Analysis of Signaling Overhead and Performance Evaluation in Cellular Networks of WeChat Software

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Abstract. The instant communication software such as WeChat, QQ and Fetion becomes popular with the rapid development of mobile terminals and wireless personal communication technology. To refresh the online or offline status of such software, signaling message must be sent every given intervals. However, the signaling message raised by huge number of users will cause severe overhead of mobile networks, which will affect the outage performance of network. In this work, we analyze the signaling overhead caused by such software and evaluate the influence using the system level simulation platform. Results indicate that, the signaling overhead will affect the outage performance when the density of users is great. Practical solution is also raised at the end of our paper.

Keywords: WeChat · Signaling · Overhead · Heartbeat · Wireless network

1 Introduction

The rapid development of wireless communication system has brought varieties of software utilizations, especially when ability of the mobile terminals becomes strong. The network applications could provide flexible functions to users. The instant communication software installed on mobile terminals such as WeChat, QQ and Fetion is a special kind, for such software will send indication message to tag online or offline status through mobile network, which may bring sever traffic load when colony of users are huge.[1]

The indication message of such instant communication software will take up the bandwidth and power resources. When the colony of users is huge, the influence to

[1] We have applied the patent of this work, the application number of Chinese patent is: 201510596158.4.

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network load could not be omitted. The behavior of the signal is like the paging signaling of network management protocol, but the paging signaling is working using the broadcasting channel and the heartbeat signal from such software will take up the traditional data resource.

Researches about traffic load in wireless networks become popular with the rapid development of wireless personal communications. In [1], the author present the scheduling method used in wireless networks, however, the scheduling method do not mention heartbeat signal such as WeChat. In [2] and [3], signaling overhead has been mentioned in wireless networks but no solution has been raised. In [4] and [5], analysis of signaling overhead in such instant message software has been discussed but evaluation of the performance is still blank. In [6], the discussion using such data optimization technology has been discussed.

In this paper, we mainly focus on the discussion and solution to the traffic load using such instant message software. The rest of this paper is organized as follows: in Sect. 2, we discuss the signaling overhead of the heartbeat signal and a comparison has been discussed; in Sect. 3, the performance evaluation under our system level simulation platform has been given; in Sect. 4, conclusion is also given in this part.

2 Signaling Overhead

To evaluate the signaling overhead of the application layer, the process must be discussed. Traditional signaling information to indicate online or offline status of cell phone is called paging signal, which will occupy specified physical channel. In such channels, the message will not take up the bandwidth of data transmission but collide the public resource.

Take WCDMA system as example. When the system want to confirm the online or offline status of a phone, paging signaling will be sent to detect the status.

In Fig. 1, we illustrate the two possible condition of paging request in WCDMA system. The Radio Network Controller (RNC) will decide the online or offline status every 180 s at least, so the downlink status request will be sent to NodeB immediately. The NodeB will then broadcast a paging request to users located at its range. If the cell phone is online, it will reply to NodeB with an acknowledgement to indicate the fact that' I have received your request and I am still alive'. So the NodeB will tag the status and report to RNC. When the cell phone is offline, there are two possible conditions: when the cell phone is out of service, it will not reply to the paging request[2] and a time out status will be indicated when the request exceed the maximum times, then the system will decide the offline status of given cell phone and tag inactive status in system register; the other condition is that the user report the offline status by itself[3], and the NodeB will report this event to controller.

[2] This condition appear when the signal is weak, e.g. when the user is moving into an area without wireless coverage.

[3] This condition appear when the user will shut down without any outer command.

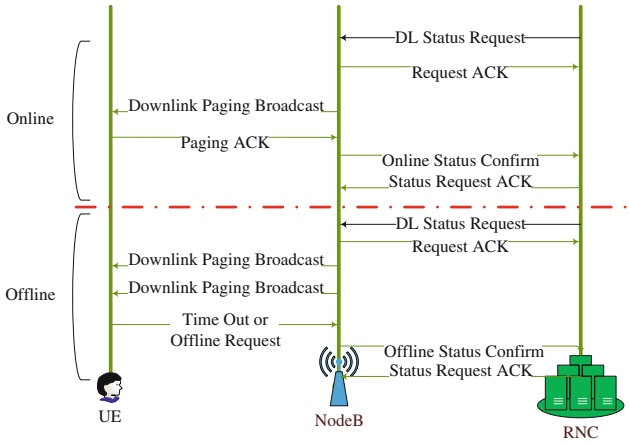

Fig. 1. Process of paging signaling with two possible status.

The paging signaling will not occupy system private resources but only public channel, so the influence has been taken into account and will not affect the system capacity when the amount of user increase under a controllable state. However, heartbeat signal from software is quite different and will affect system performance if the behavior is not controlled.

In Fig. 2, we illustrate the control of online or offline status of the system. It is clear that the application layer is a virtual layer and do not have the entity, so we use the dashed line to express the function layer of WeChat software. In this scenario, the status request is sent by Tencent server, which is a data traffic in wireless networks, so the data with status request information is a heartbeat signal, generally speaking, this information is usually 4bit or less, but it will cost a whole frame to deal with it. When the user receive the information from the target NodeB, reply information to indicate the online status of the application layer is sent using the uplink directly to Tencent server. If the software is offline, the process is quite different from the paging signaling. The downlink data will be sent from NodeB to user under the condition that the user is online in wireless systems, if the software is off, it will not reply to the downlink data in application layer, unless the positive offline request is sent when the application is on. In application layer, the unexpected time out will be detected at the side of Tencent server and then the status of the terminal is marked offline in given application layer.

To conclude, the difference between paging and heartbeat signal generated by application is the resources occupied by signal. The paging signal will take up the dedicated channel and do not affect the data transmission, on the contrary, the heartbeat signal is included in data traffic and worked in application layer, so the lower layer will only consider the heartbeat signal as a common short data traffic. When the number of users increase, the influence to data transmission will become heavy significantly, which may cause the increasing of outage probability.

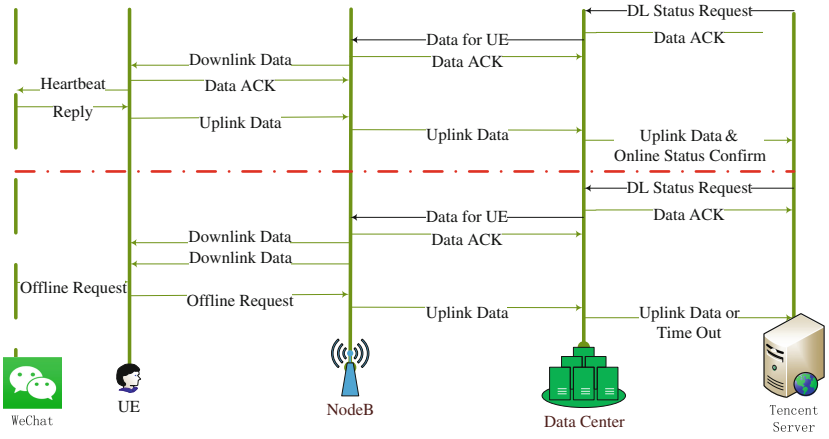

Fig. 2. Process of software on-off with two possible conditions.

3 Performance Evaluation

In this part, a performance evaluation under the system level simulation platform has been given. The system level simulation is close to the real scenario of wireless networks with the support of channel, movement, transmission, scheduling, HARQ, system level to link level mapping and graphic UI model. Simulation parameters and assumptions are given in the following table (Table 1).

Table 1. Simulation parameters and assumptions [7]

Name	Parameter
Cell layout	7 Cell/21 Sector
Radius of cell	100 m
Transmission bandwidth	20 MHz
BS Antenna (DL TX)	4
BS Tx power	6.3 w
Max re-transmission time	4
Carrier frequency	2.1 GHz
Channel model	SCME Dense Urban
Pathloss	L = 128.1 + 20.4log10 (R)
Shadowing Std	4 dB
Noise power	-107 dBm
Simulation TTIs	2000
User number	10 per cell and 100 per cell
Target BLER	0.1

We take the 7 cell scenario as an example. Each cell has three 120° sectors and the radius of the cell is 100 m. In LTE related systems, the small cell has been considered as the future base station with lower transmission power and smaller coverage. So the 20 MHz bandwidth resource and 4 downlink transmission antennas have been taken into account. The maximum transmission power is 6.3 w (38 dBm) for small cell or pico cell according to [8].

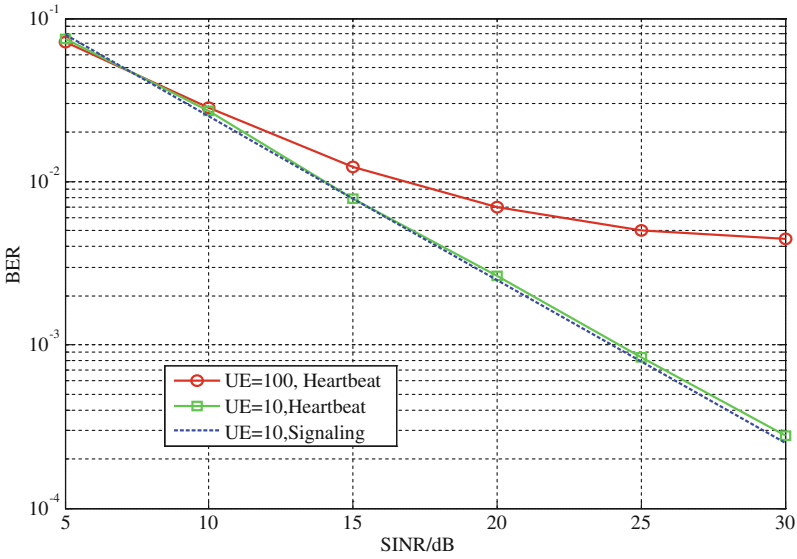

Fig. 3. SINR performance of paging and heartbeat signal with different users (Color figure online)

Figure 3 is the result of SINR versus BER for different kinds of signals. The x-axis means the SINR in dB and the y-axis means the bit error rate calculated using the simulation platform. The green curve is the SINR-BER performance of heartbeat signal with the average user number 10 per cell, the blue dashed line is the performance of paging signaling. It is clear that the performance is similar when the number of users is small, that is because the heartbeat signal will occupy the data resource. If the number of users is small, it will not affect the system performance significantly, that is why the green curve is a little bit higher than the blue one. But when the number of users is huge as is shown in the red curve, the performance will be affected greatly. Even when the SINR increase, the BER is decreasing slowly and levelled off, it is because the huge number of users will occupy the bandwidth resource used for data transmission, which will affect the common transmission because the resource for transmission will be insufficient. This result demonstrate that, the utilization of instant communication software will affect the system performance when the number of users increase, this effect is clear in resident area or working area when users are requiring such service [9].

4 Conclusion

To conclude, in this paper, we discuss the fact that the heartbeat signal from instant communication software will affect the system performance. The contribution of this paper could be summarized as follows:

1. We analyze the process of physical paging using dedicated channel and heartbeat signal using data frame, both advantage and dis-advantage have been discussed through the theoretical analysis;

2. We evaluate the system performance under the LTE system level simulation platform. Result indicates that, when the number of users is small, the influence is not clear and when it grows, the heartbeat signal will greatly affect the system performance;

There is also problem for further discussion, e.g. the complete process of cross layer sharing and the mathematical discussion of such problems, we will make further discussion in related journals.

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