more resources are available in the mobile device. The problem of supporting unbroken mobility along with ensuring connectivity to the cloud did not work out sufficiently.

3.1 Problem analysis

In the case of connecting to the cloudlet, as shown in Figure 1, the mobile device offloads its workload to a local cloudlet consisting of a number of multi core computers bymeans of association to the enterprise cloud servers (Bajad et al., 2012; Fernando et al., 2013; Altamimi and Naik, 2011). These cloudlets would be located in common areas, such as coffee shops, universities and airports. Mobile device performs as the vein of a thin client connecting over to the distant (enterprise) server through 3G (Jararweh et al., 2013).

Figure 1:Mobiledeviceconnect to a cloudlet

In traditional cloudlet approach, mobile users use the nearest cloudlet that covers limited area to get their requested services such as, storing, processing and content delivery. Cloudlets as shown in Figure 2 act as temporary service servers since they update the nodes states at the end of the communication (when the job is done) to the enterprise cloud resulting in high latency. The cloudlet presented can obtain nearby mobile devices and use for the benefit of the mobile device users who need resources, rich server within the range of server 'cloudlet'. This may help users staying at a coffee shop, waiting at the airport, universities, or in any space within a specific range. But, what about mobile users who need to accomplish their work while on the move?

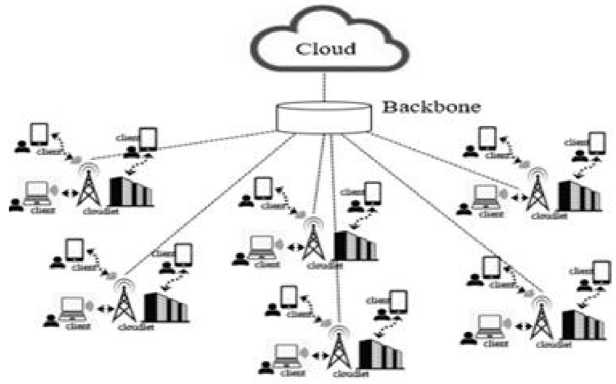

Figure 2: Traditional Cloudlet Architecture.

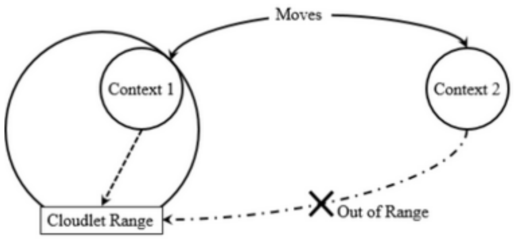

Figure 3: Context Information Changes.

When we have a client with a cloudlet or enterprise cloud, then we talk about one possible movement which is the client movement since both cloudlet and the enterprise cloud are central stable servers. A key point is to monitor the context of current user's location, when the cloudlet's user going out of the range as shown in Figure 3. A connection should be dynamically adapted for the contexts; to keep the job progress while mobile cloud members 'devices move.

3.2 Proposed architecture

We propose a new model for ad hoc network betweencloudlets not between mobile nodes. Since cloudlets process data (jobs) on behalf of user's mobile devices, cloudlets are having the same role; hence, they are peer to each other, and each can establish a connection with any other cloudlet. Figure 4 shows the cloudlets network components that includes the following:

A. An enterprise cloud (3G connection).

Cloudlets in nearby zones connecting to each other in high bandwidth wireless communication (e.g., WiMax). Set of mobile devices (laptops, smart phones, tablets)connecting to a cloudlet in high bandwidth wireless communication (WiFi).

B. Repeaters between cloudlets.

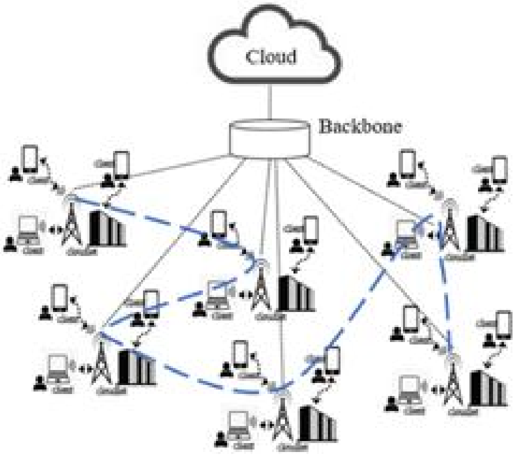

Figure 4: The Proposed cloudlet architecture.

In our framework, several mobile nodes are associated with number of deployed cloudlets. Each mobile node has a job to be processed by a nearby cloudlet. Each cloudlet presents a service(s) for any connected mobile device. The cloudlet network consists of varied set of nodes with diverse tasks; that is because this network is comprised of many mobile nodes each is connected to the cloudlet in its area – with high bandwidth wireless functionality-via wireless links. All the nodes can be mobile except the cloudlets which are fixed. We use the random way point (RWP) mobility mechanism for the movements of the mobile nodes, in addition to a modified version of the DSDV routingprotocol for nodes routing. In the original DSDV protocol, each node in the network maintains a routing table, tags each route with a sequence number, and exchanges the routing information (Broch et al., 1998). In our adaptedDSDV protocol, the cloudlets swap the routing information about the mobiles whereas the mobile nodes utilise the cloudlets as their service provider. In our proposed model, mobile nodes can send or receive data from either the nearby cloudlet or any accessible cloudlets in other zones. In addition, it has the ability to communicate with other mobile nodes in other zones also. So, the source nodes can be the cloudlets or any of the mobile devices as well as the aimed nodes. As presented in CloudTrax (2012), we can trim down the bandwidth to half by each one hop repeater. Hence, by using these repeaters in between cloudlets is apossible solution to make every cloudlet reach thedestination cloudlet in a single hop. If the mobile device arrives to a zone with no cloudlet coverage then the client's job should be delegated to the enterprise cloud server to keep the connection on. Moreover, when the mobile device senses a nearby cloudlet the client's job is delegated to this cloudlet to realise its benefits such as protection, low latency and the bandwidth cost, which is lower in WiFi connection.

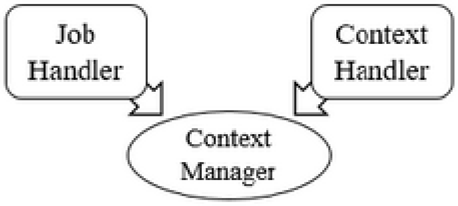

Figure5: Cloudlet server additional components.

3.3 Cloudlet's Additional Components

We assume that in each cloudlet server there are three major components: context handler, job handler, and context manager as in Figure 5. Since we focus on the mobility management issue in mobile cloud computing models, our model is based mainly on the context manager part with respect to other components benefits. Context manager is responsible for sensing and recording contextual information that are used to keep track on client nodes to register. If new devices are joining in or if current devices are moving out of the cloudlet rang.

A. Context handler

- Maintaining connections and communicating with the mobile devices.
- Monitoring potential nodes entering or leaving the coverage area.

B. Job handler

- Partitions the application and data set required into separated subtasks.
- Returns the result of each subtask to the owner of the job or to the destination cloudlet.

C. Context manager

- Keeps track of context parameters such as, device context which includes the environmental and device settings, situational context relating to monitored data on user's location.
- Responsible for the decision making procedure, where it responsible for suitable passing.

To make the right decision, the server must analyse the usercontext in addition to the job at hand. This ability may come from the fact that mobile devices context enabled features, which allow us to determine further information from the computing device itself without any user input in addition to that user interaction methods with the application depend on user's context such as location (Guan et al., 2011). Due to the possible dynamic changes of our proposed network, resulting from the mobile nodes going in/out of range, it is critical for the network architecture to be self-organising. Since consumers' mobile devices can sense and monitor their context, the context information can be helpful. While a job is performed, members associated context can change, then the situation needs to be adapted dynamically. The context information is gathered, and analysed to determine the current situation of the consumer as shown in Figure 6. Then, a most appropriate decision is selected at the stage of adapting, and then the job will be offloaded to the selected server. Moreover, the system can support a reliable information exchange mechanism between the mobile user and the cloud system by adopting the approach presented in Guan et al. (2011) and Al-Said et al. (2015).

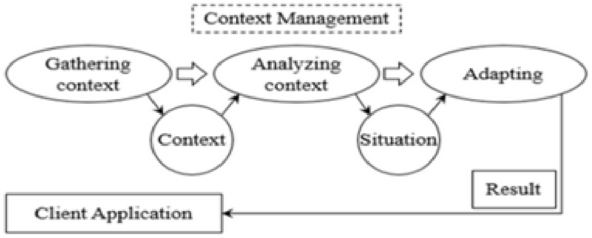

Figure: The Context Management Process and its Phases

IV. EXPERIMENTAL SETUP

The goal of our experiments is to measure the ability of the proposed model with the routing protocol and the movement model to react to network topology change as ongoing to effectively transport data packets to their destinations. Our methodology to measure this ability is to build our own simulator to achieve all the required parameters by modifying the DSDV protocol along with RWP movement model (Broch et al., 1998). We are not concerned about what the packet content is transmitted; rather measure the protocol's performance under particular conditions.

4.1 Mobility model

Nodes in the simulation move according to the RWP model due to its widely used and simplicity (Broch et al., 1998). In this model, each node begins the simulation by remaining immobile for a pause time seconds, then selects a random destination within the simulation area and moves to that destination at a speed between 0 and a maximum speed. When reaching the destination, the node stops for pause time seconds, selects a new point as destination, and repeats the previous steps for the duration of the simulation.

4.2 Routing protocol

Cloudlets in the simulation communicate with each other by a modified routing protocol based on 'DSDV' protocol (Broch et al., 1998). Where, each cloudlet keeps up arouting table recording the next hop for all reachable destinations.

4.3 Routing algorithm

The cloudlet network is composed of cloudlets and mobile nodes. The cloudlets have high bandwidth wireless functionality WiMax where the mobile nodes connected via wireless link (IEEE 802.11g) (Shin et al., 2004). All cloudlets have equivalent responsibilities. So, they are peer to each other and can perform on ad hoc basis. But our adhoc routing algorithm is not purely ad hoc; since the mobile nodes are not involved in the packets routing. Mobile nodes use the cloudlets to be connected, while the cloudlets form peer-to-peer network keep track and perform data computation on behalf of users. To address the mobility problem in how the job under processing can pass to the next cloudlet with respect to the node moving, we propose that each cloudlet has a routing table containing ID(s) of all nodes joined to it, in addition, it has the ID(s) of all reachable cloudlets around it that can communicate, to create a new ad hoc network. In this approach, the mobile wireless users are out of the routing scheme. Cloudlets carryout the routing updates and remain the routing tables. Each cloudlet propagates that it is a cloudlet for other cloudlets by spreading its existence information. This information about this cloudlet is then publicized by other cloudlets who reached this information to the others. Our network has 16 cloudlets then each cloudlet will have a routing table which contains information about 15 other cloudlets. Each cloudlet has a predefined knowledge about all the nodes in the network. Each mobile node gets its own location by global positioning system (GPS), while each cloudlet in the suggested environment that associated with this mobile node records this mobile node and broadcasts its ID to all its adjacent cloudlets. When any user requests to communicate with any one other user, the cloudlet connected to this node using its routing table – will look for the accessible information to the node.

4.4 Environment and parameters

To study the behaviors of our network, we built our own simulator using C#. Our main goal is to build a mobile-based cloud computing model to support the mobile user's movements and keep their under processing jobs on, even if they move from one cloudlet zone to a next one. Our evaluation is based on the simulation of 50 mobile nodes distributed over a square 2,000 × 2,000 meter region for 900 seconds of simulation time along with 16 wireless cloudlets where each cloudlet associated with number of our simulated nodes. The number of cloudlets considered necessary to cover the area depends on the communication range of the cloudlets. In our experiment,

4.5 Metrics

- Average throughput (TP): the number of received bytes in terms of variation of pause time and network load. • Routing overhead (ROH): the total number of control packets transmitted by the protocol during the simulation in terms of variation of pause time and network load. When the packets sent over multiple cloudlets, each transmission of the packet counts as one transmission.
- End-to-end delay (e2e delay): the time of the data file to be successfully transmitted from source to destination. It takes in the entire potential delays such as transfer time and handoff delay. We also measure the worst case scenario in our model when the source is the destination itself. The e2e delay evaluates our model in terms of variation of handoff delay; it should be low for better performance.

V. CONCLUSIONS AND FUTURE WORK

The experimental results show that the proposed model offers a vital solution for supporting the mobility problem in mobile cloud computing. Each node in our simulation can move all around the defined area with continued connectivity during the entire simulation time period. By calculating e2e delay for up to eight cloudlets using several workload sizes, we show that even with higher handoff delay, e2e delay in our model is lower than the time taken by using enterprise cloud mainly for large file size which is the foremost goal of our research.

REFERENCES

[1] Mohammad Al-Rousan, 'Cloudlet-based ad hoc mobile cloud computing: design and evaluation', Int.J.Embedded Systems vol 9, No.5, 2017.

[2] Al-Said, T., Rana, O. and Burnap, P. (2015) 'Vminformant: an instrumented virtual machine to support trustworthy cloud computing', Int. J. High Perform. Comput. Netw., August, Vol. 8, No. 3, pp.222–234.

[3] Altamimi, M. and Naik, K. (2011) 'The concept of a mobile cloud computing to reduce energy cost of smartphones and ICT systems', in Information and Communication on Technology for the Fight against Global Warming, ser. Lecture Notes in Computer Science, Vol. 6868, pp.79–86.

[4] Bajad, R.A., Srivastava, M. and Sinha, A. (2012) 'Survey on mobile cloud computing', International Journal of Engineering Sciences & Emerging Technologies, Vol. 1, No. 2, pp.8–19.

[5] Broch, J., Maltz, D.A., Johnson, D.B., Hu, Y-C. and Jetcheva, J. (1998) 'A performance comparison of multi-hop wireless adhoc network routing protocols', in Proceedings of the 4th Annual ACM/IEEE International Conference on Mobile Computing and Networking, ser. MobiCom '98, ACM, New York, NY, USA, pp.85–97.

[6] CloudTrax (2012) Cloudtrax. A Cloud-Based Network Controller Network Planning Guide, Tech. Rep. Fan, X., Cao, J. and Mao, H. (2011) A Survey of Mobile Cloud Computing, ZTE Corporation Technical Report, No. 1.

[7] Fernando, N., Loke, S.W. and Rahayu, W. (2013) 'Mobile cloud computing: a survey', Future Generation Computer Systems, Vol. 29, No. 1, pp.84–106, including Special Section: AIRCC-NetCoM 2009 and Special Section: Clouds and Service-Oriented Architectures.

[8] Guan, L., Ke, X., Song, M. and Song, J. (2011) 'A survey ofresearch on mobile cloud computing', ACIS International Conference on Computer and Information Science, pp.387–392.

[9] Hong, J-A., Seo, S., Kim, N. and Lee, B-D. (2013) 'A study of secure data transmissions in mobile cloud computing from the energy consumption side', in 2013 International Conference on Information Networking (ICOIN), January, pp.250–255.

[10] Jararweh, Y., Jarrah, M., kharbutli, M., Alshara, Z., Alsaleh, M.N.and Al-Ayyoub, M. (2014a) 'Cloudexp: a comprehensive cloud computing experimental framework', Simulation Modelling Practice and Theory, Vol. 49, pp.180–192.

[11] Jararweh, Y., Tawalbeh, L., Ababneh, F., Khreishah, A. and Dosari, F. (2014b) 'Scalable cloudlet-based mobile computing model', Procedia Computer Science, Vol. 34, pp.434–441.

[12] Jararweh, Y., Tawalbeh, L., Ababneh, F. and Dosari, F. (2013)'Resource efficient mobile computing using cloudlet infrastructure', in 2013 IEEE Ninth International Conference on Mobile Ad-Hoc and Sensor Networks (MSN), December, pp.373–377.

[13] Kostantos, K., Kyriazis, D. and Themistocleous, M. (2015) 'Realtime event management in cloud environments', Int. J. High Perform. Comput. Netw., August, Vol. 8, No. 3, pp.212–221.