Modeling M-SaaS Delivery Model for Threshold-based Credit Recharging Using M-banking

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Abstract - The emerging of cloud computing has brought about new hope for efficient adoption and use of computer-based information system. Software as a Service (SaaS) allows online customers to use applications on the Internet on a pay-as-you-go basis without investing in new infrastructure or software license. However, current SaaS delivery model bring challenge to online customers in community with poor financial services like online bank-transaction or credit cards. *T*his study proposes Mobile-SaaS delivery model to facilitate online charging and credit-recharging mechanisms for SaaS application. The model use mobile-phone monetary services (M-banking) to support online charging, and adopts threshold-based credit recharge technique to support credit recharging.

Keywords-software as a service (SaaS), mobile network, M-banking, online recharging.

I. INTRODUCTION

Software as a Service (SaaS) is a software distribution model where customer access shared application in a pay-as-you-go manner [1]. However, quality of experience (QoE) of SaaS faces challenge in community whose potential customers do not have access to financial services, like credit-cards, to support timely account recharging [2].

Mobile-phone monetary service (M-banking) has transformed the way people in developing world transfer money [3]. M-banking supports branchless monetary service whereby customer can pay utility bills through mobile-phone network without a need to visit utility-company's office [4]. As M-banking becomes a de-facto monetary service to entrepreneurs in developing economy [5, 6], its sophistication and trustfulness can be integrated into online payment of SaaS to facilitate participation of those with poor financial service.

This study considers roles of mobile network operators (MNOs) to facilitate online credit recharge for QoE of SaaS in developing economy. The paper proposes mobile-SaaS delivery model to facilitate online recharging through M-banking service. The study adopts threshold-based recharge mechanism in [7] to determine time when recharging process should be triggered. The paper organized such that section II gives an insight of useful components of MNO in online charging and recharging processes. Section III gives description of M-banking service in utility bill payment. The paper elaborates design of mobile SaaS (M-SaaS) delivery model and how the model integrated with M-banking in section IV, and concludes in section V.

II. ONLINE CHARGING IN MNOs

MNO supports data access to mobile-phone clients through data-core network infrastructure shown in figure 1. The MNO manages and monitors real-time charging by associating components such as charging trigger function (CTF), online charging system (OCS) and recharging server [8][9].

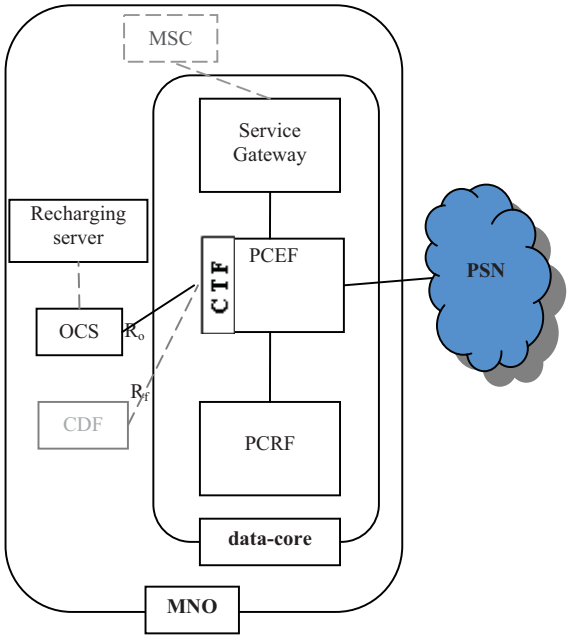

Figure 1. MNO data access support components

Policy and charging enforcement function (PCEF), a gateway entiry to packet switch network (PSN), enforces charging and QoS rules in coraboration with policy and charging rules function (PCRF). Once PCEF receives session establishment request, it uses charging trigger function (CTF) to create charging event (CE) and send it to OCS through R_o interface. The Session Based Charging Function (SBCF) associates 3rd Party auxiliary tariff

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function and Account Balance Management Function (ABMF) component in OCS to determine the value of credit that should be deducted from customer account for the session [8]. OCS returns event acknowledgement (EA), contains pricing and charging control (PCC) rules, to CTF of PCEF that determine whether permission to establish session is granted or denied based on charging policy.

The charging processes recur every time CTF triggers for credit deduction for new session, and whenever notice for insufficient credits the in-progress session would forced terminated. Our study integrates MNO's online charging processes and M-banking service to automate recharging of credit before termination of in-progress session.

III. MOBILE PHONE MONETARY SERVICE

Mobile-phone monetary service (M-banking) built on credit push-and-pull concept where customer could to-up credits into M-banking account for future transaction e.g. bills payment [5]. The security behind M-banking concept relies on already established trust relationships between customers and MNO.

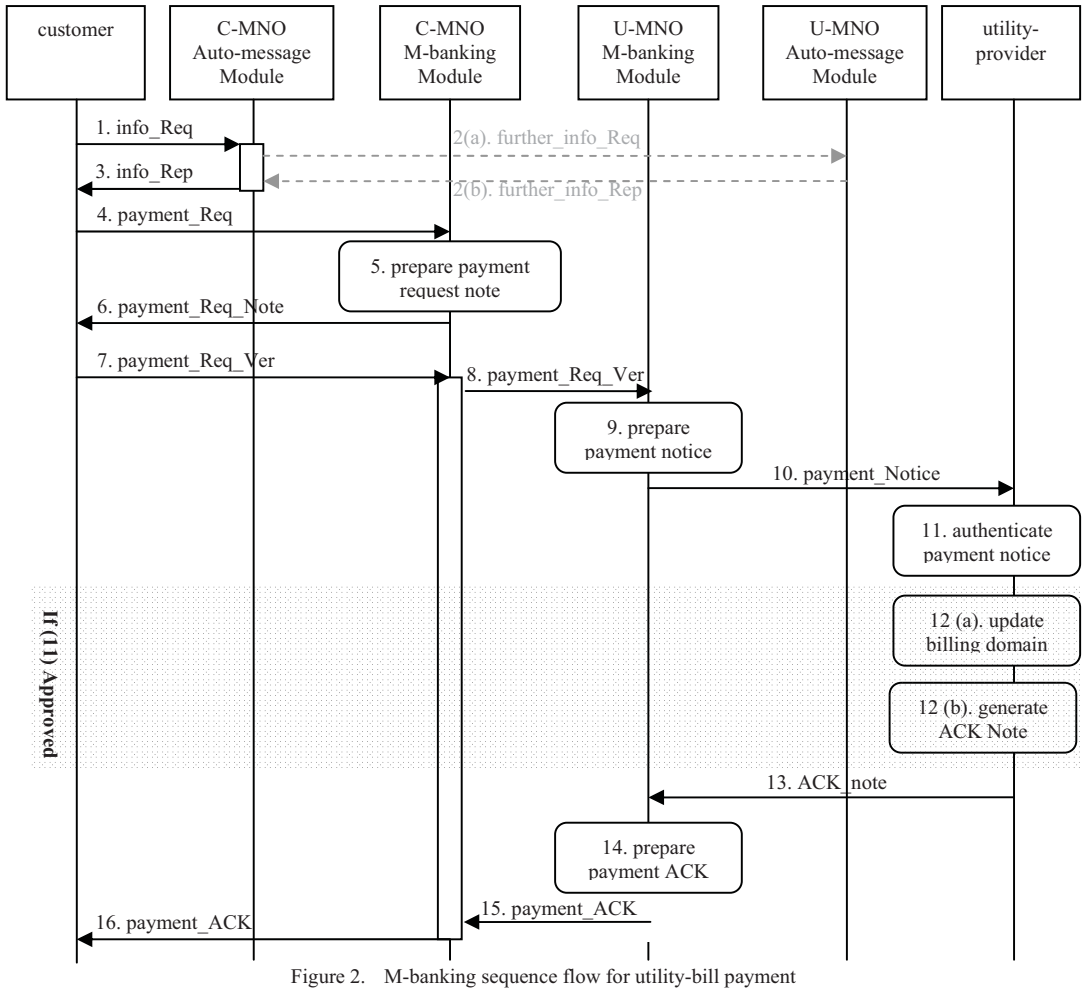

Figure 2. M-banking sequence flow for utility-bill payment

Prior to use M-banking services, a customer must register to M-banking module in respective MNO. The customer's MNO, referred here as C-MNO, creates and configure customer account in M-banking module. On the other hand, utility-provider's MNO, referred here as U-MNO, configures M-banking module with service identification information and sets unique payment number as reference point for bill-payment transaction. Figure 2 shows sequence diagram of bill payment through M- banking. Below are elaborations of steps denoted by numbers in sequences flow of figure 2:

Step 1. customer sends request for information about utility payment to auto-message module of C-MNO.

Step 2. the auto-message module can forward an inquiry to respective U-MNO if doesn't possess required information

Step 3. Auto-message module of C-MNO sends reply by indicates necessary transaction details about utility-provider.

Step 4. Customer combines transaction details with his identification and send payment request to C-MNO.

Step 5. C-MNO consults customer's account to verify availability of necessary funds and then prepares standard payment request note (PRN).

Step 6. C-MNO sends back PRN to customer for verification and authorization.

Step 7. Customer authorize PRN with verification code (e.g. PIN) and then send to C-MNO.

Step 8. C-MNO sends the authenticated PRN to U-MNO.

Step 9. U-MNO extract customer details and other necessary payment details from PRN then prepares standard payment notice (PN).

Step 10. U-MNO forward PN to utility-provide's M-banking aware module.

Step 11. The module authenticates PN and then notifies billing-aware module of utility-provider.

Step 12. (a) billing-aware module updates billing domain, and 12(b) generates payment acknowledge note (ACK note).

Step 13. ACK note includes payment authorized code and customer identity returned to U-MNO.

Step 14. U-MNO prepares payment acknowledgement (P-ACK) from ACK note in a secured format.

Step 15. U-MNO sends the P-ACK to C-MNO, which updates customer's account.

Step 16. C-MNO notifies customer with authorization code that used to get access permission to utility services.

IV. M-SAAS DELIVERY MODEL

A. Need for Independent Mediator

A participant of SaaS model can be application user (app-user), application provider (app-provider) or utility-provider. In some cases a participant can play multiple roles such as both utility-user and utility-provider as shown in figure 3 [1].

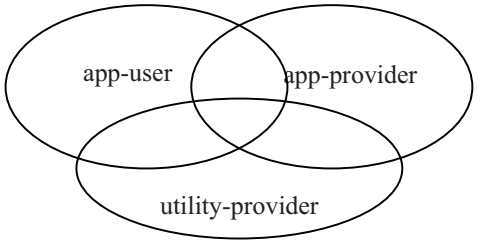

Figure 3: Roles of Participants in SaaS

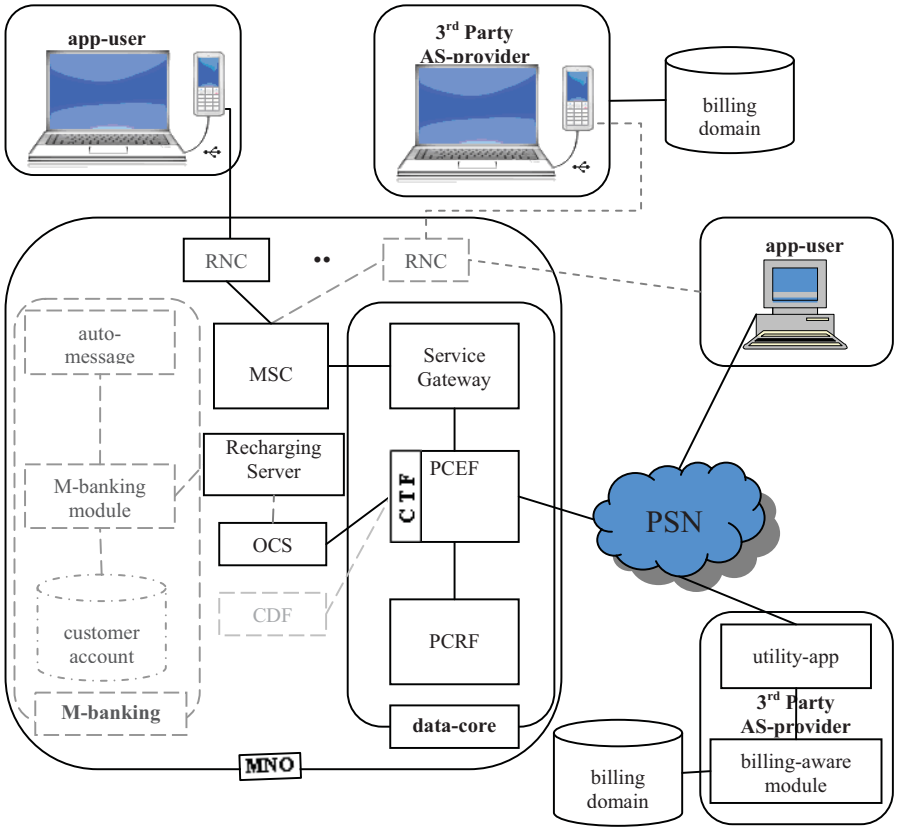

Figure 4. Enhanced model for SaaS in underdeveloped economy

The role of utility-provider is to ensure that application is available to all app-users on-demand in pay-as-you-go bases. Due to this roles, Jordi Guitart et al. in [10] suggests utility-provider to be an independent trusted mediator for substantial benefits between app-user and app-provider as well as to creates a level play field in conflict resolution.

B. Design of M-SaaS Model

Considering de-facto status of M-banking monetary services in developing economy; we argue that the trustfully relation exists between MNOs and customers make possible for MNO to facilitate online charging settlement for SaaS provision.

This study propose interface between recharging server and M-banking module in MNOs networks, based on principal identified in [11], so that SaaS customers and provider could associate their accounts to facilitate smooth online charging transaction and credit recharging process.

As depicted in figure 4, the components and roles of each component of OCS are as described in section 5 of [11]. Figure 5 shows a sequence diagram elaborates message flow of credit request procedures in following steps:

Step 1. To enable M-SaaS recharging model, customer initially associate pre-paid account in recharging server (RS) with his M-banking account by sending association request.

Step 2. For verification, RS notify M-banking module, which could be located in local or foreign MNO.

Step 3. The M-banking module send request to customer to approve originality of association request

Step 4. Customer approve association by return association approval that includes verification code (e.g. PIN code)

Step 5. After successful verification, M-banking module must send association code to both customer and recharging server for the two to run association authentication (AA).

Step 6. Recharging server sends AA request, which involves an inquiry of association code, to customer.

Step 7. Customer responds by provide his association code obtained from M-banking module. If the code matches then the triangular trusteeship is confirmed.

Step 8. while session is in-progress, ABMF periodically grant equivalent credit to SBCF to pay for an inquiry made from Auxiliary Advice of Charge Function (AACF) of 3rd party ASP.

Step 9. if SBCF determine insufficient credit or a balance below threshold then SBCF should initiate credit recharging procedure in manner similar to [7].

Step 10. First, SBCF requests whether association between recharging server and M-banking account exists.

Step 11. The server responds with association response.

Step 12. If association exists SBCF instruct ABMF using customized charge advice information (C-CAI), which would be forwarded to recharging server.
Step 13. Recharging server prepares recharge advice
Step 14. The recharging server sends different version of recharge advice to M-banking module and customer aimed to trigger automatic recharge process.
Step 15. The advice let customer initiates recharging procedures interacting with M-banking module in sequences similar to step 1 to step 7 of section III (depicted in sequence flow of figure 2).
Step 16. after user verification (e.g. provision of valid PIN) M-banking module top-up customer account in recharging server as specified by customer in step 15
Step 17. M-banking module sends recharge acknowledgement (recharge_ACK) to customer.
Step 18. Recharging server update ABMF with new balance of credits.

V. CONCLUSION

There are significant numbers of studies concerning online recharging of mobile network services. This paper complements those studies to propose a new idea of online credit recharge mechanism using M-banking account. The recharge mechanism is internally triggered by SBCF whenever account balance fall below threshold and may lead to force termination of in-progress session.

Our paper introduces virtual interface between recharging server and M-banking module of mobile networks through triangular association. The association is build on mutual trusteeship agreed between user equipment (i.e. customer), M-banking account and pre-paid credit account in recharging server.

Our next study concerns to design an analytical model to measure performance of this model. The challenge is to determine optimal session duration because credit requests from AACF are periodically transmitted based on session intervals.

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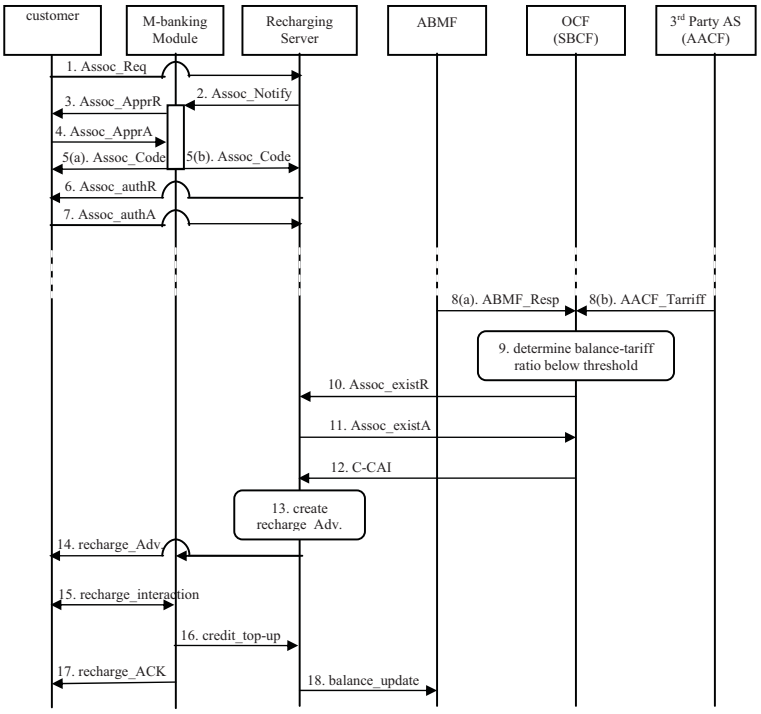

Figure 5. M-SaaS Online Credit Recharge Using M-banking Account