



White Paper: Nokia Digital Pen

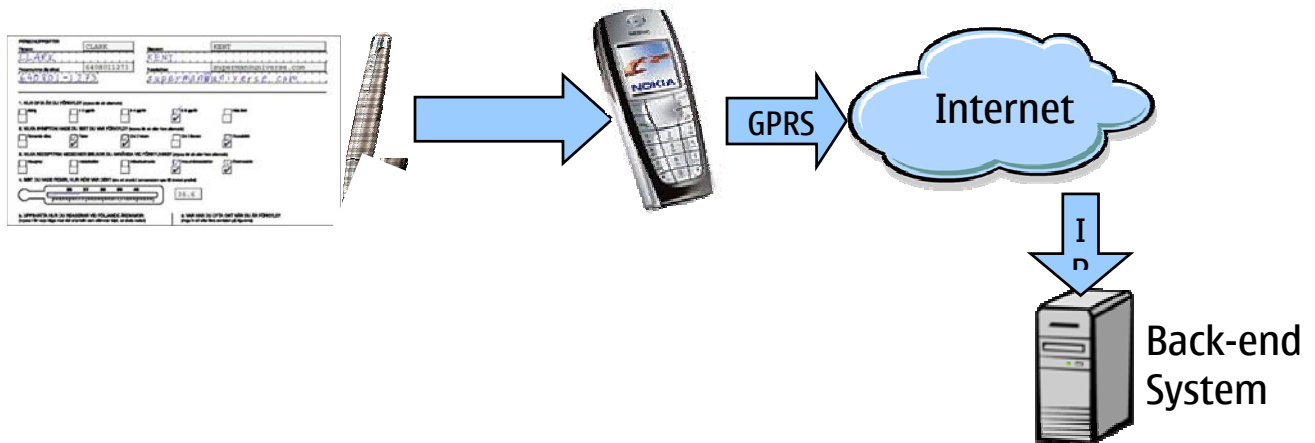
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Introduction

The Digital Pen is not a new concept. All digital pens share the same general functionality, the one of registering the strokes when the pen moves over the paper, and transferring the stroke information to the application.

Traditionally the information captured by digital pens could only be utilized once the pen was 'docked' with a PC or laptop that itself was connected to the enterprise systems. The Nokia Digital Pen is able to use the mobile phone as a Bluetooth modem and transmit captured data **directly** to the enterprise systems. This solution is revolutionizing the thinking behind remote forms-based data-capture systems design. Simply put, the Nokia Digital Pen negates the need for expensive laptops, tablets, or PDA's in the field.



Solution Benefits

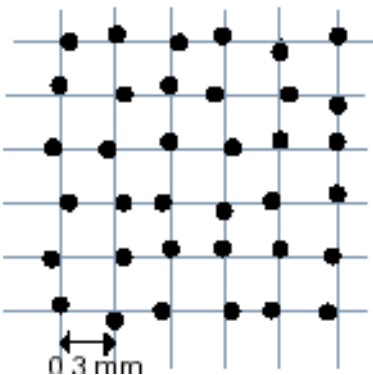
- **Costs:** At approx £120 each the pen is far cheaper than a PDA or a laptop to deploy & replace
- **User Acceptance:** It's pen & paper! One of the big problems of deploying new technology is the simple fact that people do not easily accept change. Deploying the Digital Pen requires minimum change in the method of data capture from the traditional form-filling exercise, in fact the process is simplified in many cases where the field personnel are required to enter the data from the form into a CRM system when they return to base (or home).
- **Training costs:** 'How to fill-in a form' – quick and simple. Everyone knows how to fill in a form! Training staff how to use a bespoke application on a complex operating system running on a complex device such as a PC, Tablet or PDA can be a costly and time consuming exercise resulting in varied success and support requirements.
- **Support costs:** Simple interface & operation, No OS, No 'application'. There are so many things get wrong in a PC, Tablet or PDA based solution that the support requirement is

extensive.

- **Personal Safety:** Inconspicuous, limited value to thieves. A pen fits easily out of sight and if used in public would not be perceived as a high-value item by would-be thieves. Many public-facing workers are reticent about using highly desirable equipment such as Tablets, PDA's and laptops as they represent a risk to their personal safety.
- **Speed of Business:** Real-time data input in the field. The Nokia Digital Pen solution accelerates the rate of business to real-time. As soon as the data written on the page and the 'send' box is ticked it is being sent directly to the back-end systems.

How does it work?

The Nokia Digital Pen utilises *Anoto Functionality*. This terminology refers to the proprietary *Anoto* pattern that is printed on the paper used with the pen. It is this pattern that makes it possible for the digital pen to record handwriting so that can be stored and sent digitally. The pattern consists of small dots (100 µm in diameter) arranged with a spacing of approximately 0.3 mm on a square grid. The dots are slightly displaced from the grid, each dot in one of four possible positions, as shown below, thus forming the proprietary *Anoto* pattern. Each dot carries two bits of information and since the pen registers positions by reading 6 x 6 dots, unique pattern is ensured on a very large area.

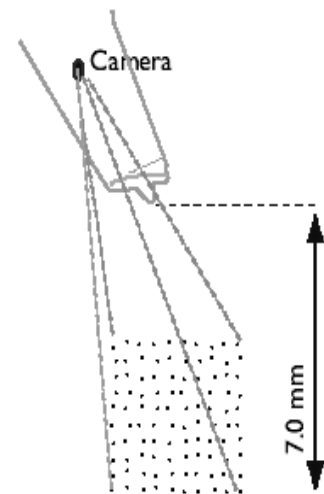


The displacement of the dots makes it possible to uniquely identify each pattern area. Thus, if a company, for example, licenses a part of the *Anoto* pattern for an application, the Paper Look-up Service (PLS) knows that any information written or drawn on that part of the pattern should be sent to a specific URL, since its address is registered with Anoto and linked to the pattern when licensed.

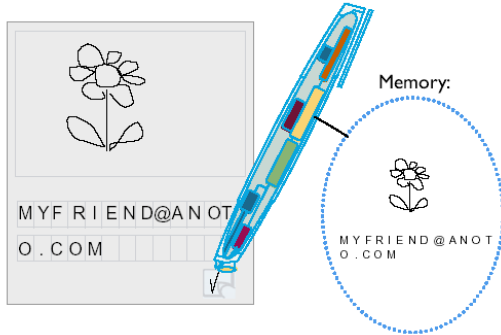
The *Anoto* pattern is huge. It covers an area of 60 million km², which exceeds the total area of Europe and Asia combined!

The pen takes digital snapshots of the pattern as the pen moves over the paper. The digital pen uses a camera and an infrared LED to take the snapshots between 50 and 100 times per second.

The pen processes the snapshots, by calculating the exact, absolute position on the entire pattern, stores the snapshots in the memory, and sends the information of what is drawn or written to the application in the form of pen stroke data (continuous curves made up of coordinates).



The pen strokes that the user makes on the paper are saved in the pen's memory. The pen can store over 100 complete A5 pages of data. When the user ticks the Magic box, the digital pen knows that the page is ready to be sent.



The digital pen stores information about the pen and the pen owner, called pen properties. The pen properties can be used to implement certain functionality such as the back-end application sending a confirmation text to the phone number stored on the pen.

When the pen user has written on the paper with a digital pen, they tick the Magic box in order for the pen to pass on the information to the application. For the information to find its way to the correct

application, the Paper Look-up Service (PLS) is required. The PLS exists in three versions in order to fulfil the requirements of system architecture for different services.

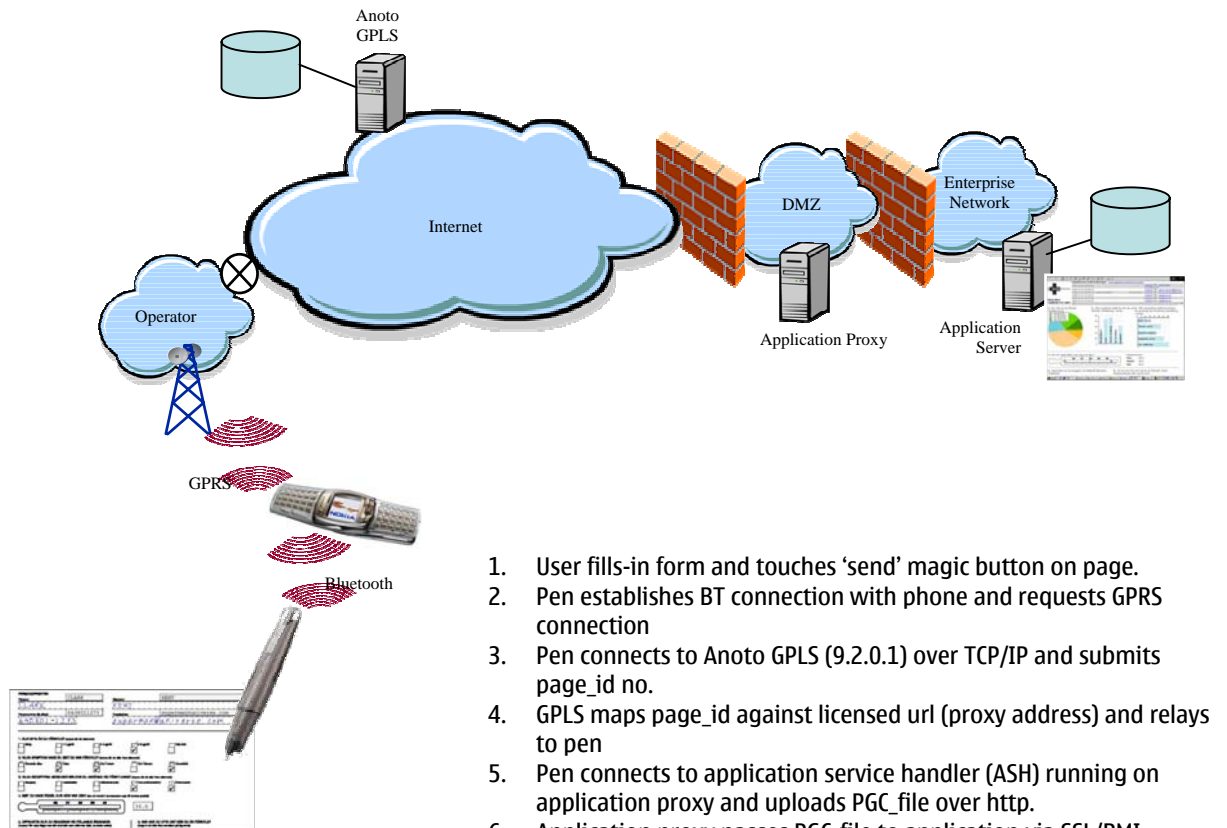
The PLS sees to that the pen requests are linked to the correct application. The PLS is contacted when a user ticks a Magic box. The reason for the pen to connect to a PLS is that the pen does not know where to send the captured data. The only address the pen knows of is that of the network PLS entered into the pens memory when it is set-up.

Depending on type of service one or two PLSs are involved in a pen request.

GPLS

The Global Paper Look-up Service (GPLS) is the Paper Look-up Service operated by *Anoto*. A service associated with the GPLS can, in principle, be accessed by all the digital pens in the world. The architecture of the GPLS is redundant enough to enable dynamic upgrades and maintenance work to be performed while maintaining the availability of services. The GPLS provides a high level of data security.

GPLS-based Architecture

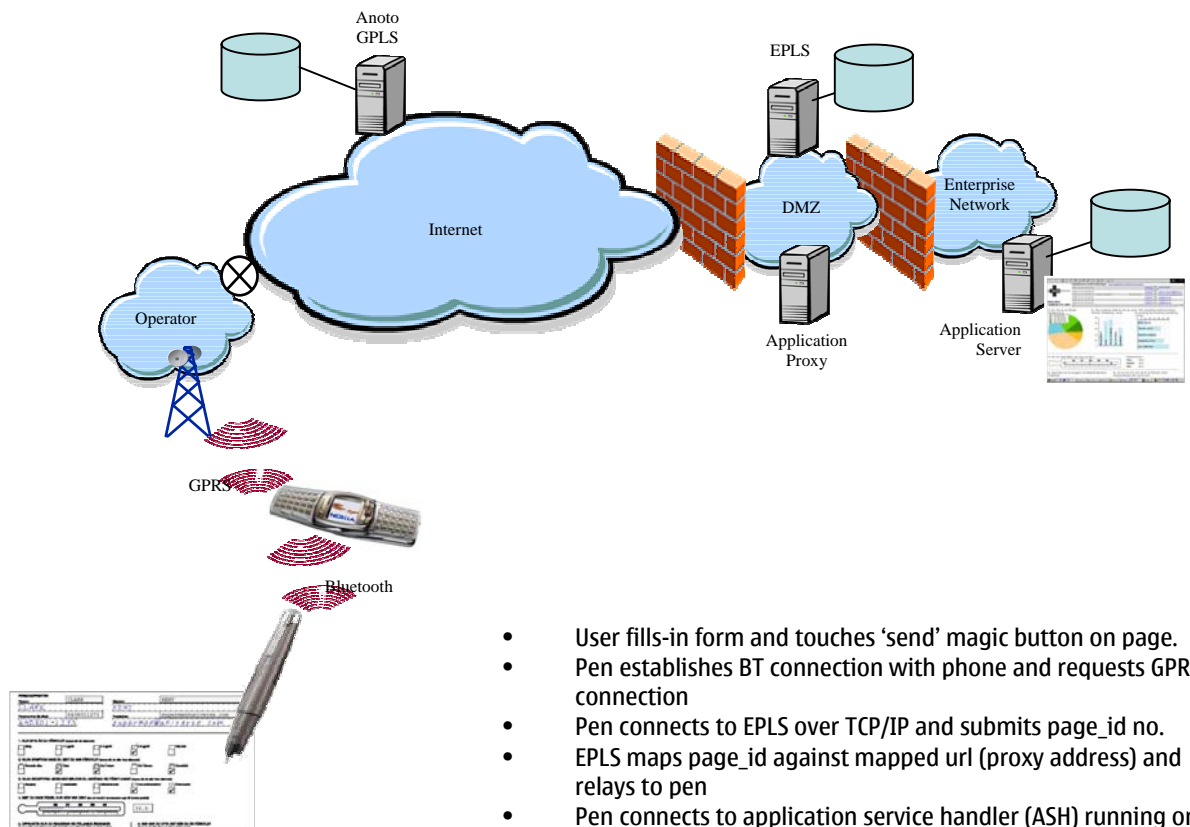


EPLS

The Enterprise Paper Look-up Service (EPLS), with functionality similar to the GPLS, has been designed for enterprises that want the full *Anoto* functionality infrastructure in-house, which can enable solutions that are independent. The EPLS and its associated services can be implemented in the enterprise's existing infrastructure and, if desired, run completely inside the firewalls of the enterprise. An EPLS routes digital pens directly to associated enterprise services. The EPLS enables the enterprise to control which enterprise applications each pen (or group of pens) can access. Equally important, EPLS enterprise services can be accessed only by those EPLS pens that are specifically given access to each enterprise service.

The EPLS can also allow a digital pen access to global open services associated with the GPLS. Digital pen access to the GPLS is always routed via the EPLS, thus maintaining the in-house control the EPLS offers.

EPLS-based Architecture

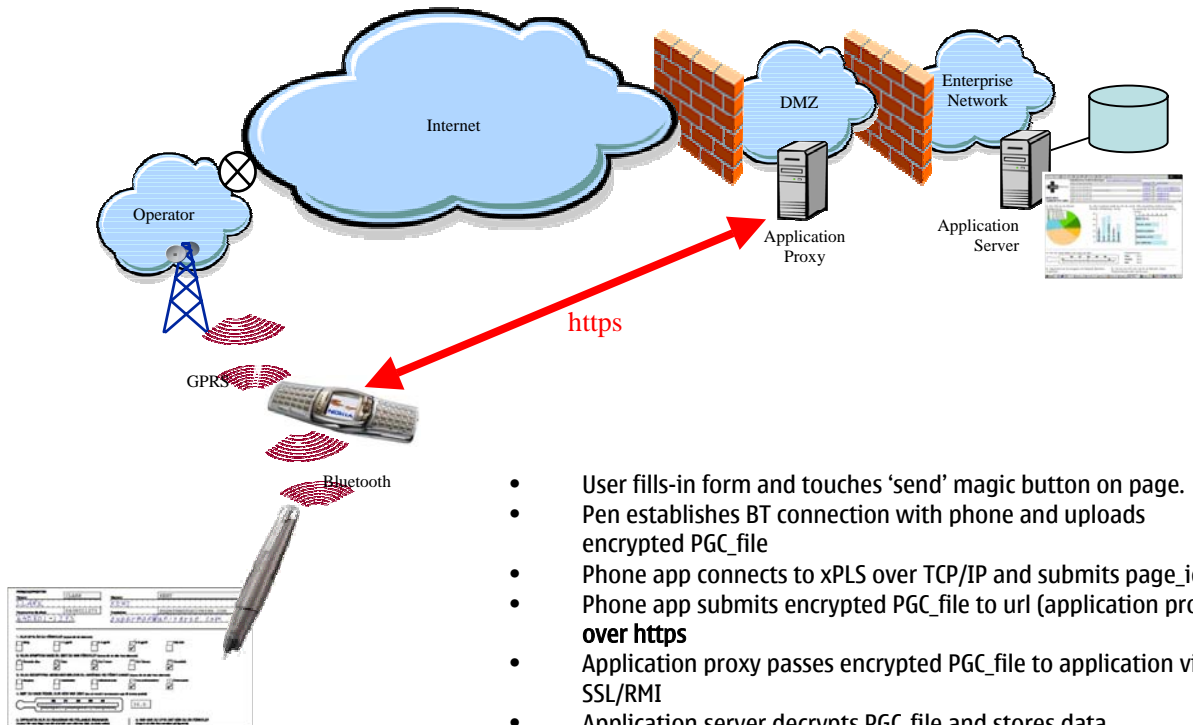


- User fills-in form and touches 'send' magic button on page.
- Pen establishes BT connection with phone and requests GPRS connection
- Pen connects to EPLS over TCP/IP and submits page_id no.
- EPLS maps page_id against mapped url (proxy address) and relays to pen
- Pen connects to application service handler (ASH) running on application proxy and uploads PGC_file over http.
- Application proxy passes PGC_file to application via SSL/RMI

DAS

The Device Application System is the newest concept that has been enabled by the emergence of Smartphones that are able to run applications on the phone itself. In this solution the device-based application negates the need for a PLS.

Secure DAS-based Architecture

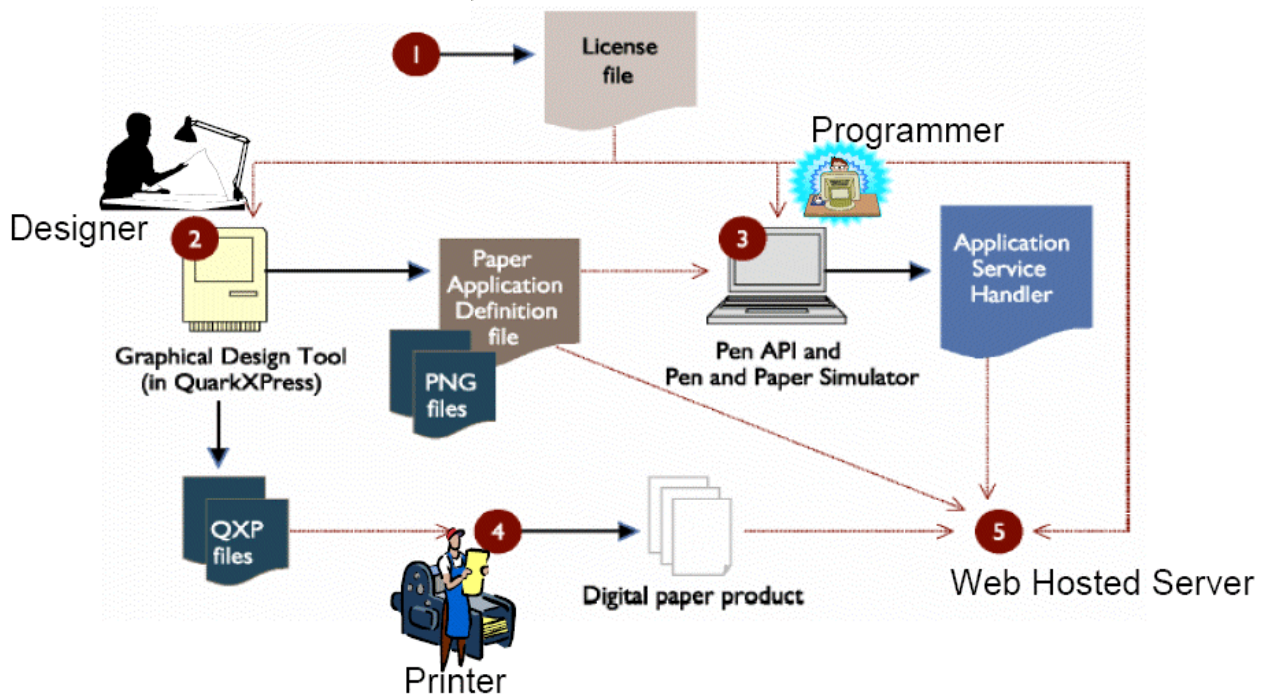


Note: The advantages of this solution are:
 1) PGC_file is transmitted over a secure connection
 2) Phone app will retry transmission until a connection is achieved

Pen Solution Process

There are a number of strings that need to be pulled together to create a Digital Pen solution.

- 1) The Anoto pages need to be defined and licensed.
- 2) The forms need to be designed and:
 - a. QuarkXpress (QXP) files sent to the printers.
 - b. PNG files collated to form a Paper Application Definition (PAD) file for the application developers.
- 3) The Application Service Handler (ASH) needs to be written to accept and interpret the pen data.
- 4) An interface needs to be created between the ASH and the back-end systems.



Authentication & Authorization

The Nokia Digital Pen has the ability to implement an extremely efficient signature recognition system, thereby enabling authentication before a form is submitted to the back-end system. The pen records both speed and pressure as the user writes, and as such this information can be used to create an extremely reliable signature recognition system.

The ASH can also authenticate the digital pen itself. This is possible because the PLS, which has already authenticated the pen, provides the digital pen with an encrypted *ticket* that the pen attaches to the pen request. This ticket contains information necessary to verify that the digital pen that sent the pen request has been in contact with the PLS. If the sending pen has been in contact with the PLS, the ASH knows that it must be a valid pen as the PLS has already authenticated the pen. The authentication is transparent to the ASH, because it is hidden in and performed by the Pen API.

Note: A ticket is only valid for ten minutes. The Pen API will not accept any pen requests with a ticket that is older than ten minutes. The ticket also enables the ASH to verify that the pen requests are valid and not recorded data.

Encryption of pen requests

Encryption of pen requests ensures not only that no one can monitor and read the pen request traffic, but also that a pen request is not tampered with. The information transmitted between a digital pen and the PLS is always encrypted using a 128-bit symmetric and unique key shared between the pen and the PLS. In symmetric encryption, the same key is used for encryption and decryption.

The digital pen also generates a 128-bit symmetric session key to encrypt the data that it sends to the ASH. This key is not the same as the key used for encryption of PLS requests. For the ASH to be able to decrypt the data, the digital pen must include this session key in the pen request. To ensure that only the ASH can read the pen request, the digital pen encrypts the transmitted key. The encryption of the pen's session key is based on standard 1024-bit RSA asymmetric encryption, which is the most common asymmetric algorithm. Asymmetric encryption is designed so that the key used for encryption (the public key) is different from the one used for decryption (the private key).

Thus, to encrypt pen requests between the pen and the ASH in an open service, you must generate an asymmetric key pair for the ASH and register the generated public key in the PLS at Anoto. This is done when licensing the pattern via the Anoto partner web site. When the user ticks a Magic box, the PLS sends this public key to the pen, and the pen uses it to encrypt the generated session key that it sends to the ASH.

Public keys are exchanged via certificates. Anoto uses the most common form of certificate, which is the X.509 standard.

About Nokia

Nokia is the world leader in mobile communications, driving the growth and sustainability of the broader mobility industry. Nokia is dedicated to enhancing people's lives and productivity by providing easy-to-use and secure products like mobile phones, and solutions for imaging, games, media, mobile network operators and businesses. Nokia is a broadly held company with listings on five major exchanges.

For more information, please visit <http://www.nokia.com/forbusiness>.

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