Network Behavior Analysis and Resource Consumption Evaluation for Android IM Applications in GPRS

Kai Shuang and Li Ni
State Key Laboratory of Networking and Switching Technology, Beijing University of Posts and Telecommunications, Beijing, China, 100876
Email: shuangk@bupt.edu.cn, nili0702@gmail.com

***Abstract*—2G data service is still an important component in mobile communication system. GPRS network bears a wide variety of data business, especially IM communication business which has a large number of users. QQ, Weixin, Fetion are beyond any doubt the most popular IM applications in the current Mobile Internet applications spectrum. Their wide use led to signaling storm, which drawn the attention of telecom operators and the research community, both interested in knowing IM applications' internal mechanisms, charactering traffic and understanding the applications' network behavior. In this paper, we dissect the network behavior and traffic consumption of QQ, Weixin and Fetion for Android in GPRS. We use a traffic sniffer to get data packets of each application in different scenarios. Furthermore, leveraging on the use of the network protocol analyzer-Wireshark and our knowledge of network communication, we study each application's behavior characteristics. Understanding the characteristics of these applications makes for a better business promotion, a more optimal network resource allocation, a positive guiding significance for business income and resources investment income.**

***Index Terms*—mobile internet, instant messaging, network behavior analysis, traffic model**

I. INTRODUCTION

The success of mobile Internet, the popularity of intelligent terminal, abundant mobile applications led to the rapid development of mobile internet data business [1-3]. For operators, a large number of mobile applications have caused a huge traffic burden, not only the data tsunami, but also a challenge to the future of mobile communication. IM communication applications such as QQ, weixin, Fetion satisfy the users' always online demand, so users can communicate Anytime, Anywhere and Anything. IM applications occupy the main data business and have a large number of users, which cause a great pressure to the mobile networks. 2G data service is still an important component in mobile communication system. The intelligence of mobile terminal and user behavior of various service make the traffic model of 2G data service significant different from the conventional voice service. For instance, China mobile' GPRS network bears a wide variety of data services, especially QQ, weixin, fetion business. Therefore, it is necessary to analyze the network behavior of IM applications and evaluate resource consumption. The description of 2G data service model should be researched according to the characteristics of different services. As for operators, the research makes for network configuration optimization and improving network performance. For users, traffic fee is still sensitive, so our study can help the application provider to promote their business and service [4-6].

At present, the study for mobile Internet applications mainly focused on analyzing the mobile Internet user behavior and some other apps' analysis. This study mainly aims at the Android instant messaging applications' network behavior analysis and research. We select three typical instant-messaging applications (i.e., QQ, weixin and fetion) for our research objects. There are three APNs (i.e., cmnet, cmwap and wifi) we can choose to connect to the Internet. A traffic sniffer (shark for root) is used to get the data packets we need. After getting all the data packets, we analysis these applications' network behavior and establishing the traffic models for each application. The results show that application shows different network behavior and network resource consumption because of itself characteristics and behavior.

II. RELATED WORK

At present, the research for mobile Internet applications mainly concentrates in studying the behavior of users or self-similarity of traffic. But it's difficult to find researches on the study of network behavior for mobile applications.

Data service traffic model is playing more and more important role in many fields of 2G mobile networks such as resource allocation, network optimization and so on. In the past recent years, traffic model of mobile data service has been researched widely. A variety of models of different data services, such as HTTP, WAP, FTP streaming media and Email have been proposed and a lot of literatures been found. However, the research on traffic models of mobile internet applications, especially for 2G mobile networks, is limited.

doi:10.4304/jsw.9.6.1463-1470

Research in [7] mainly studies the QQ self-similarity and traffic model in the 3G network. It selects QQ as the research object and gets the real QQ data from the UMTS network. It puts forward a novel QQ message model through the analysis of the communication mechanism of QQ and QQ packet format. Further study found that the packet data of network traffic flow has self-similarity and long-term dependence characteristics. Research in [8] studies the privacy of mobile social network application design. The research mainly analyzes some SNAs applications' privacy design. It completes the analysis in information obtaining, information building, accessibility and purpose through feedback and control framework.

Research in [9] presented a traffic model of M2M oriented mobile streaming. The video sources are selected according to the requirements of the M2M service aspects and the limitation of the mobile network resources. It is a kind of traffic model of probability density. The distribution of the frame size is heavy-tail. Video streams generated according to this distribution will be self-similar, which will meet the self-similarity feature of VBR video. Fitting results show that the distribution presented in the paper is 0.07% ~ 2% degree, better than the distribution presented in 3GPP specification. The mean frame size of the model is 99% similar to the mean frame size of the video source. It is proved that the traffic model provided in this paper is a model fitted to be used in mobile network for M2M streaming services.

In the paper, we mainly study the network behavior of IM applications for Android smartphones. Finally, we put forward traffic models to evaluate traffic resource consumption. The rest of this paper is organized as follows: Section 3 describes network behavior analysis method. Section 4 analyzes the network behavior and resource consumption for each application. In Section 5, we summarize the final conclusions.

III. Network Behavior Analysis Method

Different users have different habits of business using, but each data business has its own basic operations [10, 11]. For example, mobile phone QQ consists of login, sending message, receiving message, logout and so on. Studying the basic operations of the interaction and data traffic consumption makes for a better understanding of the data service and network behavior.

A. Packet Capture

The detailed steps are as follows:

Firstly, we need to prepare the environment and related tools. We choose three popular IM applications (i.e., QQ2012 (Android) 1.0Build0130, Weixin 4.5 and Fetion V3.1.4) as our research objects, Shark for Root (a software of data capturing for Android) to capture packets, Wireshark for windows to analyze packets and one smartphone with android operating system (i.e., Samsung GT-S5820, Android 2.3.5). Root privileges are needed when using the Shark for Root tool to capturing data packets. There are many ways to get root privileges. We choose the version of the application based on its popularity and downloads. We choose QQ, Weixin and Fetion because of the number of users and usage.

Secondly, select test scenarios and make test cases. The test scenarios are shown in Tab.1.

Thirdly, execute the test cases. When capturing the packets of these applications, keep the packet pure is very important. Each scenario is a capture of a single application, so we must ensure that other applications are closed except for the test object. We can use some network monitoring software to make sure only one application is communicating with the Internet. Also, we can close the uncorrelated applications in the Setting. Three steps to finish packet capture. First, start the shark software. Second, operate the application. Third, stop the shark and save the file. To guarantee the accuracy of our tests, we test at least three times for each scenario and get rid of abnormal packet.

Finally, analyze data packets. After getting the data packets, we use Wireshark-software of data capturing and analysis to perform an analysis. We can find how these applications complete the communication task between client and server, the process between client and servers (maybe more than one servers) for each application in each scenario. According to our analysis, we can build traffic models for each application and evaluate the traffic consumption.

B. Scenarios Selection

TABLE I.

Scenarios lists

Apps	APNs	s1	s2	s3	s4	s5
QQ	cmwap	login	logout	send message	receive message	heartbeat
	cmnet					
	wifi					
Weixin	cmwap	login	logout	send message	receive message	heartbeat
	cmnet					
	wifi					
Fetion	cmwap	login	logout	send message	receive message	heartbeat
	cmnet					
	wifi					

Each application has many functions and features. Each user has his habits of application service using. According to our investigation and human behavior, IM application has five basic common operations, namely login, logout, sending message and receiving message. The greatest feature of the IM application is that it can keep user always online by maintaining HTTP connection. In order to keep HTTP connection, the client must periodically send a heartbeat message to the server. So, it is important to study the heartbeat for IM application. Finally, we choose five typical scenarios for each application, which are shown in Tab.1. In GPRS, there are three APNs, namely cmnet, cmwap and wifi.

The final test scenarios are shown in Tab.1. Table column headings s1 to s5 represent login, logout, sending message, receiving message and heartbeat. Sending message means just sending one piece of message, the packet size depends on the content. So do the receiving message scenario.

IV. Network Behavior & Resource Consumption

A. Network Behavior Analysis

After getting the data packets, we can analyze the behavior of each scenario by using the software-Wireshark. The following are the detailed analysis.

1) QQ behavior analysis

a) Login

Fig. 1 and Fig. 2 show the QQ login process in different APNs. QQ client's IP is private address (i.e., 10.*.*.*), while the QQ server and related servers are public addresses. Login process in cmwap is shown in Fig. 1, establishing a connection between QQ client and QQ server to complete login. The connection will remain for the following interaction. Login process in cmnet and wifi is shown in Fig.2, interacting with four different servers. Compared to the process in cmwap, the process in cmnet/wifi needs to query the DNS server for the IP of pmir.3g.qq.com (i.e., authentication server) and conf.3g.qq.com (i.e., configuration server) to complete authentication and configuration. The number of data packets between QQ client and QQ server is different in cmnet and wifi.

QQ login process in cmnet/wifi is more complicated than that in cmwap.

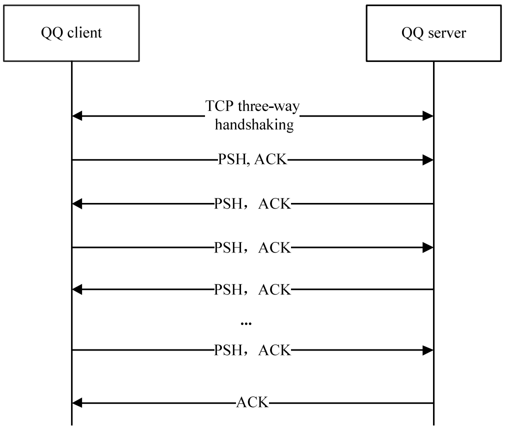

Figure 1. QQ login in cmwap

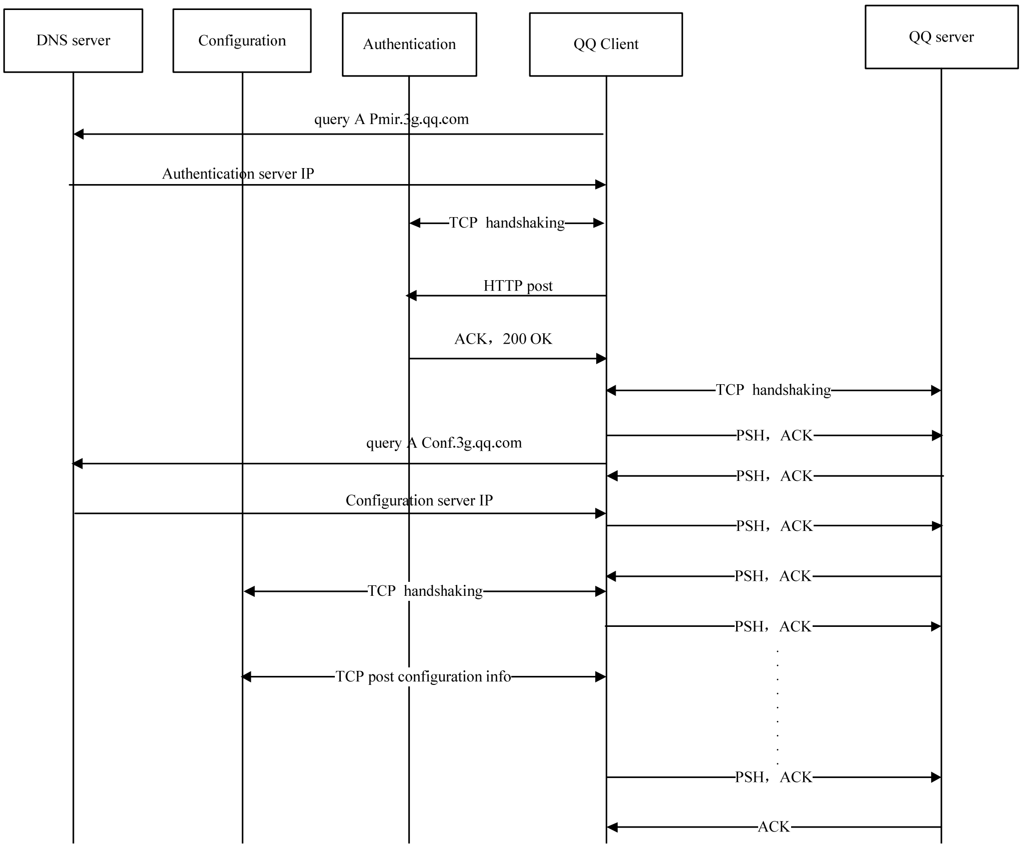

Figure 2. QQ login in cmnet/wifi (the interactive data packets between QQ client and QQ server in wifi is different from that in cmnet)

b) Logout

Fig.3 depicts the QQ logout process in cmwap, two pairs of PSH, ACK/ACK interaction packets before a TCP four times handshake to release the connection between QQ client and QQ server. The process in cmnet/wifi is more complicated as is shown in Fig.4, as QQ client needs to release the connection with configuration server and authentication server

.

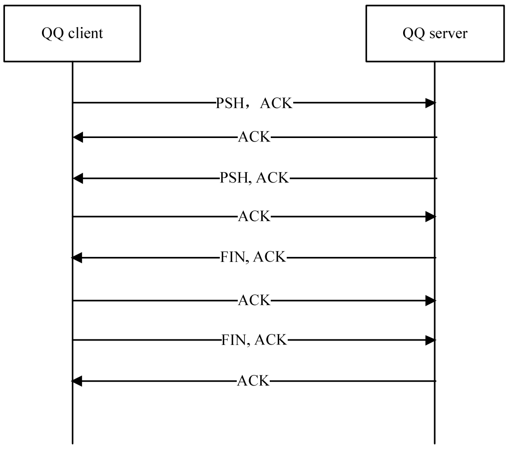

Figure 3. QQ logout in cmwap

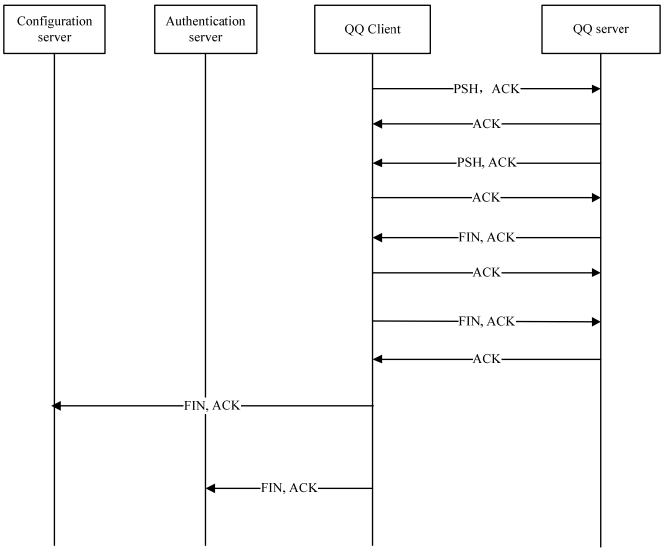

Figure 4. QQ logout in cmnet/wifi

c) Heartbeat

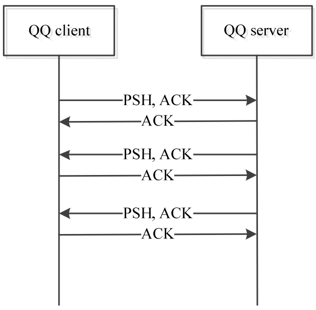

Figure 5. QQ heartbeat in cmwap/cmnet/wifi

Fig. 5 depicts only one QQ heartbeat process, each QQ heartbeat process consumes six data packets. Our test shows the heartbeat cycle is 180 seconds. QQ client sends a heartbeat message to QQ server every 180 seconds to keep the long connection.

d) Sending message

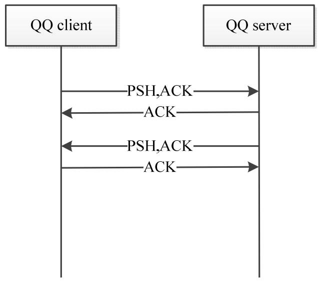

Figure 6. QQ sending message in cmnet /wifi / cmwap

Fig. 6 shows the sending message process in different APNs. Sending message only consumes four packets and no difference in different APNs.

e) Receiving message

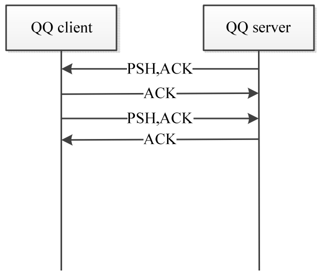

Figure 7. QQ receiving message in cmnet /wifi/cmwap

Fig. 7 depicts receiving message process. All APNs share the same process, which consumes about four packets.

2) Weixin behavior analysis

According to our tests, weixin shares the same process in different APNs.

a) Login

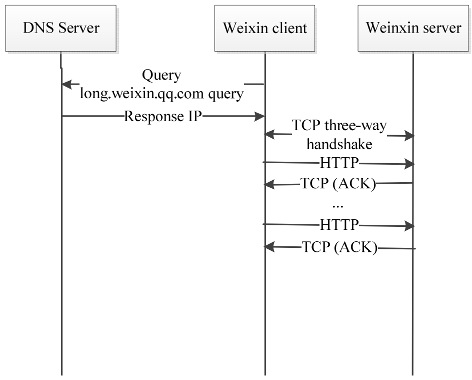

Figure 8. Weixin login in cmnet/cmwap/wifi

Fig. 8 shows that Weixin login process is simple and has no difference in different APNs. First, weixin client sends a DNS query request to DNS server for the IP of long.weixin.qq.com. The DNS server returns a response. The weixin client establishes a TCP connection with the weixin server and completes about six pairs of HTTP/ACK interaction.

b) Sending message

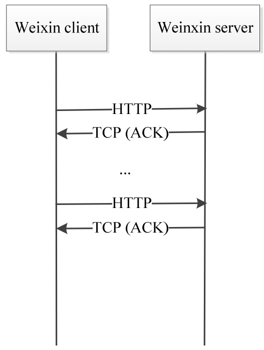

Figure 9. Weixin sending message in cmnet/cmwap/wifi

Sending message is at least six pairs of HTTP/ACK interaction as is shown in Fig. 9. There is no difference in different APNs. The number of packets depends on the length of the sending message, but at least six pairs of HTTP/ACK.

c) Receiving message

Receiving message process is similar to that of sending message. According to our test, receiving message needs to interactive at least four pairs of HTTP/ACK, namely eight packets.

d) Heartbeat

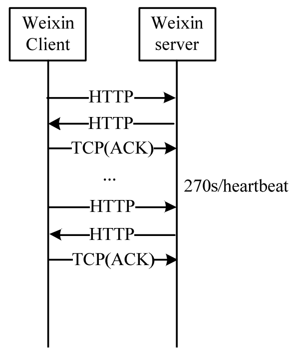

Figure 10. Weixin Heartbeat in cmnet/cmwap/wifi

Fig. 10 shows Weixin heartbeat process. Weixin heartbeat cycle is 270 seconds, each heartbeat consumes three packets.

5) Logout

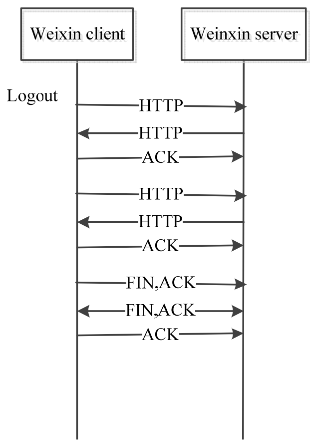

Figure 11. Weixin logout in cmnet/cmwap/wifi

Fig. 11 depicts that four pairs of HTTP/ACK interaction before the TCP four times handshake to release the connection between Weixin client and Weixin server.

3) Fetion behavior analysis

a) Login

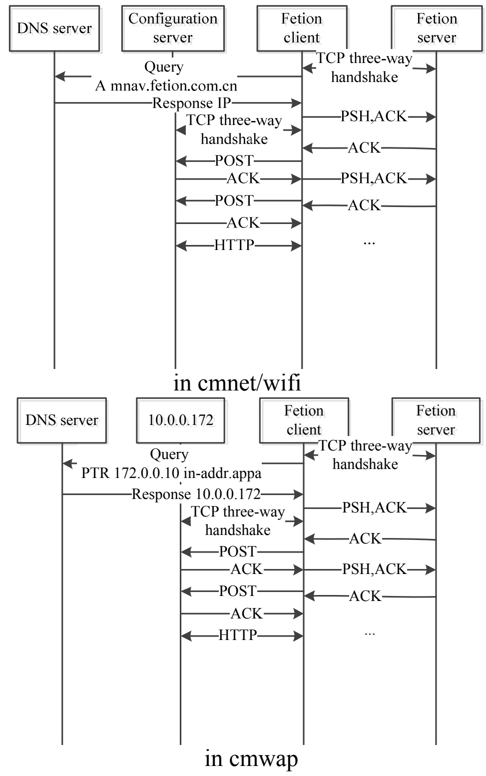

Figure 12. Fetion login in cmnet/wifi and in cmwap

Fig. 12 shows that Fetion login in cmwap is different from that in cmnet/wifi. The WAP gateway (i.e., 10.0.0.172) acts as a proxy of configuration server to complete the configuration. When Fetion client sends a Query request to DNS server, DNS server returns the IP of configuration server in cmwap and wifi instead of a WAP address (i.e., 10.0.0.172) in cmwap. Fetion client establishes a connection with configuration server to complete configuration task (i.e., detecting software update). At the same time, Fetion client establishes a connection with Fetion server to complete login authentication and remains this connection.

b) Sending message

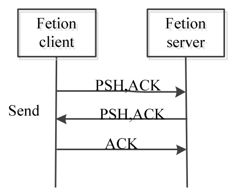

Figure 13. Fetion sending message in cmwap/cmnet/wifi

Fig.13 depicts sending message process, about three packets. Sometimes our test catches four packets. The ACK packet can be carried in the data packet, which saves one ACK.

c) Receiving message

Receiving message process is similar to sending message process.

d) Heartbeat

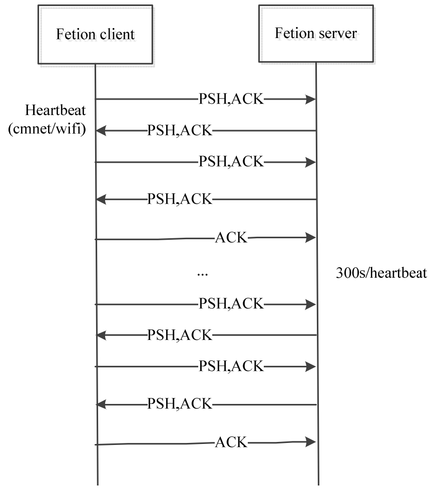

Figure 14. Fetion heartbeat in cmnet/wifi

Fig.14 shows fetion heartbeat process in cmnet and wifi. The heartbeat cycle is 300 seconds, each heartbeat consumes five packets. According to our test, there is no heartbeat in cmwap.

e) Logout

Fetion logout process needs to interactive several packets before a TCP four times handshake to release the connection between Fetion client and Fetion server. In cmnet/wifi, Fetion client also needs to release the connection with authentication. In cmwap, Fetion client needs to release the connection with 10.0.0.172.

B. Resource Consumption Analysis

According to the data packets we collected and leveraging on the Wireshark tool, we build traffic models from two aspects: one aspect is mean packet size (i.e., the total bytes of all packets) and the other is mean packet number (i.e., the number of packets). Traffic models are as follows:

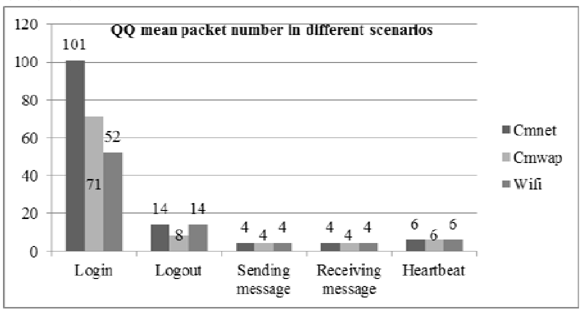

Figure 15. QQ mean packet number in different scenarios

Fig. 15 depicts the average number of packets in different scenario. QQ consists of five basic operations (i.e., login, logout, sending message, receiving message and heartbeat). The packet number of each operation is different.

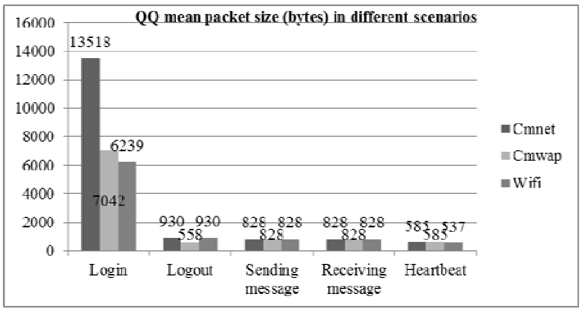

Figure 16. QQ mean packet size (bytes) in different scenarios

Fig. 16 shows QQ mean packet size (bytes) in different scenarios. Sending message consumes more traffic than receiving message. Login process uses more packets and consumes more traffic resource. QQ login and logout in cmnet consumes more resources.

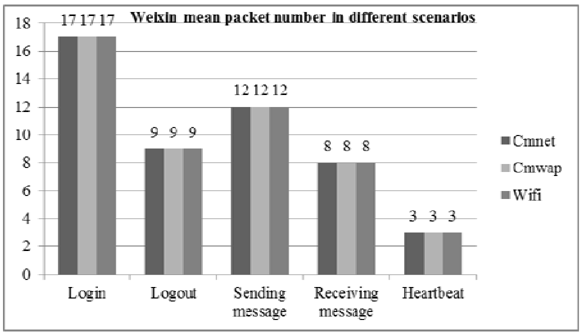

Figure 17. Weixin mean packet number in different scenarios

Weixin resource consumption is shown in Fig. 17. We study five basic Weixin operations (i.e., login, logout, sending message, receiving message and heartbeat). Three APNs are the same for different operations. Weixin login process consumes only 17 packets in all APNs, less than QQ login which consumes about 52 in wifi, 71 in cmwap, 101 in cmnet. Sending message and receiving message for weixin consumes more traffic than that for QQ. Weixin heartbeat interacts three packets while QQ uses six packets and Fetion consumes five packets.

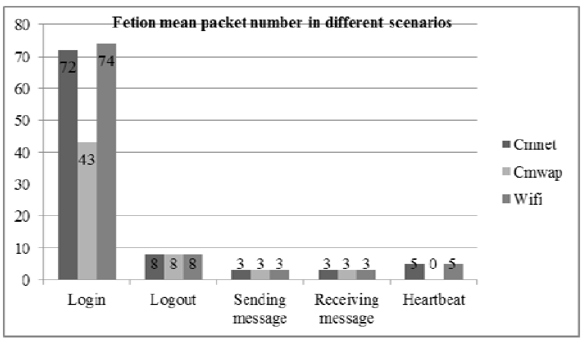

Figure 18. Fetion mean packet number in different scenarios

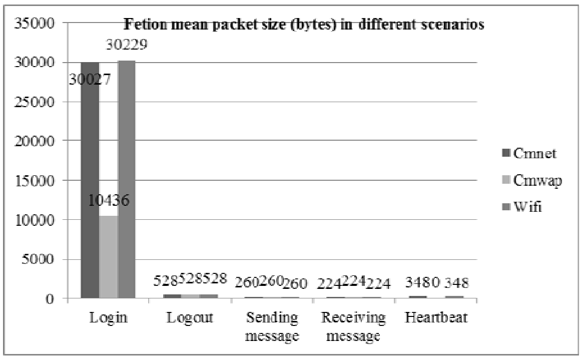

Figure 19. Fetion mean packet size (bytes) in different scenarios

Fig. 18 and Fig.19 depict Fetion resource consumption in different scenarios. Fetion consists of five basic operations. Fetion login consumes the most resources compared to other operations. The number of packets for Fetion login varies in different APNs, about 72 in cmnet, 43 in cmwap, 74 in wifi. The other four operations are the same for different APNs. Fetion has no heartbeat in cmwap. In cmnet/wifi, Fetion heartbeat consumes five packets.

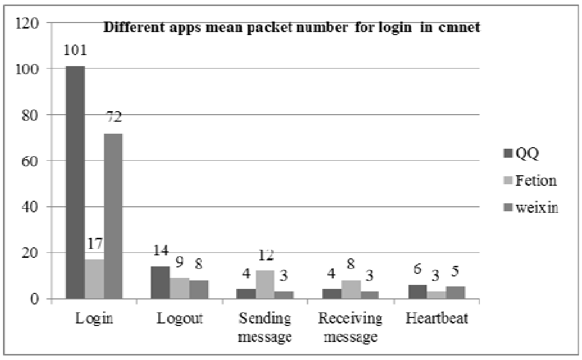

Figure 20. Different apps mean packet number for login in cmnet

Fig. 20 depicts the comparison for different applications (i.e., QQ, Fetion and Weixin). Weixin login process consumes the least traffic, Fetion consumes less traffic than QQ. As for logout process, QQ consumes more resource than Weixin and Fetion. For heartbeat process, QQ is six packets every 180 seconds, Fetion is five packets every 300s, Weixin is three packets every 270 seconds. As for sending message and receiving message, Weixin consumes more packets than QQ and Fetion.

C. Applications Contrastive Analysis

1) Different applications show diverse network behaviors

Login process shows different behavior for different applications in different APNs, which are shown in Fig.1, Fig. 2, Fig. 8, Fig. 12.

Weixin has the simplest network behavior in the login scenario. Fig.8 depicts that Weixin client establishes a connection with Weixin Server and completes login task. Fig.1 and Fig.2 show that QQ login process depends on the APNs. QQ login in cmnet/wifi is more complicated than that in cmwap, not only interacts with QQ server but also communicates with configuration server and authentication server. Fetion login is the most complicated in the three applications, Fetion client interacts with Fetion server and configuration server. Fetion client interacts with WAP proxy (10.0.0.172) to complete the configuration task in cmwap instead of directly communicating with configuration server in cmnet and wifi as are shown in Fig.12.

2) Application has various network behaviors in different APNs

From Fig.1 to Fig.14, we can conclude that Weixin has the same behavior in different APNs. Fetion's login process communicates with WAP proxy to finish configuration, other scenarios directly interact with Fetion server. QQ client interacts with QQ server directly in all APNs except the login process which depends on the APNs.

3) Heartbeat

The client periodically sends a heartbeat message to the app server to keep the HTTP long connection, so the application can be always online. Fig. 20 shows that QQ heartbeat cycle is 180s in cmnet and each time six packets, Weixin's heartbeat cycle is 270 s in cmnet and each time three packets, Fetion's heartbeat cycle is 300 s in cmnet and each time five packets. We can conclude that QQ consumes most traffic resources in the three applications and Weixin uses the least traffic.

V. CONCLUSIONS

This paper concentrates on the network behavior of IM applications (i.e., QQ, Weixin and Fetion) for Android. Our approach is as follows: first, we choose three popular IM applications (i.e., QQ, Weixin and Fetion) as our study objects and make the test plan according to several aspects of the IM applications, considering different APNs (Access Point Name) (i.e., cmnet, cmwap and wifi), different scenarios (i.e., login, logout, sending message and receiving message). Second, we get the data packets by a traffic sniffer (shark for root). Third, leveraging on Wireshark, we analyze the network behavior of different applications. Furthermore, by building traffic models, we evaluate the traffic resource consumption (i.e., packet size, packet numbers) for each application. In the paper, we demonstrate that application shows different network behavior and resource consumption in different APNs. Different applications show diverse network behavior and resource consumption even in the same scenario. Future work should focus on the analysis of new functions (e.g., voice and video communication, etc.).

ACKNOWLEDGMENT

Important national science & technology specific projects: Next-generation broadband wireless mobile communications network (2012ZX03002008-002-03), the Fundamental Research Funds for the Central Universities (2013RC1102), Innovative Research Groups of the National Natural Science Foundation of China (61121061), National Natural Science Foundation under grant 61170274.

REFERENCES

[1] Lina Lan, Xuerong Gou, Yunhan Xie, Meng Wu. "Intelligent GSM Cell Coverage Analysis System Based on GIS". Journal of Computers, Vol 6, No 5 (2011), 897-904, May 2011.

[2] Utpal Paul, Anand Kashyap, Ritesh Maheshwari, and Samir R. Das. "Passive Measurement of Interference in WiFi Networks with Application in Misbehavior Detection". IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 12, NO. 3, MARCH 2013.

[3] Maruti Gupta, Satish C. Jha, Ali T. Koc, and Rath Vannithamby, Intel Corporation. "Energy Impact of Emerging Mobile Internet Applications on LTE Networks: Issues and Solutions". IEEE Communications Magazine, February 2013.

[4] Ke Xu, Meng Shen, Mingjing Ye. "A Model Approach to Estimate Peer-to-Peer Traffic Matrices". IEEE INFOCOM 2011.

[5] Ruo Hu. "Intelligence Analysis and Processing System for Semantic Concept Network Based-on State Identification". Journal of Computers, Vol 8, No 5 (2013), 1315-1320, May 2013.

[6] Jun Tan, Xingshu Chen, Min Du. "An Internet Traffic Identification Approach Based on GA and PSO-SVM". Journal of Computers, Vol 7, No 1 (2012), 19-29, Jan 2012.

[7] He Lu, Cuibo Yu, Xuerong Gou. "Analysis of Traffic Model and Self-similarity for QQ in 3G mobile network". Advanced Intelligence and Awareness Internet (AIAI 2011), 2011 International Conference on. 2011, PP 131-135.

[8] Guanling Chen, Faruq Rahman. "Analyzing Privacy Designs of Mobile Social Networking Applications". 2008 IEEE/IFIP International Conference on Embedded and Ubiquitous Computing.

[9] Rongduo Liu, Dong Rao, Zhenglei Huang, Dacheng Yang. "An Emperical Traffic Model of M2M Mobile Streaming Services". 2012 Fourth International Conference on Multimedia Information Networking and Security.

[10] Wai-xi Liu, Yi-er Yan, Dong Tang, Run-hua Tang. "Self-Similarity and Heavy-Tail of ICMP Traffic". Journal of Computers, Vol 7, No 12 (2012), 2948-2954, Dec 2012.

[11] Shahrokh Nikou, Harry Bouwman. "The Diffusion of Mobile Social Network Service in China: The Role of Habit and Social Influence". 2013 46th Hawaii International Conference on System Sciences.

Kai Shuang was born in Liaoning Province, China, in 1977. He received Ph.D. degree from State Key Laboratory of Networking & Switching Technology at BUPT in 2006. Now, he is a associate professor at BUPT. His current research interests include next generation network technology, mobile internet and cloud computing.

Li Ni was born in Chong Qing City, China, in 1988. She is a master candidate from State Key Laboratory of Networking & Switching Technology at BUPT.