

# Firmware Management: Using Wireless Informatics to solidify the business case

## Industry Briefing

Firmware is the term used to describe the entirety of embedded handset software. This comprises the OS, middleware and application layer. This firmware can be updated by the inclusion of a firmware update agent that resides within the bootloader, i.e. the software component that runs when the phone is switched on. Recently there has been much industry interest in a subset of Firmware Management - FOTA (Firmware delivered over-the-air). As a technology, FOTA promises a number of tangible benefits to the end-user, the operator and the handset manufacturer. However, the reality is that a number of barriers –commercial, technical and social – still block the widespread adoption of the technology.

FOTA has had limited commercial success outside of Japan where it was first deployed in 2003. Handset recalls were a huge issue in the Japanese market, particularly around the time that the first 3G devices started appearing. In a one-year period (July 2000 – July 2001) more than 2.5 million devices were recalled, largely due to faulty software. The cost to industry was enormous – Sony alone lost over \$100 million dollars.

It had been assumed that Japan's high data consumption offered a tangible business case for FOTA and that as vanilla voice and SMS is largely unaffected by buggy software, the rest of the world would not see mass-market interest in the technology until 3G achieved a majority market share.

However, a review of notable firmware failures from the last two years (see fig.3) shows that the damage to the user experience comes not solely from data connectivity issues, but from wider usability failings (battery defects, screen freezes) and from the voice experience (dropped calls, earpiece volume).

WDSGlobal therefore believes that a business case exists for FOTA, but as part of a wider 'user experience' management program. It also believes that FOTA (implying the ability to deliver updates over-the-air) has become a misleading generic term for Firmware Management and that in the operator domain 'Firmware Management' must incorporate the ability to manage firmware through the most appropriate channels available, ie: cabled update, at the Point of Sale, via OTA etc.

### FIRMWARE MANAGEMENT NOT FOTA

While an OTA mechanism offers a valuable channel it may not always be the most appropriate channel when considering cost, time and the user experience. Instances of FOTA are also limited when compared with more established cabled updates methods. For example, Nokia's recently launched Software Update service only lists one handset capable of an OTA update through the service, all other terminals require a cabled connection (typically via USB).

Such cabled updates may also be applicable at the Point-of-Sale. For example, batches of handsets sitting in the retail chain (and known to contain a fault) can be reflashed prior to sale. This offers a faster approach and eliminates the end-user from any involvement. Verizon has demonstrated this approach, updating a batch of Nokia devices that had been shipped without its Vcast software at its retail stores immediately prior to sale.

As well as considering the most appropriate transport mechanism, any Firmware Management approach must also consider:

a) The necessary support infrastructure is in place to guide the end-user through the process seamlessly. Customer care or PoS staff must be knowledgeable and able to direct the end-user to the most appropriate solution while also supporting any upgrades and managing firmware failures.

b) Firmware updates are tested and validated against network parameters.

c) FOTA should not be treated as a problem-solving silver-bullet and the decision to update must be made based on accurate problem solving due to the impact on the user experience and associated costs, a Firmware reflash should be treated as a final course of action. Many perceived firmware issues may simply be a usability error or incorrect setting status. Specialized technical support desks should act as the FOTA-Gatekeepers, ensuring all possible work-arounds and known fixes have been applied before a Firmware update is started. The problem must also be accurately diagnosed to ensure the correct patch.

d) Information about the interaction (root cause of firmware failure, customer experience etc) must be shared across the mobile value-chain to mitigate recurring support costs.

This process evolves 'Firmware Management' as we know it into a more considered Wireless Informatics environment.

#### THE FIRMWARE MANAGEMENT BUSINESS CASE

WDSGlobal believes that the ability to manage firmware updates is a critical technology that addresses key concerns in the mobile handset support environment. However, we believe that full-scale deployments are not to be expected until late 2008. The traditionally quoted business cases for FOTA are anchored around the following:

##### Cost Mitigation

Remove logistical cost of handset replacement and actual device replacement cost

##### Revenue Protection

Lower revenue losses from faster fix and problem resolution

##### Brand Protection

Protect against damaged reputations

##### Future Proofing

Extending the life of the device through feature updates

#### Cost Mitigation

The cost of a recall cannot be calculated based on the hardware cost alone. Customer support calls prior to a replacement decision, as well as revenue loss from a faulty device may drive the total cost of a recall to \$142 per device (see fig.1). Once an end-user's call has been escalated up through the support environment to a stage where a handset replacement is authorized, the cost of this interaction alone is likely to have passed \$40.

It is anticipated that firmware recalls cost the industry \$1.1 billion in 2005, compared to \$725 million in 2004. A recent audit by Strategy Analytics estimated that a typical recall of 50,000 units would cost between \$21-36 million.

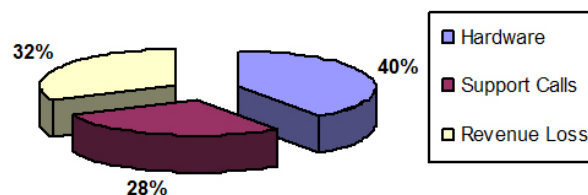


Fig.1) The cost to recall a device may reach \$142 based on peripheral costs (source: Visiongain 2006)

#### Revenue Protection

Ultimately a device that is not performing optimally is not going to deliver optimum revenue. This holds true of any performance issue, whether it be inaccurate configuration or an embedded firmware issue.

Today's mobile subscribers already suffer from a certain degree of apathy towards more complex mobile services and issues such as configuration and set-up present immediate barriers to service adoption. Firmware failures will only add to this apathy. Indeed a user may not be able to identify the root cause of a service failure and choose not to seek a resolution through existing support channels. It may therefore be appropriate to update known firmware issues prior to their discovery by the user. This may take the form of a push-update after sale, or a cabled update at the Point of Sale itself. Gfk NOP reports that 44% of all mobile data users give up trying to use data services if they do not work first time.

Additionally, there is a solid business case for treating Firmware Management not solely as a bug-fixing technology but as a means of delivering a common level of parity across the installed base of devices to ensure consistent access to service portfolios.

#### Brand Protection

While handset manufacturers bear much of the blame for handsets not functioning as expected, operators are also in the front line. Forrester Research suggests that handset manufacturers enjoy much higher brand trust than operators in much of Europe and North America. This affords them a certain degree of protection, supported by the fact that in many regions it is the operator that controls the supply (and cost) of the handset in the retail chain. If a fault occurs, consumers are typically not aware of the type of fault, or where in the device it resides (ie: firmware or application

layer). It is thus a natural reaction to look for support from the supplier of the device – most often the operator.

A 2005 sample from a US-based brand trust audit can be seen in Fig.2. Trust is graded from 1 (distrust a lot) to 5 (trust a lot).

	Trust rating	Change since 2003	Grade
Verizon	4.0	0.0	C
Cingular	4.0	-0.1	C
T-Mobile	4.0	0.0	C-
Sprint	4.0	-0.1	D-
Motorola	4.2	-0.1	B
Samsung	4.0	-0.1	D-
Nokia	4.1	-0.2	C
Palm	4.3	0	B+
LGE	4.0	-0.1	C-

Fig.2) Brand Trust audit of US mobile operators and handset manufacturers (source: Consumer Technographics Q3 2005 N.American survey / Forrester Research)

### Future Proofing

In many European and North American markets, the practice of handset subsidies hits AMPU (average margin per user) from day one. The practice was introduced to seed the market with the necessary technology and drop many of the barriers to entry for feature phones. Today, it has become a financial burden that few operators enjoy. In these regions, the operators control ~80% of all handset sales and end-users often enjoy annual upgrades. Many operators look to Firmware Management as a means of extending the lifecycle of a device beyond the typical 12-16 months through regular Firmware Management updates and the delivery of new content and services. WDSGlobal is doubtful that this logic can be applied successfully. The decision to upgrade a device is frequently made not on functionality but fashion, trends and peer pressure.

Instead, WDSGlobal sees Firmware Management as a means of ensuring the efficient running of the device in its typically short lifecycle. The impact of handset subsidies places additional importance on ensuring the profitability of a device from day one. Subsidies are included in an operator's Cash Cost Per User (CCPU); this includes the acquisition costs and upkeep of the user through customer care, network and administrative costs). It is not unusual for the annual CCPU to be over €300. It is therefore crucial that the end-user is afforded the chance to deliver adequate revenue through seamless, uncompromised access to handset features and operator services. A firmware error will greatly impede this.

### WHO'S RESPONSIBLE?

It is far from clear who should be responsible for managing the Firmware Management process. Market pressure on manufacturers to launch new products at ever-faster intervals has undoubtedly led to increased instances of firmware errors (see fig.2). Therefore a certain degree of blame and finger pointing is being made towards the OEMs. However, operators – who in many countries front the mobile user experience - are also acutely aware that their 'hub' position in the mobile ecosystem means they will frequently be the first port of call for an end-user. This may be a return to the

point-of-sale, a visit to the website or a call to customer care, all of which have an associated cost of service.

Ultimately, there is no clear-cut result. Manufacturers can be accused of releasing faulty products and operators accused of inadequate testing. However, both parties have a compelling business case for Firmware Management; a) handset manufacturers must limit the cost and financial burden of returns and b) operators must be the guardians of the end-user experience to protect ARPU and guard against churn.

In reality, differences of opinion still occur. When US consumers reported a faulty Nokia 6682 on the Cingular network, Nokia and Cingular were at odds as to who would fix the fault. Such instances are not uncommon and examples exist of faults occurring and no official recall taking place because of non-agreement over acceptance of liability.

Model	Handset	Fault
RaZr	Motorola	Dropped calls
V600	Motorola	Dropped calls
MPx220	Motorola	Earpiece volume too low
V710	Motorola	Camera alignment
K750i	SEM	Screen freeze
X1	O2 (HTC)	Overheating
6682	Nokia	Multiple
6630	Nokia	Multiple
S65	Siemens	Potential damage to users' hearing
D600	Samsung	Defective battery
T610	SEM	Poor reception / faulty charger

Fig.3) Examples of recent handset recalls. (source Visiongain 2006)

To date, 90% of all Firmware Management interactions are direct via the OEM. In 2006, Nokia launched its Phone Software Update service. To date (March 2007) more than 30 devices are listed on its site with users advised on 5-15 minute update times. Updates are available over-the-air (only one device listed as OTA updateable), or via a cabled link.

Motorola reports 30 FOTA-capable devices but does not disclose these. However, the manufacturer admits that the 'majority of mid and high tier devices are capable'.

### SECONDARY SUPPORT COSTS

It may also be in the operators' interest to accept a degree of responsibility over Firmware Management to mitigate subsequent support costs. End-users who choose to reflash their device via a 3rd party may, if the session corrupts, return to the operator for a resolution.

In many cases, such an action may have invalidated the warranty associated with that device. Operators will then have to make the decision to bear the cost of resolving the issue (to ensure subscriber loyalty and the ability of the device to function correctly and deliver revenue.) In addition, firmware is often closely associated to a particular network. Considerations may have been made and agreements reached during handset personalization to include network specific features, or indeed to lock-down features (such as WiFi ports)

## BARRIERS

Several barriers currently exist. These include:

a) Consumer market is still dominated by feature phones. It is more advanced smartphones and 3G devices that will most benefit from FOTA. Penetration of these devices must hit ~30%.

b) The number of handsets that are FOTA enabled is proportionately quite small. However, the number is growing with most new devices offering a degree of compliance.

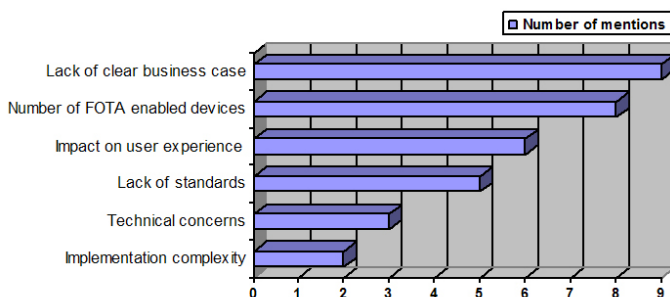
c) Operators are also unable to guarantee Firmware Management support for off-portfolio devices migrated between networks by end-users.

d) Network bandwidth limitations and higher cost to provision firmware OTA.

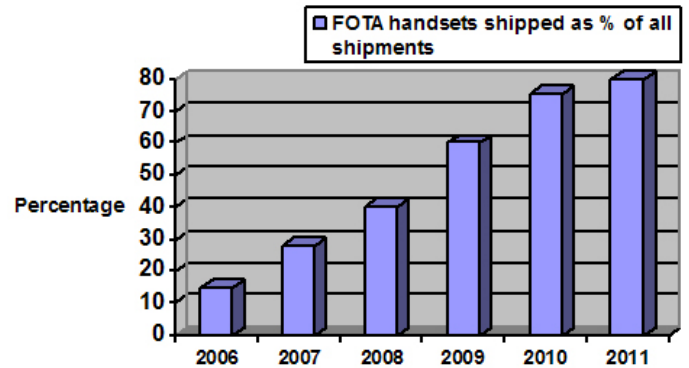
e) Manufacturer software development is not optimized for minimizing changes between firmware versions. The size of the update delta is still a concern and not of priority to the manufacturer.

f) Supporting processes must be put in place to marshal what (in the eye of the consumer) is an inherently complex procedure. What if the update fails and the device crashes?

g) The user experience must be managed. Concerns over security give way to confusion when the consumer is not adequately guided through the process. Telefonica Moviles Espana implemented a FOTA solution from mFormation / HP in 2005. The operator plans to make firmware updates available in case of a critical bug only, at least until the customer experience of FOTA improves, says Jose Antonio Moujadami Arosa, leader for MDM activities in TME's Handset and Smart Card group. During the update process the handset screen resembles an unfriendly text-only interface which is confusing to most users. To mitigate risks from poor user experience during OTA firmware updates, Telefonica plans to support the user through a concurrent call with a customer care agent (even though this would require tier-3 (i.e. specialized) customer support due to process complexity.



The exact number of FOTA-capable devices is hard to gauge, the most credible estimate is between 200-300 devices. Most manufacturers offer automatic update capabilities in new devices. These updates are typically free (outside of network airtime) and can take up to 15 minutes to run. Updates are also available to download to a PC and then loaded to the device via a wired (USB) connection.



Manufacturer	Model
Nokia	3250, 5200, 5300, 6085, 6125, 6126, 6131, 6136, 6165i, 6280, 6288, 6270, 6561i, 6630, 6680, 6681, 6682, 770 Tablet, 7370, 7373, 7390, N Series, E Series
Motorola	PEBL, V635, K1, L2, Z3, SLVR L6, L7, L2, ROKR E1, V360, E680i, E1000, C980, C975, V980, 1050, Motorola Q Company claims +30 devices / but not disclosed
LG	PM225, PM325, MM535, VI125, U8210, LX350, LX-550 (Fusic), U300, KU730, VX8300, VX9800
Samsung	A840, 800, 8300, A900, A920, M250, VI660, VMA680, MMA700, PMA740, RLA760
Sanyo	2300, MM7400, W32SA
SEM	W600, W900, W550, Z530i, K790, W800, W810i, W900, K600, K610, K800, Z550, V630, W300, K750i
Sharp	904SH, 905SH, 705SH, SH505i, SH505iS, SH506i, SH506iS, SH901iS, SH902i, SH702iD,
Toshiba	W32SA
HTC	HTC StrTrk, HTC Universal, HTC Tornado, HTC Mteor, HTCTyTN
NEC	N504i, N504iS, N505i, N505iS, N506i, N506iS, N506iSII, N902i, N701iECO, N902iS, N902iD, N701i, N902i HighSpeed, N900iG, N902iL, 705N

Fig.6) Selection of FOTA-capable devices March 2007 / (not complete list)

## HANDSET COMPLIANCE

	Firmware OTA	Firmware (cabled)	Point-of-Sale
Use cases	Batch updates of critical bug fixes Reactive handset fixes via customer care interaction Push new features & functionality to handset (lock / unlock features)	End-user maintenance Large delta upgrades	Rectify known issues prior to final sale Just-in-time updating / provisioning of vanilla handsets. Via kiosk or through manufacturer update site
Applicable to	Most suited to operators who can integrate OTA within existing support environments. Also used by manufacturers but end-user must bear airtime cost.	Large handset manufacturers who bundle necessary cable-ware with device.	All
Pros	Anytime, anywhere	Fast and low cost	Fast, low cost. Process can be removed from end-user if required.
Cons	Expensive, impact on user experience	Requires necessary cable and Internet access	Consumes 'sales person's' time. Could cannibalize repair revenues.
Standards	OMA, proprietary	Proprietary	OMA, OMSI, Proprietary

Fig.7) Complimentary approaches to firmware management

## WDSGLOBAL AND THE FIRMWARE MANAGEMENT ENVIRONMENT

Firmware Management must be closely integrated within existing support environments. WDSGlobal's Firmware Management roadmap includes a long-term vision of the evolving market, with a near-term approach to managing the issue in a cost effective and user-friendly manner.

WDSGlobal's approach to Firmware Management is bearer agnostic with a firm understanding of the value delivered by both OTA and cabled updates.

Discussions around Firmware Management (including FOTA) typically center around the distribution mechanisms. However, for Firmware Management to be a successful element of the support environment, the following must be considered.

### Testing

There are several examples of Firmware updates taking place and rendering the handset unusable. Hundreds of Nokia E70 users last year updated their handsets via the Nokia Software Update service, only to brick their device. This resulted in suspension of Firmware upgrades for that device and inconvenience for the users who were asked to return their E70s to a Nokia repair center.

Firmware updates must be adequately tested against known device / network variants to mitigate update failures. This becomes of particular importance when the operator personalizes firmware.

### Inventory Management

Firmware may often vary between networks. Unique features, or locked features, may be a factor within certain networks on operator branded devices. What impact will a generic reflash have on that device? Will unique features be disabled and to what effect?

A central knowledge bank of all known firmware releases and variants must be made available to the support environment to ensure accurate diagnosis of firmware-related issues, most appropriate release updates and unique vs generic variants.

### Support

A firmware upgrade should not be treated as a silver-bullet approach to troubleshooting due to its impact on the user experience. In many cases, a usability issue may be overcome by a simple change to default settings or service configuration. The end-user must pass through controlled tollgates (at a technical support level) before a firmware upgrade is recommended.

Support environments must be aware of current firmware variations, which issues they address and their impact on the device. Following adequate testing, firmware upgrades released by manufacturers must be categorized as follows:

*Standard Update: Update not essential to current handset operation. Update relates to feature / application upgrades. Typically a pull-update initiated by the end-user.*

*Intermediate Update: Update essential to optimal handset performance. Examples include power issues (battery performance) or connectivity issues (dropped calls, Bluetooth pairing etc). These updates are required to fix common user issues. Either a pull-update from an end-user looking for a proactive improvement / solution or a push-update in response to an inbound customer care enquiry. Historically these updates may have been managed through an operator / manufacturer repair center.*

*Critical Update: Faults that place the end-user in immediate danger (unit overheating, volume too high) or faults that represent a critical barrier to usability (repeated dropped calls, service failure).*

These issues would have historically resulted in a product recall, resulting in massive cost and service. Updates are typically pushed directly from the operator / manufacturer.

### Outsourced Expertise

Operator support environments may benefit from outsourcing their Firmware Management to a specialist technical support organization. This will ensure accurate and appropriate use of a firmware update:

- Pass through controlled diagnosis procedures to validate use of firmware update
- Identify correct firmware release
- Guide user through update procedure (this may include an off-portal cabled update)
- Rectify upgrade errors

As a minimum, operators should employ a specialist to train their support center staff and provide a 30-day launch phase support package. This will help to identify problems before mass market adoption and before they escalate and impact profitability of the support center.

### Self Serve

The idea of maintaining your device through regular updates is becoming increasingly established amongst consumers. Nokia's Update Service is designed to address this 'self-service' approach, emulating the Windows Update service with regular patches and consumers being advised to check for updates on a monthly basis. We believe that this practice will become more and more commonplace as time passes with users looking at existing self-serve portals (operator websites) for updates and download instructions.

Self Serve environments may include dedicated web forums, allowing users to problem solve and discuss issues with other users or trained moderators.

### FIRMWARE MANAGEMENT AND WIRELESS INFORMATICS

Like most support solutions FOTA is a byproduct of the increasing complexity permeating the mobile industry. It is difficult to find parallels between the customer service demands of mobile consumers and those found in any other IT or telecoms sector. Unlike other consumer electronic products, the mobile phone exposes users to an abundance of technology, jargon and technical settings many of which will need to be embraced if the user is to successfully operate even the most fundamental of device features. Couple this with the broad demographic of mobile users spanning all ages and technical literacy and the path is set for a potential customer service disaster.

Despite this singular situation, most mobile organizations still view customer support as an unfortunate yet essential overhead that continuously erodes profitability without adding to revenue (fig.8). To this end it is often the first department to be downsized, squeezed or off-shored when profits need to be bolstered. Analysis of the practices within most mobile Operator customer service departments reinforces this notion. Support efficiencies are measured in terms of call volumes, call handling time, number of calls handled

and various other telephony centric metrics. However, customer service departments that are measured solely on these metrics often mask a concerning yet widespread trend.

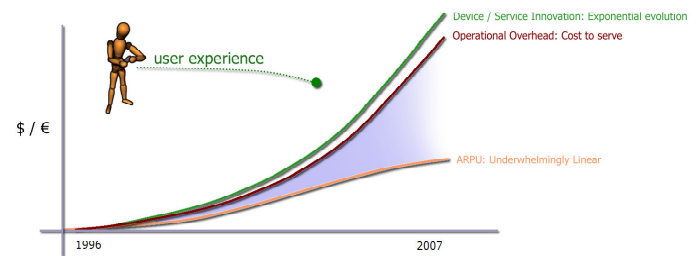


Fig.8. Traditional support environments often see a rise in support costs alongside service innovation but without a subsequent rise in ARPU.

It is a paradigm shift that the industry must embrace if mobile technological innovation is to realize new revenues and not simply reduce profitability. The mindset of 'Cost to Serve' reduction should be substituted for that of 'Cost to Delight' investment.

Organizations that invest in the User Experience will realize new revenues and reduced operational support costs as an inherent bi-product.(fig.9).

Improving the user experience does not however have to result in an upsurge in OPEX costs or call handling time. On the contrary, if measures are implemented to mitigate customer problems earlier on in the ownership lifecycle, the results will be seen in fewer post sale customer issues and consequently fewer costly support calls.

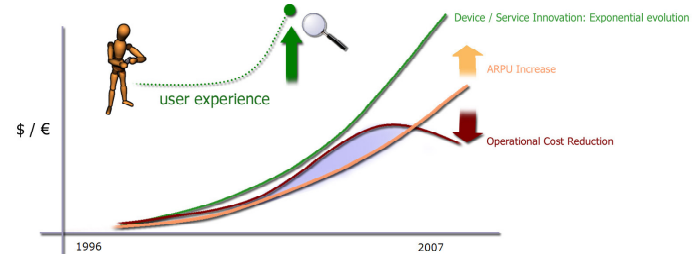


Fig.9. Increased ARPU and reduced operational support costs are a byproduct of a Wireless Informatics-based approach

For the industry to stem customer service call volumes it must be able to learn and adapt from the negative experiences that often follow a product launch. Every negative customer experience provides the foundation for improvement, enabling the industry to prepare and prevent for its recurrence with future launches. This cycle of continuous improvement needs to be underpinned by a robust set of processes and principles for the channeling and repurposing of specialist knowledge and experience. This fundamental logic forms the core principle of Wireless Informatics and a structured approach to Firmware Management.

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