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# Improving the Security of Workflow-based System using Multiple XML Digital Signature

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Abstract: ***Private companies and Government Organizations all around the world make huge investments for the automation of their processes and in the management of the electronic documentation in recent times. The main requirement in the management of digital documentation is its equivalence, from a legal perspective, to paperwork, affixing a signature on a digital document is the fundamental principle; which are based the main processes of authorization and validation, apart from the specific area of application. Main benefits for introduction of digital signing processes are cost reduction and complete automation of documental workflow, including authorization and validation phases. In essence, digital signatures allow you to replace the approval process on paper, slow and expensive, with fully digital system, faster and cheaper.***

***Keywords:*** workflow based system; Certificates; USB Tokens; XML Digital Signature; Multiple Signature***s.***

## 1. Introduction

Due to rapid development of technology, organizations are in the process of heading towards paperless environments. They have channelled their efforts to achieve this by adopting automation and by digitalizing paper documents through a series of techniques that include imaging, scanning and Electronic Document Interchange. The digital form of document enables easy management, circulation and makes it available anytime and anywhere by using Internet.

The main requirement in the management of digital documentation is its equivalence, from a legal perspective, to paperwork, affixing a signature on a digital document is the fundamental principle on which are based the main processes of authorization and validation, apart from the specific area of application.

Now-a-days, investment on system/data security in any organization has increased greatly, due to numerous attack threats lurking everywhere. So, Digital Signature is one of the many ways to authenticate the data at any point of time.

One of the major advantages of Digital Signature is that it ensures authenticity and integrity of data, which in today's date is of great importance.
From using traditional Digital Signature methods we have come a long way today to using XML Digital Signatures. W3C has introduced the syntax and promoted the usage of XML Digital Signatures.

## 2. Related Work

The popularity and growth of internet have been a driving force to make extensive use of technology to extend business operations with digitalization of documents. However the need has also been felt to maintain authenticity and integrity of information. a replay attack resilient mechanism was therefore required to embed digital signature into documents, along with a timestamp from authorized time stamping authority. The choice automatically falls on use of pki technology, which is one of the most widely used key management schemes. in this paper we present a mechanism to sign electronic document with digital signature comprising of digital certificate and asymmetric key stored in cryptography token. Thereafter, the document gets time stamped from authorized third party timestamp server so that authenticity and time of creation can be verified and repudiation attack can be handled. The mechanism is also replay attack resilient. it ensures electronic documents are digitally signed with secure signature in order to maintain authenticity and genuineness.

**Table 1:** Paper Signatures v/s Digital Signatures

| **Parameter** | **Paper** | **Electronic** |
|---|---|---|
| Authenticity | May be forged | Cannot be copied |
| Integrity | Signature independent of the document | Signature depends on the contents of the document |
| Non-repudiation | a. Handwriting expert needed.<br>b. Error prone | a. Any computer user<br>b. Error free |

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## 3. Fundamental Concepts


**Figure 1 :** Example of Digital Signatures

A 1024 bits number is a very big number much bigger than the total number of electrons in whole world. Trillions of Trillions of pairs of numbers exist in this range with each pair having following property. A message encrypted with one element of the pair can be decrypted ONLY by the other element of the same pair. Two numbers of a pair are called keys, the Public Key & the Private Key. User himself generates his own key pair on his computer. Any message irrespective of its length can be compressed or abridged uniquely into a smaller length message called the Digest or the Hash. Smallest change in the message will change the Hash value.

What exactly is a digital signature?

Hash value of a message when encrypted with the private key of a person is his digital signature on that e-Document

Digital Signature of a person therefore varies from document to document thus ensuring authenticity of each word of that document.

As the public key of the signer is known, anybody can verify the message and the digital signature

### 3.1 How Digital Signature works

The private key of the originator is used as input to the algorithm which transforms the data being signed (or its hash value). This transformation can only be reversed, and the data decrypted and accessed, by use of the originator's public key, which is provided to the recipient(s) by the originator.

1) Creating a Digital Signature with Private Key

Data encryption using asymmetric keys is an expensive operation directly proportional to the size of the data being encrypted; it potentially doubles the size of the data increasing the processing power and bandwidth required to process and transfers the data. A more efficient approach is to first use a secure cryptographic hash function (such as SHA-1) which can take large objects of varying size and produce a unique fixed-size hash value or message digest. The much smaller hash value can then be encrypted with the private key of the originator to produce the digital signature.

Having calculated the message digest this can be encrypted using the private key of the originator to produce the digital signature, as shown in the diagram below:

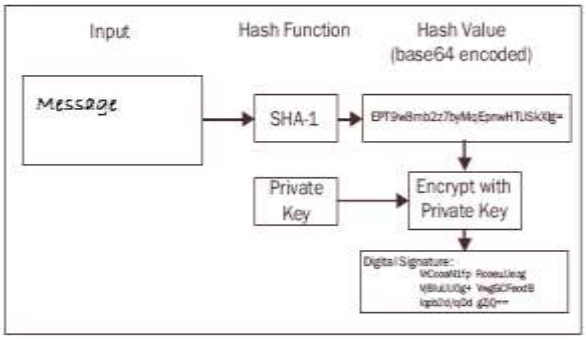


**Figure 2 :** Creating a Digital Signature

2) Verifying a Digital Signature created with Private Key

The recipient must de-crypt the digital signature using the public key of the originator and recalculate the hash value of the corresponding digital object. If the calculated hash value does not match the result of the decrypted signature, either the object has been altered since being signed, or the signature was not generated with the corresponding private key of the originator.

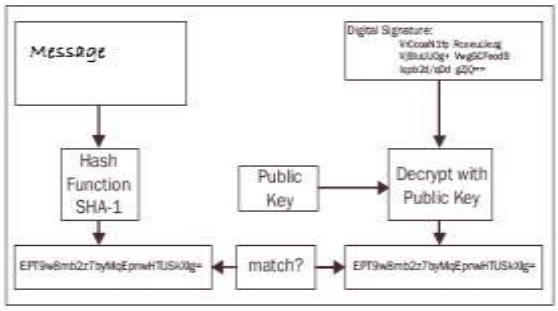


**Figure 3 :** Verifying a Digital Signature

### 3.2 XML Digital Signature

XML signature is form of digital signature designed for use in XML transactions. The XML Digital Signature standard defines a schema that is used for storing the result of a digital signature operation applied to (in most cases) XML data [2]. Like non-XML digital signatures, XML signatures add authentication, data integrity, and support for non-repudiation to the data that is object of XML digital signing process. However, unlike non-XML digital signature standards, XML signature has been designed to both account for and take advantage of the Internet and XML[18].

A fundamental feature of XML Signature is the ability to sign only specific portions of the XML content rather than the complete document. This is relevant when a single XML document may have a long history in which the different components are authored at different times by different parties, each signing only those elements relevant to it. This flexibility will also be critical in situations where it is important to ensure the integrity of certain portions of an XML document, while leaving open the possibility for other portions of the document to change. Since data security – in form of data verification and authorization - represents an important part of information system security paradigm this article is addressing the questions and possibilities of XML Digital Signature usage in everyday information system security procedures.

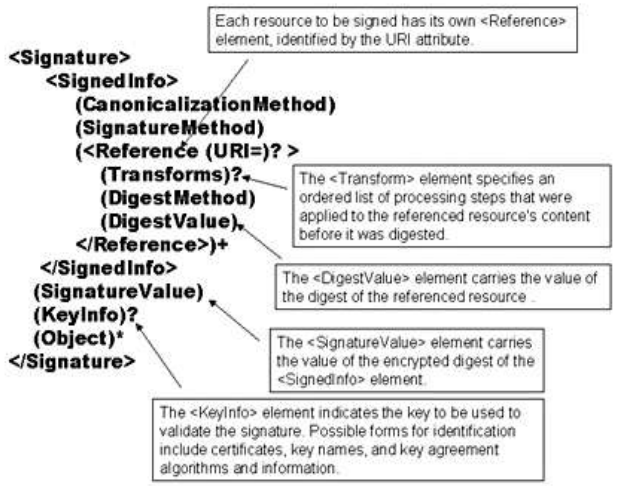


**Figure 4 :** The Components of an XML Signature

### 3.3 Creating and Verifying XML Signatures

**XML signature creation**

In this example two digital objects are to be signed with a single digital signature:

- The Paradigm logo (http://www.paradigm.ac.uk/images/paradigm.gif).
- The Paradigm home page (http://www.paradigm.ac.uk/index.html).

1. For each object a <Reference> element is created containing:
   - The location (URI) of the object.
   - An ordered list of the transforms (or processing steps) that were applied to the content of the referenced resource before its digest was calculated.
   - The actual algorithm used (such as SHA-1) to calculate the digest value.
   - The digest value (base64 encoded) for the identified object in the <DigestValue> element.
2. These <Reference> elements are collected within the <SignedInfo> element along with:
   - The canonicalisation method (e.g. XMLC14N as used in the example below) to be applied to the <SignedInfo> element.
   - The signature algorithm to be applied to the <SignedInfo> element.
3. The <SignedInfo> element does not include explicit signature or digest properties (such as date or calculation time), if these are required they can be associated via a <SignatureProperties> element attached to an <Object> element.
4. The populated <SignedInfo> element is then canonicalised using the specified <CanonicalizationMethod>.
5. Finally the <SignatureMethod> which is a combination of a digest algorithm and a key dependent algorithm (e.g. DSA-SHA1) is applied to the canonicalised <SignedInfo> element and the digest result is placed in the <SignatureValue> element.

**XML signature verification**

The verification of an XML signature consists of of two phases:

1. Signature validation
   - This comprises the verification of the <signatureValue> of the <SignedInfo> element:
   - The digest of the <signedInfo> element is recalculated using the digest algorithm specified in the <SignatureMethod> element.
   - The public key from <KeyInfo>, or from an external source, is used to verify that the <SignatureValue> matches the recalculated <SignedInfo> digest.
2. Reference validation
   - This comprises the verification of the <DigestValue> of each <Reference> element
   - The <SignedInfo> element is canonicalised using the algorithm specified in <CanonicalizationMethod>.
3. For each referenced object in the canonicalised <SignedInfo> the recipient must:
   - Obtain a copy of the object.
   - Apply any transforms specified to the object.
   - Regenerate the digest for the transformed object using the <DigestMethod> specified in its <Reference> element.
   - Validation fails if the generated digest value and the <DigestValue> in the <Reference> do not match.

## 4. Proposed System

In this project we will be making use of XML Digital Signatures, but the format specified by W3C for XML Digital Signatures will not be followed. Instead customized XML Digital Signature tags will be used to implement Digital Signatures in Workflow Based System, where signature over signature (multiple signs) will be present on the single document.

The main purpose of Multiple Signature Based Incident Report Workflow system is to transmit the created reports electronically in a secure method within the hierarchy of the organization using Digital Signature infrastructure. Digital signatures let the recipient of the report (information) was not altered while in transit. The staffs have to manually create reports and hand in to the concerned higher authorities in the existing system. The process is awkward and time-consuming for all the concerned authorities as taking action against any incident which has occurred gets delayed. Technology to electronically submit the reports electronically is available. However, there do exist certain requirements such as the authenticity of the report and confirmation of the recipient. The organization also needs to be certain about the originator of the report and that the staffs cannot falsely claim not having sent the report.

We have also modified the regular Database design to accommodate the duplication of data required for Digital Signatures. XML Documents will be generated at runtime. Authentication and Integrity of data in workflow based system is achieved by attaching a Digital Signature at every stage of the workflow with the XML Document.

XML signatures are digital signatures designed for use in XML transactions. The standard defines a schema for capturing the result of a digital signature operation applied to arbitrary (but often XML) data. Like non-XML-aware digital signatures (e.g., PKCS), XML signatures add authentication, data integrity, and

support for non-repudiation to the data that they sign. However, unlike non-XML digital signature standards, XML signature has been designed to both account for and take advantage of the Internet and XML.

A fundamental feature of XML Signature is the ability to sign only specific portions of the XML tree rather than the complete document. This will be relevant when a single XML document may have a long history in which the different components are authored at different times by different parties, each signing only those elements relevant to itself. This flexibility will also be critical in situations where it is important to ensure the integrity of certain portions of an XML document, while leaving open the possibility for other portions of the document to change. Consider, for example, a signed XML form delivered to a user for completion. If the signature were over the full XML form, any change by the user to the default form values would invalidate the original signature.

An XML signature can sign more than one type of resource. For example, a single XML signature might cover character-encoded data (HTML), binary-encoded data (a JPG), XML-encoded data, and a specific section of an XML file.

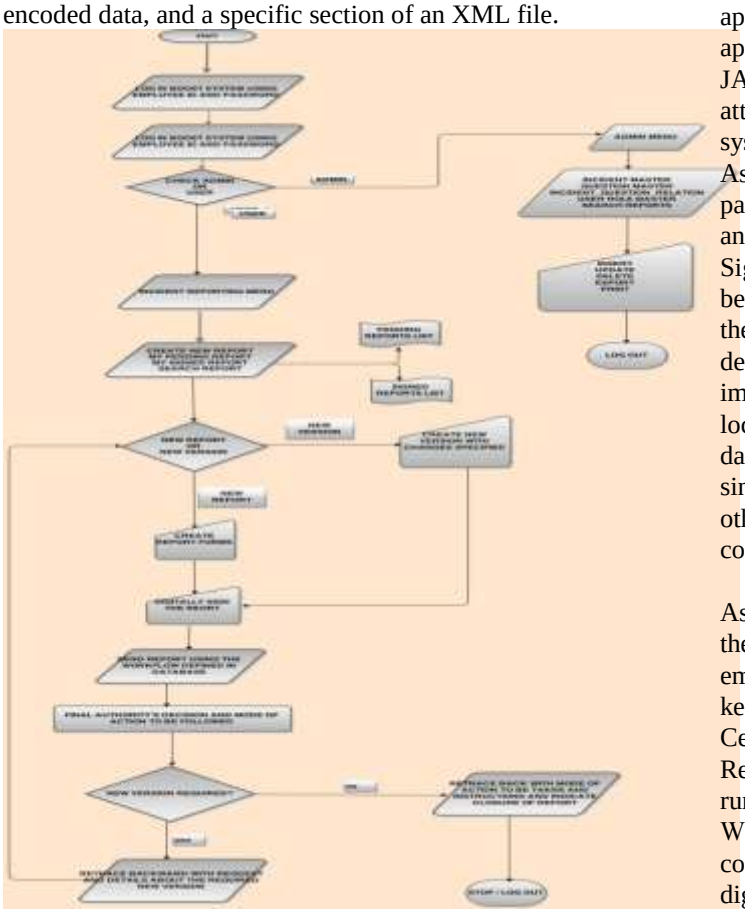

**Figure 5 :** Flowchart of Project

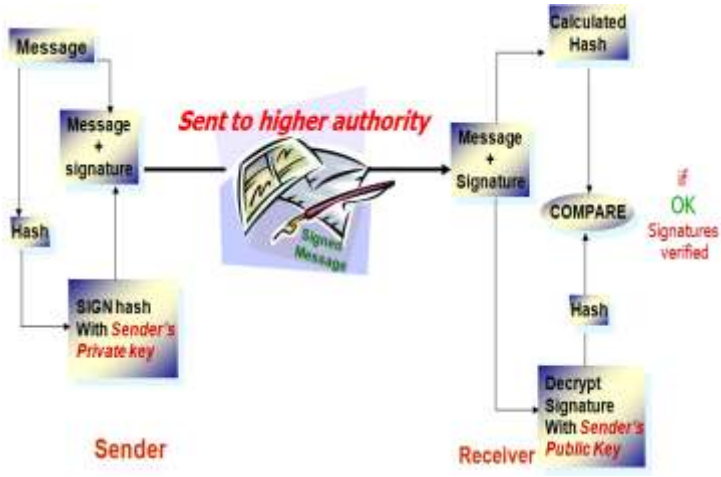


**Figure 6 :** Lifecycle of Digital Signature

The system will implement multiple XML digital signatures on a thick client based application designed using JAVA language. But we can attempt at creating a web based workflow application with multiple (hierarchal) signatures. The web application can be designed using PHP technology – GUI and JAVA Applet – signature API. The proposed system is an attempt at implementing the concept of multiple signatures in a system.

As in Fig. 5 the flow of the project is depicted. There are two parts in the project. One where the Admin controls the database and another where the actual implementation of Digital Signature will be made. The reports which will be created will be first signed by the creator, and then forwarded upwards in the hierarchy. Later on in the higher levels the employees can decide whether the report is to be reverted back for improvement, forwarded for what further action is to taken or locked (where the report will be closed and saved in the database). There will be minimum two signatures attached to a single report – one, of the employee who creates the report and other, will the one who will close the report with remarks and comments about the course of action that will be taken.

As the fig. 6 shows how a digital signature works in general, the process is followed in this application as well. The employees are given PKI USB Tokens [6] to store their private keys. The digital certificates are provided by the local Certificate Authority of BARC with the help of local Registration Authority of BARC. Then a XML file is created at runtime and shown to the user to ensure the "What You See Is What You Sign" context is taken care of [2]. The XML file contains all the data that been entered by the user before digitally signing the contents.

**Figure 7 :** Two Level Signature Output

Fig. 7 shows the XML Digital Signature for a two level hierarchy. Here the recommender is the creator i.e. 1st level of the hierarchy. Then he sends the report to whomsoever the report is marked to. Then the process of digital signature as discussed in section 3 is followed. After that the approver will sign the report and send to whomsoever the report is marked to. So when the third level authority opens the report the above will be shown as output when digitally signing the report.

## 5. Conclusion

Security threats in government organizations, when an unauthorized party inserts counterfeit objects into the system can be eliminated through the system. There are various hacking tools available that can quite easily intercept online messages, who's content, unless encrypted, will be fully available to the attacker.

There are a lot of tools that let people send "spoofed" messages. These are messages that appear to have come from someone that user know, when in reality they were sent by the attacker trying to social engineer his way into the system. If all conversations with the people that user know and trust are digitally signed, user will easily identify that the message did not come from a true sender.

Transparency among the employees is established as the process becomes digitalized. Furthermore, Automation results in organized, efficient and easy system. Automation also helps the employees greatly in Time management. Maintaining authenticity and integrity of information can be taken care of using XML Digital Signatures. The real value is in avoiding the paper and keeping your data electronic.

As XML becomes a vital component of the emerging electronic business infrastructure, we need trustable, secure XML messages to form the basis of business transactions. One key to enabling secure transactions is the concept of a digital signature, ensuring the integrity and authenticity of origin for business documents. XML Signature is an evolving standard for digital signatures that both addresses the special issues and requirements that XML presents for signing operations and uses XML syntax for capturing the result, simplifying its integration into XML applications.

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