Chapter 6
Sustainable Connectivity Management via e-SIM Multi Licence-Based Billing

Atul Narain, Pratibha Garg, and Dilshad Ahmad Ansari

Abstract This paper talks about e-SIM as a software module being used under a licencing model similar to current practices of Software Licencing. The paper talks on the sustainable model of switching to e-SIM and doing away with paper-based physical SIM especially in IoT industry. And the paper talks about how billing would be done in such a scenario of a single profile being used concurrently on multiple devices/subscriptions in different ways. The conventional one-to-one relationship between a device and its associated service profile is broken to allow for plural/concurrent service profiles to be activated and billed for use in connection with a single user profile. A separate billing identification is maintained for each service profile in order to allow for billing of concurrent usage across devices. This would enable concurrent billing across multiple devices having the same IMSI but different IMEI and eUICC ID. The Billing would be based on the combination of several parameters like—number of simultaneous devices that are active, type of device on which the profile is active (based on IMEI) and type of profile being used actively on the device. The selection of a certain profile to be active is made through a combination of IMEI, eUICC ID, and the service profile, which will enable unique billing for concurrent usage of a single user profile on multiple devices while still maintaining the device specific usage statistics.

Keywords eSIM · Billing · eUICC ID · Multi device provisioning

1 Introduction

Today when we buy any software, it comes with licence binding which can be of any of the below types. An enterprise or an individual buying a piece of software would have the flexibility to choose from any of these licencing model.

A. Narain · P. Garg (✉)
Amity School of Business, Amity University, Uttar Pradesh, Noida, India
e-mail: pgarg1@amity.edu

D. A. Ansari
A.I.D.C, Department of Commerce, Associated Lucknow University, lucknow, India

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On the contrary when we look at telecom industry today, although the user has the flexibility to buy a bill plan, however, he is restricted with a single physical SIM card to use at a time in a mobile handset. For use of multiple numbers, either a mobile handset has to support multiple SIM cards (which today is limited to maximum 2 in almost all of handsets) or the user has to do the tedious activity of changing the SIM cards every time.

The projections for IoT/M2M suggest 50 Billion connected devices in the network by 2020 and there is a need for the businesses to design and understand the impact that IoT solutions will have on integrating them into the Business Support Systems.

Now considering the evolution and rise in IoT devices, this current mechanism of physical SIM card management is a nightmare. Today mostly physical SIM is used in devices. There is an option to move towards software-based SIM called e-SIM going ahead in devices. Unlike physical SIM, an e-SIM can have multiple profiles saved in it and at any given time one of the desired profiles can be activated. If an e-SIM is used today it can be used with multiple devices with the service profile that is pre-configured in the HLR against the IMSI and MSISDN. The billing system is configured to process and bill according to the active plan associated with the MSISDN (Koshy and Rao 2018).

This paper explores the conceptual model of introducing the current Software licencing models in provisioning of e-SIM and providing the same for enterprises for the management of their IoT devices. Using an e-SIM is a great example of sustainable data consumption. Compared to cell phones SIM cards, e-SIM cards are more durable and can withstand adverse weather conditions. Some of the current Software licencing models are:

i. **Subscription Software Licence**

An individual or an enterprise can subscriber to a service and get a licence to use the service based on a certain periodic frequency e.g., each month or annual regardless of the use. The subscription is billed as per the frequency opted for. Software as a Service which is billed at a particular frequency is a subscription-based licence. It is one of the most popular approaches to software licences today. With the technology advancement, more and more of services are moving towards cloud hosted platform and subscription-based licencing is primarily available for these cloud hosted applications and services. It is easier to manage and record usage of an application or service and bill accordingly over a cloud hosted environment. Subscription-based licencing enables recurring revenue for service and application providers and as such is a preferred mode for them.

In an analogy to Telecom setup, the service providers are the hosted environment which can provide the e-SIM under subscription model and that would in return establish the recurring revenue stream.

ii. **Perpetual Software Licence**

Buy once and use as much and as long as one wish. The perpetual licence enables a user to use the application or the service forever. Traditionally before cloud hosted environments, application and service providers had only perpetual licencing model

only where applications were installed on-premise. Today and enterprise, which has a very large base of employee or software users, prefer to use perpetual licence model, so not to incur an operational recurring cost but rather incur a onetime capital expense to the requirement.

iii. **Consumption or Pay-Per-Use Software Licence**

Internet usage charging is a very relevant example for Consumption or Pay-Per-Use Software licence. It is a licencing model where an enterprise or a user is billed based on the amount of the usage or the number or instances of usage of an application or service. Smaller enterprises may not be able to afford very expensive software's or any organization may not have a consistent need for software usage. As such, paying for how much and what they use is a very convenient model for them, rather than investing on buying expensive applications. On the other hand, software providers tend to move away from this model and rely more of subscription-based mode, as the subscription-based model tends to provide a more recurring and stable revenue. However, for users or enterprises to ger a taste of or an experience of the application or service, the enterprises may still provide this as one-time trial option (Leh 2014).

iv. **Node Locked Licence**

Sometimes the application providers link the application or software to the device on which it is being used. As such in Node Locked Licence as the name suggests, the user is bound to use the application or software on a particular device only.

v. **Floating Licence**

Contrary to Node Locked, if there are multiple devices, the floating licence types enable the application or software use on any of the devices as long as the overall limitation of usage is not exceeded. Each licence can be used on any machine in the network, and when one machine stops using it, it can release the licence to be used by any other device. It is usually controlled by how many licences can run concurrently in a network at any given point of time (Gull and Wehrmann 2009).

Smart Cities, IoT, and other aspects have created the need today for enterprises to manage and provision large number of devices in their network via SIM modules for connectivity via Voice, SMS, and Data. Some of the examples of such cases are below:

- Smart City: An enterprise managing multitude of cameras, AC's, access points, etc.in a building via SIM modules
- Enterprise: Managing inventory and logistics of goods movement
- Enterprise providing Services: A typical example is car manufacturers who need connectivity to vehicles to record and manage car performances etc.
- Smart Farming: Multitude of sensors connected with SIM to network providing data related to soil, weather, temperature, humidity, etc. (Stålbrand 2017).

The paper discusses in detail the conceptual architecture of how a service provider can leverage and use the licencing models for extending provisioning and billing services towards enterprises for their multi SIM requirements (Provisioning 2018).

2 Technical Background

Today mostly physical SIM is used in devices. There is an option to move towards software-based SIM called e-SIM going ahead in devices. Unlike physical SIM, an e-SIM can have multiple profiles saved in it and at any given time one of the desired profiles can be activated. If an e-SIM is used today it can be used with multiple devices with the service profile that is pre-configured in the HLR against the IMSI and MSISDN. The billing system is configured to process and bill according to the active plan associated with the MSISDN.

In the current scenario there is limitation of one-to-one relationship between each profile on the e-SIM and the associated bill plan in the billing system against the profile. This implies that all profiles in the e-SIM are mostly provisioned in the HLR and the Billing and network systems as well and only one of them will be active at any given time.

Also todays system do not differentiate between a normal telecom subscriber and a machine. There is a need to provision and bill based on subscriber categorization e.g., IoT, M2M, Normal User, Enterprise, Critical Services, etc., which would become more of reality with the upcoming 5G network.

The conventional one-to-one relationship between a device and its associated service profile is broken to allow for plural/concurrent service profiles to be activated and billed for use in connection with a single user profile. A separate billing identification is maintained for each service profile in order to allow for billing of concurrent usage across devices. The present paper talks about eSIM as a software module being used under a licencing model similar to current practices of Software Licencing. The paper talks about how billing would be done in such a scenario of single profile being used concurrently on multiple devices/subscriptions in different ways. This would enable concurrent billing across multiple devices having the same IMSI but different IMEI and eUICC ID.

The Billing would be based on the combination of several parameters like—number of simultaneous devices that are active, type of device on which the profile is active (based on IMEI) and type of profile being used actively on the device. The selection of a certain profile to be active is made through a combination of IMEI, eUICC ID, and the service profile, which will enable unique billing for concurrent usage of a single user profile on multiple devices while still maintaining the device specific usage statistics.

Advantages of the proposed solution

The advantages of the stated approach span across different segments—customer or End User, Telecom Service Provider & M2M Service Provider. Advantages for each of them are stated below:

Customer: Assuming a customer owns multiple connections (e.g multiple devices) which can an end user, Enterprise, or an IoT scenario.

- The solution approach would enable the end user to have only a single user profile and activate service profiles in the device of his choice at any given point of time.
- Seamless portability of profiles across devices based on need, location, etc.
- Single Bill generation and single profile maintenance.
- Choice of expansion with licencing at any given time.
- No physical inventory of SIM or damage control.
- Ability of play around with multiple profiles from different Telecom Service Provider enabled on same e-SIM.
- Self-Care Management.

Telecom Service Provider: Assuming TSP is providing multiple service profiles against a given user profile for bulk/multi usage across devices (Abdou 2019).

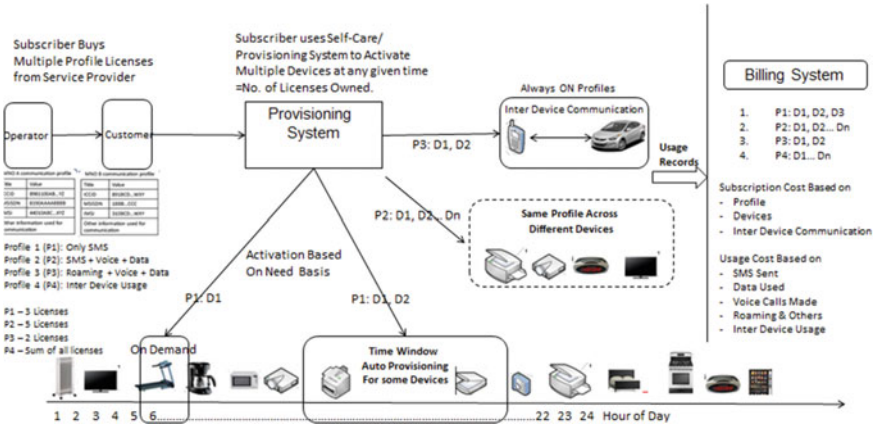
- Single profile maintenance.
- Move away from individual provisioning and activation to service profiles.
- Move away from 'Always ON' in the network to 'On demand'.
- Move away from physical generation of SIM cards as well as Distributor and Retailer management.
- Monetization using multiple licencing and device to device communication.
- Optimization on HSS, CRM, and Billing systems for data records.
- Empowered customer with Self Care.
- Planning for IoT/User using Meta data driven any industry approach.

M2M Service Provider: Assuming M2M service provider is extending a self-care towards enterprise customer for profile management as well as tie up with Telecom Service Provider for dynamic provisioning and configuration across network (HSS) and BSS (Billing and CRM)

- Move away from Distributor and Retailer management.
- Complete user and service profile Life Cycle Management.
- Extended Self-Care Management with full suite of services.

Monetization using multiple licencing and profile management (Sealy 2019).

3 Solution Approach



As stated in previous sections, this solution approach makes it possible to have a single bill for multiple devices having multiple profiles owned by a user (Mehmi et al. 2017).

1. A user will have a custom bundle of licence to simultaneously use multiple service profiles across multiple devices.
2. A user procures multiple service profiles associated with a User profile from an operator's /CSP Account salesperson.
3. A service profile can have a bundle of services and each of them can be enabled and activated on eSIM at a time, using self-care based on Customer preference.
4. A cloud-based provisioning system shall be provided as a Mobile (IoS/Android etc.) App or Web Portal, for activation/de-activation of devices and service profiles.
5. The solution enables the user to have multiple choices for associating a service profile with a particular device type.
6. The user can use the same service profile across multiple devices, as well as can use multiple service profiles simultaneously across devices, based on purchased licence bundle.
7. The billing parameters related to usage(SMS, Voice, Data) and licence (Active devices, active profiles) are configured and processed against the unique User profile.
8. The HLR and CRM would be provisioned against the User profile.
9. The purchased licences would be associated with a unique User profile and a single bill will be generated for his complete usage covering different service profiles across all the devices.

10. A single bill generation would happen based on the licence policy defined in the billing system; this will enable the user to pick and choose services across multiple devices concurrently.

The solution focuses on licence-based charging and associating multiple Service Profiles with a single User Profile, enabling the user to activate the same user profile across multiple devices (Vesselkov et al. 2015). Below given are some of the sample use case scenarios for charging as per the solution.

i. **Charging Use Cases:**

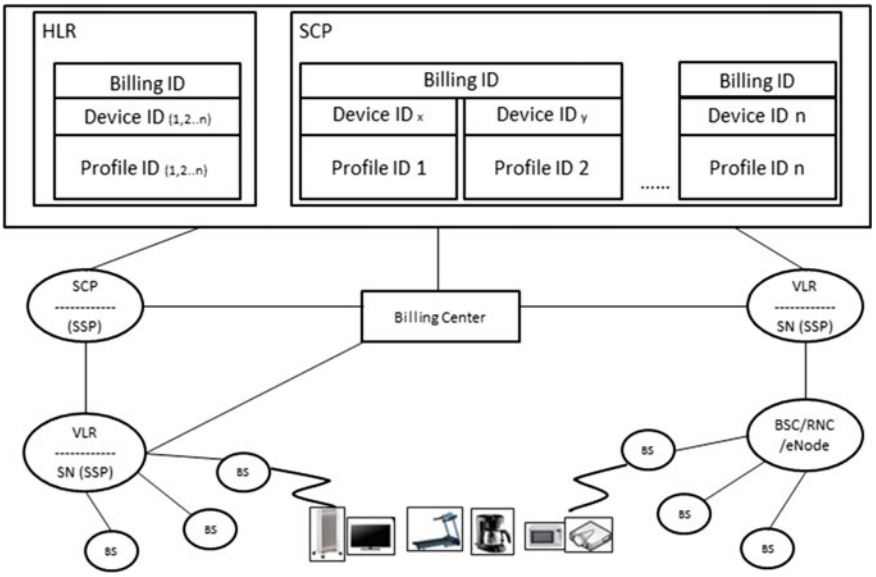
Inter Device Usage: This is an example scenario where devices using service profiles under the same user profile communicate to each other using different service type—sms, voice, or data. This is similar to a CUG scenario, and billing configuration can be similar to the way we do it today for CUG subscribers. However, at any given point of time only a specific number of such devices can be made active as per the licence procured by the customer.

Service Profile Licence Usage: This is an example scenario where a customer can configure any number of devices with the same Service profile configuration licences he has bought, however he can only activate a fixed number of devices simultaneously as per the number of licences he has procured against that Service Profile.

Flexible Mode of Billing: The CSP can configure the billing system to enable Billing as per combinations of metering data. E.g. a profile can be activated during night on one device (e.g. TV/AC etc) and during day time on another (e.g. Car etc). The billing in such scenarios can be based on any of the below combination of metering data:

- Kb Data for IP Traffic.
- Voice Minutes.
- SMS Count.
- Active Device ID's.
- Duration of Service Profile Active.
- Service Types Active on a Profile.
- Different Device ID's used against each Service Profile.
- Scheduled Activation of Service Profile on a device.

Site-Based Licencing: The CSP can provide licence based on location or service area defined by BS or BSC/RNC or a building or location. In this scenario the CSP can provide agreed/procured or any number of licences to be configured in the vicinity of the defined location and customized billing (based on location/site) agreements can be made with the customer.



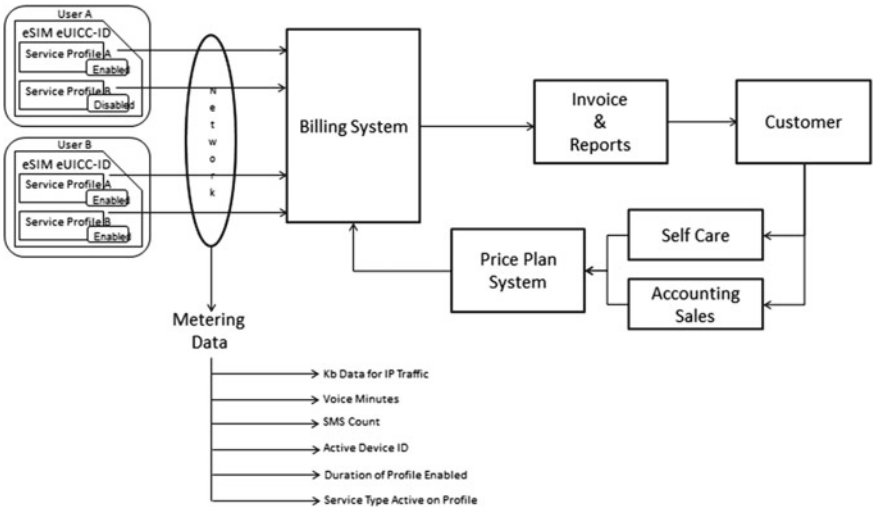
Present solution relates to cellular communication system and in particular to multiple service profile billing for an associated user profile. In a conventional cellular communications system, a one-to-one relationship is typically maintained between the mobile station and the subscription for that mobile station. In this regard the subscription refers to the contract entered by a user with a CSP. The subscription defines not only to whom billing for cellular services should be charged but also set forth the types to cellular calling services and features that are to be provided to the subscriber. Once the subscription to cellular caller services and features has been defined this data is collected in a subscriber service profile that is stored and maintained in a database. The service profile is linked in that database to an identification of the mobile station for the subscriber. Thus the conventional system also maintains a one-to-one relationship between each mobile station and the service profiles that define the cellular services and feature provided to that mobile station.

To address the need of having a single Bill association to multiple devices along with multiple service profiles associated with the user profile and usage of these service profiles concurrently on end device types, a one to many relationship is established between a User Profile ID and its associated Service Profiles and devices.

The Home Location Register (HLR) or HSS of the cellular network stores plural service profiles for such subscripted licences under User Profile ID. Each of the service profile is associated under the same unique User Profile ID to allow singular billing for use of multiple licences across different device for various services.

The user selects one of the service profiles in the Self Care or the Web portal to be activated for a device. At each selection, the service profile is sent to the provisioning system to associate the selected service profile on the e-sim of the selected devices. Once activation of the device is done, the profile would be downloaded from the HRL into the VLR (Park et al. 2013).

Charging on per service profile basis is made for both incoming and outgoing usage (data, sms and voice). In each case metering data is generated which is consumed by the billing system to do the singular charging. These metering records not only identify the service but also the associated devices for which the services are concurrently active. By processing these records, a single bill can be generated against the User Profile ID with bifurcation on device types (Çelik et al. 2018).



The above figure illustrates the billing scenario for the mentioned solution approach. The components in the architecture are Billing System, Invoice and Reporting, Customer Functions, Accounting and Sales Function, Self-care and a price Plan System.

The Billing system receives the data input from the network, and basis the usage statistics by each device in the network, calculates and generates the bill for the associated device. Post calculation of billing, the information in the process is passed on to the invoicing system, which generates the invoice for the end user.

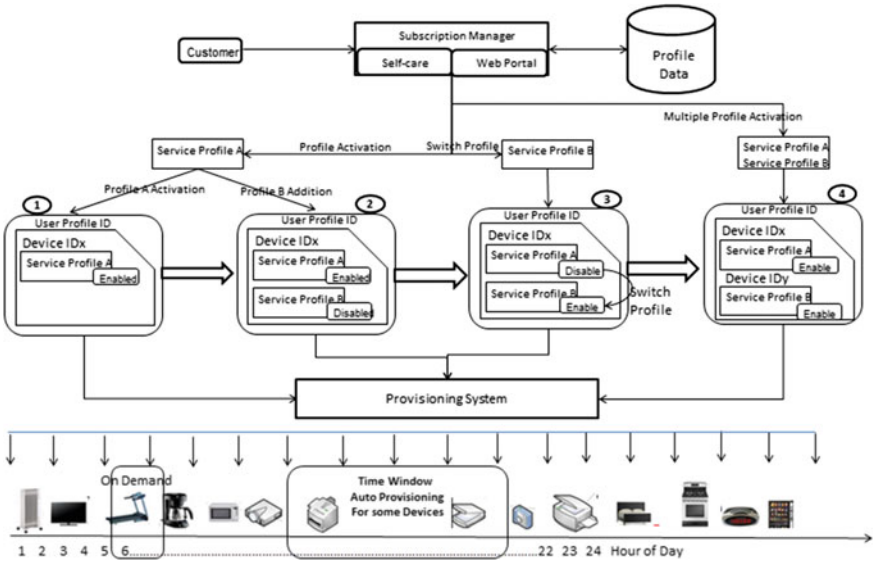
As part of the customer relationship agreement between the network and customer, the invoicing function generates an invoice for the end user. The invoice contains the information on usage and subscription rental of services. Basis the invoice an end user would make the payment towards the operator.

Every customer is associated with a price plan, which informs him of how he has been charged for usage of various services in the invoice. The customer will also have access of Self-care application (e.g. app running on android or IoS) and also accounting and sales function may help him to update or add or configure service profiles associated with his User profile (Chitroub et al. 2019).

After receiving the information on the active service profile and devices usage the billing system calculates a customer bill based upon the price plan, licences configuration, usage, and time & fixed charges. The calculated bill would then become an

input towards the invoicing and reporting function. The customer has visibility on the active service profile, usage, and licences being utilized and can actively modify or configure the service profile using a self-care to make adjustments.

ii. **SIM Provisioning**



The above figure describes a use case for Service Profile Activation and Provisioning Flow.

a. Customer selects a single Service Profile A associated to his User Profile which the enabled profile for him.
b. Customer acquires a second service profile (B) which is added to his User profile and is in the Disabled state.
c. Customer requests for a profile switch resulting in a Service Profile B to be active and Service Profile A to be disabled.
d. Customer requests for both the profiles (A & B) to be active against his/her User profile.

The customer can select to choose any of the above scenarios of combination of Service Profiles to be activated on the device or multiple devices concurrently using the self-care or any other means of provisioning based on his procured licences (Smith 2014).

4 Conclusion

The concept of Software Licence-based model has multitude of advantages for both Service Provider as well as the Enterprise trying to adopt the same. Some of the advantages are stated below.

a. Move from Silo Individual SIM Card Provisioning to Software Licence based e-SIM Model.
b. One Owner One Bill—There can be a single Bill generated against a single User profile ID which can have multiple Service Profile ID associated with it.
c. The same Service Profile can be used across multiple devices.
d. The solution takes into account e-SIM capability with multi profiling existing in the devices.
e. Scheduled and On Demand plural service profile configuration across devices.
f. Inter Device usage Billing.
g. Metering Data generation for Billing as per Service Profile usage under a single User Profile.
h. Modelling based meta data-driven approach to support any industry.
i. Self-care driven with flexible configuration options to configure need-based service profiles on devices.

We will see disruptive business models which will be enabled by e-SIM adoption and the concept discussed in the paper is one of the means towards that. It's trendy to consume data sustainably. The e-SIM technology is gaining more demand worldwide as more e-SIM compatible devices are.

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