White Paper

Dynamic SIM Allocation™
## Contents

**Introduction** 4  
Related documents 5

**Background** 6  
Provisioning in context 6  
How is provisioning done today? 7  
The problem with pre-provisioning 7  
A better way – Dynamic SIM Allocation 8

**Business opportunity** 9  
The size of the opportunity 9  
Business scenarios 10

**Detailed business scenarios** 13  
Network database efficiency 13  
Number supply efficiency 14  
SIM card supply efficiency – regional numbering 18  
Personalization - number selection 21

**Solution overview and integration** 26  
Solution architecture 26  
Business integration 29
Introduction

Today, it’s true to say that we live in a mobile world. There are over 4 billion mobile connections world-wide, almost 3 connections for every 5 people on the planet. By 2013, the GSMA predict there will be a total of 6 billion connections, attributing this growth to “the integration of mobile into previously unconnected devices and subscriber additions in emerging markets.”

Increasingly, the world is also choosing mobile broadband technology as the preferred way to connect to the internet and corporate networks. Mobile broadband technology is becoming more convenient, more widely available, and cheaper to use, helping to drive its adoption. Part of the reason for this is that mobile broadband technology is finding its way into consumer electronics and not just phones or dedicated mobile data devices.

Looking beneath the global facts and figures, one sees quite different market conditions for operators in different regions. In highly penetrated markets, growth has inevitably slowed (for instance, the ITU reports that Italy has a mobile penetration over 135% and growth of less than 10%). In developing markets, growth continues unabated (the ITU reports India has mobile penetration of less than 20% and growth of almost 80%). This variation means operators in different regions emphasize different goals – for example, increasing loyalty and retention in highly penetrated markets, and driving penetration through wider distribution and increased sales efficiency in high growth markets.

However, operators world-wide also share certain goals, as none are immune from the challenges in today’s economy and the financial crisis that has unfolded. The strategic imperatives that operators report include:

- Cost avoidance
- Growth from emerging markets
- Integrated / convergent products and services
- Balance sheet discipline

Never more so than now, operators need solutions that allow them to meet these goals – to save money yet still grow, to reduce costs yet still innovate. It is against this backdrop that this paper introduces a new and better way to organize one of the central business processes in a mobile network – the provision of service.

Mobile network operators, serving millions of customers every day, must carefully coordinate a number of activities to provision service. These tasks include forecasting, planning, supply chain management and provisioning. In the majority of networks, the supply of a SIM (Subscriber Identity Module) card is central to the whole process of service provision, no matter whether the device is a mobile phone, a laptop, or built in to a car or vending machine.

(This is why the term provisioning has two meanings. It is mostly the configuration of service platforms and network databases such as the HLR. But it also applies in some cases to the configuration of resources in the SIM card.)

The volumes involved in the process of service provision – shipping SIM cards and devices to thousands of retailers and millions of customers – mean that inefficiencies and constraints are multi-million dollar issues for operators.

This paper introduces the Dynamic SIM Allocation™ (DSA) solution from Evolving Systems. It enables a new way to provision service, called provisioning at first use, that has significant
economic and operational benefits for operators. Not only can the DSA solution save operators millions of dollars but it can also provide a new touch point for a dialogue with prepaid users.

The rest of this paper is organized as follows:

- **Background** – An overview of the service provision process and a description of the normal approach, *pre-provisioning*, and its problems

- **Business opportunity** – A summary of the business scenarios that the DSA solution can address and the problems it can solve

- **Detailed business scenarios** – A detailed description of each main scenario including, where appropriate, examples of the user experience

- **Solution overview and integration** – A description of the main solution components and an example of business system and process integration

**Related documents**

Using Dynamic SIM Allocation™ for Prepaid Registration, November 2008.
Background

Provisioning in context

The act of provisioning is just one activity in the overall business process of service provision. The other tasks include forecasting, planning, supply chain management and distribution, and, of course, customer care.

Some of the main activities that an operator must manage are:

- Demand and capacity management
  
  Forecasting demand based on a variety of market segmentation and demographic parameters. Translating forecasts into capacity plans for a variety of assets:
  
  - Physical inventory such as phones, accessories and, of course, SIM cards in various retail packaging such as cases, display boxes and blister packs.
  
  - Logical inventory such as phone numbers (MSISDNs) allocated from number ranges acquired from the numbering authority.
  
  - Inventory such as IMSI (International Mobile Subscriber Identifier) values that are allocated according to the relevant numbering rules but which also take into account network databases such as the HLR (Home Location Register).

- Supply chain management
  
  Managing the ordering, purchasing and distribution of goods supplied by 3rd parties such as SIM card manufacturers. The precise division of responsibility for personalization, packaging and distribution will depend on the 3rd party supply contracts.

- Provisioning
  
  The service provisioning process is often thought of as the process of adding a new subscriber but, in actual fact, is involved in almost all customer management activities. For example, it supports subscribers adding or modifying their preferences and service bundle, or reporting lost or stolen handsets and getting replacements. From a network operator’s point of view, the service provisioning process also supports fraud and revenue assurance activities such as barring if a bill is not paid.

  Essentially, the service provisioning process ensures that:
  
  - Access to the mobile network is authenticated and secure
  
  - The correct association is made between the IMSI and MSISDN
  
  - A subscriber’s preferences and service profile are created accurately

The rest of this section will examine the provisioning process in more detail, exploring the most common provisioning model, and looking at its advantages and disadvantages.
How is provisioning done today?

There are two main provisioning models in use by mobile network operators. Operators may implement both, using one for prepaid subscriptions and one for postpaid.

The first is what is called pre-provisioning. This is where a subscription is created and associated with a SIM card while the card is being manufactured. The result being, by the time the SIM card reaches retailers, it can be inserted into a handset and will immediately allow calls to be made. This model is often used for prepaid subscriptions as it widens the distribution network to include mass-market retailers that are not specialist communications service providers.

Indeed, pre-provisioning is very uncommon for postpaid subscribers, especially for business accounts where the services are too complex and customized to be set-up without detailed order capture and service design being done by the service provider.

It should also be noted that the pre-provisioning model does not require that the subscriber passes any personal details to the network operator. This has been seen as advantageous for some operators by lowering the barriers to entry and stimulating rapid subscriber growth. However, regulators are starting to require that network operators must begin collecting personal details for prepaid subscribers. In addition, some network operators have had policies to encourage the migration of prepaid subscribers to more lucrative postpaid contracts. This topic, called prepaid registration, is discussed in a companion white paper – see Using Dynamic SIM Allocation for Prepaid Registration.

The alternative model is called provisioning at point-of-sale. In this case, the subscription that allows a SIM card to register on the mobile network is only created as or after the SIM card has been sold by a retailer. It is possible that the subscription can be provisioned in near real-time, activating the SIM card before the subscriber leaves the retailer, but in many cases this is not achievable. This model is commonly used for postpaid subscribers. The need to collect personal details for the contract, as well as historically more complex postpaid service plans, has meant that users are more likely and more willing to use a specialist retailer to buy postpaid service.

While provisioning at point-of-sale (POS) is a flexible approach it requires a large investment in POS systems and infrastructure. If an operator is or intends to support sales via non-specialized retailers, such as supermarkets and convenience stores, then this approach is not viable – the cost of putting POS systems into 3rd party retailers, and training their staff, is prohibitive.

The problem with pre-provisioning

An early stage of the pre-provisioning process is when the SIM cards are ordered from the manufacturer with IMSI / MSISDN pairs specified by the operator. This allows the manufacturer to personalize the packaging of the cards by printing the MSISDN on them.

Later on, often when the SIM cards are dispatched from the manufacturer, the network operator creates the subscription for each IMSI / MSISDN pair. As a minimum, this requires the creation of a subscription in the HLR, along with a generic service profile, and the population of the AUC (authentication center) with the symmetric key (Ki) used for authentication and encryption.

Because the subscription exists in the HLR associating the IMSI and MSISDN, a handset holding the SIM card will be allowed to register on the network and authenticate. The generic service profile set in the HLR determines what services the subscriber can use.

The following table summarizes the advantages and disadvantages of this model.
Advantages | Disadvantages
--- | ---
• The phone works as soon as the SIM card is inserted in it and the battery is charged
• This enables a wide distribution network without requiring retailers to have sophisticated point-of-sale systems
• The subscriber can buy and start using a phone without having to use a website or other application to activate the service
• There is no provisioning in near real-time as the SIM card is sold, reducing the demands on the operator's infrastructure
• MSISDNs are associated with SIM cards a long time before the SIM card is available for sale
• This may contribute to poor utilization of MSISDNs as SIM cards may sit in the retail channel for a long time or may be lost, damaged or superseded
• HLR capacity is consumed from early on in the supply chain, increasing the associated capital and operating costs
• It is not easy for the subscriber to choose the phone number they want – they only have the choice of MSISDNs already associated with the SIM card stock their retailer has at the time
• There is no simple mechanism for the operator to capture personal details of a prepaid subscriber which may contravene local laws
• Contributes to the problems inherent with regional numbering and complicates the SIM card supply chain

A better way – Dynamic SIM Allocation

Operators using the Dynamic SIM Allocation (DSA) solution do not create IMSI / MSISDN pairs when ordering SIM cards. A MSISDN is only associated with an IMSI when the SIM card is used for the first time, delivering the main resource efficiency benefit similar to that achieved with provisioning at point-of-sale.

The critical ingredient of the solution allows for these SIM cards to be inserted into a handset and for the subscriber to then be able to interact with the solution to activate service. Recall that a SIM card that is not associated with a subscription, and the IMSI / MSISDN pair that the subscription contains, will normally not be able to register on the network, so Evolving Systems' solution demonstrates significant technical innovation.

This invention is called first use registration. It means that definitive values of both the IMSI and MSISDN can be allocated dynamically to a SIM card when it is first used. With the allocation taking place when the SIM card is sold, it can take into account not just the preferences of the subscriber but other factors such as location and sales channel.

The IMSI value that is allocated to a SIM card when it is manufactured is temporary and is overwritten by the definitive value. Using temporary IMSI values in this way provides a number of benefits that are described later in this paper.
Business opportunity

The size of the opportunity

On its way to reaching 4 billion connections, the mobile industry added 600 million new customers in 2007 according to the GSMA. In the same year, 1.15 billion mobile phones were sold, and a remarkable 2.65 billion SIM cards were sold. The fact that over 4 times as many SIM cards were sold as customers added provides some insight into the size of the problem.

Churn is one of the reasons that many more SIM cards are needed than net additions, as is the fact that there are SIM card inventories held along the supply chain in the warehouses of distributors and retailers. A final factor is the wastage of SIM cards that are shipped but never sold, due to loss, damage or obsolescence, or sold but never used.

A European operator has said that 50% of manufactured SIM cards were never used in a handset and that figure rose to 66% when they started giving SIM cards away for free. Another has said that they expect 30% of SIM cards in their own retail channels to be wasted, with that number rising to 80% in non-specialist retailers (such as supermarkets and convenience stores).

The impact of SIM card wastage is not just the cost of the SIM card, and associated logistics and retailing costs, but also the related costs and constraints due to wasted cards being pre-provisioned in the network.

These issues are likely to become much worse in the future because the number of SIM cards being distributed will increase. There are a number of reasons why this will happen, ranging from marketing strategies, changes in consumer demand, and technological developments.

On the supply side of the equation, in many countries operators have introduced SIM only deals and, at the same time, have dramatically increased the availability of SIM cards by making them free and easy to order from Web portals. This is one example of a marketing strategy where the operator chooses to “flood the market” with SIM cards, aiming to stimulate churn and gain market share.

There has also been an increase in the number of mobile devices sold that use SIM cards and associated changes in distribution strategy. One example is the explosive growth in mobile broadband and hence the rise in sales of dongles, data cards and laptop PCs with embedded radio modules. These data devices are often carried in addition to mobile phones and other connected devices.

On the demand side of the equation, in certain markets, consumers are making use of more than one SIM card even though they may have just one mobile device. This can be to swap SIM cards to get better coverage or cheaper rates when calling different contacts. Some frequent international travelers may carry prepaid voice and data SIM cards for each country they visit to get the best rates and allowances.

Finally, SIM cards are increasingly seen as disposable. To a certain extent, this is encouraged by a marketing strategy that makes them free and easy to order, but it can also reflect price / value discrepancies where, for example, it is cheaper for a consumer to keep getting a new SIM card with a voice minutes allowance rather than topping up the balance on an existing card.
Business scenarios

The business scenarios that the DSA solution can address include:

- Network database efficiency – Improve the utilization of network databases (HLR, AUC, IN, etc.) and provide better load balancing to reduce costs
- Number supply efficiency – Improve the utilization of numbers (MSISDN) to reduce costs and ensure availability
- SIM card supply efficiency – Improve the efficiency of the SIM card supply chain to reduce costs and ensure availability
- Personalization – Make it easier for end users to personalize their service through number selection and other self-care choices

This section provides a brief summary of the issues that can be addressed.

Network database efficiency

With pre-provisioning, once SIM cards are ordered from a manufacturer (more precisely, once the IMSI / Ki pairs are known), entries are created in various network databases such as the HLR and AUC. This means that because of SIM card wastage, database entries are created and never associated with a paying user.

For many service providers, this ‘wasted’ capacity in the network databases costs money. This is either because they pay the equipment vendor for each entry or ‘slot’ even if it is not associated with an active user, or because they have to buy and operate more instances of each database (HLR, etc.) because there is a limit on how many slots are supported on a single instance.

There is also the cost to the service provider of managing the early allocation of SIM cards to network databases. For example, most service providers find it far easier to order SIM card batches with a contiguous range of IMSI values, and to allocate each IMSI range to a single HLR (since that simplifies network routing configuration and avoids database dips into a flexible number register, FNR). Because of churn and SIM card wastage, IMSI ranges on the HLR become fragmented over time. This makes it harder and harder for the service provider to find suitably large free ranges.

Another issue with pre-provisioning is that the allocation of an IMSI range on a HLR to a new SIM card order cannot know how many of those SIM cards will end up being used. This is important since the HLR has two limits: an absolute limit on the number of slots in an instance, and a limit on the number of active subscribers. The latter is linked to the limit each network node has for BHCA (busy hour call attempts). So, with pre-provisioning, a SIM card batch that is allocated to a single IMSI range on one HLR, could run the risk of overloading the active subscriber limit of that HLR if more than the average number of SIM cards from it are sold and used.

Number supply efficiency

Some regulators and numbering authorities only provide number (MSISDN) ranges to operators with certain charges and conditions:

- There can be an upfront fee for acquiring new number ranges
- There can be an annual charge or rent for each number range allocated to an operator
• Number ranges are provided on the condition that a minimum utilization is achieved – measured as a percentage of numbers in a range allocated to active end users

In the latter case, the regulator may impose fines for poor utilization or may refuse to issue new number ranges.

The pre-provisioning approach allocates a MSISDN to each and every SIM card in the supply chain. Depending on the efficiencies of the supply chain, the number of inactive SIM cards can be a significant proportion of the number range, lowering the utilization. This increases costs for the operator and can lead to an operator having insufficient numbers to meet demand.

The impact of this can be greatly exacerbated if an operator wishes to distribute large numbers of free SIM cards without handsets – “flooding the market” with SIM only deals. This can result in a significant wastage of cards and hence even lower number utilization.

Another scenario where significant wastage can occur is when a tariff or price plan is replaced by a new version. It may be uneconomic to recall, re-package and re-provision existing SIM cards associated with the old tariff - leading, again, to more wastage and lower utilization.

**SIM card supply efficiency**

The supply of SIM cards to retailers can be constrained in two ways. First, with regional number plans and pre-provisioning, SIM cards are associated with pre-determined regions (actually, to the numbers in a region). Retailers have to stock many SIM cards types, one for each region they serve.

Second, with products or tariffs that have their own specific SIM card profile, retailers again have to stock many card types. In both cases, service providers have a complex demand forecasting and a SIM card distribution problem to solve. If they get it wrong, a retailer may be left without the right SIM card type to sell.

The impact of this is obviously negative to market share, subscriber growth and revenue if the operator is unable to meet demand. There is also the cost overhead of managing a complex SIM card supply chain.

Furthermore, in some countries, SIM cards and handsets are bundled together into a package before distribution to retailers. This magnifies the constraints described above, since, when a service provider wants to change a product or tariff, they have to recall the handset packages for updates. This is not only expensive to monitor and perform but it runs the risk of some packages being left for sale after a product has changed. In this case, some service providers will re-provision the SIM cards in those handset packages so that the user is directed to an IVR (Interactive Voice Response) system or to a call center, allowing them to explain to the user that what they have bought is no longer available. This re-provisioning is expensive and results in a poor user experience.

**Personalization**

The end user’s experience when buying and first using a mobile device is extremely important to operators. While the user experience delivered by a pre-provisioned SIM card is, in some ways, good (the SIM card works straight away), the pre-provisioning of numbers and other identifiers is a real constraint. Essentially, the end user has very limited choice over their number, with the option only to hunt through SIM card packages in the store.

This constraint is most acute in countries where great cultural significance is placed on numbers.
Performing a number change after buying the SIM card is possible, but then the end user has to ask the retailer to use their point-of-sale system, or must contact the operator directly. In many countries, the retailers of prepaid SIM cards do not have point-of-sale systems. And, in any case, there is still the cost and delay associated with placing an order for a number change post sale.

In certain countries, end users can potentially pay large amounts of money for vanity or golden numbers. Again, pre-provisioning creates large obstacles to offering this, as well as allowing the operator to monetize their stock of golden numbers. Even where point-of-sale systems are available, not all retailers have access to all golden numbers.

Another example of personalization requirements is prepaid registration, where the regulator or administration requires as service provider to collect personal details from its prepaid users. See the companion white paper *Using Dynamic SIM Allocation for Prepaid Registration* for more details on this topic.
Detailed business scenarios

Network database efficiency

Situation
Operators that implement the pre-provisioning approach can incur significant expenses for SIM cards that are not sold and, therefore, are not associated with an end user that is generating revenue. The pre-provisioning of the SIM card in the network means that network database “real estate” is used by inactive SIM cards. (The real estate refers to the cost of each slice or slot of network database capacity taken up by an IMSI.) Inactive SIM cards may never be sold, may be sold but never used, or may be sold and not used for a very long time. All of these situations increase the operator’s costs.

The impact of pre-provisioning network database capacity is:

- There may be a fee payable to the network equipment vendor. This varies from operator to operator. Many operators pay a licensing fee for each slot taken up in a network database by an IMSI. The main network database is the HLR but this licensing model can apply to other equipment such as AUC and OTA (Over-the-Air) platforms.

- The network database equipment has a finite capacity. An operator will have to purchase and operate additional network database platforms in order to support the total number of records pre-provisioned in the network for each SIM card (whether active or not).

- There is another subtle effect that can arise because of pre-provisioning. This occurs when SIM card batches are ordered and distributed with contiguous ranges of IMSI values, and where a single IMSI range is associated with a single HLR. This means the allocation of a SIM card to a HLR is made when the card is manufactured, a long time in advance of when the card is sold and used.

This means it is difficult to distribute records evenly among HLRs. An operator has no way of knowing how many and when SIM cards in a single batch will be sold (many can be wasted). In particular, this means that if an HLR becomes overloaded, there is nothing that can be done to prevent SIM cards already in the supply chain been sold and adding further to the problem.

This not only means that inactive SIM cards can cause significant costs for operators but also that any change in marketing or distribution strategy could have large incremental costs. In fact, operators have said that they have had to push back against marketing plans that would have dramatically increased SIM card distribution because these incremental network costs could not be funded. These marketing plans have included the roll-out of mobile broadband products as well as new strategies for prepaid SIM card distribution.

Possible solutions and barriers
One possible way to avoid the pre-provisioning of SIM cards in the network is to adopt a provisioning at point-of-sale approach, where every SIM card is provisioned on-demand. This approach, however, has a very high cost associated with providing the point-of-sale systems and infrastructure. More importantly, it does not work well when operators are trying to widen the distribution of SIM cards away from traditional operator-owned stores.

Another approach that may be attempted is to try and use device detection tools to detect the use of a SIM card that is un-provisioned. The main problem with this approach is that the event
that is detected is the failure of the SIM card to attach to the network. The result is that the end user has a very poor experience of seeing an error message and being forced to re-try (and not simply call the operator or throw the phone away!).

**DSA solution and benefits**

Evolving Systems’ DSA solution allows SIM cards to be distributed without pre-provisioning but it retains the same, simple user experience of turning on the phone and being able to make calls. By avoiding pre-provisioning, the solution avoids the costs associated with allocating resources for inactive SIM cards in the network databases. Only active SIM cards are provisioned in the network.

An operator that is addressing this problem may well choose not to allow number selection. Instead, the end user is simply allocated a number automatically without any intervention.

**Business case**

The business case has two main components.

- Improve utilization of network databases
  - Reduce the capital cost of acquiring new databases
  - Reduce the operating cost by avoiding new databases
- Reduce SIM card inventory
  - Reduce SIM supply chain / logistics costs
  - Reduce administrative effort

**Number supply efficiency**

**Situation**

Every mobile network operator must maintain an inventory of phone numbers (MSISDNs) in order to meet demand. This means that operators must not only manage their inventory of numbers effectively but also meet any requirements set out by the numbering authority from which number ranges are acquired.

It is common for numbering authorities to impose strict requirements on the utilization of existing number ranges before they will release new ones. For mobile operators, therefore, ensuring that number utilization meets the minimum requirements is critical. If it does not, then the operator can find that they are unable to acquire new number ranges. Why could this be a problem? If the utilization of existing ranges is low, doesn’t the operator have spare numbers available?

In fact, one of the major contributing factors to poor utilization of numbers is the wastage or leakage of numbers because they are pre-provisioned to subscriptions associated with SIM cards that never get used. These numbers are unavailable for use unless they are recycled.

An African operator has said that their model was a “spray and pray” approach where they put as many SIM cards as they could into the market through multiple channels. They were unable to achieve an utilisation of more than 60% of their number ranges.
The issue is compounded by the fact that pre-provisioned subscriptions consume the MSISDN from early on in the SIM card supply chain. As a result, numbers are allocated a long time before they are distributed to retailers as the SIM card supply chain can be 40-90 days long.

For example, if an operator with 10 million subscribers sells 10,000 SIM cards a day, and the supply chain is 60 days long, then the pre-provisioned SIM cards require 600,000 HLR entries which are 6% of the total HLR space used.

There are many root causes to the leakage of numbers in this way. Some examples are:

- Supply chain issues
  - SIM cards are lost or damaged in the supply chain
  - SIM cards are abandoned when a retailer folds and closes down
  - SIM cards are made obsolete by re-branding or some other change
  - If SIM cards are manufactured with an expiry date, they may be destroyed after that date

- Customer usage issues
  - Some operators offer free prepaid SIM cards – they may be ordered but never used
  - Some operators cancel prepaid SIM cards with some months of zero balance

The same flexibility and portability that SIM cards provide to prepaid users also causes them to be seen as disposable items, leading to the leakage of numbers that can result as SIM cards are disposed of. The DSA solution doesn’t help with SIM cards that are disposed of after being used but it does prevent number wastage for SIM cards that are manufactured and never used.

The impact of poor utilization of numbers is also seen when one looks at the cost of acquiring number ranges. It is increasingly common for the numbering authority to charge for each new number range or even levy penalties for unused numbers. And, in some countries, as well as an up-front charge, an annual rental is also charged. For example, in at least one country in Africa, the numbering authority charges an up front fee of $4 million for 10 million numbers and is considering an additional annual rental charge of $2 million. Poor utilization, therefore, has a direct impact on operating cost.

**Possible solutions and barriers**

One possible way to mitigate number wastage, and to avoid the pre-provisioning of numbers early on in the supply chain, is, of course, to adopt a provisioning at point-of-sale approach. This only allocates a MSISDN at the point-of-sale. But, as we have seen, the provisioning at point-of-sale approach carries a large burden in terms of the retail and back office infrastructure required. Fundamentally, the requirement to have sophisticated point-of-sale systems in shops just does not scale for the many countries that have very large prepaid subscriber bases in rural or undeveloped regions.

Another approach is to accept that number wastage occurs and to have a MSISDN recycling process to make numbers available again for use. A barrier to this approach is that it requires an expiry or sell-by date on the SIM card. This can result in expired SIM cards being sold, assuming the retailer does not properly manage the disposal of expired cards, with the result that the customer has a very poor user experience and the operator incurs customer care and logistics costs as they deal with the customer and dispatch a replacement card to them.
A further barrier to MSISDN recycling is that, while a network operator may have the back office systems in place to perform it, they may have service providers or MVNOs (Mobile Virtual Network Operators) that are unable to recycle numbers. In this case, the effectiveness of recycling will be reduced if it is only applied to the operators’ own numbers.

**DSA solution and benefits**

The DSA solution provides a powerful solution to the problems of poor utilization of numbers. Because the solution does not allocate a MSISDN to a subscription until the SIM card is first used, it has the same efficiency benefits as provisioning at point-of-sale. Number wastage does not occur essentially since MSISDNs are not allocated until they are needed and SIM cards in the supply and distribution chain do not consume MSISDNs at all.

The solution allocates the definitive IMSI and MSISDN values based on the preferences of the subscriber. As before, the allocation process can be completely automatic or can involve interaction with the subscriber.
User experience

The user inserts the SIM card and powers on the phone.

The user is then prompted to either receive a number allocated automatically by the solution or to browse a list of available numbers.

In this case, the user has chosen to receive an automatically allocated number. This step may be missed out if an operator does not wish to allow users to browse a list of available numbers.

The user is told what number has been allocated to them.

To act as a more permanent reminder, the user is also sent a text message confirming their new number.

Business case

The primary component of the business case is reducing costs and driving revenue through the improved utilization of numbers and the elimination of number wastage. Improved utilization reduces the quantity of number ranges an operator has to acquire from the numbering authority, leading directly, in those countries where charges are levied for numbers, to a reduction in operating cost.

The other significant benefit of improved utilization is that an operator will not face the situation of being unable to meet demand due to a number shortage. It may be surprising, but in the operators that Evolving Systems has spoken with, a number have said that they have run out of numbers, at least in certain regions, and been unable to take on new subscribers. Clearly, as well as the damage to reputation and brand that this may cause, every subscriber that cannot be serviced will go to a competitor. The revenue and profit that they generate is lost.
In summary, components of the business case are:

- Improve utilization of MSISDN inventory
  - Reduce cost of acquiring and owning number blocks
  - Ensure new number ranges can be acquired to support subscriber take-on

**SIM card supply efficiency – regional numbering**

**Situation**

In some networks, the population of subscriptions in the HLR is constrained regionally. Commonly, this is when the MSISDN is a geographic number, but other factors may also have been taken into account including network size, signaling network design, network management or simply convention and history. In any case, the situation is that subscribers with phone numbers in region A, say, must be allocated a MSISDN / IMSI pair located on a HLR also in region A.

As a result, when SIM card batches are ordered, they are destined for a named region in which the IMSI range for that order is located. This places limits on supply chain management, stock control and distribution.

One of the biggest constraints is that SIM card stock cannot be easily moved between regions. While, in theory, stock could be moved from one region to another, this requires updating the translation tables on each mobile switching center (MSC). In order to prevent the translation tables becoming fragmented and difficult to manage, such stock movement would ideally need to involve large batches of, say, 10,000 SIM cards. As a consequence, operators may find that they are unable to meet demand for new SIM cards in one region while having an excess of SIM cards in another.

In order to avoid this situation, operators will be tempted to increase the amount of stock held in each region, to create a bigger buffer against running out of stock. Excessive stock levels are expensive for operators to maintain, as each SIM card batch has its own procurement, logistics and retail costs. For example, estimates provided to Evolving Systems state that the cost per SIM card of logistics and retail is as much as 2.5 times the cost of the SIM card itself.

Compounding the situation of excessive stock is the fact that either every retailer, or just retailers that are located on the boundary of different regions, are required to hold stock that can operate in all the regions or those surrounding them. This not only increases their retailing costs but it also increases the administrative effort required to track and forecast demand in many regions and retailers. Of course, as well as needing to hold SIM card stock for each region, the retailer also has to hold each type of SIM card that the operator supports.

In summary, the business issues created by regional numbering are:

- SIM card stock cannot easily be moved between regions
- This can result in demand not being met in one region while another has a surplus of stock
- Forecasting demand for many regions causes operators to hold excessive levels of stock
- There are real procurement, logistic and retail costs due to excessive stock
• In addition, the administrative cost is higher to manage forecasts and stock distribution

Possible solutions and barriers
If the biggest issue created by regional numbering is the inability to easily move SIM card stock to meet demand, then one possible solution has already been mentioned and dismissed, that is the option to simply allow stock movement by manually reconfiguring the MSC translation tables for the affected IMSI ranges. As stated above, this option has high administrative costs and practically requires SIM card batches to be moved completely to avoid translation table fragmentation. For operators with many, small retailers, it is likely that SIM card batches are split as they are distributed to the retailers, which would make this option very difficult.

A second potential solution is to remove the restriction between IMSI range and region altogether by using a flexible numbering approach. The barrier to this solution, in some circumstances, is that it exacerbates the signaling network limitations that are themselves the cause of regional numbering. For some operators this is a viable solution, but for others it is not without a major overhaul of the signaling network.

DSA solution and benefits
The DSA solution, with its innovative first user registration capability, addresses the problems caused by regional numbering. Using the solution, operators order SIM cards with temporary IMSI values. The temporary IMSI values are associated with the First Use Register component of the solution rather than an HLR and this means that SIM cards can be dispatched to any region. Clearly, SIM cards can also be moved any number of times between regions and retailers, as the definitive IMSI and MSISDN values are only allocated when the SIM card is first used.

The SIM cards with these temporary IMSI values can be thought of as being generic or universal. Not only are they not constrained regionally, but operators can also use the same universal SIM card for both prepaid and postpaid subscribers, rather than manufacturing and supplying SIM cards that are tied to a charging method.

In fact, one operator that has addressed this problem using the DSA solution had almost 2,000 different SIM card inventory lines to manage – a combination of multiple products types (e.g. prepaid, postpaid, SIM only, etc.) and 350 different geographic area codes. The complexity of managing these inventories led to SIM card wastage of 20% and situations where SIM cards were not available to meet demand.

When a SIM card is first used, the solution allocates the definitive IMSI and MSISDN values based on the preferences and location of the subscriber. The solution allows for subscribers buying SIM cards outside their normal region and will ensure that the values are allocated based on the correct geographic number. The allocation process can be completely automatic or can involve interaction with the subscriber.
User experience

The following charts present an example user experience.

The user inserts the SIM card and powers on the phone.

They are prompted to state whether they are in their home location or not. This is needed since the solution will allocate a geographic number and therefore needs to know what location/region to use when selecting the number.

In this case, the user says, yes, they are in their home location.

The solution then automatically determines the location of the handset and therefore what geographic region they are in.

The user is then prompted to either receive a number allocated automatically by the solution or to browse a list of available numbers.

In both cases, the solution takes into account the user’s location in order to determine which geographic numbers to use.

In this case, the user has chosen to receive an automatically allocated number. This step may be missed out if an operator does not wish to allow users to browse a list of available numbers.

The user is told what number has been allocated to them.

To act as a more permanent reminder, the user is also sent a text message confirming their new number.
Business case

There are two main components of the business case. First, the reduction in SIM card inventory due to supplying universal SIM cards to all regions and retailers results in lower costs. Second, operators offering the unique user experience provided by the DSA solution can improve their competitiveness and drive revenue.

In summary, components of the business case are:

- Reduce SIM card inventory
  - Reduce SIM supply chain / logistics costs
  - Reduce administrative effort
  - Reduce network capacity requirement / costs
- Improve competitiveness
  - Reduce churn and increase customer lifetime value
  - Ensure new number ranges can be acquired to support subscriber take-on

Personalization - number selection

One feature of the DSA solution that has particularly excited many operators is the ability to allow prepaid subscribers to choose their phone number.

SIM cards that have been associated with pre-provisioned prepaid subscriptions can be sold in a variety of retailers without requiring a point-of-sale system. But this approach does not allow the subscriber to choose their number, other than by looking through the SIM card packages that the retailer has available at the time.

In many markets, the cultural significance of a number is very high, and interest in being able to choose a number is seen as offering a major competitive advantage. It is not uncommon, for example, for retailers in some countries today to have boards listing the available numbers from their SIM card stock – as each one is sold the retailer wipes the number off.

Vanity and golden number monetization

If numbers have cultural significance, or subscribers are simply excited by the novelty of being able to choose their own number, then certain numbers could have direct commercial value to operators.

Vanity, golden or easy-to-remember numbers could attract an up front fee. All too often, operators say that they have no way to distribute vanity numbers to their retailers. Even if retailers do receive an allocation of such numbers, they complain that they cannot look at the numbers available in different branches of the retailer or what numbers the operator could make available to them.

DSA solution and benefits

The DSA solution enables operators to offer subscribers interactive number selection as a natural part of the first use registration process. The temporary IMSI value allocated to the SIM
card means that, as the mobile device is first used and attempts to register on the network, the registration is directed to the First Use Register component of the solution rather than an HLR.

As soon as this happens, the solution creates a temporary subscription in order to allow the device to register, authenticate and establish a mobile communications session. The subscription permits just an interactive dialogue with the user of the device, allowing them to browse and choose their number through a SIM based application.

The interaction allowed by the solution includes:

- The user can choose to have a vanity number but has no choice over which one.
- The user can receive a short list of available numbers and select from it. If there are no suitable numbers in the list, the user can request a new list. The number of times the user can request a list can be restricted to a certain number of attempts.
- The user can enter a few digits and the solution will return a list of available numbers that pattern match the entered digits. For example, the user could enter “888” and receive numbers such as 07799 1288834, 07799 123888 or 07799 888888.
- The user can enter a few characters and the solution will return a list of available phone number mnemonics. For example, the user could enter “JOHN” and receive numbers such as 07799 125646 (12JOHN) or 07799 564611 (JOHN11).

**Charging**

The solution allows operators to monetize their valuable number inventory with a variety of different charging models.

In one model the operator creates different tiers of SIM card package. At the bottom tier, either no number selection is allowed or the user can only choose a normal, non-vanity number. This lowest tier has the lowest price (which could be zero). The next tier would have a higher price and would allow the user to choose a vanity number. The next tier would also allow the user to choose a vanity number but its higher price would allow the user to choose from a list of more valuable and preferred numbers. Operators would be free to decide how many tiers to choose and how to allocate their vanity number inventory to them.

In another model the price of a number would be debited from the prepaid account balance. This model requires prepaid SIM cards to contain a starting balance. It also means that the price of the numbers would need to remain lower than the price of the starting balance although, similar to the model above, the operator could make available SIM cards with different starting balances and different prices.

It is also possible to integrate the solution with an m-commerce platform and allow for the charges for a number to be paid for from a credit or debit card.
User experience
The first example considers the simple case of a subscriber browsing a list of available numbers.

The user inserts the SIM card and powers on the phone.

The user is then prompted to either receive a number allocated automatically by the solution or to browse a list of available numbers.

In this case, the user has chosen to browse a list of available numbers.

The user is told what numbers are available to them.

They can also request a new list if they don’t see a number they like.

The user is told what number has been allocated to them.

To act as a more permanent reminder, the user is also sent a text message confirming their new number.
The next example is slightly more functional. It shows how a user can search for numbers that pattern match a number of digits that they enter.

The user inserts the SIM card and powers on the phone.

The user is then prompted to receive a number allocated automatically by the solution, browse a list of available numbers, or search for numbers that match some digits they are prompted for.

In this case, the user has chosen to search for a number.

The user has entered the string “123” when prompted.

The operator can control how many digits can be entered and also how the solution searches for that subsequence in the available numbers.

The user is told what numbers are available to them.

They can also request a new list if they don’t see a number they like.

The user is told what number has been allocated to them.
To act as a more permanent reminder, the user is also sent a text message confirming their new number.

---

**Business case**

Adding the possibility for prepaid subscribers to choose their number can stimulate revenue for operators in two ways. First, the offering may positively affect competitive differentiation and thus increase market share by attracting more new subscribers. The result is lower churn and higher customer lifetime value, directly increasing revenue.

Second, the option to monetize vanity or golden numbers can provide a new revenue stream for operators, either through selling higher priced SIM cards that grant the ability to choose a vanity number, or by integrating with an m-commerce platform.
Solution overview and integration

Solution architecture

One of the main innovations in the DSA solution is the process of first use registration. As stated, this allows SIM cards that are not associated with a subscription in the network to be inserted into a handset and for the subscriber to then be able to interact with the solution, over the mobile network, to activate service. Recall that a SIM card that is not associated with a subscription, and IMSI / MSISDN pair, will normally not be able to register on the network.

This section explains at a high level the operation of first user registration. The next section describes how the complete solution is integrated into existing business processes and systems.

Wireless device registration

This section briefly summarizes how mobile devices register on the network. It shows the main functional network elements involved in registration and authentication.

As the following figure shows the HLR is the key network element that signaling messages are addressed to when either a mobile device registers on the network or when call handling takes place - in this figure when a mobile terminating call is received.

The registration procedure is the cornerstone of mobility management in a cellular network, allowing the mobile device to inform the network of its location. A mobile device will register when it is first switched on as well as periodically after power up.
First use registration

First use registration is the process that detects that a mobile device is being used for the first time and triggers the allocation of definitive IMSI and MSISDN values. While there are a number of different business scenarios that can be addressed by the DSA solution, the process is core to them all.

The figure shows that the solution is addressed as if it were an HLR when the device is first switched on. The solution allocates a temporary MSISDN from a pool that it manages, enabling it to establish a generic service profile for the device. The service profile allows the device to take part in either SMS (Short Message Service) or USSD (Unstructured Supplementary Service Data) dialogue that is sufficient for the optional user interaction and the update of the SIM card at a later stage.

What happens next depends on the business scenario being addressed and on options chosen by an operator. The simplest case is when the solution is being used to improve the utilization of MSISDNs and where the operator has chosen not to allow the user to select their own MSISDN. Instead, the solution automatically allocates one.

In this case, the solution allocates a definitive, or permanent, IMSI and MSISDN from a pool that it manages. The solution ensures that all network databases, such as the AUC and HLR, are updated correctly with the definitive values.

Finally, the solution updates the SIM card to change the temporary IMSI to the definitive value. This is followed up with a short message reminding the user of the number that has been allocated.
Solution components

The main components of the solution are shown in the following figure.

The main components and their interfaces are:

- **First Use Register** – This integrates over a SS7 / SIGTRAN interface to the MSC / VLR to detect when a SIM card attaches to the network for the first time, and to enable USSD or SMS dialogue with the device. It also acts as a proxy to the AUC during network attachment.

- **Task Management** – This component orchestrates the overall process. It also integrates to network systems, such as SMSC and OTA platforms, and to business systems, such as billing, provisioning, and dealer management application.

- **Resource Management** – This maintains the resource inventory used by the DSA solution (temporary and definitive IMSI and MSISDN values). It also integrates to the existing ERP (Enterprise Resource Planning) or SCM (Supply Chain Management) systems for the purposes of SIM card ordering.

- **Menu Server** – This enables the flexible and dynamic definition of menus presented on the end user’s handset.

The DSA solution supports a range of handset integration options, covering both the underlying mechanisms and bearer services used for interactive dialogue and SIM card updates (e.g. USSD, OTA / SMS) as well as the handset application (STK, DSTK). The choice between these options depends very much on each operator’s environment and detailed requirements.
**Business integration**

This section explores how the DSA solution integrates with the existing business processes and systems in an operator. While every operator has unique processes, it is possible to describe a generic fulfillment process that includes elements of the three processes mentioned at the start of this paper: demand and capacity management, supply chain management, and provisioning.

**Current business processes**

The figure below shows a high-level schematic of the processes involved in ordering and supplying SIM cards where subscriptions are pre-provisioned.

The systems listed are logical descriptions only; the actual mapping of process step to system will depend on an operator’s existing back office infrastructure. Some systems shown below may be combined into enterprise solutions such as enterprise resource planning (ERP) and supply chain management (SCM). Where possible, the sequence of activities is shown left to right (i.e. steps on the left happen before steps on the right). The position of activities vertically does not necessarily relate to the system that would implement them.
Forecast demand

Plan IMSI, MSISDN and HLR capacity

Create new IMSI / MSISDN ranges

Order SIM cards with IMSI / MSISDN pairs

Encryption keys loaded into AUC

Manufacturer returns list of values for Ki, PUK, PIN, etc.

SIM cards dispatched to distribution

Update translation tables for new ranges

Subscriptions pre-provisioned in network
Processes with Dynamic SIM Allocation

The figure below highlights how the DSA solution integrates with existing business systems. Compared to the previous figure, new activities are shown with a black border; changed activities are shown with a white background.

It can be seen that five new activities are introduced, two of which happen one time, and three which are repeated. The one time set-up of the IMSI range to be used as temporary IMSI involves both a resource management and a network management activity. Once the range to be used as temporary values is set up, the solution manages the pool of temporary IMSIs and will recycle them.

The next new activity, as well as a change to existing processes, is to use the DSA solution as the source of IMSI value lists to send in SIM card orders. This replaces the existing process of using the resource management system to allocate new IMSI values for orders. As expected, the solution only allocates IMSI and not MSISDN values.

The process of ordering, purchasing and distributing the SIM cards is the same (although, it is simplified since SIM cards can be sent to any region and retailer). Similarly, when the SIM manufacturer returns the list of encryption key values for each SIM card, the AUC is updated as normal. Note that this is optional and that it is also possible for the DSA solution to provision the AUC on-demand as the SIM card is first used.

The final change, at this stage in the process, is to remove the bulk provisioning of subscriptions triggered by the dispatch of SIM cards. It is replaced by either the on-demand provisioning of the HLR, and other service platforms as needed, as the SIM card is first used, or a repeated process of allocating and provisioning batches of definitive IMSI / MSISDN pairs in the network. These pairs create a pool of definitive subscriptions that the DSA solution used when detecting the first use of a mobile device.

This is an optimization, although it has the effect of placing a limit of the numbers available for allocation. The former approach is to avoid any pre-provisioning at all and simply create definitive subscriptions on-demand. The issue with this is that it imposes a large demand on the existing provisioning system to support on-demand provisioning of new subscriptions.
- **Process:** Demand and Capacity Management
- **Systems:** Forecasting
  - Forecast demand
  - Plan IMSI, MSISDN and HLR capacity

- **Systems:** Resource Management
  - Create new IMSI / MSISDN ranges
    - Order SIM cards with temporary IMSIs
    - Encryption keys loaded into AUC
    - SIM cards dispatched to distribution
  - One time create IMSI range used as temporary IMSIs
    - Manufacturer returns list of values for Ki, PUK, PIN, etc.
  - One time update so that temporary IMSIs route to DSA
  - Provide temporary IMSI list from pool

- **Systems:** SIM Order Management
  - Definitive IMSI / MSISDN batch identified

- **Systems:** Purchasing
  - Batch of definitive IMSI / MSISDN pairs provisioned

- **Systems:** Dynamic SIM Allocation
  - Definitive IMSI / MSISDN batch allocated

- **Provisioning:** Network Management
- **Provisioning:** Customer Relationship Management
- **Provisioning:** Service Provisioning
  - One time update so that temporary IMSIs route to DSA
About Evolving Systems

Evolving Systems, Inc. (NASDAQ-EVOL) is a provider of software and services to over 70 network operators in more than 40 countries worldwide. Its portfolio includes market-leading solutions for activation, dynamic allocation, number portability, number inventory and mediation. Founded in 1985, the Company has headquarters in Englewood, Colorado, with offices in the United States, United Kingdom, Germany, India and Malaysia. Further information can be found at www.evolving.com