Software Defined Radio Forum

Business Model for Wireless PCS

S&A-BC

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1 Overview

Wireless users benefit from the enhancement to their personal capability provided by wireless systems, and are transitioning from a perception of Personal Communications Service (PCS) as a wireless telephone to its use as a vehicle for mobile application services. As typical users broaden their horizons to utilize additional services, the revenue generated will increase. So the goal of participants in this mobile PCS market is to enroll more customers, encourage them to use more billable units, and encourage the use of higher value services.

Growth in this market is expected to be more than 40% per year for the next four years, to $150 billion in 2006. It is the intent of this discussion to explore the participants in that revenue stream of nearly $500B, examine the funds flow between them as they do business with each other, and review the size of opportunities involved as revenues are retained or passed on to suppliers.

The picture below provides a view of the business connections between participants in the PCS market.

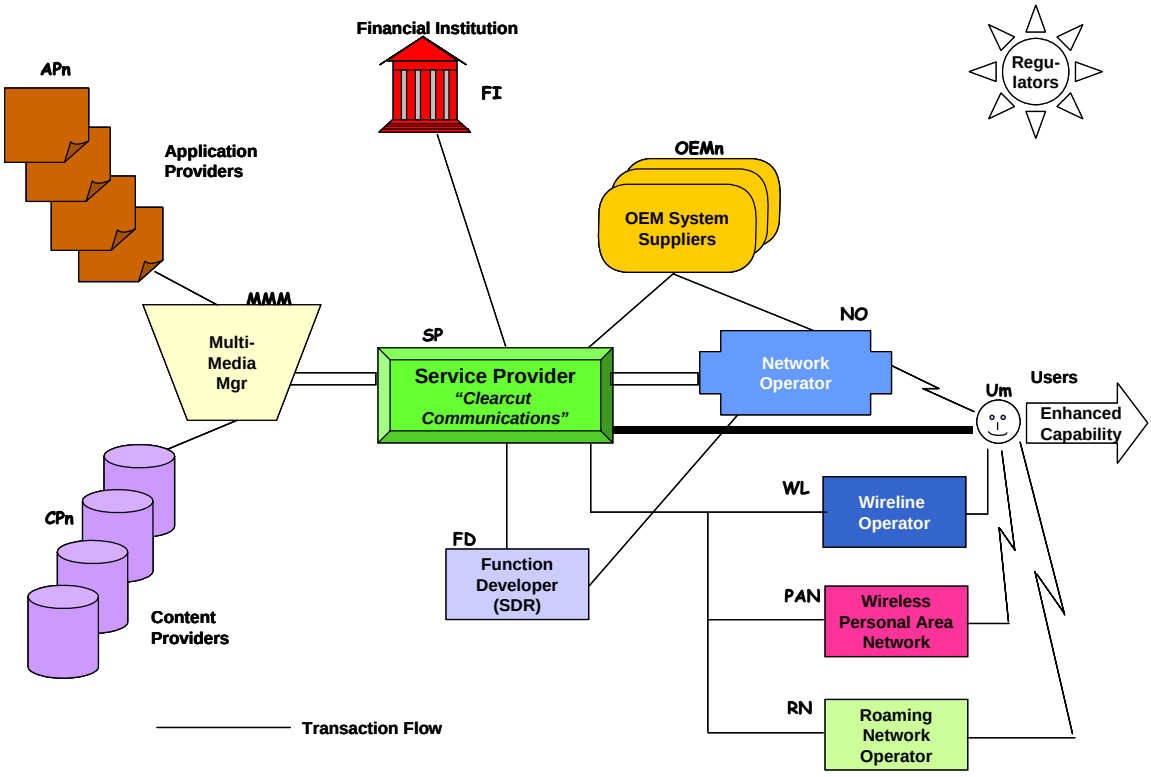


Figure 1-1 PCS Participant and Transaction Diagram

The net result of all this activity is to deliver services that enable the users have enhanced capability, to enable them to do things they could not do before those services were

provided. The underlying assumption is that they will see the services as valuable, they will pay for them, and generate a revenue stream that can flow to all the participants in the market.

1.1 Transaction Characteristics

Transactions in the picture are indicated with lines. In general, transactions are bi-directional: one party delivers goods and services, and the other party pays for them. Exceptions may occur for one-directional transfers, for barter, or when offsetting transactions are pooled. Transactions between any two participants are possible, the prevalent ones are shown on the diagram. To designate a specific link, this document will use the originator followed by the recipient in the form:

SP-Um

A series of links make up a revenue stream, and is designated by the participants in the form of a series of links:

AP1-MMM-SP-NO-Um

2 Participants

The following are participants in this model as indicated in the picture above. The role of each is described.

2.1 Wireless User (Um)

Individuals subscribe to PCS services, and benefit from their use. Users usually obtain a terminal and subscribe to a service that provides them with a telephone number and sometimes an IP address. With these identifiers the user can make telephone calls and access data base services.

2.2 Network Operator (NO)

The Network Operator is the organization that has an infrastructure to provide the fixed termination of the link to the mobile user. The NO operates the radio equipment, and faces the continuing challenge of offering adequate capacity in the designated coverage area in the face of growing demand, new service offerings, and a developing technology base. The NO may be a cost center within the SP organization, or an independent profit center that is paid for operating the infrastructure. The NO may provide service to customers of several SPs and may operate its base stations using a number of waveforms or air interfaces.

2.3 Service Provider (SP)

The SP is center of entrepreneurial energy in the market. It offers a product, and establishes branding of the offering to the user. Often the service provider will supply the user's terminal. The SP has the financial responsibility for establishing the credit of the

user and a means of payment for the services rendered. The NO authorizes delivery of service by entering the identity of the user and the terminal equipment into the Home Location Register (HLR), or equivalent master data base, that is checked by the NO before connecting any session. When there is a problem with any aspect of the services, it is the SP that the user will look to for resolution. The Service Provider also maintains secure links with financial institutions.

2.4 Application Provider (AP)

There are a myriad of services that users can access from their terminals. Many of them involve some specific application capability, such as current stock market activity, sports results, weather, or games. The SP cannot hope to cover all the possibilities. So it is the role of the AP to package their capability in a specific application area so that it can be accessed by the small screen and low-speed link of a wireless terminal.

2.5 Multi-Media Manager (MMM)

With a number of applications being offered, there is need to maintain a look and feel that is consistent so the user does not need to learn a number of different interface styles. The appearance must also be consistent with the SP branding program. So the MMM works with the APs to package their offerings, and with the SP to assist in marketing them. The MMM is often an department within the SP organization.

2.6 Content Provider (CP)

A number of organizations maintain data bases of information in the course of their business. Access to this information can be an important part of some application offerings. The content provider may connect with the application provider or directly with the MMM to provide such access, often under a series of constraints.

2.7 OEM System Provider (OEM)

These organizations design and manufacture the equipment used in providing PCE services, including Base Stations and Mobile Terminals. OSPs are responsible for the reliability and performance of their product offerings. They have traditionally been reluctant to open their systems to third party functions.

2.8 Function Developer (FD)

The FD develops or acquires software to run on network nodes and determines network functionality. As a supplier of functionality that may effect the RF characteristics of the system, the FD is a trusted individual who must operate within the bounds established by regulatory agencies and the security policy of the system. The FD also provides system interfaces that can be used by APs to deliver system application content. The AP is rarely concerned with details of system performance and functionality.

2.9 Wireline Operator (WL)

Wireline operators often provide backhaul and communications channel bandwidth to the NOs. They may also want to provide some level of SP branded service over their landline network telephones.

2.10 Wireless Personal Network (PAN)

In the future there will be locales in which a wireless network is available to offer services to users. The wireless PCS terminal is a logical device to interact with PANs, including providing payment of money stored in the handset in a fashion similar to smartcards.

2.11 Roaming Network Operator (RN)

When the user leaves the service area of the service contract, connectivity may be provided by Roaming Network operators located there. The users home SP will pay the RN for providing such service, and may make an extra charge to the user for doing so.

2.12 Wireline/Cable Operator (WL)

In some circumstances the users may wish to obtain services at a fixed location in addition to mobile access. If so, fixed operators may become involved , and participate in market revenues,

2.13 Regulator

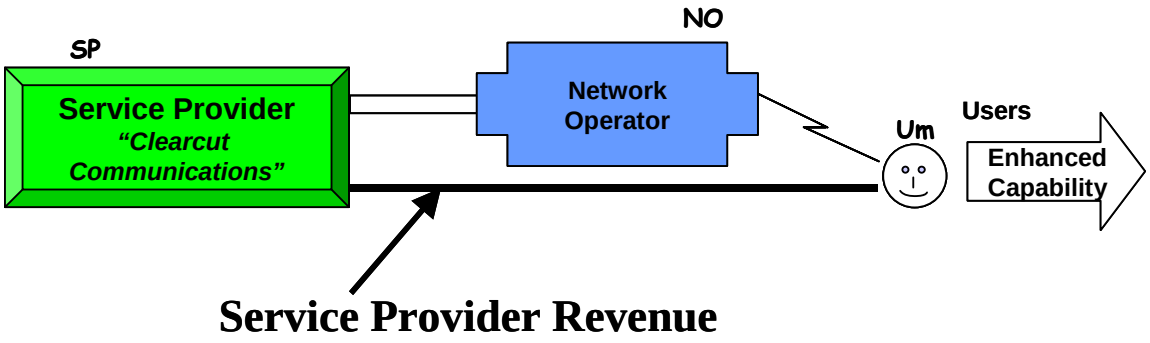
Regulators make the rules under which PCE systems operate. They also auction spectrum to Network Operators.

3 Transactions and Revenue Streams

The following are comments on some of the transactions indicated in the model picture.

3.1 SP-Um

This is probably the most important link – the connection between a organization that is managing the market, the Service Provider, and its customer, the user that pays to use the offered services.. In this document we have given the SP the identity "*Clearcut Communications*" to indicate the importance of this relationship and the need for brand recognition. *Clearcut* will work hard to establish its brand presence, and to encourage the customer to both generate more billable units of service and to turn to *Clearcut* when they want additional services. They also want to provide a level of service that will retain users and lower the "churn" or departure of users to competitive services.



Among the transactions across this link are:

3.1.1 Service Initiation

The SP must provide a distribution channel through which prospective users are signed up for service. Sales personnel may be installed in retail outlets or kiosks. Distributorship agreements enable other retail establishments to sign up customers. A variety of incentives may be provided new users to encourage them to sign a service agreement. All of these expenses are distribution channel costs

3.1.2 Terminal and Accessory Sales

In order to use PCE services, the User must have a terminal. SPs often subsidize the cost of the terminal to the user to encourage them to sign a longer-term agreement with a termination penalty. Terminal accessories are also available at the point of sale. These sales are not normally a major source of revenue for the SP.

3.1.3 Billing

The primary revenue stream of the SP is from a monthly billing. Normally it consists of a fixed service fee, and a per-unit charge for access to the system. Units are often minutes of air-time for voice calls, and packets for data.

The monthly bill is a continuing point of contact where the SP can reinforce the *Clearcut* brand identity, provide information about how the system can be used, and promote new services.

3.1.4 Service Delivery

The user receives services from the NO rather than the SP in return for the payments made to the SP.

3.2 SP-NO

The SP and NO work closely together to deliver a seamless package to the user. The NO maintains the wireless link with the user according to SP requirements, exchanges

information with the SP, and is paid by the SP for actual usage of connect time and packet delivery.
Transactions across this interface are:

3.2.1 Service Initiation

The NO must exchange information as part of a sign-up to authorize delivery of service. This registration provides information about the user and the users terminal necessary to maintain system security.

3.2.2 Payment

The SP pays the NO for actual airtime minutes billable to users, and for data packets processed.

3.3 NO-Um

The user operates with the NO in the home area, and is subject to quality of connection, operation of hand-off between cells, and availability of service.

The network operator puts in place a network, balancing capacity with demand. The following table highlights the fact that the cost to the NO of installing a base station that will provide 300 voice circuits to its served area is not just infrastructure cost but also a significant ongoing operating cost. The infrastructure cost shown as an example. Actual cost will vary with the technology used and of course the supplier costing model

"Other cost" is the cost of buying, leasing or renting the land, building a facility, installing a tower, and making utility and transmission connections. "60 month payment" is the monthly amortization needed to pay off the capital cost of installing the station.

BS First Cost	
Radio	$300,000.00
Other cost	$300,000.00
total	$600,000.00
BS Monthly Cost	
60 month pmt	$11,600.00
Utilities	$150.00
Maint.	$175.00
Software	$175.00
Comm Line	$2,000.00
total	$14,100.00

This station is capable of handling calls that will generate up to18,000 billable minutes in its peak hour. Connections will become increasingly difficult to complete because the

number of busy signals increases as traffic volumes approach capacity. 2% call blockage is the amount normally considered the maximum desirable.

The NO can increase capacity by adding more base stations, reducing the power used to transmit the signals. Traffic patterns are typically bimodal, having a morning peak, an afternoon peak, and very low minimum hour at night. Network planning has to concentrate on peak hour capacity, while marketing strategy tries to find ways to build non-peak hour billable minutes.

If we assume that total daily usage is 3 times peak hour traffic, then the base station above generates up to 54,000 billable minutes per day. Using 20 days per month, that is 1,080,000 minutes of revenue-bearing time for the $14,100 monthly cost, or 1.31 cents per minute.

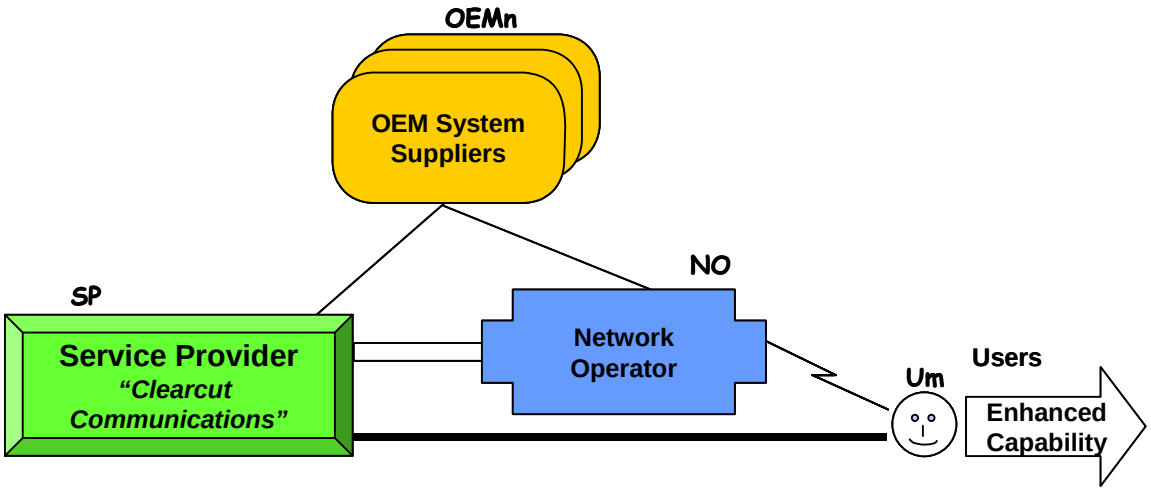
3.3.1 Service Delivery

The user receives services by accessing the network operated by the NO, but the presence visible to the user is that of the SP. User satisfaction will depend on the quality and reliability of that service delivery, and the utility of services made available.

3.4 OEM-NO

OEMs are developers and manufacturers of the equipment and software that permit the system to function. They take a strong position in the development of standards, and to a large extent control the offerings that SPs can make to their customers.

Transactions across this interface include:



3.4.1 Delivery of Systems Infrastructure.

The OEMs build the equipment necessary to operate the system, and deliver it to base station sites provided by the NO. The SP typically has a strong voice in the selection of equipment and system operating characteristics.

3.4.2 Payment

Payment for system equipment is a major funds transfer in this model.

3.5 OEM-SP

The SP has a strong influence on the selection of services from the OEMs product offerings. The SP also offers terminals to users, typically working with multiple OEMs to have a variety of product offerings.

Transactions across this interface include:

3.5.1 Delivery of terminals

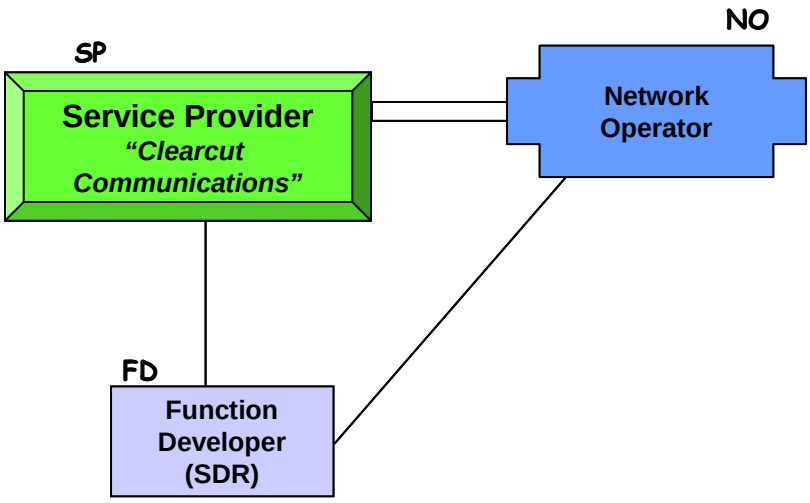
Terminals are provided by OEMs who may or may not be the same as provided the network infrastructure. Terminals are usually tailored to reflect the brand image of the SP.

3.5.2 Payment

The SP buys terminals from the OEM, and either resells it to the user, or provides it free of charge on the basis of future service commitments.

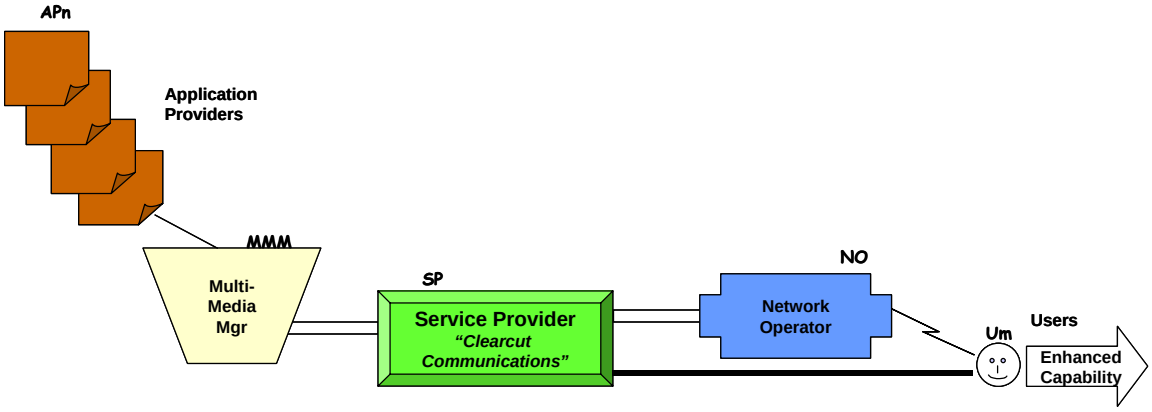
3.6 FD-SP-NO

The FD works with the SP to define system functionality, and with the NO to install it.



3.7 Apn-MMM-SP-NO-Um

Continued use of the system by users is dependent on their perceived value of the services received and used. No one organization can hope to fulfill all of the potential niche applications for specific groups of users. For that reason the architecture of the system must accommodate independent application providers. These organizations develop software that is delivered by the network to mobile users.



There are two models of the economic relationship between the SP and Apn.

3.7.1 Application Development Service

In this model, control of the application space remains with the SP, and the AP is under contract to develop and deliver the service to SP requirements. Control remains with the SP, and the SP markets the service. SP retains a large portion of the revenue.

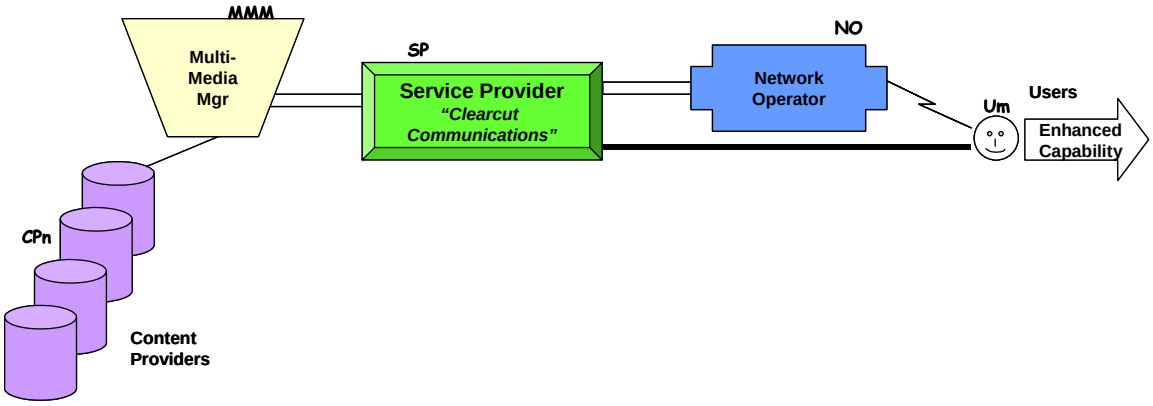
3.7.2 Independent Application Developer

The AP provides the entrepreneurial thrust in this case. The AP defines and develops the application, and the SP provides a delivery mechanism. The MMM

provides application development tools, and assures that the final result meets the SP standards for applications on their service.
The AP markets the service, and receives a commission on any service initiations resulting from users signing up for the SP service as a result of wanting the application. The AP retains control of the product, and receives the revenue from it after paying for carriage by the SP.

3.8 CPn-MMM-SP-NO-Um

This path is similar to the previous one, except that the CP is the owner of data that users want access to. The CP receives revenue based on amount of data demanded and paid for by users.

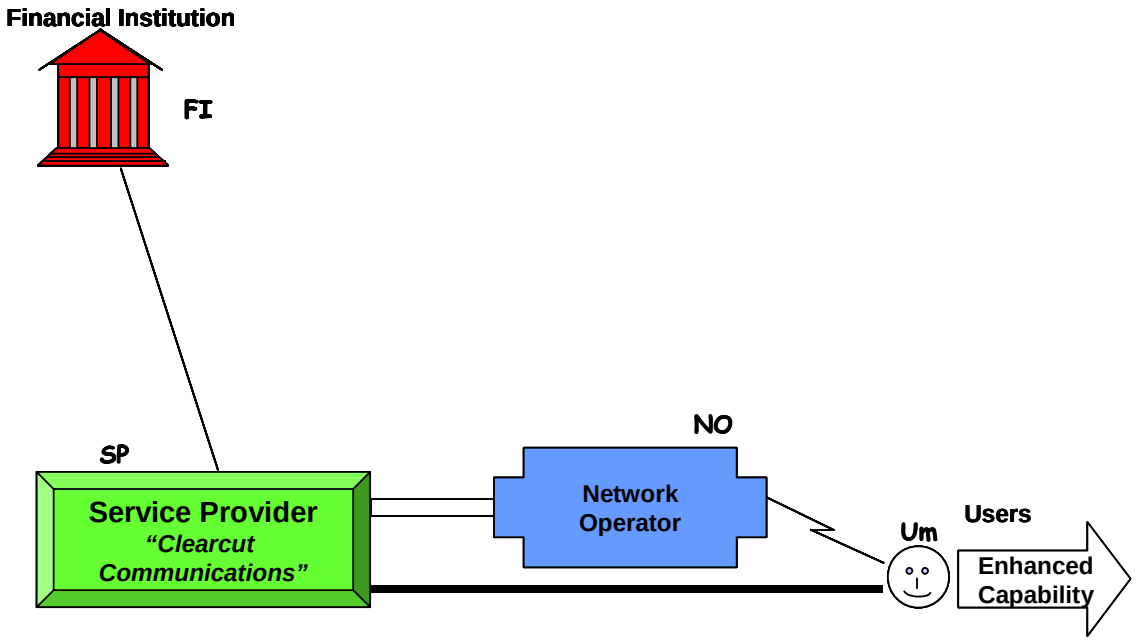


3.9 FI-SP-NO-Um

Financial institutions are providing alternate ways for consumers to pay for goods and services. Credit Cards and Smart Cards are two of the innovative approaches that could take advantage of the capabilities of a wireless system.

An institution issues a credit card to a user, permitting the user to purchase goods and pay for them later after receipt of an itemized bill. The mobile terminal can provide the same services by using a wireless link to establish the users identity and authenticate the credit line.

Under the Smart Card concept a supply of money is carried around in the mobile terminal. Spending these funds results in a reduction in the amount in the terminal's internal "purse." The chief difference between these approaches is the ability to make an anonymous purchase.


Financial Institution
FI
SP
Service Provider
"Clearcut Communications"
NO
Network Operator
Um
Users
Enhanced Capability

4 SDR Technology in the Model

SDR technology resides in the infrastructure operated by the NO. The hardware necessary is supplied by the OEM supplier. Software, however, and be initiated from a number of points in the model, and transferred by software download to the network. In this section we will investigate the impact on various participants of the availability of SDR on their individual business operations.

To fully understand the impact of Reconfigurability particularly within the Telecommunications Business one must consider the interactions of the actors within the Business model.

4.1 The Emergence of the Brand

4.1.1 The Traditional Model

The traditional telecommunications business model was developed from the early days of fixed Networks and extended into Mobile Networks. It tended to focus upon the Infrastructure Manufacturer, the Handset Manufacturer (which may be a different division of the Infrastructure Company as described above but is considered as separate for this discussion) and the Network Operator. The Service Provider was a key player for the Network Operator as the main customer interface, but within this traditional model was as a reseller of the airtime of Network Operators, (one or many) with little control on the operation of the Network itself. The state of development of the technology in the early days meant that Services in the Network sense, such as Call Forwarding, Call Waiting, etc were an integral part of the fabric of the Network and thus the sole responsibility of the Network Provider. Reconfigurability in this context was considered as part of Network Management and viewed as a capability for remotely changing parameters such as frequencies (within the spectrum allocated to the operator) and power levels within the Basestation for optimisation, re-hosting and other maintenance activities.

4.1.2 The Effect of Convergence

However in the new converging world of Information Technology and Telecommunications, the whole approach is changing. In the US ATT has been broken up, while elsewhere telecommunication companies are now predominantly privatized with shareholders and within the Mobile Business domain, there are much greater competitive pressures through recent spectrum auctions bringing new operator entrants into a market that in some areas is reaching a plateau in terms of the potential number of new subscribers. The current emphasis is therefore upon the provision of revenue generating innovative services for customer retention and possibilities of attracting customers from other networks. Mobile Operators are now focussing upon building a

direct relationship with the customer network and operator brand projection is of significant importance.

4.1.3 Over-the-Air Reconfiguration

A major factor in Operator Brand Projection has been the development of over-the-air reconfiguration for provisioning of SIMs in Handsets. This has allowed the customer to obtain handsets from standard branded retail outlets and deal directly with the Operator Customer Services departments building a customer relationship from the outset. To further build on this, some Operators have a close relationship with Handset manufacturers to specify the features and levels of reliability and brand the handset. This approach, however, has significantly eroded the original business model for the Service Provider and a different role as a Multimedia Service Provider has emerged.

4.1.4 The Multimedia Service Provider (MMSP)

This is an extension to the role of the Multimedia Manager described above. The MMSP acts a Multimedia Content aggregator by developing commercial relationships with different Content Providers to form a package of Services. In the MMM role he would negotiate with a Service Provider to sell the Package of Services which would then be branded by the Service Provider for their own customers to run on Service Platforms owned by the Service Provider. However there are a number of MMMs and traditional Airtime Service Providers previously focussing on the Voice Market that have made a decision to enter into the Multimedia Service Provider Role by offering an extended range of Services and Content hosted on their own Service Platforms. Broadcasters are also entering the arena as content providers and aggregators. In some cases the Network Operator may set up their own MMSP in order to ensure maximum revenue gain and brand projection and protection.

Further development of SIM download capability in the form of the SIM Toolkit enabling applications to be downloaded over-the-air to the Handset and run locally has greatly increased the scope and variety of features available to the User and therefore making a more attractive proposition. In addition current Handsets have the capability to download personalisation features such as ring tones and Screensavers from the Internet. Whilst this is encouraging usage of handsets and increasing airtime revenue for the Network Operator, this reconfiguration capability is also a means to provide significant competition to Operators with a strong brand presence. Handset manufacturers are increasingly promoting their own brand by offering internet sites where features and games can be downloaded over the air and this aspect of the commercial relationship between Operator and Manufacturer has to be carefully managed.

A good example of the differing revenue models adopted by different Operators can be seen in comparing the approaches to Multimedia distribution by NTT Docomo (Japan) and Orange (UK). Docomo heavily markets the I-mode cellular bearer technology over which content providers sell their services directly to the cell phone users on the basis of

a revenue share to Docomo. However Orange will form a direct relationship with Content Providers and market the services solely with the Orange brand or form strategic partnerships so that content is provided in such a way that both brands are promoted. An example of this is the Orange Traffic Service. When selected, an announcement is made prior to receiving the information - "The Orange Traffic Service is brought to you in conjunction with Royal Automobile Club and Traffic Master". Both Models are perfectly valid. The difference is that a much larger percentage of revenue share is retained by the Network Operator in the Orange model than with I-mode.

4.2 Impact of SDR

Software Defined Radio offers a number of key benefits and opportunities to all the actors within the various communications markets. The technology is already widely accepted as a necessity for Military Radio applications and increasingly within the Civil/Emergency Services market to enable Interoperability. However there are some considerable challenges and resistance from manufacturers using traditional techniques to be overcome in order for the technology to be widely adopted within the Commercial Cellular Market. These same challenges will also reflect across into the other markets but are initially likely to be addressed in a different way given that the users in the Military and Civil Market can be considered as a closed user group even if somewhat large in terms of numbers. However with the US Homeland Defense initiative in the context of the JTRS the merging of the requirements for all the markets in order to ensure interoperability will be a significant technological and market driver for the US and for its strategic partners. The section below looks at the Opportunities and Challenges of SDR in terms of the actors within the Business Model.

4.2.1 Benefits and Opportunities

4.2.1.1.1 Economies of Scale

Developments in Software Defined Radio will be beneficial to both Operators and Manufacturers. For Terminal manufacturers there is the opportunity to reduce costs through economies of scale being able to overcome make one design for the radio part for global markets and uploading the software at the last point in manufacture. For the manufacturer this is an opportunity to increase profit margins, however it is understood that Operators who buy Terminals at full price even though they may sell them with a subsidy will expect some of these savings to be passed on. This is a key commercial interface for the business model. The same argument can also be made for the basestation manufacturer. However, for the Operator, although cost reduction is an important issue given the potential investment in 3G networks, equally important is value for money. For example, a basestation at the same price could be acceptable if a wider range of features is available.

4.2.1.1.2 Ease of Upgrades and Fault Correction

A key business benefit for both Manufacturer and Operator is being able to download software upgrades to terminals and corrections as standards develop, potentially reducing returns to base and repair costs for both parties. The costs and logistics involved of changing out terminals on a mass-market benefit because of a software fault are huge. With terminal design for such technologies as 3G being potentially immature and the complexity of the technology itself means that this is a very real threat. Similar points can be made concerning the basestation.

4.2.1.1.3 Dynamic Network Reconfiguration

For the Network Operator, feature changes and fault management can already be carried out through existing remote Network Management systems. However SDR allows the possibilities of reconfiguring a particular Basestation to WLAN Office system during the day and wide area for busy hour or 2G to 3G or vice-versa depending upon the nature of the traffic. This approach also applies to Network Rollout where 3G Services can be dynamically rolled out to areas using 2/2.5G infrastructure according to customer demand.

4.2.1.1.4 Spectrum Management

Although the situation for global spectrum allocation is improving, there are still many instances where the use of particular bands of spectrum may be prohibited within a particular country, although available in other parts of the world for use by a roaming subscriber. SDR will enable local variations to be automatically applied as well as allowing Operators to join up spectrum allocations in different technology domains in a manner that is apparently seamless to the end user.

4.2.1.1.5 Content Provision Opportunities

The Software for SDR itself offers an opportunity for a third Party Software Provider who will in general form a commercial relationship with other parties in the value chain. Should this party be the Manufacturer or Network Operator then security and quality requirements are easier to specify for end to end operation. In the first instance it is anticipated that the Manufacturer will provide the SDR Software for the basestation and terminal for delivery in conjunction with the Network Operator.

For this scenario there is some concern about the possible situation where a third Party Software Provider is a MMSP offering such SDR software direct to the customer via an internet subscription without full support. The effect of a data corruption or error in SDR could be considerably greater than for application software as this is directly concerned with the operation of a Terminal rather than just a feature has potential implications for

the business case of the manufacturer and Network Operator/Service Provider. This is through having to potentially support Fault Finding and Customer Services queries for problems which are outside their control which in the event of an unsatisfactory solution may erode the brand values.

4.2.1.1.6 Common Look and Feel of Services

Within the Cellular Markets, particularly in Europe, it is widely accepted that there is a decline in the numbers of new subscribers as markets reach saturation. In addition the economy dictates that there is an emphasis on EBITDA performances in order to maintain the share price and commensurate value of the company. Therefore it is the stated aim of the majority of Cellular Operators particularly the Operator Groups such as Orange and Vodafone to increase the Average Revenue Per User in order to maintain their businesses. It is viewed that the main driver for increased ARPU in an increasingly competitive environment is the provision of innovative, compelling Services.

For companies with a strong brand presence who own networks supporting a number of different communications technologies, it is important for their brand projection strategies to have a common look and feel for services irrespective of the network technology.

At the same time it is recognized that the appeal of any particular service is greatly enhanced through its ability to support personalization.

SDR enabled Over-the-Air Reconfiguration offers opportunities to address these areas in a compelling manner. For example one can consider a possible scenario where a Wide Area Cellular user would be able to access a certain package of Operator branded services for display on his “thin client” SDR handset through the various technologies available on that network GPRS or HSCSD.

The User may then wish to change his display by activating his PDA linked by Bluetooth. This action will also request an over-the air service reconfiguration update to the network to request that the required information is re-purposed to suit the new display and then a reconfiguration command is delivered to divert the content.

However when the User enters his home he may wish to receive additional leisure services as well as office services so that a reconfiguration of his terminal occurs through the download of SDR to make it a Wireless LAN Terminal with greater bandwidth and an inter-domain handover takes place. While the service delivery is in progress he may then choose to have the service delivered to a different device Desktop PC within the same domain and through a reconfiguration request as above the service is diverted.

As described above the key factor throughout all of these changes is that the services are personalised but are always presented with a “Common Look and Feel” in order to maximise the brand projection and through a combination of over-the-air reconfiguration techniques and SDR can be delivered over the appropriate technology.

4.2.1.1.7 Special Needs

The support of those with Special Needs in the past has been regarded as a niche activity, with Research mostly focussing upon the Fixed Network, for example the Big Button phone for those who are visually impaired or with motor difficulties, and text phones for those who have impaired hearing.

However, there is now a large ageing population of a generation used to the convenience of the cellular phone, and who by nature of their age will naturally suffer some deterioration of their faculties. It is also the case that all sectors of the population will most likely at some point be in a situation, albeit temporarily, where one or more of the senses are impaired. For example those working in a noisy environment with protective gloves, have both their hearing and their dexterity affected, or the Fireman in a smoke filled building will be working in reduced visibility.

This means that rather than differentiating between those with Special Needs and other mass market segments, it now makes commercial sense, as well as being more socially acceptable, to treat Special Needs support as simply another aspect of mass market Service Personalisation. In adopting the same “Common Look and Feel” approach as described above this goes very much along the way to meeting a future vision of Ubiquitous Communication Capability - Anytime, Anywhere for Anybody.

In the same way the Personalization profile and Reconfiguration profile would contain information about the existing communication capabilities of the devices in the environment, and the preferred method by which the user wishes the information to be received and transmitted. However in this case it could include the description an interface device with the appropriate level of adaptation to suit the user within that particular environment which could also be dynamically configured by local Software download.

4.2.2 Challenges

4.2.2.1.1 Brand Erosion

The document has already described how within the Multimedia Business Model there are now opportunities for third Party Software Providers to act as an MMSP and market their own branded package of Services direct to the customer with the associated threat to the Brand of the Network Operator/Service Provider. Now that this Software Provider could now include SDR Software within his portfolio this presents new challenges to other actors within the Business Model.

Network Operators and Service Providers accept that there will be competition and those that already have a strong brand presence within the market will assign large-scale marketing budgets for both Customer Attraction and Retention to ensure that this remains

the case. This is a cost that has to be considered in the overall revenue stream model. However a particular concern to the existing Network Operator/Service Provider with considerable investment in the infrastructure is the possible situation where a third Party Software Provider is a MMSP offering such SDR software direct to the customer via an internet subscription without full support. The effect of a data corruption or error in SDR could be considerably greater than for application software as this is directly concerned with the operation of a Terminal rather than just a feature. This has potentially huge implications for the business case of the Manufacturer and Network Operator/Service Provider. It is likely that they will have to provide support for Fault Finding and Customer Services queries for problems which are outside their control, and that the third Party Provider is not able to resolve. In the event of an unsatisfactory problem solution by the Operator from a Customer perspective it is the Operator Brand values and confidence that may be eroded not the third Party Software Provider. This dissatisfaction may aggravate churn, which again has an impact on the revenue stream.

4.2.2.1.2 Security

Even where the source of the SDR software is trusted from a platform within the manufacturer's premises or within the premises of the Network Provider or Service Provider themselves there are still security issues to be considered. The process involves the delivery of the Software from the host platform to the Wireless Terminal across a number of system interfaces almost certainly involving transmission of data across the air interface. Corruption may occur at any one of these interfaces through natural causes as well as deliberate interventions described in the Security Vectors Threat Analysis of Document S&A-SEC SDRF-02-S-0010-V2.00

It is thus essential to ensure that only software that is approved by the relevant parties is able to be downloaded and this dictates the need for a common approach to the management of downloaded software. This is to ensure that correct functionality is maintained and access is only granted to approved parties. These features are addressed within the implementation of the RMA as described in Document SDRF-02-S-0015-V2.01 S&A-NET **:** Wireless Network Architectures and it is believed that if widely adopted will make a significant impact on the market.

4.2.2.1.3 Network Management

A key factor when assessing the merits of any new technology for introduction into the Network is how such a technology can be managed whist in Service in respect of remote configuration, performance optimisation and Fault Management. Existing systems already have an extensive remote reconfiguration capability through software download but changes in the air interface are currently restricted to power and frequency settings and antenna down-tilt settings. Remote RF Modulation changes through SDR will be a new feature.

Network Management issues are not just a concern for the Network Operator, as part of any normal commercial arrangement between the actors would be product support. A

Network Operator would normally put into place 7x24hr First and Second Line support, but it would be anticipated that this would be backed up by 7x24hr availability of product experts from the equipment manufacturer. It is then anticipated that the manufacturer would put a similar back-to-back arrangement into place with any third Party Supplier to offset their product liability.

For the basestation, live status information including alarms is required. It is likely that the technology will require additional software analysis skills to be learned by both the Network Management Staff and the Field Support Engineers for Fault Finding and training costs will have to be factored into the equation. The appeal of an SDR product will be greatly enhanced if consideration has already been given to simplify this.

The existing network infrastructures already have a significant Software Platform presence for hosting Services but these tend to be located in controlled environments. Detailed software analysis of a complex basestation located in an exposed location is less appealing than being able to identify and change out a faulty module as is now the case. However, should the “blue-screen-of-death” syndrome occur, and all remote access be lost, resulting in a field engineer visit to the basestation location, software updates are still simpler than module replacement.

When fault finding or carrying out software upgrades another key capability for the network is to be able to regress to a default or previous working condition to maintain links to the basestation and restore service as soon as possible. Some consideration will need to be given to this in the design of an SDR system. It may be preferable to have a default operating condition implemented in hardware.

4.2.2.1.4 Rogue Terminals

A particular cause for concern for all the actors within the business arena, but particularly for the operator and manufacturer, is the potential download of rogue software that would affect the operation of the handset. Worse still, particularly with Software Defined Radio, it could cause a loss of service to other users in the vicinity. This could cause a potential increase in calls to Customer Services from these users and unnecessary returns to the manufacturer for repair and possible erosion of brand values as above. It is essential that techniques are developed to remotely detect and disable a Rogue Terminal as part of a Network Management Capability.

4.2.2.1.5 Customer Relationship Management

The discussion on Network Management issues above has focussed predominantly on Basestation and Infrastructure issues, but the key driver for the whole business model is the revenue stream generated from the End User. The Service Provider establishes a relationship with the End User, which is in general channelled through the Terminal as a means of generating airtime revenue. SDR and Reconfigurability offer many benefits as described above but there are some issues that need to be considered particularly when SDR techniques are used.

As described above, the effect of a data corruption or error in SDR could be considerably greater than for application software, as this is directly concerned with the operation of a terminal rather than just a feature. The implication is that some tools and techniques will need to be developed to provide support for fault finding, assistance for Customer Services queries for problems which are outside their control, and issues that the third Party Provider is not able to resolve. In the event of an unsatisfactory problem solution by the Operator from a Customer perspective, particularly in the business setting, it is the Operator Brand values and confidence that may be eroded not the third Party Software Provider. This dissatisfaction may aggravate churn and loss of contracts, which again has an impact on the revenue stream.

5 Conclusion

Reconfigurable Radio and SDR techniques offer potential benefit to all the actors in the Business Model. However the impact of reconfigurability of an SDR is that it is likely to change the Business Model from the traditional model built around the Network Provider to one focussed upon the Service Provider.

It also allows the potential for Handset Manufacturers to project their own brand more prominently than that of the Network Operator or Service Provider by linking directly with the Customer through download of features and applications for personalisation outside the control of the Network Provider. This may possibly lead to difficulties in product support for Customer Services of the Network and or Service provider further eroding brand values and confidence.

In the worse case rogue software downloaded to the Terminal accidentally or maliciously may cause the performance of the network to be detrimentally affected which would affect the business case of all the actors. It is thus essential that all the legitimate actors in the SDR and Reconfigurable Radio Market space cooperate with each other to ensure techniques are put into place at the outset to combat this threat which would be detrimental to everybody.