Platforms in the Palm of Your Hand: Mobile Value Chain Evolution

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Abstract— **The last decade has seen the telecommunications industry responding to a process of revolutionary change. Infrastructure, technology, supply chains and customer demands have evolved more in the last 5-10 years than in the previous 30. In this paper we explore how technical changes have contributed to the evolution of the mobile network value chain and consider how the latest developments in mobile and cloud computing are likely to continue the revolution. Finally, we investigate the impact of this on the business models of the telecommunications industry.**

Keywords-mobile network; value chain; cloud computing; virtualization.

I. MOBILE NETWORK VALUE CHAINS 1990 - TODAY

The value chains of Mobile networks have evolved rapidly over the past few years [1]. As a result, bargaining relationships that have been well established since the beginning of the mobile industry between consumers, operators, network vendors have been fundamentally redefined. The associated business models have therefore also been redefined [2,3]. The traditional value chain until the introduction of 3G networks is illustrated at a high-level in fig 1. Operators had significant control over the services an end-user could access and an extremely close relationship with handset manufacturers, which they used to define requirements for mobile terminals. Requirements were established within telecommunications standards forums between many different companies [2]. Value was embedded in the joint development of a platform for voice services, where each actor in the chain had a well-defined role and share of the volume sales created by the mobile network standards.
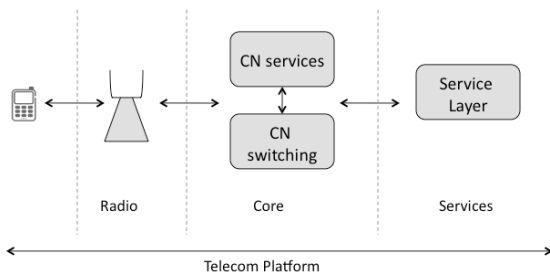

Fig 1: Mobile Value Chain: Era One

This value chain was to a large extent defined by capacity of the component technologies. Low processing capacity available on mobile devices and the low bandwidth available on mobile networks at the time meant that a lot of functionality for services needed to be housed as functions in the operators' networks. The terminal, and hence end-user, was not able to perform any processing locally on his or her handset. As a result, network operators were able to extract a lot of value from the market by providing these services. Network equipment manufacturers, meanwhile, earnt money from the sales of products to support these services [2].

This picture began to change radically ca. 2005. The continuing march of progress led to ever more capable mobile handsets with powerful processors, plentiful storage, and hardware such as large touch-screens supporting rich interaction. Where previously operators and vendors had made substantial profits across all the boundaries previously shown in Fig 1, the importance of the service layer and corresponding core network support began to diminish. During this period, semiconductors and associated electronics increased in speed and decreased in size enough to enable the use of packet switched (IP) technology on the core network of operators, rather than traditional circuit switched. While operators and equipment manufacturers still created and captured value from both core and radio networks, the value capture in the service layer of mobile networks began to shift to new entrants, shown in fig 2.
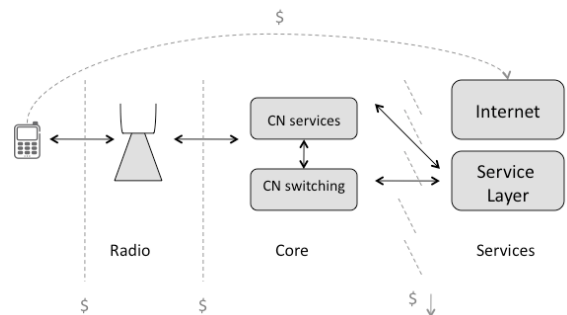

Fig 2: Mobile Value Chain: Era Two

The situation of the present day is shown in Fig 3. The progress began ca. 2005 has continued at "Internet pace", with significant service creation coming from Internet companies such as Google and Facebook and also start-ups. Open source developers are also an important part of the ecosystem.

Simultaneously, mobile handsets have developed (smartphones and tablets) and now behave more like traditional computers, running commodity operating systems such as Linux (Android), iOS (iPhone) and Windows (Windows CE and Windows Mobile 7). This is also challenging the established role of handset manufacturers whose main value add is currently in hardware [3]. This allows new entrants such as HTC to present a significant challenge to the established players and is causing a reconfiguration of the mobile handset industry. Of the three operating systems available on the mobile handset market, computing companies, rather than traditional telecommunications manufacturers now develop all of them.
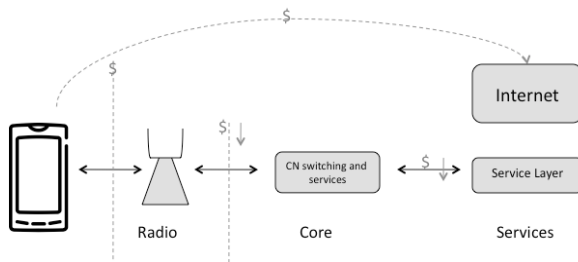

Figure 3: Mobile Value Chain: Era Three

II. CONTINUING COLLISION: XENDROID

Currently Internet service companies are gaining ground in the mobile telephony value chain and the open standards, extensible protocols and innovation regime of the Internet are increasing in importance. Current trends might suggest that there is a simple reconfiguration of bargaining relationships, with new entrants merely taking the place of the slower to innovate incumbents.

We believe this to be a mirage, however as the current rates of technical change within the mobile handset and computing industries indicate that innovation that is taking place around virtualization. Companies such as VMWare and XenSource have demonstrated the value in the many possibilities that arise when a software layer is interposed between the physical hardware and the operating system above which applications execute, e.g., resource isolation, enhanced security and privacy, and very high degrees of multiplexing of virtual machines onto physical hardware. In short, the flexibility and total efficiency gains that virtualization provide are substantial and have had a significant impact on the IT industry at all levels.

Following these technology developments, the impact of a technology that applies virtualization to take a mobile phone platform into the cloud could be substantial and would have another profound effect on the evolution of the mobile handset value chain. Specifically, consider enabling a complete Android smartphone image to be hosted on Amazon's EC2 cloud computing platform. (We have taken the initial step in this direction by booting the Android 2.2 operating system as a guest OS on the Xen hypervisor, Amazon's chosen virtualization technology.) A simple client app can connect to the cloud-hosted Android image, enabling the user to interact with it, to share personal data with it, and to sync device configuration with it. More complex apps can use code migration techniques to seamlessly move code between the

mobile device and the cloud according to performance measurements, developer hints, or other data sources. Such a platform permits several interesting developments, of which we outline three below.

A. Performance enhancement

Most smartphone and tablet platforms use low-power ARM processors for obvious reasons. By hosting the phone image in the cloud allows them to make use of higher power Intel x86 CPUs, making many more processor intensive applications feasible.

B. Future-proofing

A problem with uptake of modern smartphones is their high cost, which leads them often to be offered subsidised on high duration contracts. In turn, this means users are slow to upgrade, retarding uptake of new technologies and the applications they support. The cloud hosted images enable users to upgrade their experience without having to change contracts or even upgrade their handsets.

C. Universal access

Of course, the client software used to access the cloud-hosted image need not be limited to run on the same platform as the image to which it provides access. For example, client software that provides access to cloud-hosted Android images could equally well run on the iPhone or even legacy feature phones, albeit with a reduced fidelity user experience. This could both greatly accelerate penetration of smartphone technologies into developing markets, and break down the walls developing between the different app stores/marketplaces.

The full version of this paper will elaborate and substantiate the above argument, discuss the Xendroid platform in more detail, and point to how we see this revolution continuing to develop. It analyses the impact of Xendroid and similar platforms on the bargaining relationships within the mobile handset industry, specifically focusing on the new roles of value creation and value capture that are enabled by the 'virtualisation' of mobile handsets. This paper also analyses how this creates a competitive clash of platforms between the mobile and computing industries.
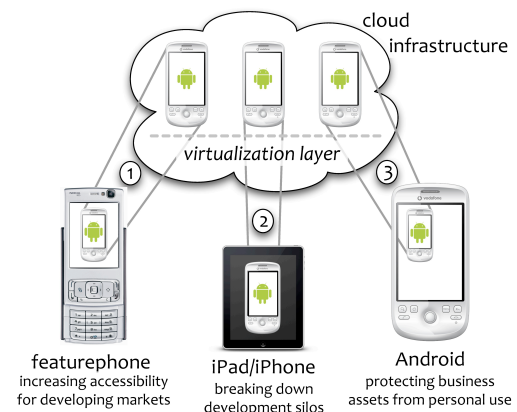

Fig X: Xendroid Platform

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