

The expanding machine to machine market – opportunities for the Communications Service Provider

Nokia Siemens
Networks



Machine to Machine Connectivity

Introduction

There are billions of machines throughout the world, electronic or mechanical, that need to communicate autonomously with other machines. Machine to machine (M2M) communication is therefore not new but until now has relied on a whole range of industry-specific technologies to achieve this communication. These include radio frequency identification (RFID) transponders, optical recognition solutions, satellite-based communication (including GPS-based systems), radio broadcast techniques and a whole range of fixed or wireless-based network approaches.

There are, however, various M2M needs that can be extremely well served by cellular network technologies, particularly at a time when Communications Service Provider (CSP) voice service revenues are declining due to saturation and new opportunities are being sought after. This is of particular interest when the machine in question is itself mobile, for example a car or truck, and the data can be treated similarly to subscriber data. The market, albeit still underdeveloped, is expanding rapidly as more and more applications and areas of usage are being found. There are therefore potential opportunities for CSPs operating cellular networks and offering services on top of them, and these are becoming of increasing interest as CSPs seek to avoid becoming simply “bit-pipe” providers, where most of the added value comes from elsewhere. If, however, the data storage, processing and routing capabilities inherent in the network are effectively utilized, then an entirely new world of possibilities opens up.

A machine that can autonomously communicate using cellular (SIM card-like) techniques can be treated, for data communications purposes, as if it were another “subscriber”.

This document attempts to briefly examine the most commercially appealing M2M communications applications utilizing cellular technology and discusses CSP opportunities. It also shows a current use case as an example, from which it will be seen that provision of a real-time data repository for subscriber data management is a key benefit for CSPs considering entry to this market. The paper concludes with a short explanation of the Nokia Siemens Networks Subscriber Data Management solutions applicable to this segment.

M2M Market Considerations

A potentially huge market

Although the cellular M2M market is today small, it has major potential. It is even possible that in the near future this market will grow faster than the voice services market. One of the reasons for this is that in times of economic crisis, businesses look for new ways of optimizing their operational costs. In addition, as connection technologies and wireless devices have matured and become more easily and cost-effectively available, machine to machine connection has become increasingly feasible, with some applications (such as energy consumption metering) being actively encouraged at government level.

the price of the M2M infrastructure goes down, the number of applications of M2M technologies will increase. This is however conditional on cumbersome applications, inflexible service conditions and prohibitive installation procedures not hampering growth prospects. Taking an approach geared towards subscriber-centric business models, however, will allow CSPs to pursue innovative new business models and revenue-generating possibilities.

While the value of the M2M market will depend on various factors and some of these are related more to human psychology, geographical and cultural issues than to technical aspects, growing competition in the existing cellular communications market and the squeezing of average revenue per user (ARPU) is fueling the search for new business opportunities. As



Figure 1: Opportunities in the machine to machine market

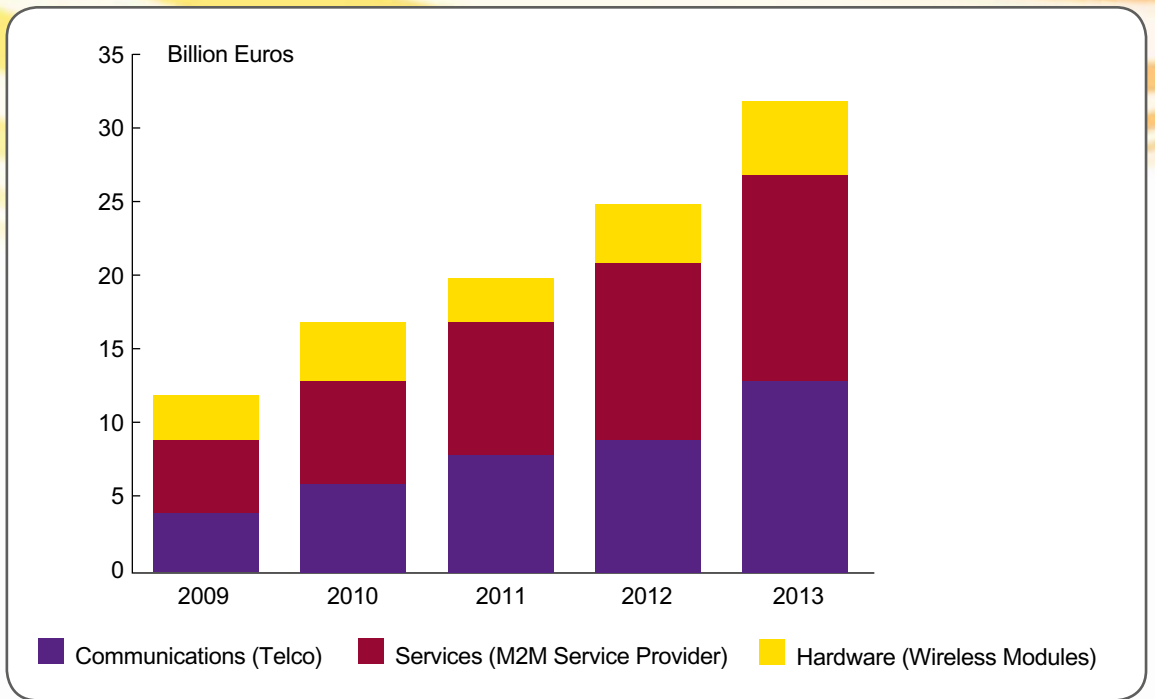


Figure 2: Machine to machine global revenue

Market split

Although figures for the M2M market vary considerably, all available figures agree that the market is growing rapidly. According to the IDC forecast “M2M Communications and RFID in Western Europe, 2007 – 2012” extrapolated worldwide by Nokia Siemens Networks, revenue from the total M2M market is expected to be just short of 25 billion euros by 2012.

The proportion available to those CSPs intending to supply connectivity services will be around 34% in 2012 (worth approximately 8.5 billion euros) while, if the CSP enters the M2M market and supplies specific solutions or hosted services, around another 50% becomes available. As can be seen in Figure 3 below, an entire chain is required to create an M2M solution although only part may be of interest to the CSP. However, it should be noted that there are opportunities for the CSP in the devices business also.

The equipment needed for machine to machine services does not have to be sold at cost, but it can be used to generate an additional profit, or to tighten the relationship with the customer. Jasper Wireless, a mobile data virtual network operator (MVNO), estimates that there are over a billion machines worldwide used by businesses, and which could be connected. They report that ARPU per SIM is currently in the range of 3 - 7 euros (USD 4.6 - 10.9) per month, while according to “Wireless Telematics & Machine to Machine 2006- 2011” by Juniper Research, the total revenue of the M2M market will reach \$70 billion by 2011. Even if, as previously stated, estimates of market size differ, this is a potentially extremely large market which cannot be overlooked.

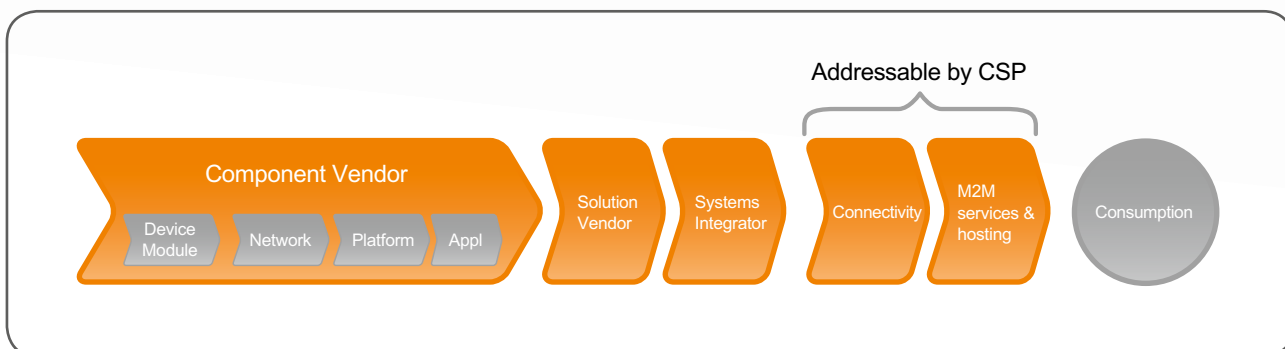


Figure 3: The machine to machine value chain

A World of Opportunities

Cellular M2M opportunities of interest to CSPs

As established, although the market for M2M connectivity is enormously broad and represents a huge potential, only relatively small sections of the market are of interest to CSPs, since other parts are effectively covered by a range of alternative technologies such as radio-frequency identification (RFID), optical recognition, satellite-based communication and bespoke radio applications. In addition, a clear differentiation must be made between those cases utilizing stationary terminals such as vending machines or utility metering that require remote monitoring with a range of speed and response times, and those requiring full mobility and real-time handling such as many automotive applications. The data here can be treated in many respects in the same way as subscriber data requiring a real-time response.

In order to impose a degree of classification on this somewhat loosely defined market, Gartner, in its June 2008 report, split the market according to main categories of applications and estimated growth to 2010, taking 2006 as the base. This resulted in the following figures, which show that healthy growth can be expected in all categories:

- Automotive + 37%
- Track and trace + 87%
- Vending/Point of Sale/Payment + 139%
- Remote monitoring + 188%
- Security + 115%

As outlined above, applications fall into two mainstream categories, those which are stationary, generally exchanging small amounts of data with or without real-time requirements, and those which are mobile. Mobile applications generally exchange larger amounts of data and often need to be real-time.

Although very different in character, both categories have one characteristic in common – they produce low ARPU, as most M2M applications generate low amounts of chargeable packet traffic. But CSPs have a valuable asset in place that can become a new source of revenue; the often already-amortized legacy GPRS networks. This packet network equipment can be rented or sold for M2M-specific purposes, or CSPs can host the entire network operations for M2M providers and charge for it. Buying bandwidth or air-time from network CSPs would therefore be just another option.

If the CSP decides to expand and transform its business and become an M2M service provider, M2M and GSM profiles can be hosted on a common real-time subscriber database, such as the Nokia Siemens Networks One-NDS, to reduce CAPEX and OPEX, including gains from efficient network management. If a CSP decides to embrace M2M services, they will look for solutions offering similar capabilities.

As well as the options described above, efforts are currently being undertaken to define a reference architecture which will accommodate the very different needs that M2M applications have, but still have the ability to utilize the transport and core elements of a 3G network, albeit through different access mechanisms. In both cases this will open the door to M2M-specific pricing. The choice of application is obviously of great importance here, for example those such as the reading of utility meters, which can drastically save on manpower. This allows higher-ARPU structures to be designed. The following section briefly describes some of the main areas of interest, although many other use cases are in development.

Vending machines, point of sales systems and payment solutions

Today, unmanned gas stations, vending machines or parking meters are representative of a large group of charging terminals currently requiring usage of credit cards or cash. The transactions involved are, however, imperfect, firstly because many youngsters and elderly people do not possess a credit card, and secondly because the presence of cash in a machine can lead to criminal acts which result not only in the loss of the money collected, but often in the destruction of the vending equipment itself. Direct debiting of an account solves this problem, but is not the primary reason why those who supply and stock up such equipment are considering real-time wireless connections. Keeping the vending machine stocked with supplies in a timely fashion reduces the workload of the supply personnel and, more importantly perhaps, reduces 'sold-out' outages during which money is not being earned.

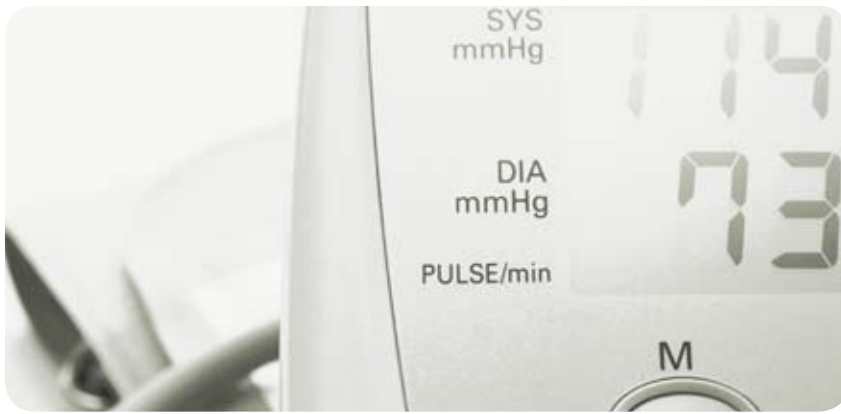
In addition, direct online access to the machines makes it possible to bar some products at certain times of the day, a good example being legislation in some countries that prohibits the selling of alcohol in the vicinity of schools during their opening times. Here also, remote monitoring links can be used for maintenance and repair purposes, informing the vending machine owner of failures and providing information on which module needs to be repaired or exchanged. In many cases, the major attraction of using a cellular form of connection is that vandalism is much less damaging than if a fixed line is installed, since this can often be ripped out of a vending machine or otherwise damaged.

Remote monitoring – metering and servicing

Meter readings are often transmitted via fixed networks due to the co-location of many utility grids and fixed telephony systems. However, in some locations - due to the installation costs - wireless modules can be the only feasible option.

The ability to make meter readings in real time opens up various possibilities related to so-called 'smart tariffs'. A good example of such a tariff is the one where the price of the utility depends on seasonal or daily changes in utility consumption. If the utility company decides to increase (or decrease) the price of the utility, the new tariff can be introduced almost immediately without sending the workforce into the field to read and reset the meters. Such metering is not limited to utilities. Equipment supervision and remote servicing application of various machines such as photocopiers or escalators may be introduced in the near future.





Remote monitoring – medical metering and alerting

Health monitoring can be seen as a special case of metering in which some degree of mobility may be required. This field is becoming more and more important as an aging population needs more extensive medical services. However, mounting budget pressures have triggered a search for possible cost-saving measures to avoid keeping patients in hospitals or other care facilities just for monitoring purposes. In the near future, non-critically ill patients may stay at home while their vital body functions are supervised remotely. Home-based equipment is already in use for various tasks such as recording electrocardiography, but has drawbacks. Portability is limited due to the need to connect to a fixed telephone line – usually dial-up – and real-time response is too slow to allow effective remedial action. Once available, however, the provision of such cellular-based services may also become critical to treatment in remote or developing regions where, due to the distances involved or the lack of transport infrastructure, provision of conventional healthcare is difficult.

There is no doubt that cellular network support of medical devices, assuming that this permits fast response times, can vastly increase their usability. Another advantage to medical health practitioners of having truly mobile equipment is that the costs can be amortized over a large number of patients only requiring short-term care. There are, however, barriers to entry. Certification and reliability are paramount in medical applications and it is critically important to assure quality of service and security of data transmitted. In spite of this, it can be confidently predicted that the sheer pressure of the number of patients resulting from aging societies and the ongoing automation of medical procedures will trigger rapid evolution in this market.



Security – alerting and reporting systems

Security and alerting services cover a broad spectrum of mobile and non-mobile applications that range in their real-time requirements from instantaneous response through to systems used for backup purposes only. A good example of the former is automatic car accident reporting, which by its very nature is bound to wireless technology. A cellular system seems to be an obvious choice for such services. Driving safety, both from the citizen safety and wastage of resources perspectives, has become so critical that the EU has launched an initiative called Ecall which proposes mandatory in-car cellular modems which generate an emergency call should a crash occur. However, only detailed localization information and additional in-car sensor readings will give emergency services a description of events precise enough to take appropriate action. Here again, GPS-assisted UMTS systems are the obvious choice.

Cellular solutions may also play a significant role in highly secure security and observation systems such as audio and video surveillance. Such systems are today bandwidth-consuming (although systems which only transmit upon detecting a change are less so) so 3G media will be used. This is, however, a specialized market and no massive influx of customers is expected. More promising are various forms of access control systems which permit or bar individuals from entering restricted areas. Although conventionally covered by RFID circuits, some applications will utilize cellular M2M technology, for example to trigger parents' attention if a child de-routes from his usual school-home track or to send an alarm to a nurse if an elderly or handicapped person moves unusually far from a care location without prior notification.

Automotive – tracking of vehicles and expensive assets

The tracking of vehicles or assets, toll collection and fleet management are among the best examples of M2M applications. Insurance companies in some countries already offer 'traffic-dependent' policies incentivizing low mileage users or promoting safe driving habits. Fleet management in particular gives the companies unprecedented rapid increase in operational effectiveness. The wide coverage of the cellular network constitutes an ideal platform for such track & trace applications. In addition, GPS-assisted localization is a part of the 3G standard, which makes service implementation much easier.



Automotive – vehicle recognition, parking and tolling

If vehicles can be identified by cellular means, the information obtained can also be used for tolling and traffic optimization. Various cities around the globe are introducing a fee for driving into certain parts of the city or a congestion charge for using the roads or parking at certain times of the day. If a 'stop and pay' procedure is used, this requires heavy investment in infrastructure such as toll barriers, and that disturbs the flow of traffic. Although in theory payment could be processed over a mobile phone, most countries prohibit its use while driving, and so the driver must again stop and interrupt traffic flow. Automatic car identification by means of an in-car cellular connection overcomes these problems. Mobile embedded M2M systems can also be used to manage traffic light working patterns, since the numbers of approaching cars can be counted and smart traffic optimization systems may alter the working patterns of the traffic lights with, for example, extra priority being assigned to fire engines, ambulances and police vehicles.

Although in many ways this field is ideally suited to cellular connectivity, a mobile traffic differentiation mechanism is needed due to the necessity to separate fast-moving traffic such as cars from stationary or pedestrian users. Similar measures are, however, used today for cell reselection.

Automotive – live maps

In today's world, the abundance of in-car GPS receivers created a mass market of real-time routing maps. Those currently in use, however, show no information concerning real traveling times on particular roads. Although some GPS devices are able to receive traffic information (e.g. road works and traffic jams) transmitted by radio stations (via TMC, Traffic Monitoring Channel), in general no information related to the average speeds on a particular road is available. In UMTS networks, GPS-assisted localization allows position, bearing and average speed to be reported, pointing the way to real-time traffic map preparation. This can be done in a centralized server which would create a dynamic map overlay, consisting of average speeds measured by the users traveling on particular roads. Such maps can be downloaded to the in-car systems and used on-demand for the calculation of the fastest route to the destination.

A particular case of automotive usage is represented by advertising. While this market is still in its infancy, mobile M2M terminals may be used to receive various advertisements, and, if located inside a bus or tram, can display an advertisement related to the facilities, for example stores, cinemas or fitness centers, being passed at that moment. From the advertising agency perspective, this is attractive because it is similar to personalization of a message, since the viewer can readily associate with, and remember, the particular location involved.



Nokia Siemens Networks and M2M

Application considerations and implementation

It is the service requirements of each M2M application that will lead to the definition of the media used for transmission of M2M data and the security mechanisms needed for exchange of data, authorization and billing. Although some applications use low data rates, others such as live maps, monitoring and colorful advertisement will utilize fast media due to the higher spectral efficiency and shorter transmission time.

The CSP must also address certain characteristics that apply to the many facets of the M2M market and yet are common to the many apparently differing vertical implementations. These include the management of network access in the cellular device, the avoidance or rectification of “locking” the SIM due to network failure and the sequencing of transactions by application and device. In addition, consideration should be given to the saving of IP addresses through optimized network dimensioning.

As can be seen from the M2M opportunities already quoted, some of the data concerned must be managed in real time. This only applies to those M2M applications that do not require mobility or session information. The increase in mobile broadband usage, coupled with the fact that it will often be less expensive to utilize existing SIM card technology instead of developing bespoke stripped-down solutions, will in all likelihood mean that this data is available anyway. It will therefore only be a matter of time before its usage is included in the application. If current applications do require this data, it can be managed in the same fashion as normal subscriber data, i.e. mobility and session information being centrally available in sub-second near real time, with historical data being accessible for post-processing.

Here Nokia Siemens Networks One-NDS, the company's unique data repository at the heart of the Company's Subscriber Data Management solution, offers an excellent basis for the implementation of M2M communication.

The Nokia Siemens Networks One-NDS (Network Directory Server) is an open, subscriber-centric directory containing all subscriber and service data in one logical entity for existing and future domains and applications. Nokia Siemens Networks applications provide the standard components of a mobile, fixed and converged network – including Home Location Register (HLR), Home Subscriber Server (HSS), Authentication, Authorization and Accounting (AAA), Equipment Identity Register (EIR), Mobile Number Portability (MNP) and Bootstrapping Server (BSF).

Open interfaces enable data to be linked to business applications such as reporting, analytics and dashboards, giving the ability to fully leverage knowledge about customers. The openness of the system also permits easy implementation of, for example, M2M-specific applications. Because One-NDS and Nokia Siemens Networks applications are hosted on open, commercial off-the-shelf (COTS) computer hardware, and applications run on open, standard Solaris or Linux IT platforms, the capital cost of introducing the new architecture is much less than that of maintaining a silo infrastructure. Administrative costs are also lower because all subscriber data is held in one place, which eliminates the problems associated with the synchronization of service data across many systems and speeds up time to market.

One-NDS and all Nokia Siemens Networks-supplied applications have been proven to scale from 100,000 to over 250 million subscribers, which lets M2M applications start small and scale up according to needs. Data can be held across 1 to 256 geographically separate sites, thus providing high resilience to network disruption.

The next section shows an example of One-NDS in use, and in the concluding sections, both it and the Nokia Siemens Networks Subscriber Intelligence Framework (SIF), a complementary solution which permits leverage of the consolidated subscriber data by acting on it in real-time, are briefly discussed.

How iMetrik utilizes One-NDS

iMetrik, a Canadian company, provides automated remote asset tracking across existing mobile networks. iMetrik's services use simple mobile radio devices attached to valuable assets to provide instant updates, via cellular networks, to any number of asset tracking databases, people or remote billing and payment systems. Initial applications involve using the iMetrik service to cost-effectively track vehicles. This includes a distance tracking facility to enable pay-as-you-drive car rental schemes, delinquency management, which reduces credit risk and aids the repossession of vehicles, and security and surveillance, which helps trucking, insurance and rental companies safeguard their investments. To effectively manage remote asset data and link it to the relevant customers, iMetrik has chosen Nokia Siemens Networks to supply its One-NDS Subscriber Data Management platform, including the Home Location Register (HLR). This allows iMetrik to efficiently use open, consolidated subscriber information when developing its services.

By using the Nokia Siemens Networks One-NDS platform, iMetrik is able to deliver its M2M communications services across continents with a single global SIM card and a single invoice for its customers, while creating new data revenue streams for mobile network CSPs. For example, a car rental agency can use M2M applications developed by iMetrik to offer reduced rates based on restricting the car's usage to a limited driving area. iMetrik applications can, using the agency's database and the Nokia Siemens Networks Home Location Register, obtain the details of the renter's profile and auto insurance purchased and verify whether the vehicle is covered in its current location. Because this happens in real-time, the rental agency and the driver can both be instantly notified if the driver strays outside the coverage area.

In this application iMetrik utilizes a 'multiple IMSI on a single SIM card' approach, aggregating wireless carriers and managing the service. The company's M2M devices can have up to eight IMSIs (International Mobile Subscriber Identity) numbers, with software on the SIM choosing the right IMSI based on business rules to provide the most efficient coverage for the devices. Since iMetrik does not use a SIM card but rather a SIM chip soldered directly onto the device's printed circuit board, the proper IMSI or group of IMSIs can be loaded onto the SIM during manufacturing depending on where it is going to be shipped, and these can be updated later. This is particularly useful where the application provider has, for example, a global agreement with one service provider and a regional agreement with another at preferential rates, or where contingency backup is required. This also applies if the device (dual-IMSI or multi-IMSI) is used in a roaming application. The SIM can switch from the native IMSI to a partner IMSI, but the subscriber is still reachable at the original MSISDN (Mobile Subscriber Integrated Services Digital Network Number) since all the routing lookups are being done in the same Home Location Register and it therefore does not matter which IMSI is in use.

Through combining such rich subscriber data and real-time processing, iMetrik is now developing innovative applications and services that generate new revenue streams while reducing customer costs.

Subscriber Data Management – One-NDS and SIF

If data can be made available in real-time, CSPs can dramatically enhance the number of M2M opportunities open to them. Bringing data into a single centralized real-time data repository is the first step in realizing these possibilities. The repository can store data such as identities, locations, devices, preferences and network usage status. The second step on the road to effective use of this data is to implement a Subscriber Data Management solution that consolidates all essential subscriber information across an array of networks and services. This in itself realizes massive cost efficiencies, achieved by reducing data silos and proprietary interfaces between applications and the data they require. An effective Subscriber Data Management solution then sets the scene for the third step – the use of subscriber intelligence.

The methods historically chosen by many CSPs to store data can be loosely categorized as enterprise data warehouses (EDWs). These are typically very good at storing large sets of historical data for billing and high level business intelligence, but they are not fast. Usually information arrives at the EDW over time, in batches, and is eventually loaded into the system through a transformation process which can take from 12 hours to several days. Reports can take minutes or hours to run due to large data sets and generating ad-hoc reports can often take inordinate amounts of time. EDWs are optimized for very large, relatively static datasets, where the sort of immediate response required in some M2M applications is not the focus. This capability requires a super-fast 'sense and respond' capability and is essentially what One-NDS provides. Moreover, as previously noted, One-NDS, often in combination with SIF for application access, also interfaces to Nokia Siemens Networks applications that provide the standard components of all types of networks – in particular HLR, HSS, AAA, EIR, MNP and BSF.

Taking AAA (Authentication, Authorization, Accounting) as an example, this is important for resource admission control, the traffic per group of subscriptions for one customer, through preventing overload situations due to uncontrolled communication from millions of M2M devices. The EIR (Equipment Identity Register) can be used to track devices with the HLR (Home Location Register) giving information on their location, while the BSF (Bootstrapping Server) can be utilized to prevent the use of bogus identities.

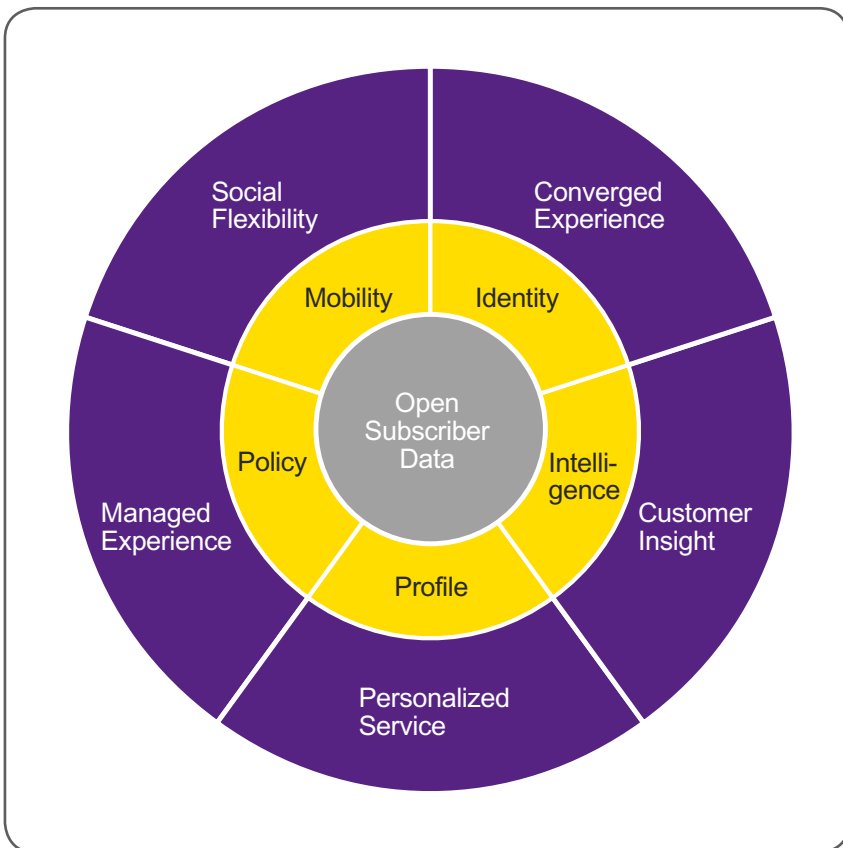


Figure 4: The Nokia Siemens Networks SDM Portfolio

The SIF solution is a complementary solution based on an industry-standard relational database utilizing the ubiquitous Structured Query Language (SQL). SIF shadows One-NDS and allows one or more concurrent applications to access One-NDS and historical data warehouses in standard fashion and process information in sub-second real time without degrading the One-NDS performance. Subscriber behavior, in this case the behavior of the autonomous machine, can be seen, analyzed and acted on as it happens and existing historical or archiving systems can be communicated with and referred to. Events that can be triggered include, for example, a change of location area if a fixed sensor changes state or if it detached from the network due to loss of power or coverage or if pairing between the device and a SIM card or unit is broken, or customer notification if data usage reaches a threshold within a certain period or while roaming.

Real-time databases such as One-NDS require specific tailored load and access methods to preserve their performance characteristics, and since the drive to more subscriber-centric business means that more and more applications access network data (including those M2M applications where response times can be measured in seconds as opposed to milliseconds), interfacing can become non-trivial. SIF utilizes industry-standard interfaces such as Open Database Connectivity (ODBC) and employs the SQL query language, thus presenting an open and commonly used interface to the outside world and providing CSPs considering entering the M2M market with a portfolio of applications to drastically reduce their interfacing costs.

Why Nokia Siemens Networks

Solution vendor and system integrator

Nokia Siemens Networks is one of the world's leading providers of telecommunications solutions, with over 20,000 services professionals offering service, and a local footprint in over 150 countries. The company takes on end-to-end responsibility for complete solutions and is proud of its ability to deliver customer-specific solutions with verified functionality that are on-time and on-specification and can be delivered virtually anywhere in the world. This is significant to CSPs rolling out high-profile M2M applications such as congestion charging or those which must be implemented across borders, such as vehicle tracking.

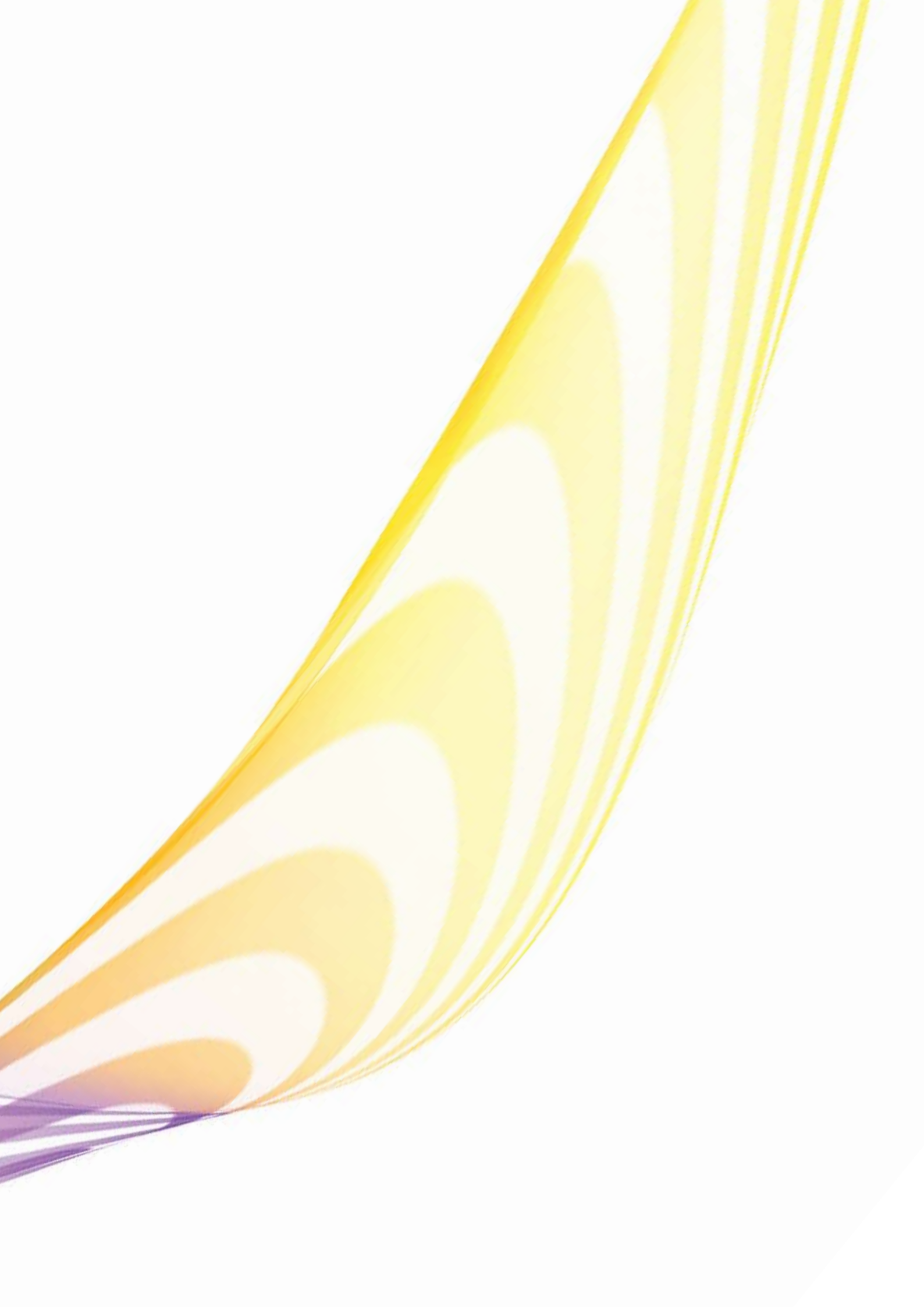
Market expertise, solutions and experience

Nokia Siemens Networks Packet Core solutions, with more than 290 customers throughout the world, are acknowledged to be the most reliable in the industry – an important consideration in critical applications such as medical monitoring or security applications. Moreover, these solutions have extremely high subscriber capacity and transaction support, of increasing importance since the large numbers of machines connected will grow dramatically.

Nokia Siemens Networks is the world's leading provider of Subscriber Data Management solutions, with around 1 billion subscribers at over 74 customers in 47 countries. It provides a complete Subscriber Data Management solution including the One-NDS unified data repository, multiple Nokia Siemens Networks and 3rd party applications and additional solutions such as Identity Management and the Subscriber Intelligence Framework. With its Subscriber Data Management and Subscriber Intelligence Framework solutions, the company also possesses profound expertise in the provision of an open, subscriber-centered architecture that ideally meets the requirements of mobile M2M applications.

Managed services

As ARPU in mature markets declines, CSPs are seeking new business models. In the M2M market, success depends on providing affordable services in a low ARPU environment. Managed services provide a superb tool to improve efficiency and operational performance, while freeing up the CSPs' resources, allowing them to focus more closely on their core business. Nokia Siemens Networks Managed Services provide a range of solutions to operate networks and optimize service providers' end-to-end performance, service platforms and terminals. In addition, the company is one of the few vendors that can offer and roll out such services on a truly global basis.



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