WHITE PAPER

High Capacity SIMs

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ABOUT SPANSION

Spansion [NASDAQ: SPSN] is a leading Flash memory solutions provider, dedicated to enabling, storing and protecting digital content in the wireless, automotive, networking and consumer electronics markets. Spansion, previously a joint venture of AMD and Fujitsu, is the largest company in the world dedicated exclusively to developing, designing, and manufacturing Flash memory products and systems. For more information, visit www.spansion.com.

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Abstract

Since the early days of GSM, SIM cards have been made available with a tiny amount of memory, enough to store a few hundred contacts. Fuelled by the miniaturisation of memory technology, a new generation of high-capacity SIMs is coming to market, raising SIM capacity by around 1000 times. European operators are already planning to commercialise high capacity SIM cards enabling applications such as multimedia file storage and SIM-based home-screen customisation. This paper analyses the market, the promising applications for high-capacity SIMs and the new business opportunities which they open up. It also presents the challenges lying ahead for high-capacity SIM cards, and the complex ecosystem landscape into which they are arriving.

Section A - High Capacity SIMs: the Renaissance of the SIM?

Introduction

Designed as a subscriber identification mechanism, SIMs have been used as a cornerstone of GSM services since the inception of digital mobile telephony. Essentially a type of smartcard similar to the ones used on credit cards, SIM cards have been designed to extend to basic services such as storing SMS messages and contacts, presenting a menu of operator services to the user and communicating with the network via SMS messages. With the launch of 3G networks, SIM has evolved to USIM, which has been designed for hosting multiple, independent 3rd party applications. However, in the last few years (U)SIMs[1] have been increasingly lagging behind handset operating systems and removable memory modules, in terms of processing speed, memory capacity, communication speed and the richness of the user interface that can be delivered.

High Capacity (HC) SIMs address the limited memory that so far has been the norm with the vast majority of SIM modules. Branded as MegaSIMs, High Density (HD) SIMs and SuperSIMs, depending on the vendor, this new generation of smartcards feature anywhere between 4MB to 1GB of memory, a massive 1000+ fold increase in storage capacity. HC SIMs boast several new applications, such as secure storage of multimedia content and service distribution. The HC SIM paradigm has been fuelled by the advances in memory manufacturing technology, pioneered by vendors such as Spansion, M-Systems, Atmel and Samsung, as well as SIM card manufacturers such as Axalto, Gemplus, Giesecke & Devrient, Oberthur and Sagem Orga. 2005 saw the announcement of several pilots of high-capacity SIMs with operators, while commercial availability for early deployments is expected in the first half of 2006. Wider adoption of high capacity SIMs by operators is expected to be achieved from the second half of 2007 onwards. Led

[1] Technically speaking, a SIM is an application which resides in a physical module called the integrated circuit card (ICC). A Universal Integrated Circuit Card (UICC) is the 3G equivalent of an ICC and can host multiple applications, including a SIM and multiple USIM applications (the 3G equivalent of the SIM application), which can be from different service providers. For the sake of simplicity, in this report the term SIM will be used to refer to both the SIM and USIM as the physical module. The technical and commercial implications of high capacity SIM modules apply equally to SIMs and USIMs.

by Orange, several operators have been keen to promote the HC SIM paradigm, instigated by the impending threat of the open Internet and the convergence of IT and Telecoms.

2006: The Year of High Capacity SIMs

2006 is the year when the high capacity SIM paradigm came into the commercial limelight. Virtually all major vendors announced a next-generation SIM card product at February's 3GSM World Congress, including Gemplus with .SIM (pronounced dot SIM), Axalto with U2 SIM, Oberthur with its 'GIGantIC' card, Giesecke & Devrient with GalaxSIM and Sagem Orga with SIMply XXL. All next-generation SIM card products feature up to 512 MB of storage and advanced applications such as a SIM-based web server. Spansion, a leading Flash memory manufacturer, announced it is developing a new class of secure, single chip Flash memory for SIMs, with 64MB to 256MB of storage, which will be available in 2007. Finally, M-Systems, a long-time evangelist of high capacity SIM cards, and supplier of essential IP for many next-generation SIM cards, announced several partnerships and collaborations which will see the role of the SIM extend well beyond its traditional role in GSM.

The announcements echoed well beyond the confines of the SIM card vendor domain. Intel announced an initiative in collaboration with the GSM Association, to equip future notebooks with a SIM card slot. The initiative, driven by the convergence of IT and Telecoms, aims to make the SIM the authentication vehicle for all wireless data access across 2G, 3G and WiFi networks. The chip giant will work with the GSMA to develop guidelines for manufacturers to incorporate 3G and WiFi authentication support in laptops. The initiative has been backed by Orange, Vodafone and Cingular Wireless.

Furthermore, Nokia announced the addition of the Bluetooth Access Profile as a standard feature in Nokia smartphones based on the S60 3rd Edition software (devices include Nokia E-series product range, Nokia N71, N80, N91 and N92 as well as the Nokia 3250). This allows compatible car phone terminals (such as the one that comes with the new Volkswagen Passat) to 'borrow' the subscriber identification data from the SIM card. Nokia has also added an implementation of JSR-177 as a standard feature of its S60 3rd Edition, a critical enabler of security applications based on high-capacity SIM cards.

From the operator camp, Orange's support for the high capacity SIM paradigm has been by far the most vocal. Following a successful soft-launch of 5000 Gemplus SIM cards with 128MB of memory packaged within customised Sagem handsets in France in November 2005, Orange announced a collaboration with M-Systems, Oberthur Card Systems and LG Electronics to launch the world's first 512MB high-density SIM Card. According to the operator, the high density SIM will be rolled out across Orange European markets in 2006, commencing in France, where it will be initially available on an LG U8210 handset with a high speed interface[2]. Orange is positioning these next-generation SIM cards as offering subscribers the ability to store comprehensive SMS, MMS and e-mail archives, complete with attachments, in addition to complete PIM and calendar

[2] At 3GSM 2006 Orange demoed the LG U8210 handset transferring data from the SIM card to an attached desktop PC at an average rate of 250Kbps, 20+ times faster than most SIM cards today.

functionality. Ultimately the value proposition for Orange today is that HC SIMs influence the handset purchasing decision in favour of the operator and provide stickiness to the operator during the product lifetime and therefore, reduced churn.

Table 1: Recent announcements of High Capacity SIMs and related products.

Vendor	Date	Announcement
Gemplus	February 2006	Gemplus launched .SIM (pronounced dot SIM), its line of high capacity SIM cards that enable operators to offer multimedia services through mobile, web, fixed line and TV channels.
Axalto	November 2005	Axalto introduced its U2 SIM, offering features such as management of digital content rights and hosting of Internet blogs on the SIM.
Oberthur	January 2005	Oberthur announced GIGantIC, a 128MB SIM card which offers advanced crypto-functionality for digital content protection, allowing storage and secure access to multimedia files, games and personal settings.
Sagem Orga	February 2006	Sagem Orange introduced its SIMply XXL high capacity SIM card, which offer operators new capabilities for handset customisation and segmentation.
Giesecke & Devrient	February 2006	G&D announced the GalaxSIM, which features between 64MB and 512MB of content and applications and includes its own Web server.
M-Systems	February 2006	M-Systems and its subsidiary Microelectronica announced the planned commercial availability of 1GB MegaSIM cards by the end of 2006.
Spansion	February 2006	Spansion announced it is developing a new class of secure, single chip Flash memory for SIMs, with 64MB to 256MB of storage, which will be available in 2007.
Orange	February 2006	Orange announced that it will roll out a line of high density SIM cards across Orange European markets in 2006, commencing in France.
Intel	February 2006	Intel in collaboration with GSMA, announced an initiative to equip future notebooks with a SIM card slot, aiming make the SIM, the authentication vehicle for all wireless data access across 2G, 3G and WiFi networks.
Nokia	February 2006	Nokia announced that the Bluetooth SIM Access Profile will be a standard feature in Nokia smartphones based on the S60 3rd Edition software. This profile will allow authorised external devices to read the subscriber information and phonebook stored in the SIM card.

Source: Informa Telecoms & Media

Figure 1: Some recently announced high capacity SIMs

Sagem Orga's SIMply XXL

Oberthur's GIGAntIC

Gemplus's .SIM

Gieseck & Devrient's GalaxSIM

Axalto's U2SIM

Source: Relevant Manufacturers

Pros & cons

High-Capacity SIMs bring several advantages to rejuvenate the popularity of the aging SIM. With the proliferation of multimedia handsets, secure storage of digital rights objects and protected content are some of the key applications of HC SIMs. In addition, HC SIMs may enable easier deployment of multimedia services by pre-packaging content on the SIM. By virtue of their large capacity, HC SIMs can store personal information such as music, pictures and videos, as well as application settings in a way that can be ported across handsets. In addition, HC SIM cards may be used to store offline WAP content, which is refreshed over-the-air (OTA) and in a location-specific fashion[3], to provide a smooth browsing experience on low-end handsets, even when GPRS coverage is poor. Finally, HC SIMs will find applications in corporate environments where secure storage and cryptographic capabilities are of primary importance. It is worth pointing out that High-Capacity SIMs are targeted at feature-rich and high-end handsets as their advantages relate primarily to multimedia services.

At the same time, HC SIMs are only a piece in the puzzle of end-to-end multimedia services. As such, their success is dependent on a number of other commercial factors. Firstly, poor handset and SIM interoperability is known to be the main cause of stalling the technological evolution of SIMs to date. The speed of SIM-handset and SIM-network communication is also a critical success factor for HC SIMs, as these are notoriously slow (although HC SIMs typically feature increased communication speeds). Programmatic access to the SIM from handset applications is also a strong determinant for success, with key enablers, such as JSR-177 support being slowly implemented across handsets[4]. Cost will also play a role, as in the medium term the increase in memory capacity is expected to come to at least twice the price tag of normal USIMs ($3-$4) with bulk pricing. Finally, HC SIMs are coming up against competition not only from removable storage cards (MMC, SD and MemoryStick), but also handset operating systems with increasing memory and security features.

Overall, the HC SIM card market may enjoy some admirable thrust from Orange, but at the same time the market is still in an "incubation period", according to M-Systems' Ira Cohen, VP of Marketing and Business Development.

In the remainder of this section the capabilities and applications of the SIM card will be examined, as well as the advantages that High Capacity SIMs will offer.

The SIM card: back to basics

The Subscriber Identity Module (SIM) is a physical token whose primary function is to identify the subscriber to the network operator, via a secure algorithm. The SIM has been employed for this purpose since the era of the first GSM networks. The SIM card itself has also been used to store user data (such as text messages and contacts list), running operator applications (for example, service menus and group messaging applications) and more recently for promoting operator

[3] through cell broadcast technologies

[4] Nokia has added support for JSR-177 in their S60 3rd edition software platform, while manufacturers like Sagem are implementing a high speed MMC interface to the SIM.

services and directing traffic from roaming users. The table below lists the main SIM card and silicon vendors as well as several SIM application vendors.

Table 2: Main SIM card, silicon and SIM application vendors

SIM card manufacturers	Memory and microcontroller manufacturers	SIM application vendors
Axalto[5]	Atmel	Aspects Software
Gemplus[6]	Hynix	Atchik-Realtime
Giesecke & Devrient	Infineon	Bantry
ORGA-SAGEM[7]	M-Systems	Celltick
Oberthur	Renesas	SmartTrust
I'M Technologies	Samsung	SoNear
ST In Card	Spansion	
	ST Microelectronics	
	Toshiba	

Source: Informa Telecoms & Media

The SIM has been designed as an operator-controlled physical token that ties the handset user to the subscription and the network services. Historically, manufacturers have had little motivation to promote usage of the SIM, as the operator agenda has been typically in conflict with that of the manufacturer. As a result, handset and SIM interoperability has been historically poor, with most handsets adhering to a subset of GSM specifications such as ETSI 11.14. In addition, historically operators have not been promoting SIM-handset interoperability as a strategic agenda.

Functionality

The SIM is essentially a smartcard for use in GSM phones. As such it is designed to offer the following functionality:

- Storage of data relating to the subscriber such as the international mobile station identifier (IMSI) and the mobile station international subscriber dial number (MSISDN)
- Storage of data relating to the list of preferred and forbidden networks as well as use of applications that update these lists to route roaming users to a preferred network.
- authentication of the subscriber and encryption of voice and data traffic
- storage of user data such as SMS messages and address book
- secure storage of application data such as digital certificates.
- an execution environment (native or JavaCard) for SIM applications.
- an interface (called SIM Toolkit) to the handset operating system which allows the SIM to interact with the user via text menus, as well as static or animated images.

[5] Formerly Schlumberger Smart Cards and Terminals

[6] Gemplus announced a merger with Axalto in December 2005. Once the merger is approved by shareholders and regulators, the company, known as Gemalto, is likely to account for close on 50% of SIM card sales globally

[7] Sagem Orga is the new name for Orga Kartensysteme, following the company's acquisition by Sagem Defense Securite, a subsidiary of the SAFRAN Group.

- An interface from the handset to the SIM (as defined for example by JSR-177) which can be used by a handset Java application to retrieve data such as certificates from the SIM (although today very few handsets support JSR-177)
- Cryptographic functions: the SIM can be designed to support both symmetric and asymmetric cryptography, including for example creating digital signatures.
- An interface to the network to send and receive SMSs. This enables over-the-air download of applications or data onto the SIM card post-sales, e.g. so as to update the SIM phonebook (albeit currently using SMS messages only as a transport mechanism which is applicable to very low bandwidth applications).
- An interface to the Cell Broadcast protocol, enabling the operator to push content to millions of subscribers in a matter of seconds.
- A Bearer Independent Protocol (BIP), a standardised high speed interface that opens new channels to the SIM (in addition to the SMS channel) such as GPRS and 3G, making it possible to distribute content and applications to the SIM (although very few handset models support this feature currently).

At the same time, there are limitations to what the SIM can do. Current SIM cards are capable of storing around 64KB of data and applications, which typically amounts to 250 contact entries, 30 SMS messages and five downloaded ringtones. This pales in comparison to the handset's embedded memory, which ranges from 512KB in basic phones, to 32MB for today's typical feature-rich phones, to 4GB for high-end phones such as SonyEricsson's new Walkman range.

Today's SIM cards are also limited in terms of the communication speed between SIM-handset and SIM-network. In the first instance, communication with the handset can be as slow as 9.6kbps, roughly 20 times slower than GPRS. SIM communicates with the network via SMS messages, which lends itself to sending notifications, SIM updates or micro-browser content updates, but not to transmitting large data files such as roaming lists, phone list records, Java applets, music tracks, pictures and videos. In addition, due to the memory limitations, very few GSM device models rely on SIM cards for storing data.

Furthermore, a SIM has limited processing speed (a processor typically running at 5-10MHz) and as such cannot be used in applications that require intensive processing (e.g. for email message encryption). In addition, there is no mechanism to allow the SIM to fulfil a transaction – instead the SIM can only initiate a hidden premium SMS message. In some handsets, there is no ability for the SIM to determine the handset model being used and thus cannot be used to adapt the content served (e.g. ringtones) to ensure it is compatible with the handset.

Standards

There are a number of standards activities which play a role in the evolution of the SIM. The SIM low-level characteristics conform to ISO 7816 standard for smartcards. The SIM functionality is primarily defined by 3GPP specification TS 11.10-4, while several new specifications have been added by 3GPP. Mobile operators today typically require compliance to 3GPP Release 5 specifications for SIMs.

Other standards include Sun's JavaCard application environment specification (currently the latest implementations are at version 2.1.1) and the OMA Device Management 2.1 specification. There are also a number of SIM card manufacturer-driven standardisation activities such as the SIM Alliance and the Smart Payment Alliance.

SIM applications

Mobile operators have used the SIM card for a range of different applications, the most notable of which are listed below:

- Roaming application: ensures that the handset selects the default operator network after roaming. A SIM application can also add the operator name on a handset screen whenever the handset is roaming on a partner operator network.
- Automatic detection of device model or IMEI for content staging[8] and device change detection (although not all handsets will support this).
- Micro-browser: a SIM-based portal that can display WAP content, for use in services such as games, infotainment, ticketing and mobile banking. The content pages can be stored locally on the SIM card and refreshed over the air. This is exemplified by SmartTrust's Wireless Internet Browser (WIB), a micro-browser specification that has been implemented by the majority of SIM card manufacturers[9]. SimAlliance's Toolkit (S@T) is another example of a micro-browser specification[10].
- Use of the SIM for bootstrapping in device management operations (i.e. selecting which server to use), as specified in OMA DM 1.2 standard.
- Content discovery: Celltick's LiveScreen is an application that displays interactive content teasers sent over broadcast channels to the subscriber's handset while it is on idle mode. With a single click, the user can react to the content (text & graphics) displayed and access a WAP page which offers more information, download a ring tone, or set up a call to a call center and get more information about the message displayed. Celltick counts VimpelCom, AIS, Globe, Hutchinson, Orange Israel, China Unicom and MTN Networks among its customers.
- Singaporean operator MobileOne (M1) uses Xplorer, a SIM application to offer services including movie listings and lottery results, horoscope, stocks and ringtones, charged on a per-use basis. The Xplorer menu is personalisable for each user through the web.
- Vendor SharedPhone has pioneered the use of a SIM application that locks the handset after a phone call so that it may act as a payphone. The handset owner

[8] Content staging is the process of selecting the right content format for the device in use.

[9] SmartTrust's latest specification WIB 1.3 allows graphics to be displayed, while the browser can be updated with plugins over the air. SmartTrust WIB 1.3 support is now a mandatory feature of SIM cards, as required by major operators.

[10] The SIMAlliance Toolbox of S@T is a specification which defines protocols, commands and browser behaviour guidelines for micro-browsers, and was first published in 2000. The specification is being pushed by the main smart card manufacturers. According to the SIM Alliance, in 2005 dynamic menu (also known as micro-browser) applications grew faster than any other SIM technology. S@T implementations represented 9% of the total available market for micro-browser applications.

would make the service available to anyone who cannot afford a handset or airtime. Such SIMs have been rolled out by Vmobile in Nigeria with low-cost handsets.

- A SIM application may act as a customer relationship management (CRM) agent, collecting information regarding user actions within a micro-browser and calls made or received. The agent can then feed this information back to the mobile operator for use in CRM applications.

Following the review of functionality, standards and applications for SIM cards current technologies for SIM card memory are reviewed.

Memory technology

Within the plastic packaging of a SIM module resides the processor RAM, ROM, EEPROM or Flash memory and logic circuits. Random Access Memory (RAM) is a volatile memory that is used for temporary data storage by the processor. Read Only Memory (ROM) is a non-volatile memory that is typically used to store program code. It is not designed to be updated, as it requires a time-consuming mask process. Electrically Erasable Programmable ROM (EEPROM) is a special form of ROM that allows data to be stored persistently but also updated dynamically. Most SIM cards shipped today contain 64-128KB of EEPROM memory.

Flash memory is a special type of EEPROM. The principal difference is that EEPROM requires data to be written or erased one byte at a time whereas Flash memory allows data to be written or erased in blocks. The technology makes flash memory faster and more dense, resulting in a much smaller footprint per MB than EEPROM. Flash memory is used in most external storage cards today such as MMC, SD and, Memory Stick and is starting to make its appearance on high capacity SIMs from vendors such as Spansion. Due to the density limitations of EEPROM, the only viable option currently with high-capacity SIM cards is Flash memory. The table below summarises the primary differences between memory types used in SIM cards.

Table 3: Primary differences between memory types used in SIM cards

ROM	Read-Only Memory: Mature, high density, reliable, low cost; time consuming mask required, suitable for high production with stable code
EEPROM	Electrically Erasable Programmable Read Only Memory: Electrically byte erasable; lower reliability, higher cost, lowest density
FLASH	Low cost, high density, high speed architecture; low power; high reliability

Source: Intel

High Capacity SIMs: the new generation

The arrival of HC SIMs marks a milestone in the evolution of the SIM. The limited storage capacity, an obstacle in realising multimedia services via the SIM, is being lifted. High Capacity SIMs are designed to embed 64MB to 1GB of Flash memory, a 1000+ fold increase in storage capacity compared to traditional SIMs. High-Capacity SIMs typically feature a high-speed

communications channel to the handset in the form of a USB[11] or MMC interface and in some cases a high-speed communication protocol to the network in the form of a Bearer Independent Protocol (BIP) implementation. In addition, HC SIMs can incorporate advanced security features such as asymmetric cryptographic functions, single-core architecture for enhanced security as well as sensors to detect physical tampering.

Benefits

HC SIM cards retain backward compatibility to 3GPP standards, but more importantly enable a range of new applications. In addition to allowing portable storage of multimedia content such as videos, pictures and music, HC SIMs are well suited for securely storing DRM-managed content, rights tokens and digital certificates, in a user-centric manner, as the content and rights can port across handsets.

Furthermore, HC SIMs can prove more effective than traditional channels[12] in deploying operator services post-sales and promoting service trials, because of the ubiquitous support for SIMs across handsets, the reduced time-to-market, and the simplified logistics for operators.

Similarly, HC SIMs are well suited for targeted customisation and personalisation by operators as well as card manufacturers (see appendix), due to their straightforward integration with the operator customer segmentation operations and logistics. HC SIM cards are also designed for secure multimedia storage, unlike removable memory cards which were primarily designed for storage, not security. Finally, HC SIMs will find applications in corporate environments where cryptographic capabilities like the generation of a one-time password (OTP) are of primary interest.

Challenges

High Capacity SIMs are also faced with several important challenges. Cost-wise, the extra capacity is likely to impose a significant increase in the SIM card pricing which is expected to be around the $10 mark in the medium term, or twice the current price tag of USIM modules. Although currently SIM card manufacturers are tight-lipped when it comes to HC SIM card pricing, it is estimated that the cost of HC SIM cards will be approximately 30% higher than the cost of silicon (and therefore the cost of the SD or MMC removable cards of similar form factor). The increase is due to the added cost of the card operating system, the embedded applications, and the cost of maintaining compatibility with legacy applications and standards. Most important therefore for the viability of the HC SIM proposition is that the cost of silicon (memory and processor) drops significantly and predictably over the next 12-24 months.

Complexity is another issue facing SIM card vendors, as new operating systems are being developed to cater for the increased capacity of the SIM. Handset interoperability remains a thorny issue, given that few handset models currently support high-speed network interfaces to

[11] As demonstrated by Axalto and Intel in February 2005, using an Intel PXA270S development handset.
[12] Compared to OTA download and removable storage cards.

the SIM such as the BIP protocol and high speed handset-SIM communication interfaces such as USB or MMC.

High Capacity SIMs will also face indirect competition from removable storage cards such as the MMC, SD and MemoryStick formats. Removable storage is only available on a small subset of handsets - in 2004, around 9.2% of handset sales featured at least one type of memory slot. This percentage is expected to have risen to 13.4% in 2005 and by 2010 Informa Telecoms & Media anticipates that 65% of all handset sales will feature at least one flash memory slot. While removable storage is not as ubiquitous as the SIM, it is being promoted by several tier-1 manufacturers of feature-rich and smartphone handsets, rather than the SIM. Storage capacities for MMC and SD cards are already at a whopping 2GB in commercial quantities, a capacity which is well suited for multimedia storage applications.

Open OS handsets already feature programmatic interfaces to access content stored on removable storage, contrary to the situation today with SIM cards (although HC SIM cards address this limitation by design). In addition, memory card standards are evolving to compete on DRM, VPN and other applications requiring secure storage. In March 2004, the MMC Association announced the formation of a working group to boost the adoption of SecureMMC V2.0 as the basis for OMA DRM 2.0 specification for removable secure storage media and for VPN applications requiring secure storage of the PKI token. Samsung offers its SecureMMC based on OMA standards, while 4c Entity offers SD cards that implement this scheme using Content Protection for Recordable Media (CPRM) standards.

It should also be noted that the instantaneous removability of SD, MMC and Memory Stick cards gives them a role as a complementary token to the SIM that can be removed from the handset without compromising network connections. Ultimately, the SIM and secure removable cards may work not in competition, but as a complementary pair, interacting with the handset and network in many client-server applications such as DRM. In another potential scenario, SD/MMC cards may be used for ultra high capacity (above 1GB) unsecured storage, while HC SIM cards may be used for high capacity (up to 1GB) secure storage. However, there are many factors (often political) influencing the future role of SD/MMC cards vs that of HC SIM cards. As a result, the eventual outcome remains uncertain.

Last but not least, HC SIMs compete with the memory embedded in handsets for applications such as user data storage (although less so for pre-sales customisation and personalisation). The majority of feature-rich phones and smartphones come with more than 16MB Flash memory. In these market segments, the norm will jump to 64MB and more by 2010. Furthermore, the user interface of SIMs pales in comparison to the handset user interface (UI) for target handsets (i.e. feature-rich and smartphone handsets), both in terms of UI richness and click-distance[13] to SIM applications.

[13] Click-distance is a common industry term for the number of clicks that are required to access an application from the handset idle (home) screen.

Standards

As mentioned, high capacity SIM cards require a high speed handset-SIM interface in order to exploit the extra storage capacity. The European Telecommunications Standards Institute (ETSI), which governs specifications for GSM infrastructure, has been debating which high-speed handset-SIM interface to standardise. The contenders are the USB protocol, common in the PC world, and the MultiMediaCard (MMC) protocol, used for the homonymous removable storage card. Both protocols are able to transfer data between the handset and the SIM at a maximum of 12Mbps, 1000 times faster than the current minimum speed of handset-SIM communication. However, the industry is split between the two standards, as no agreement has been reached at the time of writing.

According to some industry observers, the debate is mostly about technology and intellectual property rights. The MMC interface can be easily implemented in most handsets, as it is an adaptation of the removable card communication interface that is embedded in many feature phones today. The USB, on the other hand, is much more fully featured, including Internet protocols allowing a web server implementation, but at the same time is more complex to develop and integrate within handsets. According to Jean-Christophe Tisseuil, Head of Product Marketing at Sagem Orga, "implementation of the USB protocol for handset-SIM communication might take up to 18 months to enable a large enough range of handsetse to be brought to market. We are able to have handsets in the field now with a fast SIM communication channel. It's a window of opportunity that the industry should not miss."

Technology

The increased memory capacity of HC SIMs is made possible using the advances in Flash memory storage. The first NOR-type Flash chip was introduced by Intel in 1988, followed by NAND flash from Samsung and Toshiba in 1989. NAND Flash has faster erase and write times, higher density, and lower cost per bit than NOR flash. However it allows only sequential access to data (as opposed to random access). NAND Flash is the memory technology behind removable cards such as SD and HC SIM cards, while new memory technologies are being introduced such as Spansion's MirrorBit™ ORNAND™ technology for HC SIM cards which combines the benefits of NAND and NOR.

HC SIM card manufacturers use the ROM for storing the card operating system and security functions (which rarely change), and Flash storage for operator-dependent variations such as applications, files and operating system deltas. Flash-based storage can be re-written much more quickly and readily, at the point of sale, at SIM insertion, during the SIM lifetime or when repurposing SIM cards at the factory for stock management. This is in contrast to ROM storage which requires a time-consuming mask process. Major SIM card manufacturers are switching from ROM to Flash-based storage even for ordinary, low capacity SIM cards, due to the increased flexibility and similar costs.

Besides memory technology, HC SIM cards technical features are a marked evolution compared to the traditional SIM card, as shown below.

Table 4: Comparison of ordinary SIM card and high-capacity SIM card technology

	Typical SIM	Typical High Capacity SIM
Processor	8- or 16-bit microcontroller	16- or 32-bit RISC microcontroller
Memory	64KB - 128KB (EEPROM)	4MB – 1GB (NAND Flash)
Frequency	5-15 MHz	10-50 MHz
OS	Typical card OS and JVM	May require extension of the OS to support new high speed communications protocols
Silicon	150 nm	100 nm
Capacity	250 contacts	20 full-length tracks, 200 pictures, 2000 contacts

Source: Informa Telecoms & Media

Conclusions – High Capacity SIMs: The renaissance of the SIM?

The arrival of HC SIMs marks a milestone in the evolution of the SIM, both in terms of commercial applications and technical specifications. HC SIMs arrive amidst a complex commercial environment, and fierce competition from alternative technologies. M-Systems, a company which has been evangelising the HC SIM paradigm since 2004, acknowledges that the market is still at an early stage. Ira Cohen, VP of Marketing and Business Development at M-Systems concedes that the growth of the HC SIM paradigm will require a fundamental shift in the market, but asserts that M-Systems has accomplished similar market shifts, as when it introduced the USB Flash Drive. According to Cohen, "we are at the incubation period - there are many more steps to be taken in the high density SIM market. This will require a change of paradigm and we're not afraid of changing industry paradigms."

In the next section the critical questions surrounding the commercial success and viability of HC SIMs will be addressed.

Section B - The business case for High Capacity SIMs

The HC SIM paradigm within the mobile ecosystem

The SIM was never designed as a standalone service delivery platform. Instead, its role has always been an enabler, i.e. a piece in the puzzle of end-to-end mobile operator services. As such, the success of the SIM has been dependent on the collaboration of three entities: the SIM card manufacturer, the mobile operator and the handset manufacturer.

A 3-player game

The mobile operator has always been the primary force behind SIM evolution; after all the SIM is a physical manifestation of the subscriber[14] identity in the form of a security token owned by the operator. The SIM is also a distribution channel which lies entirely within the operator walled

[14] Technically speaking, the SIM is a manifestation of the identity of the subscription, and not necessarily the subscriber.

garden. This is contrary to wireless distribution channels where the era of walled gardens has gone by irreversibly.

SIM card manufacturers have naturally been incentivised to promote the technology evolution of the SIM. At the same time, as there are no standards on SIM card operating systems, operators have in the past been challenged to ensure similar SIM application behaviour across their SIM card suppliers. With the proliferation of JavaCard implementations, this challenge has mostly subsided.

Manufacturers of memory and microcontrollers for the SIM are a key part of the value web, but are less influential as they are mostly driven by customer demand, i.e. the requirements of SIM card vendors.

Device manufacturers, on the other hand, have not always seen their interests being served by the advancement of the role of the SIM. This is because, traditionally, the SIM has firmly been in the control of the operator and used to advance operator services which might conflict with the manufacturer agenda. As a result, manufacturers have not been motivated to invest in SIM standards compliance for their handsets, resulting in a wide variance of SIM standards implementation across handsets. For example in late 2002, a major European operator was seeing manufacturer support of SIM features vary between 31% and 76% of features defined in the 3GPP SIM standards at the time. However, in recent years, the operator-manufacturer duel on controlling the last mile to the subscriber has subsided, leaving control with the operator. As a consequence, manufacturers have been reconsidering their role in the value web and have been keen to add value to their handsets for their operator customers. Handset-SIM interoperability has also been advanced as a result of this.

New players

Paradoxically, a new player joined the SIM value web to advance the role of the SIM, where traditional standards efforts had failed. SmartTrust, pioneered the SIM-based browser in the early days of mobile internet, before GPRS and WAP became an integral part of all standard handsets. Smartrust's Wireless Internet Browsing (WIB) specification, first launched in 1999, set forth a proprietary set of protocols, commands and guidelines for SIM-based micro-browsing. By making its specifications widely available, by running a WIB specification programme and by concentrating its value on the server part of the solution, SmartTrust succeeded in making the WIB a 'standard' feature of SIM cards. According to SmartTrust, its WIB technology is now integrated into more than 200 million SIM cards. Its latest version, WIB 1.3 is being specified a mandatory feature of SIMs group-wide by at least one major GSM operator. SimAlliance's Toolbox (S@T) is a similar specification initiative, albeit backed by major SIM card manufacturers, which has accomplished only a small market share in the market for micro-browsing.

Moving forward, a new type of player may be entering the SIM value web in 2007: the handset middleware vendor. Due to the lack of handset support for essential SIM standards such as JSR-177 and Bearer Independent Protocol, operators are likely to turn to platform-based solutions for establishing stronger handset-SIM interoperability, consistently across their device sales base. At

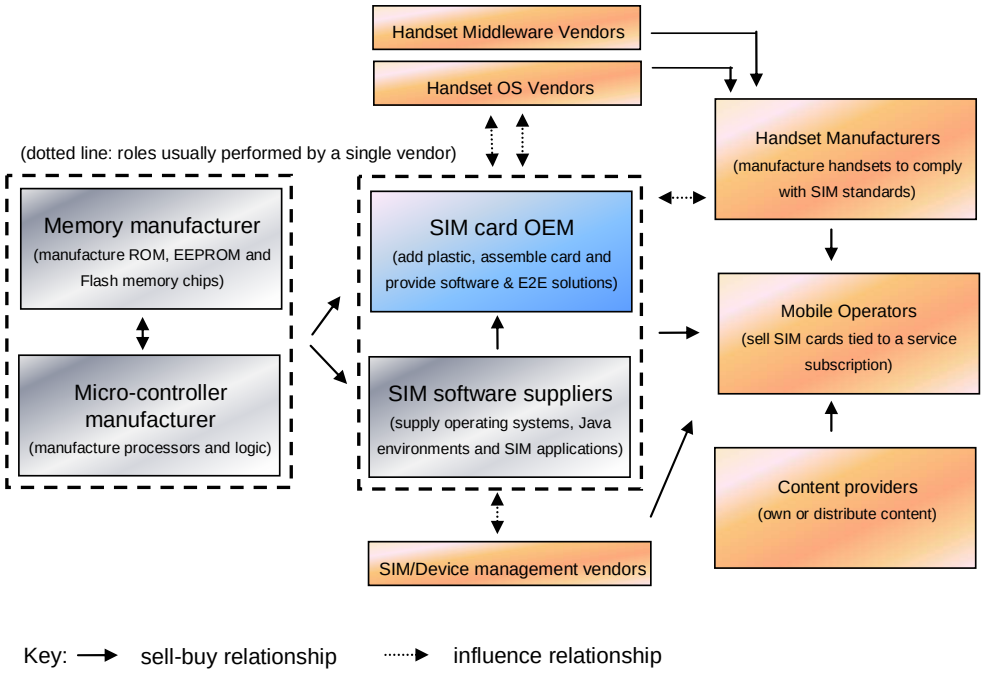
the same time a new wave of device middleware vendors such as Openwave, Access, Obigo, Sky Mobile Media, TTPCom and Tao are coming to cater for manufacturer and operator device customisation requirements in a consistent, yet cost-effective manner across mass-market devices. This new wave of device middleware vendors is also likely to play a role in the SIM value web by embedding advanced handset-SIM interfaces into the handset middleware, in order to raise their value proposition for operators. Device middleware vendors, like device operating system vendors, will also play an influential role in the SIM value web.

Lastly, content providers are likely to take an interest in the role of the SIM, in particular, due to its prospective role in DRM and content protection. However, as the SIM is entirely within the control of the operator, content providers are unlikely to take a direct role in the SIM value web. They are, however, likely to take an indirect role by insisting that mobile operators meet their Service-Level Agreements regarding controlled content distribution, regardless of which technology components the operators choose to utilise. Even in the case of media-centric MVNOs such as Disney and ESPN, content providers and media companies are unlikely to take an innovating approach to SIM cards, due to the costs and the risks involved in all new technologies.

Value web

The value web formed between the ecosystem players is shown below. The diagram depicts both the *buy-sell* and the *key influence* relationships.

Figure 2: Value web of SIM card ecosystem players



Source: Informa Telecoms & Media

Within the diagram, the role of the SIM software supplier encompasses card OS and JavaCard suppliers, SIM application suppliers and SIM middleware vendors.

High Capacity SIMs: the ecosystem perspective

Following a high-level overview of the ecosystem and the value web around the SIM, in this section the ecosystem perspective on high capacity SIMs is discussed and the viewpoints of the most influential players in the value web, i.e. operators, manufacturers and content providers, are examined.

Operators have the most to gain from HC SIMs. Firstly, when used as a user-centric storage medium for multimedia files, HC SIMs can influence the handset purchase decision in favour of the operator brand and provide stickiness to the operator during the subscriber lifetime by reducing churn. Secondly, HC SIMs can act as an effective service distribution medium for operator-customised applications, since it is logistically far easier to customise SIM cards rather than handsets. Finally, HC SIMs are a long term strategic play for mobile operators, protecting operator value at the dawn of the open Internet and the convergence of IT and Telecoms sectors.

At the same time, the lack of a critical mass of handsets supporting the USB or MMC interface and the initial high cost of HC SIM cards may make some operators hesitant about adopting the HC SIM paradigm. Even for the most innovative operators, requiring stronger SIM standard support on customised handsets will imply an additional cost to the operator. Generally, operators will readily encourage improvements in handset-SIM interoperability but may take a more back seat role in promoting HC SIMs to avoid additional investment costs.

Orange has been the most forward-looking operator, willing to support the HC SIM paradigm. Following the sell-out of 5000 SIM cards with 128MB memory soft-launched in France in November 2005, Orange is now committed to move to high capacity SIM cards from the top levels of the operator organisation. It is also working with manufacturers to embed support for their high capacity SIM initiative (branded as SIM+) within Orange's signature (i.e. customised) series of handsets. According to Yves Christol, Device Development Director at Orange, "We expect half of the top ten handset suppliers to comply with our SIM+ requirements in 2006. Our target is to reach SIM+ compliance for 25% of our signature handset range by the end of 2006."

Orange is managing to convince manufacturers to embed SIM+ support in their handsets, as an external high capacity SIM card can counterbalance the memory bill of materials (BOM), thereby incentivising the manufacturer. At the same time, Orange has to invest by being an early adopter of the technology, since the burden to convince manufacturers to support HC SIM cards will fall onto the operator's shoulder alone.

Operators such as Telefonica are known to be still debating their strategy regarding high capacity SIM cards. According to a French SIM card supplier, the HC SIM agenda has not yet captured the attention of the key decision makers in several operator organisations.

Overall, given the extreme sensitivity to handset pricing variations[15], operators will need a clear business case for the adoption of HC SIM cards that demonstrates the return on investment

[15] Even half a dollar in bulk handset pricing can affect a handset ranging decision by large operators.

through cost savings and service sales. This may be through the replacement of removable cards by HC SIMs as a vehicle for secure service distribution, or the ability to market to new segments such as the enterprise market which has much to benefit from the secure storage enabled by HC SIMs.

It is also worth noting that the cost of replacing a SIM card is typically 10 times more than the cost of the SIM itself, which means that operators will tend to rely on new subscriptions or upgrades to 3G handsets for replacing the installed SIM base with HC SIMs, a process which will take some time [16]. However, by the same token, operators will likely focus on handsets and SIM cards which have the ability to manage the SIM over the air to download new applications and data post-sales. T-Mobile for example commissioned Gemplus in early 2005 to develop a new SIM card operating system, which allows not only applications and data, but the OS itself to be updated over the air.

For handset manufacturers, High Capacity SIMs reinforce control of service distribution by the operator. There is less incentive for them to promote handset interoperability with HC SIM essential features such as the support of USB or MMC protocols. At the same time, operators have recently been successful at convincing manufacturers to support such high-speed protocols, in return for reduced embedded memory requirements, and therefore reduced handset cost.

While the power in the industry now rests with the operators, manufacturers will continue to look for novel handset features and services that add value to their handset and differentiate them from competitors' devices. Consequently GSM handset manufacturers who have traditionally maintained a strong operator relationship (such as Sagem, LG and HTC with Orange) are adapting their handsets to support advanced HC SIM features. Other manufacturers such as Nokia are showing a strong support for Java and implementing JSR-177 support in their latest S60 3rd Edition software platform which has shipped on Nokia's E-series devices for enterprise customers. Such moves will undoubtedly contribute to the successful emergence of High Capacity SIM cards. Tier-1 manufacturers such as Nokia and SonyEricsson are less in favour HC SIMs; however even they may have to follow the example of other manufacturers and implement support for MMC or USB protocols around 2007.

Content providers are naturally keen to see the emergence of trusted end-to-end mechanisms for secure and controlled content distribution. HC SIMs can play an important role in this respect by acting as a secure, user-centric storage of rights tokens and protected content. At the same time, because control of the SIM rests with the operator, content providers have recently shown some resistance to operator control of the subscriber relationship, just as manufacturers did earlier in the decade. Although the operator-manufacturer power struggle seems to have calmed and gone in favour of the operators, the situation with content providers may have a different outcome. In Europe, at least, the split between off-portal vs on-portal transactions is 70/30, according to QPass. Consequently operators will be looking for ways of attracting business from major content providers, including the use of HC SIMs as a secure distribution medium for protected content.

[16] According to Celltick, mobile operators replace 20-35% of their SIM cards annually, simply due to user churn, subscriber growth and handset upgrades.

It is also worth bearing in mind that there are several components in an end-to-end trusted content management service, of which the SIM is only one. Hence content providers will be seeking firstly a trusted DRM service provider with a compatible revenue model, in addition to seeking assurances as to the security of individual service components, such as the SIM. In addition, content providers' interests are mostly in recurring sales of high value, time-sensitive content, contrary to sales of content with a long lifecycle. Such scenarios are enabled more easily through secure removable storage cards, which have a short lifespan and are easier to distribute.

On the other hand, HC SIM cards bring several advantages to the table compared to removable storage cards. SIMs combine portability across handsets, but are tied to the subscriber's identity, and hence cannot practically be shared. In addition, SIM cards are restricted to the mobile world, unlike removable cards which can be transferred to a PC, a fact which increases content protection to the benefit of the content provider. Overall, the ubiquity and security aspects of HC SIMs, when combined with a compatible revenue model may prove appealing to content providers, as an alternative, trusted content distribution medium.

Key success factors

Based on the above discussions the strengths, weaknesses, opportunities and threats for high capacity SIMs are presented below.

Table 5: SWOT analysis – High Capacity SIMs

Strengths:	**Weaknesses:**
• Portable storage of multimedia content such as videos, pictures and music, when most users are familiar with the notion of the SIM • User-centric DRM where content, rights tokens and digital certificates persist across handsets • Very effective at deploying operator services post-sales • Well-suited for operator -driven targeted customisation and personalisation (which can also be delivered by card manufacturers • Designed for secure multimedia storage and compliant with smartcard security standards • HC SIMs will find applications in corporate environments where secure storage and cryptographic capabilities are of primary interest • HC SIMs can act as a replacement of removable memory cards or expensive handset embedded memory	• Industry adoption is dependent on a critical mass of handsets supporting the USB or MMC interface. • Cost of SIM likely to double in the medium term due to additional memory • Unsuitable for processor-intensive applications • User interface is less attractive than handset user interface for target handsets, both in terms of richness and click-distance
Opportunities:	**Threats:**
• HC SIMs will benefit from the strong influence that mobile operators have in the industry, and especially Orange which is the most ardent supporter of HC SIM cards. • The merger of Axalto and Gemplus (once approved) is likely to align the agendas of SIM card vendors behind that of Gemalto, the category leader • Handset manufacturers such as Nokia, are launching handsets with JSR-177 support. These will fuel demand of HC SIMs by early adopters such as corporate customers	• HC SIMs have a relatively narrow window of opportunity in the competition against replacement technologies such as removable storage cards. • New handset functionality and security solutions (eg fingerprint scanner, GPS, antivirus) do not involve the SIM, a situation that may proliferate

Source: Informa Telecoms & Media

High Capacity SIM cards are clearly emerging amidst a very complex commercial environment. In order to win market share they will need not only the support of operators but also the collaboration of other industry players such as manufacturers and SIM card vendors, whose interests have not always been closely aligned. Within this convoluted business landscape, there are two major success factors for the commercial success of the HC SIM paradigm:

Handset manufacturer support for handset-SIM interfaces

Without doubt, support of USB or MMC high-speed protocols on the majority of feature-rich handsets is a critical success factor for the High Capacity SIM paradigm. The two protocols are competing head to head for standardisation at ETSI. Implementation of the USB or MMC interface to the SIM on a critical mass of handsets will allow handset native applications to access HC SIM functionality, including data and applications, making it practical to transfer large amounts of data between the handset and the SIM. While Orange is convincing a significant portion of manufacturers to implement support for such interfaces, it is too early to take this industry optimism for granted. Tier-1 manufacturers are known to be hesitant in adopting MMC or USB interfaces and their attitude will be crucial to the success of this new paradigm.

JSR-177 is a programmatic Java interface on top of the handset-SIM communication channel that enables handset Java applications to access data or applications running on the SIM card, including access to cryptography functions. Also known as Security and Trust Services API (SATSA), JSR-177 allows the SIM card to function as the 'security element' of a handset Java application, allowing the handset application to perform signature operations, user authentication and invoke custom SIM applications. Wide availability of JSR-177 will allow 3rd party application to developers to finally access the power of the SIM. In the case of High-Capacity SIMs, JSR-177 is critical to enabling scenarios such as user-centric DRM and corporate security applications. Handset manufacturers have started to release high-end handsets with JSR-177 support – Nokia for one has included JSR-177 support in their S60 3rd Edition software platforms, which will see HC SIM support feature widely across Nokia's high-end handsets.

Although implementation of the JSR-177 programmatic interface is an important enabler for several applications of HC SIM cards, it is not the only alternative. Software vendors such as Abaxia and Beep Science are opting for developing a combination of a handset application and a SIM application, which establishes a proprietary programmatic interface for accessing SIM functionality. Due to the slow emergence of standardised programmatic interfaces for SIMs such as JSR-177, in practice it is very likely that proprietary handset-SIM programmatic interfaces will form *de facto* standards, for implementing applications such as home-screen replacement, content discovery and DRM. Celltick's LiveScreen is an example of such an emerging de facto standard. According to Ran Wellingstein, VP Business Development at Celltick, "leading SIM card manufacturers are now loading our LiveScreen content discovery applet on the ROM by default, even to operators who are still at a prospect status. This is in the knowledge that once these operators decide to launch LiveScreen services, they will already have substantial service penetration."

In parallel to handset-SIM interfaces, availability of high speed SIM-network interfaces will greatly promote the cause of HC SIMs. As SIM cards have a long lifecycle and are expensive to replace, they can benefit substantially from OTA management for the download of new data and applications. In the case of HC SIM cards, it would be unthinkable[17] to use the current SMS-based transport mechanism for Remote Application Management (RAM) and Remote File Management (RFM). The BIP is a solution[18] to address this limitation by enabling SIM-network communication via GPRS and 3G channels. The prerequisite of the BIP technology is that the handset and SIM must support SIM toolkit class E commands, which are available on very few handsets today. There are, however, signs of a turn-around as both SmartTrust and Celltick recently launched BIP controller applications which allow TCP/IP communication to the network via extensions to the ETSI standard protocols. Given the success of SmartTrust's WIB and Celltick's LiveScreen products, growth of BIP support among manufacturers is likely.

A business case for subsidising High-Capacity SIM cost

Mobile operators are the primary advocates of the SIM, and by extension, HC SIMs. However, as discussed in section 2.2, operators may be deterred by the increase in the cost of SIMs due to higher capacity. As such, it is crucial for the industry to demonstrate a business case showing clearly the service deployment scenarios in which return-on-investment (ROI) can be secured. Given the operators' extreme price sensitivity to handset cost and the industry criticisms on mounting subscriber acquisition costs, the demonstration of such a business case is a critical success factor for the commercial success of High Capacity SIMs. This may be through the replacement of removable cards by HC SIMs as a vehicle for secure service distribution, or the ability to market to new segments such as the enterprise market which has much to benefit from the secure storage enabled by HC SIMs. For example, according to Celltick, operators are willing to spend more than $3 per subscriber (the cost reflecting on a higher capacity SIM card and Celltick's license fee[19]) to drive usage of content and new services.

In parallel, SIM card manufacturers need to demonstrate a solid roadmap for the HC SIM card pricing that will drop to $3-$4 in the next 2 years, i.e. the current cost of ordinary SIM cards. A price drop of this kind has certainly been demonstrated in the past with removable cards (particularly SD and MMC where supplier competition created price erosion), but it has to be orchestrated at a rate and in a fashion that the operators will feel comfortable with.

Conclusions – The Business case for HC SIMs

High-Capacity SIMs offer many appealing applications, solutions and opportunities for mobile operators, content providers and enterprise customers. At the same time, there are plenty of challenges ahead before commercial viability of HC SIMs can be guaranteed. Based on the facts

[17] For example, downloading of an 8KB Java Application would take more than 60 SMS. One missing SMS means application fails to download.

[18] Standardised OMA DM protocols can also be used to manage data and applications stored on the HC SIM card, by acting via a handset application. Upon receipt of custom OMA DM objects the handset application can manage the HC SIM card, although such a solution is not as standardised an approach as the BIP protocol.

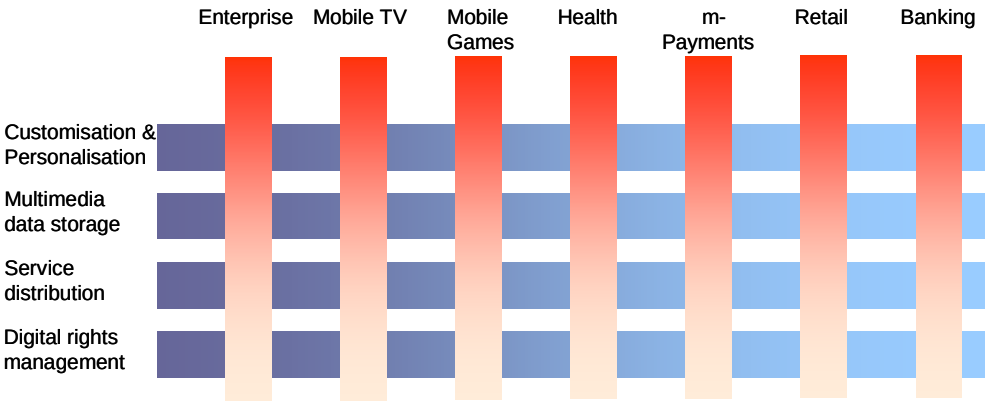
[19] Priced per active subscriber

and projections presented in this white paper, Informa Telecoms & Media expects High Capacity SIMs to see growing demand by the second half of 2007, as an operator tool for content protection, service customisation and distribution, as well as an enabler for secure enterprise services. Assuming that at least one major operator group will join Orange in the promotion of the HC SIM paradigm, we believe that most major manufacturers will include support for MMC or USB interfaces in their handsets by the end of 2007, fuelling the market of High Capacity SIM cards.

Section C - Business Applications of High Capacity SIMs

Having analysed the market and the challenges lying ahead for high-capacity SIM cards, the focus will now turn to some of the key markets where HC SIMs may have an impact, and specifically Mobile Enterprise, Mobile TV and Mobile Games. We will also look at the use of HC SIMs in an enabling capacity, such as multimedia data storage, service distribution and digital rights management.

Figure 3: Vertical markets vs enabling uses of HC SIM cards



Source: Informa Telecoms & Media /Spansion

Mobile Enterprise

Enterprises of all sizes have always been concerned with data security, both in terms of securing confidentiality of information, and of protecting against data loss, whether accidental or by theft. The high capacity SIM paradigm is well suited for mobile enterprise applications. The secure, extended storage and cryptographic capabilities of the HC SIM paradigm lend themselves to numerous applications, from one-time password generation to secure email and access to Internet services.

The Mobile Enterprise Ecosystem

The key players in the mobile enterprise value chain are the enterprise solutions providers, the mobile operators, the system integrators, and the enterprise customers.

The mobile enterprise solution providers are technology vendors who specialise in wireless communication and management applications for enterprise customers, such as mobile email and device management vendors.

The system integrators are the established vendors who provide end-to-end integration services encompassing both traditional IT infrastructure and mobile data services. System integrators are typically the entry point for sales into the enterprise, as they have established accounts and knowledge of customer circumstances.

Mobile operators have started to directly sell into enterprise customers, through tailored voice and data tariffs, tailored handsets and data cards, and recently by offering combined landline and mobile calling plans.

Naturally, the HC SIM card paradigm will mostly be promoted by mobile operators, although system integrators are most likely to take it to market, given their existing accounts with enterprises.

Role of the SIM

By leveraging the secure, extended storage and cryptographic capabilities, the HC SIM paradigm lends itself to numerous mobile enterprise applications:

- one-time password (OTP) generation. One time passwords are used in the enterprise environment for accessing secure services on the corporate intranet or extranet. OTPs are typically generated by an external handheld terminal, or through an SMS sent to the subscriber's handset[20]. HC SIMs can bring a unique advantage by hosting a standalone, secure application on the card itself that generates the one-time password, without the need for the mobile device to be within network coverage. The OTP can also be unique to the subscriber, based on the IMSI or the MSISDN identifiers stored on the SIM card. The OTP can then be typed in by the user into the web interface or communicated automatically to a PC via a Bluetooth connection.
- Secure email and database access. For handsets used to access corporate email and intranet databases, the high capacity SIM card can be used to store the client private key, as part of an asymmetric client-server architecture for data exchange. It should be noted that without a secure path between the email (or database) client and the SIM, such a security solution is vulnerable to a *man-in-the-middle* attack. At the same time, it is true to say that storing the client private key in the SIM is likely to be more secure than storing it in the handset memory.
- Access to intranet or services. By connecting the handset (and by extension the HC SIM card) to a PC terminal, a dedicated SIM application can silently authenticate the subscriber, when accessing Intranet services. The handset and the PC may be connected via either wired or wireless – in the wireless case, the Bluetooth SIM Access profile maybe used by the PC to access the specialised SIM application within

[20] An example is Mideye's solution which sends a one-time password via SMS to the user's handset as part of a two-factor authentication system.

the handset that will generate an authentication token. Such an application would have marginal benefits over a one-time-password generation via a standalone SIM application, but would also be more costly to implement.

In the above applications, HC SIM cards also enjoy benefits traditionally associated with ordinary SIM cards, such as the ability to block the SIM immediately through a call to the operator.

Overall, for HC SIMs to leverage their extended, secure storage and cryptographic capabilities within mobile enterprise applications, mobile operators will have to be involved. Given the early stages of the HC SIM paradigm and the organisational inertia typically associated with tier-1 operators, HC SIM enterprise applications will likely appear in the long term. That said, the benefits for the innovative operator who does launch SIM-based enterprise solutions will be significant, as such solutions will provide stickiness to the operator and reduce churn. Operators therefore need to move proactively and explore the use of HC SIMs in their capacity as critical enablers for mobile enterprise applications.

Table 6: SWOT analysis –High Capacity SIMs as an enabler in mobile game applications

Strengths:	**Weaknesses:**
• HC SIM cards are well suited for generating one-time passwords, replacing external security devices. • HC SIM cards lend themselves well as an enabler for corporate PKI applications, since the private key can be stored securely on the SIM card. • HC SIM cards may be used for silent, convenient access to corporate internet or intranet services.	• Operator organisations are typically slow at approaching enterprise customers and therefore may not exploit the opportunities opened by HC SIM cards
Opportunities:	**Threats:**
• HC SIM card enabled corporate solutions can provide customer stickiness and loyalty for the operators • System integrators (SIs) will find many more corporate applications for HC SIM cards, assuming that mobile operators will adopt an open approach for SIs to manage corporate SIM cards and the associated services.	• Inertia at operator organisations and lack of operator familiarity with enterprise organisations may delay corporate HC SIM applications to the longer term.

Source: Informa Telecoms & Media

Mobile TV

It has been said that in 2004 the notion of 3G meant video-calling, in 2005 it meant high-speed data cards, while in 2006 it means mobile TV. Indeed, mobile TV has been generating interest from many sectors of the mobile and broadcast industries, including mobile operators, handset manufacturers, broadcasters and content providers. It is difficult at this early stage to prescribe the role of the SIM card as an enabler in mobile TV; it will at the least be a peripheral component and at best a critical enabler. In this section we briefly review the mobile TV ecosystem, and the role that the SIM may be called to play in this business application.

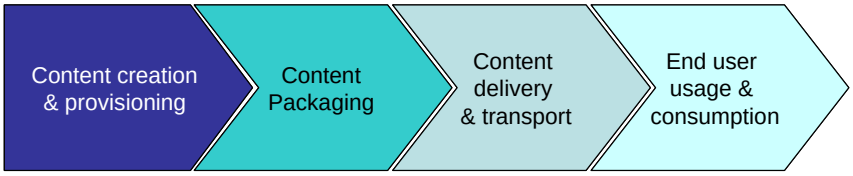
There are a number of competing standards for mobile TV, such as DVB-H, DMB, ISDB and Mediaflo, each involving different broadcast technologies, business models and points of control

within the value chain. A key determinant of each technology and the related business model is whether the mobile data network will be used for delivering the TV content and/or the application metadata that add interactivity to the TV programming. Interestingly, the mobile TV market has the potential to bring some of the largest players in the entertainment industry, such as Disney, Time Warner and Sony Entertainment up against the major mobile operators.

The Mobile TV ecosystem

Much like the terrestrial digital TV ecosystem, the mobile TV value chain consists of four basic value areas, as shown in Figure 4 below.

Figure 4: Mobile TV value chain



Source: Informa Telecoms & Media Mobile TV report (2005).

Content creation and provisioning refers to the creation and supply of original content, which is provided by film studios, music labels, broadcasters and providers of brand intellectual property (IP).

Content packaging refers to the aggregation and publishing of content for distribution, which is provided by public broadcasters, television channel providers, cable operators and satellite companies.

Content delivery and transport refers to the physical delivery of content over a mobile operator's or a broadcaster's network.

The final piece of the value chain refers to the end user usage and consumption of TV content.

The mobile operators' strength lies in being able to provide a return channel for interactivity, and in their relationship with the end user, where they are responsible for service provisioning, billing and customer care. In addition, mobile operators often have a strong influence on handset specifications, handset distribution and subsidy. They are also well positioned to provide location-based services and DRM. On the other hand mobile operators are reliant on content owners and providers for the supply of original branded content, which is what generates user attraction.

A key issue in mobile TV is how the services will be charged for. The most likely charging scenarios of pay-per-view and subscription basis will be easier to implement in partnership with mobile operators who already have a billing relationship with the end user.

Mobile operators will be responsible for leveraging the benefits of high-capacity SIM cards in Mobile TV applications. Players in the two first part of the value chain (i.e. content creation and

content packaging) are not anticipated to take a strong interest in high capacity SIMs – such players will most likely impose the content licensing conditions, which mobile operators must comply with. Use of the SIM for Mobile TV applications is therefore ultimately up to mobile operators.

Role of the SIM

At first, the role of high-capacity SIMs may seem peripheral to mobile TV, pertaining only to subscriber authentication. However, HC SIMs offer compelling value to the mobile TV market in a number of areas, such as DRM, service provisioning and service management. Specifically, HC SIM cards may be used to:

- securely store the TV content rights objects as part of an end-to-end DRM scheme and allow these to be managed OTA by the mobile operator. This offers portability of content rights when the user changes to a different handset, although does not extend to the case where the user churns to a different operator. Since October 2005, T-Mobile in the Czech Republic has been trialing use of the SIM card as a key element for securing access rights within their interactive 'TV in your pocket' service, based on DVB-H technology.
- HC SIM cards can use an internal algorithm to generate the content descrambling key on a regular basis, for increased content protection. HC SIM cards are well placed to deliver this functionality compared to handset software, due to the closed nature of the SIM architecture.
- provision and manage the service settings, such as interactive data channel settings. SIM cards can be easily customised for different target end-user segments, so this makes them a well-suited vehicle for storing mobile TV service settings.
- provision, store and OTA manage the personalised Electronic Program Guide (EPG) and user profile data relating to the service. Once stored in the SIM card, the EPG can be easily personalised over the air, and in a consistent fashion across all handsets.

Naturally, high-capacity SIM cards need to be adapted to accommodate the above-mentioned mobile TV usage scenarios. It is essential that HC SIM cards support a high-speed communication protocol with the handset such as USB or MMC, as the traditional protocols are notoriously slow for most data applications. Furthermore, for the SIM card to act as a trusted agent, it needs to establish a trusted link to the media playback and management agent residing on the handset, which can only be fully delivered using a combined hardware and software security solution.

There are also some pitfalls in the use of HC SIMs in mobile TV applications. Firstly, the management of SIM-based content such as service programs and EPG guides over the air, will require use of either a proprietary SIM OTA infrastructure, or management of these settings via proprietary DM objects, and through a proprietary mobile TV client application on the handset. In practice, it is envisaged that user profile and application settings such as EPG guides will be resident on the handset, while service bootstrapping information will be stored in the SIM card. In

addition, HC SIMs would not be as suitable for storing pay-per-view credits, as traditionally all billing and settlement is managed through the mobile network, rather than the SIM.

Table 7: SWOT analysis –High Capacity SIMs as an enabler in mobile TV solutions

Strengths:	**Weaknesses:**
• well-suited for storing TV content rights objects • can easily be adapted to generate content descrambling keys on a regular basis • suited for provisioning and managing service settings • suited for provisioning customised or personalised Electronic Programme Guides.	• requires consistent adoption of handset-SIM protocol (USB or MMC) across handsets • requires trusted communication channel between mobile TV application on handset and related application on HC SIM card, which in turn requires a combination of hardware and software (this is still in the pre-commercial stage)
Opportunities:	**Threats:**
• increase the security and trustworthiness of mobile TV applications, in the eyes of the content owners and providers • Increase the operator control points in the mobile data services value chain.	• The mobile TV already suffers from a divergent set of business models and technology fragmentation. It still has to be proven as a revenue-generating service and a win-win business case for all parties involved. Bringing the SIM into this equation will complicate matters even further and as such the move is likely to be resisted.

Source: Informa Telecoms & Media

Mobile Games

Mobile games constitute one of the main sources of revenue for mobile operators, following voice and messaging. A major problem in the mobile games industry is fragmentation of handsets platforms, handset specifications, operator requirements, and diversity of channels and languages to be supported. The mobile games market is also one where margins are small, therefore experimentation in new technology platforms such as high capacity SIMs for use in mobile games will require an investment into R&D and strong industry drive for them to materialise. The role of the high capacity SIM is likely to be marginal in mobile games applications.

The Mobile Games Ecosystem

The mobile games value chain has lengthened considerably over the past three years. The key players in the mobile games industry include mobile operators, video-games publishers, brands, mobile games publishers, mobile games developers and managed service-solution providers.

Video-games publishers follow an indirect route into the market, through licensing their intellectual property (IP) to mobile games publishers or developers. Most brands and media companies have also chosen an indirect approach to the mobile games market.

The operators remain the channel by which the majority of mobile games are sold to consumers and are therefore a key link in the value chain. Most mobile operators in Europe, North America and mature markets in the Asia-Pacific now offer mobile games download services.

Mobile games publishers license IP from brand-owners, typically paying an up-front fee. The publisher either develops a game in-house or out-sources it and then negotiates distribution deals with mobile operators and independent distributors.

Games developers work for clients that may include publishers and brand-owners, licensing IP from brand-owners for games development, or developing games based on their own original IP.

Role of the SIM

Currently, the role of SIM cards in the mobile games market is peripheral. SIM- and SMS-based games were in vogue in 2001, but their popularity has faded, as handset games have since managed to deliver a much richer user experience – after all the SIM card was never designed as a games platform, while some handsets are. More recently, SIM-based service discovery and micro-browser applications have been playing a peripheral role in mobile games and mobile services in general, by providing a personalised list of services that is refreshed over the air.

In the new age of high capacity SIM cards, mobile games are likely to continue being only peripherally related to the SIM. This is for a number of reasons:

- HC SIM cards may be used to store the user profile, high score table and games settings. Although such a concept has been demonstrated in the past[21], there is no reason why game-related data cannot continue to reside in handset memory, particularly when games developers have little incentive (financial, technical, or otherwise) to change this state of affairs. Additionally, the typical lifecycle of a downloaded game is much shorter than the lifetime of the handset, which implies that the HC SIM card is unlikely to be employed to port game-related data to a new handset.
- HC SIMs may be utilised as a distribution mechanism, as in the case of operator-customised applications. However, in practice high-end games, such as Handy Games' Townsmen 3, come in nearly 100 variations for different handsets, in addition to the variations required to comply with different operator requirements and regional languages. In practice, bundling all game variants into one package for distribution via HC SIM cards would necessitate several hundreds of megabytes of storage, which is clearly not feasible practically, even with high capacity SIM cards. Furthermore, the handset lifecycle is very different from the SIM lifecycle, which implies that games developers could not possibly ship their game in a SIM card and ensure that it is compliant with handsets coming out in 12-24 months.
- HC SIMs could offer security features to mobile games, but again this is not something currently demanded by mobile games' developers. However, in the long term, assuming SIM-based mobile DRM prevails, it is plausible that such DRM

[21] In 2004, Trusted Peer Technologies, USA demoed a Collectible Object Game, where game objects were purchased in packs and collected and traded between players. In this COG system, players competed with each other using virtual game objects that were stored on the players' SIM card. According to the company, the SIM card was used to store the game objects, enforce the rules for peer-to-peer play and secure the purchase and trade of the game objects.

mechanisms will also be employed to protect rights owners' interests in mobile games distribution.

- Finally, it could be argued that high capacity SIM cards could be used to facilitate micro-payments for after-sales purchases such as extra games levels, and new characters. However, as mobile billing typically takes place through network-based reverse billing or premium SMS, SIM-based micro-payments would bring little benefit to mobile games.

Finally, mobile games developers are faced with small margins, and are diversifying their customer base across geographies and projects, in order to sustain growth in their business. As a result, they are reluctant to invest in new platforms such as high-capacity SIMs, without a clear financial benefit or operator support.

Table 8: SWOT analysis –High Capacity SIMs as an enabler in mobile game applications

Strengths:	**Weaknesses:**
• Used as an enabler for discovering games residing on the operator portal. • Limited use as a service distribution medium for promoting games applications.	• Not an effective option as a games distribution medium, or as storage for games-related settings.
Opportunities:	**Threats:**
• HC SIM cards can leverage their potential future role in SIM-based DRM schemes so as to expand their role in mobile games.	• None - gaming and HC SIMs are only peripherally related

Source: Informa Telecoms & Media

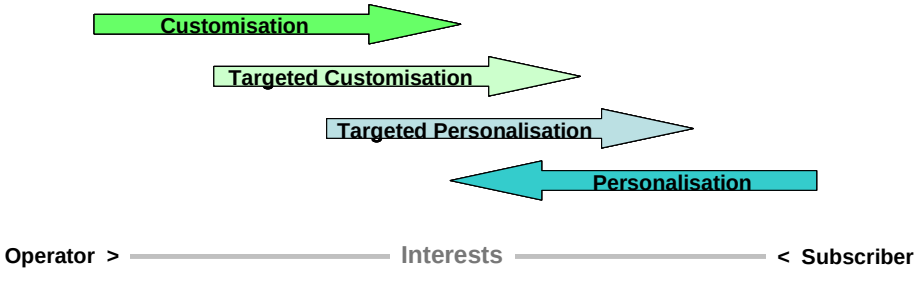
This section has so far looked at three vertical markets where high capacity SIMs may act as an enabler. The remainder of this section will turn the argument around and look at business applications that could be delivered by HC SIMs and may be suitable for a number of different markets. Four business applications of HC SIM cards are analysed: customisation & personalisation, multimedia data storage, service distribution and digital rights management.

Customisation and Personalisation

Device customisation is a term that has been in vogue since 2004, and is likely to remain so through 2006. Device customisation is when the device look and feel is adapted to fulfil operator requirements. Within the context of the SIM, customisation of the device to target a specific end-user audience is particularly important. We refer to this type of customisation as targeted customisation. An example is a handset with a shopping application targeted to a female end-user audience.

On the opposite end of the user-operator relationship lies personalisation, i.e. the user-initiated act of modifying the handset look & feel (e.g. ringtones, wallpaper). Of particular interest within the context of the SIM is targeted personalisation, i.e. the operator-initiated act of modifying the served content or applications to better accommodate each individual user. An example is a WAP portal that serves the most frequently visited menu options at the top of the menu.

Figure 5 : Customisation and personalisation in the operator-subscriber relationship



Note: Arrow direction indicates where action is initiated

Source: Informa Telecoms & Media

Targeted customisation and personalisation are of significant and increasing importance to operators for a number of reasons. Firstly, operators are faced with competition from numerous media brands and falling ARPU. Faced with the limitations of a single brand, operators resort to customer segmentation via service and device customisation to better monetise from niche customer groups. Secondly, poor accessibility and discoverability of content are important reasons for the slow takeup of data services – targeted personalisation improves these aspects of the user experience by servicing relevant content and customising applications to the profile of the end user.

High capacity SIMs offer several advantages to targeted customisation and personalisation. GSM operators have for some time been using SIM-based customisation to adapt services and handsets to different geographies (e.g. France vs UK service settings), subscriber segments (e.g. corporate activation of line 2) and distribution channels (e.g. promotional pay-as-you-go SIMs for selected channels). In early 2005, Gemplus also announced that it was working with Orange to store the operator portal on the SIM – this is another application which lends itself to targeted customisation. HC SIMs can offer important leverage to targeted customisation operations, by allowing operators to package trial services and application settings within the SIM card, while requiring minimal business process changes. The use of HC SIMs in the above scenarios maintains a fast time-to-market since SIM customisation occurs independently of handset customisation, the latter being a highly complex and time-consuming process.

Furthermore, HC SIMs offer newfound advantages when it comes to targeted personalisation. The user profile stored in the HC SIM may comprise a range of application preferences such as colour scheme and background, favourite artists for ringtones and recently viewed content which is cached on the SIM. This information can be instantly reused by handset applications[22] without requiring any communication with the network. Furthermore, the information can be ported across handsets, persisting across the lifetime of the subscription, so that the user may carry their profile with them, even when they change handsets (to a second handset that the user carries with her in the evening, or to a fancier handset that the user upgrades to). The benefits of targeted personalisation enable new scenarios for user loyalty which can be termed a 'sticky

[22] Assuming handset support for the JSR-177 handset-SIM programmatic interface and high speed handset-SIM communication interface such as USB or MMC.

garden': were the user to churn from the operator (and hence invalidate the SIM), the personal settings would be lost. The HC SIM capabilities therefore act here as a disincentive for the user to opt-out.

In terms of technology, HC SIMs use Flash-based (as opposed to ROM-based) storage for customised applications and settings requested by the mobile operator. HC SIM card manufacturers use the ROM for storing the card operating system and security functions (which rarely change), and Flash storage for operator-dependent variations such as applications, files and operating system deltas. Flash-based storage can be re-written much more quickly and readily, as opposed to ROM storage which requires a time-consuming mask process. With HC SIM cards using Flash storage, operator customisation or targeted personalisation files can be provisioned at several different times: at the Point of Sale (via a card reader terminal), OTA at the point when the SIM card is inserted into the handset, OTA during the SIM card lifetime, or to recycle SIM card stocks and repurpose SIM cards with new content. As a result, major SIM card manufacturers are switching from ROM to Flash-based storage for even ordinary, low capacity SIM cards.

Multimedia data storage

There is significant debate surrounding the use of high capacity SIMs to store users' multimedia data files, such as videos, pictures and music. In November 2005, Orange soft-launched 5000 customised Sagem myX-62 handsets (featuring 32MB of internal memory) with 128MB SIM cards supplied by Gemplus. According to a number of reports, the new handsets, clearly marketed as offering enhanced storage for user files, were sold within 3 weeks of availability, without any communication campaign whatsoever. The success of this soft launch convinced Orange to invest in its SIM+ programme, which it plans to roll out across 25% of its signature handset range within 2006.

At the same time, it must be noted that to transfer multimedia files from the HC SIM card to a desktop computer for archiving and sharing, presumes a technology-savvy user. Thus the success of HC SIMs as a multimedia storage medium will depend on the choice of end-user segment that such SIMs will be marketed to.

Service distribution

Mobile operators frequently include customised applications in their handsets which are either standalone (e.g. a help guide application) or integrated with a network service (e.g. a music download application). Delivery of customised applications (and on-device services generally) to handsets necessitates a lengthy process which typically takes 12-18 months from concept to launch. High Capacity SIM cards can substantially reduce this process to 1-3 months by deploying the service via the SIM card and removing the handset dependency. The service (in the form of an application) can thus be provisioned on the HC SIM card by the SIM manufacturer just-in-time, i.e. at the manufacturer site, at the operator distribution hub, or at the point of sale.

As demonstrated by Gemplus, Orange and Abaxia, high capacity SIM cards may be successfully utilised as a service distribution and activation vehicle. This business application is a form of just-in-time customisation, where the operator orders a number of HC SIM cards from their supplier, each customised for a different end-user segment. When a user inserts such a SIM card into a compatible handset, a hidden handset application modifies the idle screen to adapt it to the target segment that the user belongs to. This scenario requires the operator to deploy proprietary applications on both the handset and the HC SIM, although the handset can carry a 'vanilla' application, whereas the HC SIMs can be customised for any number of different market segments. A security mechanism is required in this case between the handset and SIM applications in order to discourage use of this application by non operator-trusted parties.

By extension, HC SIMs may be used to deploy many other types of applications onto the handset, replacing removable storage cards (such as the Orange Try cards). However, practical use of HC SIM as a service distribution medium is limited to applications or content which are relatively independent of the handset model; for example operator-customised applications would lend themselves to such use, while mobile games would not.

Digital Rights Management

Digital Rights Management (DRM) is a mechanism for enforcing protection of the interests of content owners, as the content is used and shared across users, devices and networks. Given the secure storage facility and portability of SIM cards, high-capacity SIM cards are likely to be employed to store rights objects for certain DRM schemes. At 3GSM 2006, Axalto showcased such a proof-of-concept in collaboration with Beep Science, a leading provider of DRM solutions.

Although high-capacity SIM cards may be an important enabler for DRM applications, they are not sufficient in their own right. An end-to-end secure DRM solution would necessitate a trusted path between the SIM card application and the handset application responsible for media playback – such a trusted path is however only feasible using a combination of software and hardware solutions, which is today far from being a commercial reality. In addition, rights objects stored on the SIM card could only be managed through a Device Management solution, via proprietary local handset software, as SIM OTA solutions are not as advanced today.

Overall, use of high-capacity SIM cards for DRM is expected to materialise only in the long-term solution. According to Jan Rune Hetle, CEO of Beep Science, "We're expecting to see SIM-based DRM solutions deployed in the market in 2007, but not earlier".