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Value Chain scenarios for M2M Ecosystem

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Abstract - **Recently attention has been directed to Machine to Machine (M2M) wireless communications by a number of stakeholders which include device manufacturers, applications developers and mobile network operators across the globe. As voice revenues for most mobile operators enter a decline due to the new data oriented networks and services being availed into the market, there is growing need to adopt new revenue models through adoption of wireless connectivity in a wide range of devices. With the introduction of these new applications and services, new stakeholders come into play in the M2M communications value chain. A way to market these M2M devices can thus involve creating a platform of services that adds value and functionality to the devices and is a result of a combination of synergies between device manufacturers, application developers and mobile operators. This paper discusses several value chain scenarios which form the M2M ecosystem wherein all stakeholders assume different levels of control over the customer relationship and the assets that make up the value proposition.**

Index Terms— **machine to machine communications, mobile network operators, application developers, device manufacturers**

I. INTRODUCTION

Wireless M2M communication if a form of data transfer that lets machines communicate directly with one another with little or no human interaction or intervention. It covers a wide range of applications, including smart metering, healthcare monitoring, fleet management and tracking, remote security sensing and on-demand business-charging transactions. Historically, M2M applications were developed to increase the productivity of industrial resources, whether the resource was a fleet of delivery trucks or a remote gas pipeline. Currently M2M technologies are enabling more broad-based and consumer-focused applications that have the potential to make a big impact on choices we make in our daily lives that will have positive benefits to individuals and society.

The M2M industry has become more prominent, primarily because of the widespread availability of wireless connectivity (3G, LTE), declining prices of M2M modules, regulatory pressures and incentives for certain industries such as smart grids. M2M is enjoying a renewed interest from mobile operators in pursuit of new markets and applications to improve revenues and profit margins. The emergence of the Internet of Things [1] paradigm is driving a potentially growing M2M market [2] [3]. Recent standardisation efforts are also emerging through 3GPP, IEEE, FIA and ETSI [4]. Moreover, Telenor, Sierra Wireless and Vodafone have already started providing platforms that integrates IT applications and infrastructure with the mobile operator's network [5] [6] [7]. We can conclude that the M2M paradigm is deemed to open new markets and create new streams of revenue for device manufacturers, application developers and mobile network operators.

A way to market these M2M devices as well as develop product differentiation could then involve creating a platform of services that adds value and functionality to these devices and is a result of a combination of synergies between device manufacturers, application developers and mobile operators.

In this new M2M ecosystem, relationships between the various stakeholders need to be established in order to define, among other things, the roles of the partners, the interfaces between the parties, the business logic and the revenue streams. For instance, Ballon [8] proposes four different types of platforms oriented around their relative control over the customer relationship on the one hand, and the control over crucial tangible and intangible assets that make up the value proposition on the other.

This paper proposes a number of value chain scenarios for M2M product creation and differentiation through a platform wherein application developers, devices manufacturers and mobile network operators take more or less active roles, i.e. control customer relationship and control the assets that compose the value proposition of the platform. This discussion reports to four technical cases described in the following section. Section III introduces the business model methodology for the proposition and section IV benchmarks and details several business scenarios.

II. TECHNICAL USE CASE

A. UC 1 - Home Energy Management System (HEMS)

Spurred by recent advances in M2M technologies, Smart Grid (SG) smart meters are expected not to require human intervention in characterizing power requirements, energy distribution and collecting energy consumption data. In this use case we take a scenario of a home energy management system which is capable of reducing global energy consumption by more intelligent control of the heating equipment, while still allowing the home tenants full control over their energy bill. A mobile application is developed which monitors the HEMS and facilitates for the two-way communication between devices and the gateway, device control and information delivery of energy consumption. The HEMS maybe be tailored to suit the needs of the tenant automatically through intelligent control systems.

B. UC 2 - Access Control

This use case is situated in the building access control domain. It combines a video feed monitoring the entrance with a

presence function for the home tenants. Some reasoning/scripting logic establishes a communication between the person at the entrance of the building and someone that has the authority to open the door, wherever that person is at the moment, based on the presence information. This communication could be a VOIP based session, not necessarily limited to a point–to–point call (suppose it is someone visiting your children, you might want to check with them if they know the person involved).

C. UC3 - mhealth Applications

In this use case we look at the telemedicine developments, driven by M2M which promise to make diagnosis and treatment more manageable. Intelligent devices worn by or implanted in patients offer continuous remote monitoring of biological data that removes the barriers of distance and makes medical knowledge more accessible to a large number of people. Geographically dispersed populations can be diagnosed and treated immediately without the need for them to travel to distant medical facilities, while the elderly can retain the freedom to live their lives at home without the need for institutionalisation or becoming a burden to their families. Patient sensors provide data for doctors treating chronic illnesses such as cardiac disease, high blood pressure, diabetes and obesity. Continuous two-way data feeds over the M2M network provide detailed monitoring information. This allows doctors to spot early warning of medical deterioration and apply treatment earlier. Mobile applications which offer easy access to the patient records are developed by the device manufacturer or independent developers.

D. UC 4 - Driver Monitoring Systems

There are several new M2M applications which are being developed and deployed that use the principal of behavioral economics to provide incentives to people to "do the right thing". This use case involves an insurance company with an application and device to monitor the driving behaviour of its auto-insured customers. The program can be completely optional to the participants. Customers who sign on receive a self-installed, small, compact M2M device integrated into the vehicle computer box. The device captures driving data, including distance, time, sudden acceleration, and braking from the vehicle's on-board computer and sends it back to the insurance operations center over a GSM/GPRS cellular network via a GSM/GPRS module in the M2M device. Users receive an initial discount for participating in the program and further discounts based on their good driving behavior. This system has a lot of benefits to the customer, insurance company, application developer, mobile operator and device manufacturer.

III. MODELING APPROACH

The various value chain model scenarios brought up in this paper show different ways of delivering the services to the consumer, as well as different types of interactions between actors. The various scenarios were modelled using three main building blocks – roles, actors and stakeholders. A business role can be defined as a discrete set of responsibilities, actions, activities and authorizations that together have a coherent value-adding logic [5], e.g. design, mobile access provision, etc. A business actor is a marketplace entity that encapsulates a coherent set of roles and a stakeholder is a real-life organisation, e.g. an individual, institution, company, etc. with an interest in the outcome of a certain action [5]. In the context of this paper, the following roles were considered:

- Application Design: consists of the first phases of the software life cycle and is usually taken up by a software house or individuals.
- Application Hosting: consists of hosting the software code and the data required to run the application. This can occur in-house or outsourced (PaaS).
- Application Provision: comprises the delivery and selling of software to specific market segments and technical support.
- Application Usage: is the act of using application services by end-users.
- Network Equipment Development: comprises the design and development of network equipment, implying the ownership of the intellectual capital necessary for the manufacturing of this equipment.
- Network Equipment Integration: consists of the provisioning of integrated network solutions to network operators.
- Mobile Access Provision: is the act of providing access to a given network to customers. In the context of this report, this role was simplified and therefore also includes backbone provision, last-mile provision and broadband access provision and applies to internet, fixed line or mobile services' subscriptions.
- Mobile Access Consumption: is the act of using network access purchased from network access providers.
- Consumer Electronics (CE) Device Development: comprises the design and development of CE devices, implying the ownership of the intellectual capital necessary for the manufacturing of these devices.
- CE Device Marketing: consists of bringing to market consumer electronics devices to be used by consumers to interact with applications.
- CE Device Usage: is the act of purchasing and using a consuming electronics device obtained from a CE device marketer.

The main stakeholders considered relevant for this discussion are:
- Device manufacturer: the entity that develops and builds CE devices or other devices considered relevant in the M2M ecosystem, e.g. sensors, etc.
- Mobile Network Operator (MNO): the entity that provides mobile network connectivity to a device.
- Application Developer: designs and develops an application that explores the capabilities of a device or integrates information from different sources.

This entity can be represented by an individual or an organisation.
- Application Integrator: the entity that, on one side, provides to developers an ecosystem for hosting and

running applications, and on the other side, integrates and provides applications in the user environment e.g. Apps Store and Android Market.

- Consumer: the consumer holds a CE device and enabled with a mobile access subscription makes use of an M2M application.

All value chain scenarios considered in the next section exhibit the same value network illustrated in Figure 1.
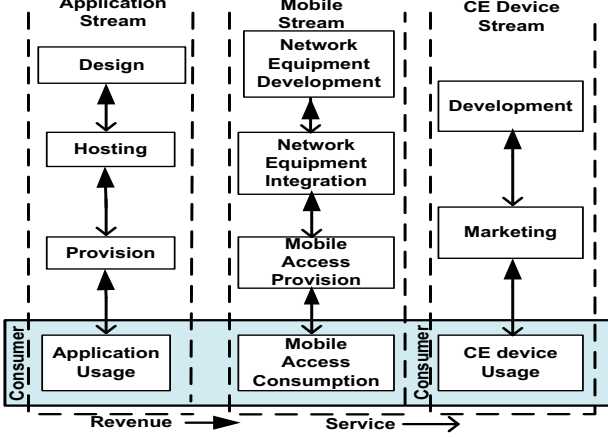

Figure 1: Generic Value Chain

. In this figure, the value streams between roles and from and towards the consumer are depicted. This way, dark arrows indicate service flows, while white arrows represent revenue flows. Only direct revenue flows are indicated though. The use cases considered in this paper privilege the access to information stored in devices and sensors (consumer electronics, utility meters, etc.), followed by the publication of this information over a mobile network and potentially combining it with mobile network operator's contextual information and services (customer information, location, messaging, etc). Therefore it was assumed that the consumer holds a CE device (mobile phone, television, computer, set-top box, etc) and a mobile telecommunications subscription (data or voice subscription). In addition, it was considered that there are APIs made available by CE manufacturers and MNOs to facilitate, respectively, access to and integration of functionalities of devices and mobile networks. It was not considered relevant for this analysis to explore the actors that assume the roles of Network Equipment Development and Network Equipment Integration as those roles are related to the functioning of the network and are just mentioned here to make the value chain clear.

IV. VALUE CHAIN MODEL SCENARIOS

The scenarios presented in this section are aggregated by the streams shown in Figure 1.

A. *Application Stream Scenarios*

1) *Description*

In the application stream two scenarios can be considered:
1. The application developer establishes a platform for software development, provisions and manages a direct

relationship with the customer or sells applications to MNOs (Figure 2).
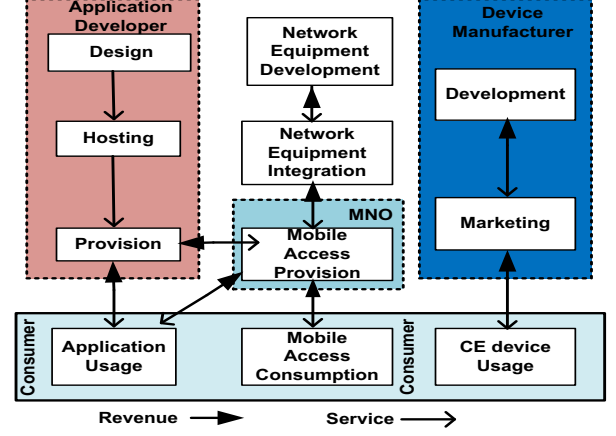

Figure 2: Application Developer scenario

In the first scenario, the application developer develops, hosts and provides applications, i.e. establishes the entire platform for application development and provision. The application developer collects revenues from several operators or from only one, based on an exclusivity contract. Alternatively or complementary, the application developer provides applications directly to the consumer. While the application developer can have two sources of revenue from distinct stream stakeholders, there is also potential for the MNO to collect revenues from consumers.

2. The application integrator establishes a platform for hosting and provision of applications, but relies on application developers to develop and publish applications on the platform (Figure 3).
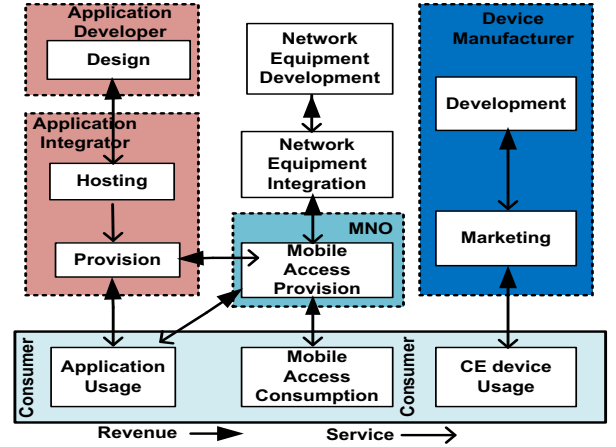

Figure 3: Application Integrator scenario

The second scenario considers an application integrator that setups an application development platform in order to host and provide applications (PaaS). Through this platform a set of APIs to interact with network devices, CE devices is provided, in order to leverage creativity and innovation of a developer's community or application developers such as ISVs or startups. In this context, the application integrator collects revenues from application developers using the platform and from consumers or MNOs to whom these

applications are sold. In both scenarios consumers have direct access to the applications available in the platform without the mediation of the MNO.

2) Discussions

Although selling applications directly to consumers seems a reasonable business scenario for application developer or application integrators, a close cooperation with MNOs would be beneficial to guarantee platform adoption due to their large customer base and control over customer data. On one hand, applications can be charged to consumers on a one-time fee or pay per usage basis and on a pay per number of users basis to MNOs, on the other hand. Additional license fees or exclusivity contracts could also be negotiated with MNOs. In the second scenario, the application integrator could also charge developers for access to the platform on the basis of resource consumption, access to particular APIs or on a monthly fixed fee. The application integrator may strengthen its relationship with application developers and the value proposition of the platform towards developers by offering attractive revenue sharing contracts. A fast way to establish this platform could involve simply the expansion of an existing platform to incorporate M2M applications, avoiding high investments and risks. Innovation is a responsibility of the application developers/designers in this case. It should be mentioned that the main potential bottleneck of these scenarios is the lack of cooperation between platform owners and device manufacturers, preventing developers to get access to hardware-specific APIs. In this scenario the barriers to entry for a tech entrepreneur (developer) are low. MNOs in Africa usually get a larger percentage from the revenue share.

B. Mobile Stream Scenarios

1) Description

In the mobile stream several scenarios reflecting more or less control of the value chain by the MNO can be considered. Still, the MNO guarantees the direct relationship with the customer for application provisioning:
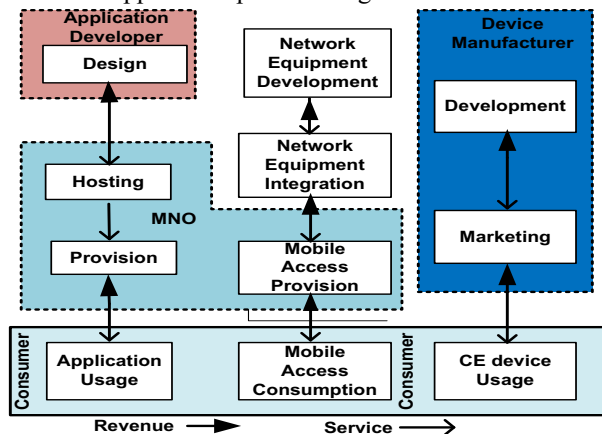

Figure 4: MNO holds application provision scenario

3. The MNO setups an application development platform in order to host and provide applications, holding at the same time a marketplace to distribute applications submitted by application developers to its customer base. One of the

disadvantages is the MNO relies on developers' innovation for the success of the platform (Figure 4).

4. Apart from holding a platform for hosting and provision of applications, the MNO also chooses to have a technical department to develop applications internally. In this case, third-party applications developers are not involved and do not contribute to the innovation loop (Figure 5).
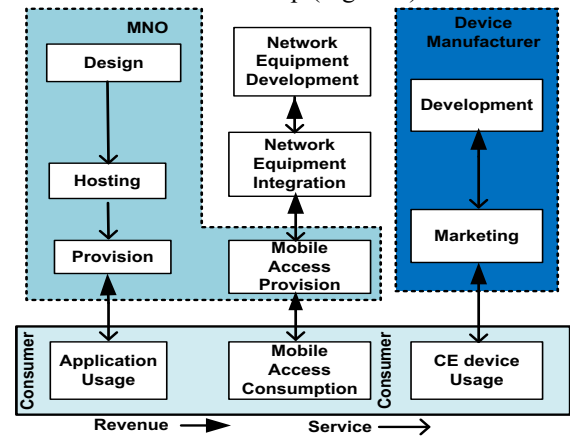

Figure 5: MNO holds application design scenario

5. In a slightly changed configuration of the previous scenario, the MNO not only takes an active role on the application stream, but also takes up the active role of marketing devices to the end-user and takes control of additional functionalities delivered to the customer. This scenario can be compared to the bundle offers (mobile phone plus medium/long contract), which are mobile operators' common practice across Europe and South Africa (Figure 6).
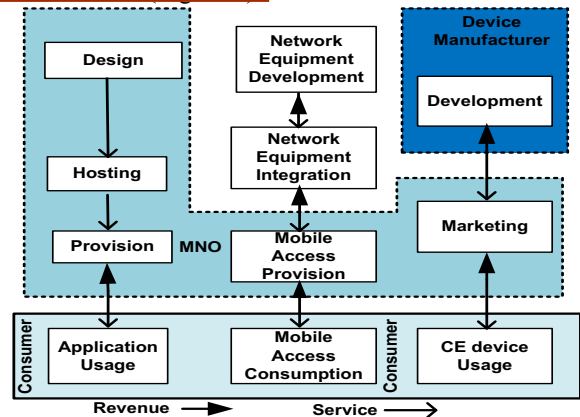

Figure 6: MNO holds CE device marketing scenario

6. In this scenario, although the MNO still holds the customer relationship for application provisioning, the device manufacturer assumes a more active role in the application stream. The device manufacturer bundles the devices with software that is made available to the consumer through a platform established by the MNO. In addition, the MNO maintains its role of marketing devices to the customer (Fig. 7).

7. The device manufacturer holds application provisioning, but as part of a deal with the MNO, the device manufacturer provides the application provisioning platform to the MNO. In a nontransparent way, the costumer is redirected to the

manufacturer's platform whenever he tries to buy new software or use interfaces of the application. The MNO still sells the CE device to the customer and charges him for each application bought or used (Figure 8).
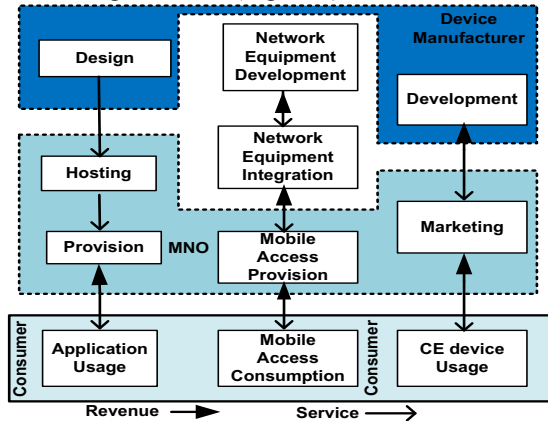

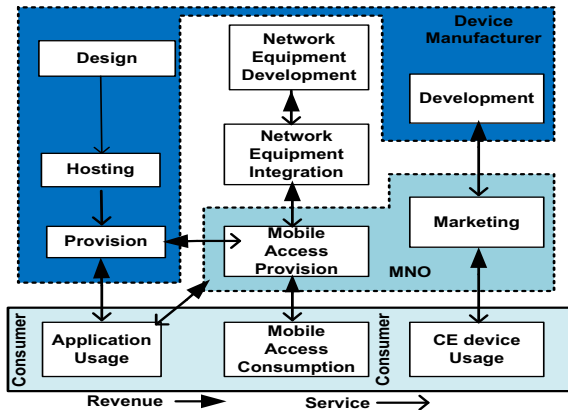Figure 7: Device Manufacturer holds application design scenario

Figure 8: Device Manufacturer holds entire application stream scenario

8. Similarly to the previous scenario, the device manufacturer holds application provisioning, but opens the platform to the contribution of application developers. In this case, the revenue of an application is split between the MNO, the manufacturer and the application developer (Figure 9).
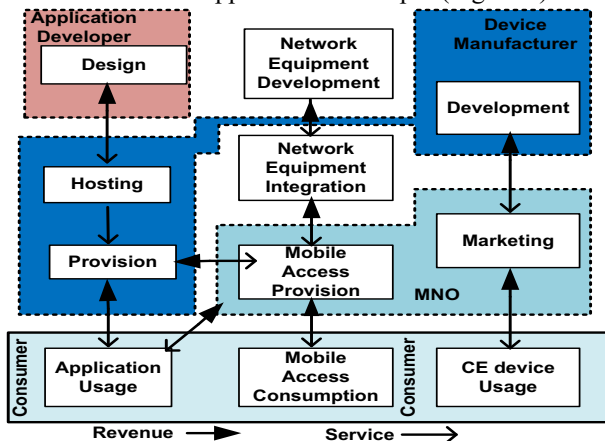

Figure 9: Device Manufacturer holds application provision to MNOs scenario

2) Discussion

The mobile stream scenarios envisioned deliver the advantage of involving the MNO and hence leverage the integration of

mobile services and mobile network functionalities with consumer electronic devices. In all these scenarios, the MNO charges directly the customer either through the monthly bill or through one-time micropayments per application bought or used. Scenarios 3 and 6 reflect a two-sided business model and enable the MNO to collect revenues from selling applications to consumers and from application developers or manufacturers using the platform to host and market applications. Platform adoption by developers and manufacturers would mainly depend on an open platform and attractive revenue sharing rates. In these scenarios developers and manufacturers collect revenues from one or several MNOs. However, compared to developers, manufacturers could actually have more bargaining power, since they control the underlying access layer to CE devices, resulting in both actors trying to exert a certain control over each other.

In scenarios 4, 5 and 7, the MNO and the manufacturer, respectively, control the entire application development stream. These actors might incur in the risks of not having the necessary technical skills to implement the platform, having difficulties understanding the requirements of customers and developers, and neglecting this stream of their business, since revenues can be marginal, at least during an initial stage. In scenarios 5 to 8, the MNO takes up the additional role of marketing CE devices. This option is more pronounced in Africa because MNOs also offer better customer relations management. This role can be feasible if the MNO establishes an alliance/agreement with certain device manufacturers in order to facilitate the deliverable of M2M devices to customers. This would increase implementation speeds, reduce the cost and complexity of delivering M2M devices to customers and enable economies of scale for manufacturers. In this case a revenue share deal between the two actors could be set up and would facilitate the deployment of technical use cases UC 2 and UC 4. Scenario 8 seems the least interesting scenario, since both MNOs and manufacturers rely on developers for the success of the platform implying a considerable risk for the former stakeholders e.g. Alcatel-Lucent and Nokia [9] are using this model. In addition, revenues would be split among three actors, potentially leading to a revenue split not that interesting for developers.

B. CE Device Stream Scenarios

1) Description

In the CE device stream scenarios the device manufacturer holds the customer relationship for application provisioning and device marketing. The device manufacturer thus sells CE devices directly to the customer and likely also provides applications directly to the end-user through, for example, an application portal. These scenarios are similar to real-life cases of mobile handset manufacturers that hold platforms to sell applications to device owners:

9. The device manufacturer allows third-parties to participate in the application design and shares revenues with them (Figure 10). Apple's new strategy of opening retail shops to sell Apple devices. Google tried it before when they launched the G1 but it was not really a success it was different from the traditional MNO based retail strategy.
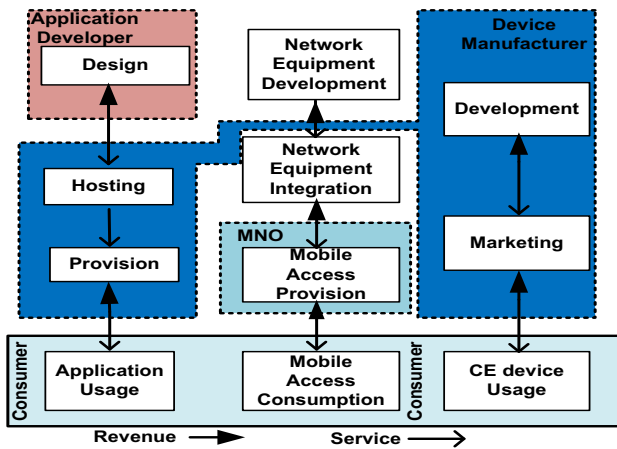
Figure 10: Device Manufacturer holds application provisioning without application design scenario

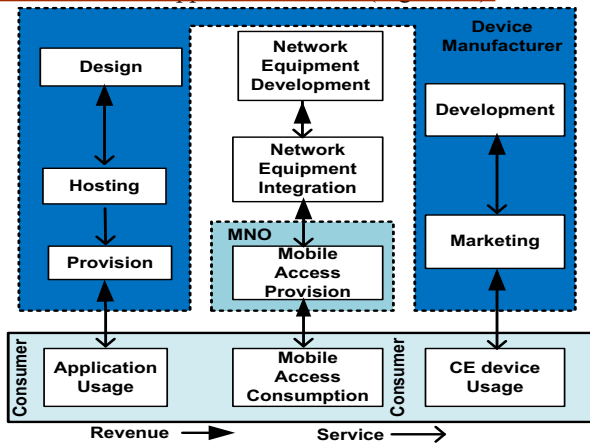10. In addition to the device stream, the device manufacturer assumes the entire application stream (Figure 11)

Figure 11: Device Manufacturer holds application provisioning scenario

2) Discussion

The technical cases UC 2 and UC 4 could be deployed taking these two scenarios into account, since access to hardware-related APIs would be obviously facilitated. However, given that the MNO is not involved in the application provision, the possibilities to integrate with mobile phone functionalities decrease. In these scenarios, the device manufacturer sells applications directly to consumers, similarly to existing mobile manufacturers' platforms, such as Nokia Ovi and Samsung Apps. Similarly to previous scenarios, consumers could be charged on a one-time fee or pay per usage basis. Previous considerations regarding opening the platform to application developers also apply to scenario 9. Although these two scenarios seem to have little implementation potential, they are comparable to the platforms established by mobile phone manufacturers, which are currently more successful than similar platforms established by mobile operators. ZTE and Huawei [9] offer M2M platforms, devices and handle their retail.

V. CONCLUSION

The key to the success of the M2M business will be a focus on the value created for the end users, new collaborative business models and ecosystems where all participants can be successful. Stakeholders need to build consortiums which have sufficient clout together to negotiate and position the innovative business models into market. Although restricted to a specific set of technical cases, these scenarios can also be extrapolated and applied on more generic deployments and seem to have real-life applicability. Apart from the business configuration, there are however other issues that influence synergies that should be considered when planning strategies to efficiently deliver M2M devices to consumers which include:

- current standardisation efforts by 3GPP, IEEE and FIA.
- regulatory constraints and incentives.
- harmonising of roaming prices for MNOs.
- promoting the alignment between MNOs, device manufacturers and application developers by clear communication of the market and research opportunities.
- security and privacy issues related to information sharing and collaboration with third-party stakeholders.

The feasibility, advantages, disadvantages of these scenarios, as well as, the impact of external factors on their successful deployment could be topics of further research. Additional insight could be gained from a deep discussion about the similarities between these scenarios and real-life case studies of platforms available in the mobile services domain.

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