Fujitsu's PalmSecure-Based e-POS System for School Cafeteria

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The first commercial application for PalmSecure in Europe is an unusual one. Rather than the expected high security application for a bank or government facility, Fujitsu's PalmSecure biometric technology has proved itself to be an ideal way for Primary School pupils in Scotland to pay for their school meals. This opportunity was discovered through Fujitsu Europe Limited's (FEL) innovative Enterprise Business model where no prejudgement of possible applications is made, end user needs are identified through dialogue directly with end-users and solutions are quickly provided through close collaboration with Fujitsu Group companies and third parties alike. FEL worked closely with a construction company (Amey), a software developer (Abelon), and a developer/system integrator (Yarg) amongst others to develop a solution whereby school children can quickly and simply pay for their meals by presenting their palm to the PalmSecure reader, rather than use cash, vouchers, swipe cards or some other system that would prove open to abuse or mis-use. This solution has been rolled out successfully in the first school, Todholm Primary School in Paisley, and is at the time of writing being rolled out to other schools in Scotland and is under consideration for Schools across the UK.

1. Introduction

Biometric technology is becoming increasingly prevalent in today's society. It is now quite common to see some sort of biometric security device in offices and certain public places wherever there is the need for secure personal identification. Fingerprint technology is by far the most common followed by iris recognition technology, but there are many other technologies related to voice, signature profile, hand geometry, facial recognition, smell, and even the way you walk, all of which can be used to identify individuals. Although there is a great deal of interest from government and business alike to implement such systems, there is equally a growing public resistance to the "big brother" nature of some technologies, and a general public mistrust of government, and especially business. A successful biometrics technology must therefore be all of the following:

- Secure
- Acceptable
- Voluntary

The need for security is self-evident and needs no further explanation here, but what makes a biometric acceptable? First, it must be a contactless system so that users need not touch anything, thus alleviating any hygiene issues and many concerns from different ethnic and religious groups, but it must also be inclusive so that no one is excluded, discriminated against, or denied access (if authorised) due to the biometric feature used. Fingerprint-based systems, for example, can exclude up to 10% of the population, such as manual workers and certain ethnic groups, which is completely unacceptable. More controversially, a biometric measure intended for public use should have no forensic value. For instance, who

would use a solution that might be used to link them to a past misdemeanour? Finally, a biometric should be voluntary. There may be a definite legitimate need for governments to use remote facial recognition systems for national security where those scanned have no idea that they are being scanned, but such a system has no place in the public domain and certainly not in primary schools. Fujitsu's PalmSecure product meets all these criteria. The other key point is a business one: it is useless to impose a system on a society that does not want it. Instead, the challenge is to identify the true needs of both security and convenience to the customer. PalmSecure technology is well positioned against competing technologies (**Figure 1**). In this case, Fujitsu Europe Limited has worked with many partners to identify and meet the real needs, and consequently succeeded where other vendors have failed.

The first customer in this case is Todholm Primary School in Paisley, near Glasgow in Scotland.

There is a Scottish Government initiative called "Hungry for Success" that is intended to encourage the provision of high-quality nutritious meals to schoolchildren.

The problem is that such meals are expensive and offering a hot, well-balanced meal to all entails necessary financial support, so that children from less well-off families can benefit alongside those from wealthy families.

In order to eliminate the issues and risks associated with young children carrying money, a cashless system was proposed. This solution needed to minimise the costs associated with ongoing maintenance, as well as the opportunity for bullying and theft, especially where free school meals are offered.

Other technologies like card-based systems are vulnerable to certain problems associated with cash payment such as loss or coercion, and so a biometric-based system is needed.

And so Fujitsu's PalmSecure proved to be an ideal solution. Although not a particularly high security application, thereby not requiring the need for very high false rejection rate (FRR) and false acceptance rate (FAR) performance as provided by PalmSecure, it needed to be inclusive with everyone being able to use it and acceptable to the target audience. PalmSecure scores highly on both counts and we have rolled out the first system in Todholm with others to follow.

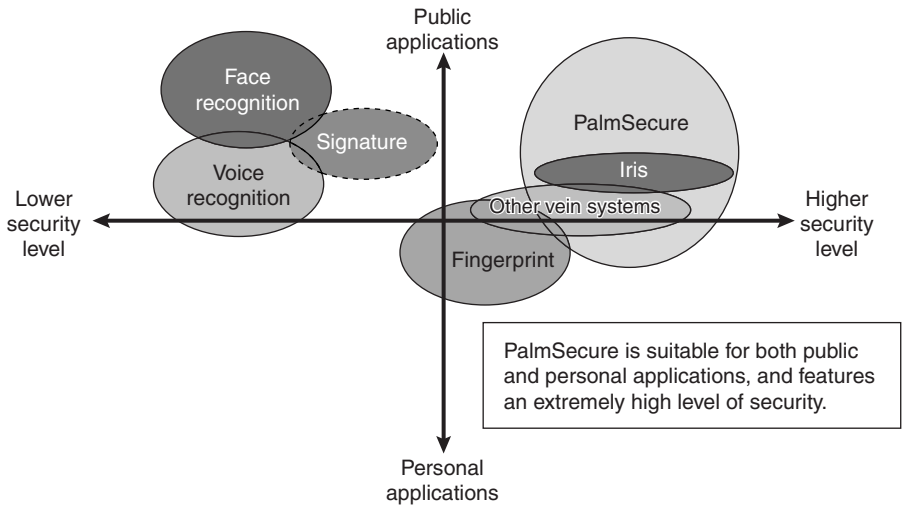

Figure 1
PalmSecure positioning against other biometric technologies.

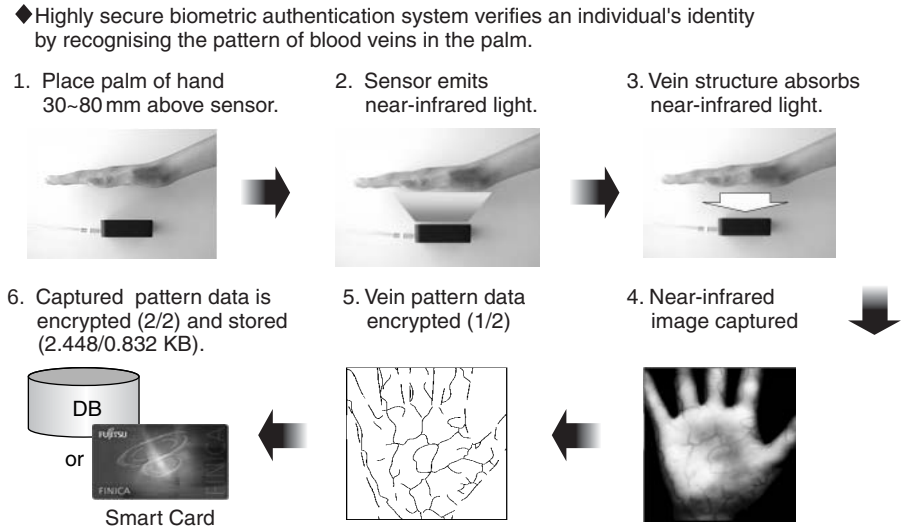

Figure 2
PalmSecure operation.

2. Introduction to PalmSecure

Fujitsu's PalmSecure product is a small 3.5 × 3.5 × 2.7 cm block containing a near infrared light source, a sensor, and a degree of processing encryption creativity. It interfaces to a host system via a USB interface.

De-oxygenated haemoglobin in the blood flowing in the veins of the palm absorbs near infrared light of a certain frequency.

By this principle, the vein pattern can be "seen" by the sensor (**Figure 2**).

The pattern of veins in a human palm is unique as it is formed in the womb and remains constant from cradle to grave. Of course, the size may vary, but the basic pattern remains the same. Left and right palms are also different, and even the palm vein patterns of identical twins are unique.

Security levels of FAR and FRR are second to none, thus making palm veins an ideal biometric and PalmSecure an ideal sensor (**Figure 3**).

3. Background

Hungry for Success was initiated at the end of January 2002 by the Scottish Executive, a panel convened to revitalise school meals by relating the meals as part of health education into the school curriculum. The panel was charged with devising a strategy to:

- Develop standards for school meals
- Improve the presentation of food and increase the number of pupils eating the meals
- Remove the stigma associated with the provision of free school meals

Yarg Biometrics (hereafter, Yarg) developed a single-board computer based on ARM9[note 1)] architecture and employed an optical contact fingerprint sensor to provide an e-POS solution called "Finger Swipe" that would manage payment transactions in an anonymous way, and thus address the stigma issues associated with free meals. Although Finger Swipe offered a reasonably good fingerprint-based solution, this proved inappropriate for the application, as children without sufficient motor skills could not use the system efficiently. The PalmSecure-based solution proved to be both easy and enjoyable for

note 1) ARM9 is 32-bit RISC processor with ARM and Thumb instruction sets, typically used in hand-held products, digital consumer products, and embedded systems.

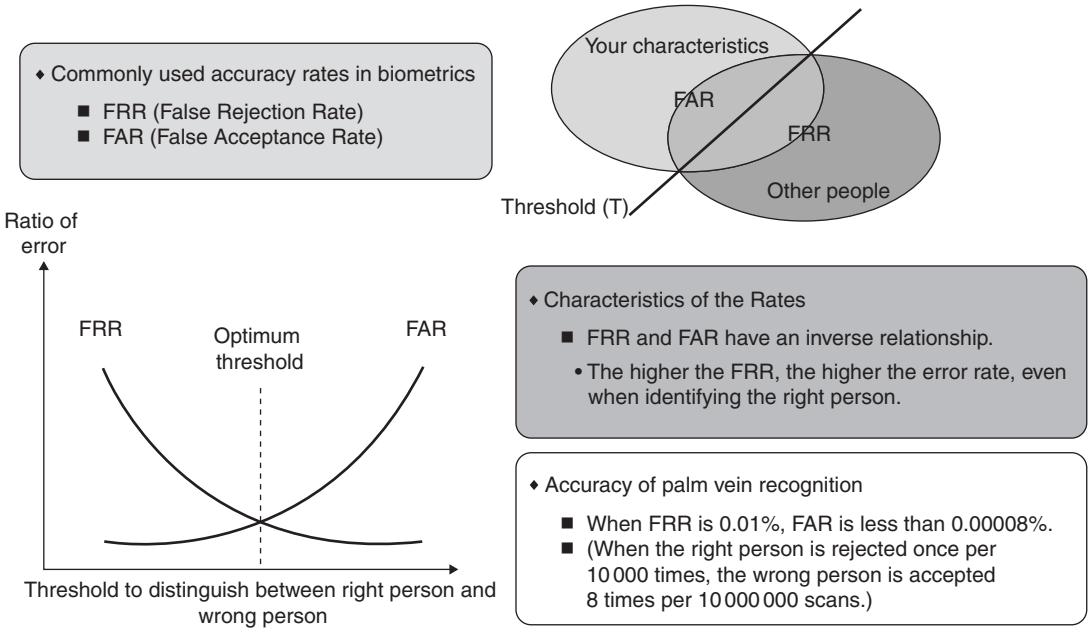

Figure 3
Accuracy of authentication.

children to use (**Figure 4**).

4. Challenges

The initial challenge for PalmSecure technology was to ensure that the key requirements could be met as follows:

- PalmSecure could succeed where other finger solutions failed.
- The pupils could use the system with minimal supervision.
- The system should interface with existing catering management software.
- Lunch queue process time should not be increased.
- PalmSecure needed to operate on the existing ARM9 SBC[note 2)] architecture.

In order to meet these requirements, Fujitsu Europe Limited needed to work with not only Yarg, but also with specialist hardware and software companies, each providing the various elements to present a final solution to the delivery partner.

note 2) ARM9 SBC is a single-board computer with an ARM9 processor designed for embedded systems.

Source: http://www.scotland.gov.uk/Publications/2003/02/16273/17566

Figure 4
Pupil at Todholm Primary School cafeteria.

In addition to Fujitsu Europe Limited, the following organisations participated in this development: Yarg, Abelon Systems, Amey Construction, Todholm Primary School, CRB, and Eye Tech Product Design (**Figure 5**).

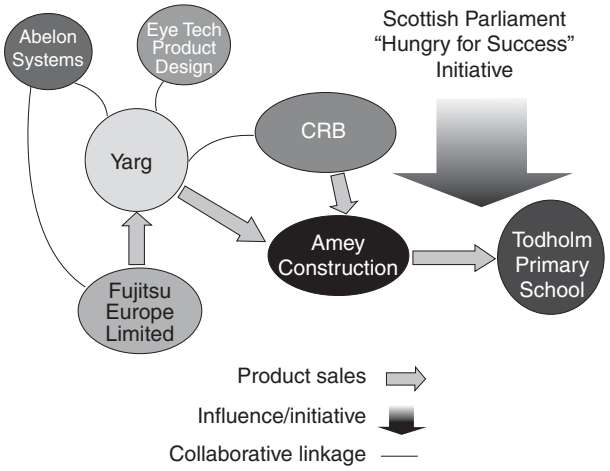

Figure 5
Collaborative forum to develop solution for Todholm.

5. Solution concept

The broad spectrum of applications for biometrics technology, especially PalmSecure, requires that solutions are easily applied to a variety of environments and specific tasks, ranging from physical access control to computer login scenarios.

Meeting these demands requires an adaptable and flexible hardware solution. In addition to the physical design requirements, it is imperative that the design be aligned with contemporary technologies that enhance and simplify usage of the application. With this approach, the final product should be flexible with regard to various applications, simple to install, and scaleable in deployment. Supported by Fujitsu, Yarg developed a product that could meet the initial project requirements, as well as providing a solution for the wider market.

Interfacing the PalmSecure with the existing ARM9 architecture was not possible, and the demands of the lower specified finger solution that were served by the ARM9 SBC could not meet the requirements of the USB-based PalmSecure unit.

Yarg's system was designed as a fully flexible solution providing features that ensured that the product could meet and exceed the initial cashless catering project requirements. By adopting a modular hardware design, changes, additions, and custom-made aspects can be incorporated into the PalmReader, thus ensuring that future project and application requirements can be met with minimal re-engineering (**Figure 6**).

To meet the requirements of the PalmSecure sensor, the existing Finger Swipe SBC was redesigned to accommodate a 733 MHz processor with VIA chipset supported by 256 MB memory, USB 2 was added to the SBC to support PalmSecure.

The features of the PalmReader unit based on the re-engineered SBC now offer an integrated capture device with a keypad and display, which through the integrated 802.11g wireless connectivity or wired Ethernet port enable connection via a network to the Yarg Biometric Server for matching and processing.

A built-in Wiegand Interface enables the support of physical access protocol and an external USB port provides a peripheral interface that can be connected to external devices such as Smart Card readers.

These system features and the topology harness the flexibility of a centrally located biometrics database with the robustness of embedded acquisition devices. A template of the user's palm pattern is transmitted from each PalmReader over the network to the Yarg Biometric Server for matching and processing.

Software features of the system are equally essential. The Yarg Biometric Server runs BioEngine software that allows units to be configured and managed from a central location, so that each reader can be configured and enabled to perform the functions for which it is designated and, should it be required, remote Web enabled diagnostics can be performed on target readers.

The network security features ensure that each PalmReader device is subject authentication at startup, and thus only registered terminals can be added to the network. In addition, the

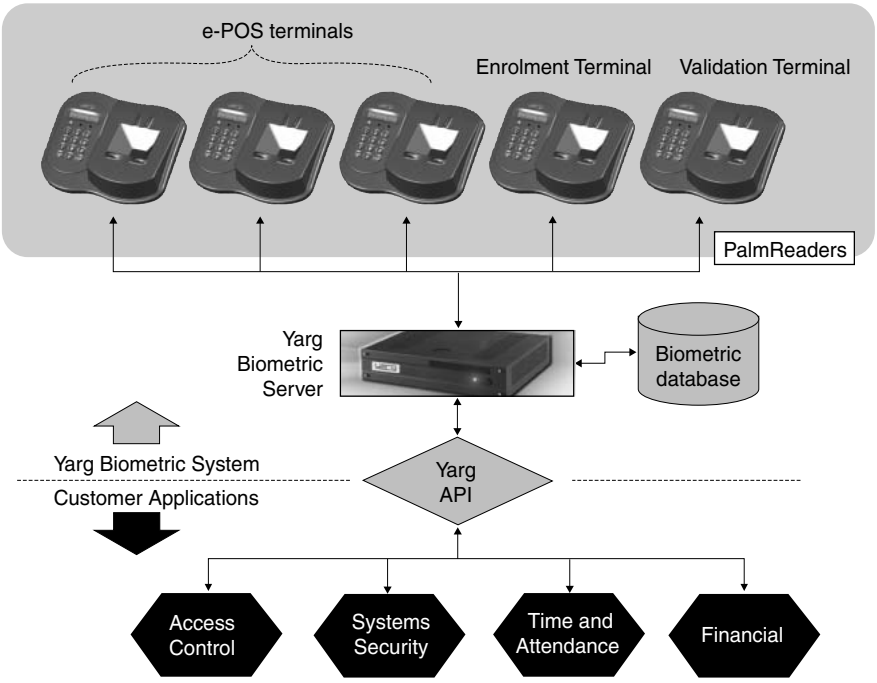

Figure 6
System topology.

Yarg Biometric Server downloads firmware to each reader at power-up.

To ensure the security of remotely located readers, all Biometric templates are stored on the central Yarg Biometric Server to ensure that matching is performed in a secure environment and the required template data retained at one easily secured location.

The combination of hardware and software provided Amey Construction — our infrastructure partner — with simple installation, utilising the existing network structure to connect the terminals and interface to the back office functions for the Yarg Biometric Server features. Future system additions can be easily installed to meet the various future requirements of the school.

6. Development and installation

To ensure that the PalmSecure technology could achieve the key requirements of the project, Fujitsu supported a trial with the pupils at the school; this simple demonstration showed that the PalmSecure unit could operate where the previous solution struggled. By supporting the trial in an open manner, Fujitsu was also able to easily and promptly convince both the school staff and Yarg team of the technology's suitability for the project.

The youngest of the children have a limited attention span and coupled with their limited motor skills, achieving a repeatable image capture at the reader was difficult. To address the issue of hand presentation, a smaller hand guide was designed based on the average size of the pupil's hands, and thus provided a stable platform for the children to use when interacting with the reader (**Figure 7**).

To ensure that the children registered correctly — the most crucial and starting point of system use — Yarg modified the Fujitsu guidelines aimed at adults to reach the children in a simple manner, since some of the children cannot read and have limited numeric skills. The "Be a star — Make a star" training scheme was the culmination of this effort. It is a simple memorable instruction that ensures that both children and

Figure 7
Be a star.

adults present a flat palm to the reader.

The architecture used at Todholm Primary School required three types of terminals, all having the same basic design to ensure familiarity and repeatability.

The back-office enrolment unit intended for administration functions is installed in the catering office alongside the Yarg Biometric Server.

The e-POS terminals at the checkout counter where the biometric secures the appropriate account after meal selections are updated with the transaction value.

The re-validation terminal is where the children and teachers can authorise the transfer of additional money to accounts via a cash-receiving unit.

The re-validation units are wall-mounted, whereas all others are desktop (horizontally) orientated.

High system performance was achieved through a combination of hardware design, software modification, and training, with all tailored to meet the specific project requirements.

The biometric component in Hungry for Success is an enabler and not the key objective of the initiative; therefore, it was important that the PalmReader be able to interface with existing catering software through minimal changes made to the existing architecture. In order to achieve this, Yarg developed an API for their developed biometric system, thus matching the Fujitsu strategy of having a simple Software Development Kit (SDK) to enable rapid and easy use of the product, and Abelon interfaced the PalmReader to the existing POS architecture in less than a week.

Since the time allowed for lunch at the school is limited, application of the biometric solution cannot add to the overall queue time. For the initial Todholm school project, this was achieved by reducing the identification database size to simply the children in one class, and therefore, by entering the single-digit class number, the children were "matched" against only their classmates. In evaluating this potential timing issue regarding the system, consideration was given to future projects where either database size or the number of parallel users would have a serious impact on processing time. To address this issue, a master and slave configuration was devised whereby the master database is replicated and the daughter process runs on database copies, ensuring that processing time is minimised at peak system access (**Figure 8**).

7. Benefits

The PalmReader provides a biometric interface to the existing school catering environment and helps realise the Hungry for Success project. The solution utilises leading-edge technology in an atypical manner, providing an innovative solution for the school, and the children now have a simple method of receiving the improved meals provided without being concerned with intimidation by their peers.

The solution provides for later additions to the network, thus providing added value to the school by expanding the solution in a staged manner to support biometric security in a host of

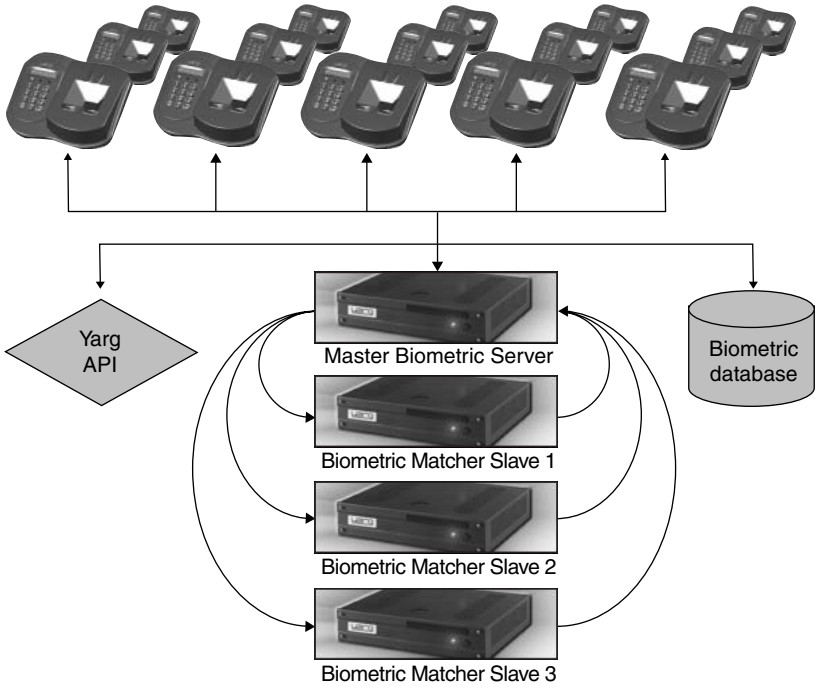

Figure 8
Scalability.

different applications, all centrally managed and secured.

Yarg created a highly flexible and efficient solution that can be deployed not only in other similar education-based projects, but also in the wide range of commercial market opportunities that biometrics will enjoy.

8. Conclusion

The key to the success of the project was first to understand the client requirements and seize the opportunity to use Fujitsu technology in an unorthodox arena. To achieve the objective in this way, the Fujitsu team had to operate in areas of business where we had no experience, particularly interfacing with companies that had little knowledge of Fujitsu products and convincing clients that a cutting-edge technology could realise their goals through partnership with a small business with only a short track record.

The PalmReader is now subject to multiple project opportunities and the final product is clearly the result of collaborative work between Fujitsu and its new partners.

The challenge for Fujitsu was working with companies to achieve their objectives, so that we could realise our own objective — selling PalmSecure. It is not enough to simply sell the product but to truly engage with our customers and partners in realising our collective ambitions.

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