Using the GOST R 34.10-94, GOST R 34.10-2001, and
GOST R 34.11-94 Algorithms with the
Internet X.509 Public Key Infrastructure
Certificate and CRL Profile

Status of This Memo

This document specifies an Internet standards track protocol for the
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Abstract

This document supplements RFC 3279. It describes encoding formats,
identifiers, and parameter formats for the algorithms GOST R 34.10-
94, GOST R 34.10-2001, and GOST R 34.11-94 for use in Internet X.509
Public Key Infrastructure (PKI).
1. Introduction

This document supplements RFC 3279 [PKALGS]. It describes the conventions for using the GOST R 34.10-94 [GOST3431095, GOSTR341094] and GOST R 34.10-2001 [GOST3431004, GOSTR341001] signature algorithms, VKO GOST R 34.10-94 and VKO GOST R 34.10-2001 key derivation algorithms, and GOST R 34.11-94 [GOST3431195, GOSTR341194] one-way hash function in the Internet X.509 Public Key Infrastructure (PKI) [PROFILE].

This document provides supplemental information and specifications needed by the "Russian Cryptographic Software Compatibility Agreement" community.

The algorithm identifiers and associated parameters are specified for subject public keys that employ the GOST R 34.10-94 [GOSTR341094]/VKO GOST R 34.10-94 [CPALGS] or the GOST R 34.10-2001 [GOSTR341001]/VKO GOST R 34.10-2001 [CPALGS] algorithms, as is the encoding format for the signatures produced by these algorithms. Also, the algorithm identifiers for using the GOST R 34.11-94 one-way hash function with the GOST R 34.10-94 and GOST R 34.10-2001 signature algorithms are specified.
This specification defines the contents of the signatureAlgorithm, signatureValue, signature, and subjectPublicKeyInfo fields within X.509 Certificates and CRLs. For each algorithm, the appropriate alternatives for the keyUsage certificate extension are provided.

ASN.1 modules, including all the definitions used in this document, can be found in [CPALGS].

1.1. Requirement Words

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Algorithm Support

This section is an overview of cryptographic algorithms that may be used within the Internet X.509 certificates and CRL profile [PROFILE]. It describes one-way hash functions and digital signature algorithms that may be used to sign certificates and CRLs, and it identifies object identifiers (OIDs) and ASN.1 encoding for public keys contained in a certificate.

Certification authorities (CAs) and/or applications conforming to this standard MUST support at least one of the specified public key and signature algorithms.

2.1. One-Way Hash Function

This section describes the use of a one-way, collision-free hash function GOST R 34.11-94, the only one that can be used in the digital signature algorithm GOST R 34.10-94/2001. The data that is hashed for certificates and CRL signing is fully described in RFC 3280 [PROFILE].

2.1.1. One-Way Hash Function GOST R 34.11-94

GOST R 34.11-94 has been developed by "GUBS of Federal Agency Government Communication and Information" and "All-Russian Scientific and Research Institute of Standardization". The algorithm GOST R 34.11-94 produces a 256-bit hash value of an arbitrary finite bit length input. This document does not contain the full GOST R 34.11-94 specification, which can be found in [GOSTR341194] (in Russian). [Schneier95], ch. 18.11, p. 454, contains a brief technical description in English.

This function MUST always be used with parameter set identified by id-GostR3411-94-CryptoProParamSet (see Section 8.2 of [CPALGS]).
2.2.  Signature Algorithms

Conforming CAs may use GOST R 34.10-94 or GOST R 34.10-2001 signature algorithms to sign certificates and CRLs.

These signature algorithms MUST always be used with a one-way hash function GOST R 34.11-94 as indicated in [GOSTR341094] and [GOSTR341001].

This section defines algorithm identifiers and parameters to be used in the signatureAlgorithm field in a Certificate or CertificateList.

2.2.1.  Signature Algorithm GOST R 34.10-94

GOST R 34.10-94 has been developed by "GUBS of Federal Agency Government Communication and Information" and "All-Russian Scientific and Research Institute of Standardization". This document does not contain the full GOST R 34.10-94 specification, which can be found in [GOSTR341094] (in Russian). [Schneier95], ch. 20.3, p. 495, contains a brief technical description in English.

The ASN.1 object identifier used to identify this signature algorithm is:

```
id-GostR3411-94-with-GostR3410-94 OBJECT IDENTIFIER ::= 
  { iso(1) member-body(2) ru(643) rans(2) cryptopro(2)
      gostR3411-94-with-gostR3410-94(4) }
```

When the id-GostR3411-94-with-GostR3410-94 algorithm identifier appears as the algorithm field in an AlgorithmIdentifier, the encoding SHALL omit the parameters field. That is, the AlgorithmIdentifier SHALL be a SEQUENCE of one component: the OBJECT IDENTIFIER id-GostR3411-94-with-GostR3410-94.

The signature algorithm GOST R 34.10-94 generates a digital signature in the form of two 256-bit numbers, r' and s. Its octet string representation consists of 64 octets, where the first 32 octets contain the big-endian representation of s and the second 32 octets contain the big-endian representation of r'.

This definition of a signature value is directly usable in CMS [CMS], where such values are represented as octet strings. However, signature values in certificates and CRLs [PROFILE] are represented as bit strings, and thus the octet string representation must be converted.
To convert an octet string signature value to a bit string, the most significant bit of the first octet of the signature value SHALL become the first bit of the bit string, and so on through the least significant bit of the last octet of the signature value, which SHALL become the last bit of the bit string.

2.2.2. Signature Algorithm GOST R 34.10-2001

GOST R 34.10-2001 was developed by "GUBS of Federal Agency Government Communication and Information" and "All-Russian Scientific and Research Institute of Standardization". This document does not contain the full GOST R 34.10-2001 specification, which can be found in [GOSTR341001] (in Russian).

The ASN.1 object identifier used to identify this signature algorithm is:

\[
\text{id-GostR3411-94-with-GostR3410-2001 OBJECT IDENTIFIER ::=}
\{ iso(1) member-body(2) ru(643) rans(2) cryptopro(2)
gostR3411-94-with-gostR3410-2001(3) \}
\]

When the id-GostR3411-94-with-GostR3410-2001 algorithm identifier appears as the algorithm field in an AlgorithmIdentifier, the encoding SHALL omit the parameters field. That is, the AlgorithmIdentifier SHALL be a SEQUENCE of one component: the OBJECT IDENTIFIER id-GostR3411-94-with-GostR3410-2001.

The signature algorithm GOST R 34.10-2001 generates a digital signature in the form of two 256-bit numbers, r and s. Its octet string representation consists of 64 octets, where the first 32 octets contain the big-endian representation of s and the second 32 octets contain the big-endian representation of r.

The process described above (Section 2.2.1) MUST be used to convert this octet string representation to a bit string for use in certificates and CRLs.

2.3. Subject Public Key Algorithms

This section defines OIDs and public key parameters for public keys that employ the GOST R 34.10-94 [GOSTR341094]/VKO GOST R 34.10-94 [CPALGS] or the GOST R 34.10-2001 [GOSTR341001]/VKO GOST R 34.10-2001 [CPALGS] algorithms.

Use of the same key for both signature and key derivation is NOT RECOMMENDED. The intended application for the key MAY be indicated in the keyUsage certificate extension (see [PROFILE], Section 4.2.1.3).
2.3.1. GOST R 34.10-94 Keys

GOST R 34.10-94 public keys can be used for the signature algorithm GOST R 34.10-94 [GOST341094] and for the key derivation algorithm VKO GOST R 34.10-94 [CPALGS].

GOST R 34.10-94 public keys are identified by the following OID:

id-GostR3410-94 OBJECT IDENTIFIER ::= 
{ iso(1) member-body(2) ru(643) rans(2) cryptopro(2) 
gostR3410-94(20) }

The SubjectPublicKeyInfo.algorithm.algorithm field (see RFC 3280 [PROFILE]) for GOST R 34.10-94 keys MUST be set to id-GostR3410-94.

When the id-GostR3410-94 algorithm identifier appears as the algorithm field in an AlgorithmIdentifier, the encoding MAY omit the parameters field or set it to NULL. Otherwise, this field MUST have the following structure:

GostR3410-94-PublicKeyParameters ::= 
SEQUENCE {
   publicKeyParamSet
   OBJECT IDENTIFIER,
   digestParamSet
   OBJECT IDENTIFIER,
   encryptionParamSet
   OBJECT IDENTIFIER DEFAULT
   id-Gost28147-89-CryptoPro-A-ParamSet
}

where:

* publicKeyParamSet - public key parameters identifier for GOST R 34.10-94 (see Section 8.3 of [CPALGS])
* digestParamSet - parameters identifier for GOST R 34.11-94 (see Section 8.2 of [CPALGS])
* encryptionParamSet - parameters identifier for GOST 28147-89 [GOST28147] (see Section 8.1 of [CPALGS])

The absence of parameters SHALL be processed as described in RFC 3280 [PROFILE], Section 6.1; that is, parameters are inherited from the issuer certificate. When the working_public_key_parameters variable is set to null, the certificate and any signature verifiable on this certificate SHALL be rejected.
The GOST R 34.10-94 public key MUST be ASN.1 DER encoded as an OCTET STRING; this encoding shall be used as the contents (i.e., the value) of the subjectPublicKey component (a BIT STRING) of the SubjectPublicKeyInfo data element.

GostR3410-94-PublicKey ::= OCTET STRING -- public key, Y

GostR3410-94-PublicKey MUST contain 128 octets of the little-endian representation of the public key $Y = a^x \pmod p$, where $a$ and $p$ are public key parameters, and $x$ is a private key.

Some erroneous applications discard zero bits at the end of BIT STRING containing the public key. It is RECOMMENDED to pad the bit string with zeroes up to 1048 bits (131 octets) on decoding to be able to decode the encapsulated OCTET STRING.

If the keyUsage extension is present in an end-entity certificate that contains a GOST R 34.10-94 public key, the following values MAY be present:

- digitalSignature;
- nonRepudiation;
- keyEncipherment; and
- keyAgreement.

If the keyAgreement or keyEncipherment extension is present in a certificate GOST R 34.10-94 public key, the following values MAY be present as well:

- encipherOnly; and
- decipherOnly.

The keyUsage extension MUST NOT assert both encipherOnly and decipherOnly.

If the keyUsage extension is present in an CA or CRL signer certificate that contains a GOST R 34.10-94 public key, the following values MAY be present:

- digitalSignature;
- nonRepudiation;
- keyCertSign; and
- cRLSign.


2.3.2. GOST R 34.10-2001 Keys

GOST R 34.10-2001 public keys can be used for the signature algorithm GOST R 34.10-2001 [GOST341001] and for the key derivation algorithm VKO GOST R 34.10-2001 [CPALGS].

GOST R 34.10-2001 public keys are identified by the following OID:

```
id-GostR3410-2001 OBJECT IDENTIFIER ::=  
{ iso(1) member-body(2) ru(643) rans(2) cryptopro(2)  
gostR3410-2001(19) }
```

The SubjectPublicKeyInfo.algorithm.algorithm field (see RFC 3280 [PROFILE]) for GOST R 34.10-2001 keys MUST be set to id-GostR3410-2001.

When the id-GostR3410-2001 algorithm identifier appears as the algorithm field in an AlgorithmIdentifier, the encoding MAY omit the parameters field or set it to NULL. Otherwise, this field MUST have the following structure:

```
GostR3410-2001-PublicKeyParameters ::=  
SEQUENCE {  
   publicKeyParamSet  
      OBJECT IDENTIFIER,  
   digestParamSet  
      OBJECT IDENTIFIER,  
   encryptionParamSet  
      OBJECT IDENTIFIER DEFAULT  
      id-Gost28147-89-CryptoPro-A-ParamSet 
}
```

where:

* `publicKeyParamSet` - public key parameters identifier for GOST R 34.10-2001 (see Section 8.4 of [CPALGS])
* `digestParamSet` - parameters identifier for GOST R 34.11-94 (see Section 8.2 of [CPALGS])
* `encryptionParamSet` - parameters identifier for GOST 28147-89 [GOST28147] (see Section 8.1 of [CPALGS])

The absence of parameters SHALL be processed as described in RFC 3280 [PROFILE], Section 6.1; that is, parameters are inherited from the issuer certificate. When the `working_public_key_parameters` variable is set to null, the certificate and any signature verifiable on this certificate SHALL be rejected.
The GOST R 34.10-2001 public key MUST be ASN.1 DER encoded as an OCTET STRING; this encoding shall be used as the contents (i.e., the value) of the subjectPublicKey component (a BIT STRING) of the SubjectPublicKeyInfo data element.

GostR3410-2001-PublicKey ::= OCTET STRING -- public key vector, Q

According to [GOSTR341001], a public key is a point on the elliptic curve Q = (x,y).

GostR3410-2001-PublicKey MUST contain 64 octets, where the first 32 octets contain the little-endian representation of x and the second 32 octets contain the little-endian representation of y. This corresponds to the binary representation of (<y>256||<x>256) from [GOSTR341001], ch. 5.3.

Some erroneous applications discard zero bits at the end of BIT STRING containing the public key. It is RECOMMENDED to pad the bit string with zeroes up to 528 bits (66 octets) on decoding to be able to decode the encapsulated OCTET STRING.

The same keyUsage constraints apply for use of GOST R 34.10-2001 keys as described in Section 2.3.1 for GOST R 34.10-94 keys.

3. Security Considerations

It is RECOMMENDED that applications verify signature values and subject public keys to conform to [GOSTR341001, GOSTR341094] standards prior to their use.

When a certificate is used to support digital signatures as an analogue to manual ("wet") signatures, in the context of Russian Federal Electronic Digital Signature Law [RFEDSL], the certificate MUST contain keyUsage extension, it MUST be critical, and keyUsage MUST NOT include keyEncipherment and keyAgreement.

It is RECOMMENDED that CAs and applications make sure that the private key for creating signatures is not used for more than its allowed validity period (typically 15 months for both the GOST R 34.10-94 and GOST R 34.10-2001 algorithms).

For security discussion concerning use of algorithm parameters, see the Security Considerations section in [CPALGS].
4. Examples

4.1. GOST R 34.10-94 Certificate

-----BEGIN CERTIFICATE-----
MIICCzCCAboCECMk42BG1ST0wvk1BqfuswCAYGKoUDAgIEMGkxHTAbBgNVBAMM
FEdvc3RSQzqMC05NCBleGFtcGxlMlMRIwEAYDVQQKDAAtDcnldG9qcm8xCzAJBgNV
BAYTA1JVMScwJYJwZhcNAQkKBFhhHb3NUUjM0MTatOTRAZhhbXBsZS5jb20w
HhcNMDUwODE2MTizMjUwWHhcNMTUwODE2MTizMjUwWjBpMRowGwYDVQQDDBRBHB3N0
UjM0MTatOTQzXhhbXBsZTESMBAGA1UECgwJQ3J5cHRvUHiHvMmQswCQYDVQQGEwJS
VTEnMCUGscgS3Ib3DQExJARYY23zdFizNDExMTkQVGv4YW1wbGUuY29tMIG1MBwG
BiqFwIFBAABSQgcqQMCMtACBgqMQCAhEAMGkzF5nl02CyAfxOo
GWZxV/6MVCUhrR28wCy3RpiG+0dVvrey85NaObVCNyaE4g0QiOIHwxCTsS7ESuo
v2Y5MyUI8Gc/h/jEvYJJYfMDjrv05YmKCYJo01x5pg+2kBAljeM+fJyRlwNCw+
eMG1wra3Gqqi0Wk3Iydrp7MAgGBiqFAwICBANBABBHWC4S3AlxAiMPr3aPyqB
q1djBZ4y5DjULicHeIveF81W91OxGkZxnrbFjXBSqjLcFkgF1hffX0AP7zUM=
-----END CERTIFICATE-----

0 30 523: SEQUENCE {
  4 30 442:  SEQUENCE {
  8 02 16:  INTEGER
    :  23 0E E3 60 46 95 24 CE C7 0B E4 94 18 2E 7E EB
  26 30 8:  SEQUENCE {
  28 06 6:  OBJECT IDENTIFIER
    :  id-GostR3411-94-with-GostR3410-94 (1 2 643 2 2 4)
  :  }
  36 30 105:  SEQUENCE {
  38 31 29:  SET {
  40 30 27:  SEQUENCE {
  42 06 3:  OBJECT IDENTIFIER commonName (2 5 4 3)
  47 0C 20:  UTF8String ‘GostR3410-94 example’
    :  }
  :  }
  69 31 18:  SET {
  71 30 16:  SEQUENCE {
  73 06 3:  OBJECT IDENTIFIER organizationName (2 5 4 10)
  78 0C 9:  UTF8String ‘CryptoPro’
    :  }
  :  }
  89 31 11:  SET {
  91 30 9:  SEQUENCE {
  93 06 3:  OBJECT IDENTIFIER countryName (2 5 4 6)
  98 13 2:  PrintableString ‘RU’
    :  }
  :  }
  102 31 39:  SET {
  104 30 37:  SEQUENCE {
  106 06 9:  OBJECT IDENTIFIER emailAddress (1 2 840 113549 1 9 1)
IA5String 'GostR3410-94@example.com'

SEQUENCE {
    UTCTime '050816123250Z'
    UTCTime '150816123250Z'
}

SEQUENCE {
    SET {
        SEQUENCE {
            OBJECT IDENTIFIER commonName (2 5 4 3)
            UTF8String 'GostR3410-94 example'
        }
    }
    SET {
        SEQUENCE {
            OBJECT IDENTIFIER organizationName (2 5 4 10)
            UTF8String 'CryptoPro'
        }
    }
    SET {
        SEQUENCE {
            OBJECT IDENTIFIER countryName (2 5 4 6)
            PrintableString 'RU'
        }
    }
    SET {
        SEQUENCE {
            OBJECT IDENTIFIER emailAddress (1 2 840 113549 1 9 1)
            IA5String 'GostR3410-94@example.com'
        }
    }
    BIT STRING 0 unused bits, encapsulates {
        OCTET STRING

In the signature of the above certificate, \( r' \) equals
\[
0x22F785F355BD9446C6919C50D702A78CBB7852A017585F7D73803FBCD43
\]
and \( s \) equals
\[
0x11C708E12DC02F102232947768F472A818350E307CCF2E431238942C873E1DE
\]

4.2. GOST R 34.10-2001 Certificate

-----BEGIN CERTIFICATE-----
MIIB0DCCAX8CECv1xh7CEb0Xx9zUYma0LiEWCAYKGkUDAgIDMG0xHzAdBgNVBAMM
Fkdvc3RSMzQxMC0yMDAxIGV4YW1wbGUxEjAQBgNVBAoMCUNyeXB0b1BybzkELMAKGA1UEBhMCUlUxKTAnBgkqhkiG9w0BCQEWGkdvc3RSMzQxMC0yMGUxGQYDVQQGEwJSVTEpMCcGCSqGSIb3DQEJARYaR29zdFIzNDEwLTIwMDFAZXhhbXBsZS5j
b20wYzAcBqghQMChAMEhQKmQgYHkUdAgIeAQNDARAhJvoldWACGkBiCM07tJDGJLP31BQ6wIA9CafIWiUd+SN6qa7f1bHy70df
-----END CERTIFICATE-----

0 30 464: SEQUENCE {
4 30 383: SEQUENCE {
8 02 16: INTEGER :
2B 8C 66 E1 79 9E 5B 34 D8 80 7F 13 A8 19 66
71 57 FE 8C 54 25 21 47 6F 30 0B 27 77 46 98 C6
FB 47 55 BE B7 B2 F3 93 6C 39 B5 42 37 26 84 E2
0D 10 8A 24 0E 1F 0C 42 4D 2B 3B 11 2B A8 BF 6F
39 32 5C 94 8B C1 A8 FE 1B 63 12 F6 09 25 87 CC
75 1B F4 E5 89 8A 09 82 68 D3 5C 77 A6 0F B6 90
10 13 8D E3 3E 7C 9C 91 D6 AC 0D 08 2C 3E 78 C1
B5 C2 B6 B7 1A A8 2A 8B 45 81 93 32 32 76 FA 7B
}
}
450 30 8: SEQUENCE {
452 06 6: OBJECT IDENTIFIER :
id-GostR3411-94-with-GostR3410-94 (1 2 643 2 2 4)
}
460 03 65: BIT STRING 0 unused bits :
11 C7 08 7E 12 DC 02 F1 02 23 29 47 76 8F 47 2A
81 83 50 E3 07 CC F2 E4 31 23 89 42 C8 73 E1 DE
22 F7 85 F3 55 BD 94 EC 46 91 9C 67 AC 58 D7 05
2A A7 8C B7 85 2A 01 75 8F D7 38 03 FB CD 43
}

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id-GostR3411-94-with-GostR3410-2001 (1 2 643 2 2 3)

SEQUENCE {
    SET {
        SEQUENCE {
            OBJECT IDENTIFIER commonName (2 5 4 3)
            UTF8String 'GostR3410-2001 example'
        }
    }
    SEQUENCE {
        OBJECT IDENTIFIER organizationName (2 5 4 10)
        UTF8String 'CryptoPro'
    }
    SEQUENCE {
        OBJECT IDENTIFIER countryName (2 5 4 6)
        PrintableString 'RU'
    }
    SEQUENCE {
        OBJECT IDENTIFIER emailAddress (1 2 840 113549 1 9 1)
        IA5String 'GostR3410-2001@example.com'
    }
    SEQUENCE {
        UTCTime '050816141820Z'
        UTCTime '150816141820Z'
    }
}

SEQUENCE {
    SET {
        SET {
            OBJECT IDENTIFIER commonName (2 5 4 3)
            UTF8String 'GostR3410-2001 example'
        }
        SET {
            OBJECT IDENTIFIER organizationName (2 5 4 10)
            UTF8String 'CryptoPro'
        }
        SET {
            OBJECT IDENTIFIER countryName (2 5 4 6)
        }
        SET {
            OBJECT IDENTIFIER emailAddress (1 2 840 113549 1 9 1)
            IA5String 'GostR3410-2001@example.com'
        }
    }
    SEQUENCE {
        UTCTime '050816141820Z'
        UTCTime '150816141820Z'
    }
}
In the public key of the above certificate, x equals
0x577E324FE70F2B6DF45C437A0305E5FD2C89318C13CD0875401A026075689584
and y equals
0x601AEACABC660DFDB0CBCEB7567EBBA6EAE8DFAEA857C9AD0038895B916CCEB8F
The corresponding private key d equals
0x0B293BE050D0082BDAE785631A6BAB68F35B42786D6DDA56AFAF169891040F77
In the signature of the above certificate, r equals
0xC1DE176E8D1BECC71B593F3DD369355577688989176220F4DAB131D5B51C33DEE2
and s equals
0x3C2FC9094B727AA9ECA7D5E9FB536DD2C3AA647C442EDEED3116454FBC543FDD

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6. References

6.1. Normative References


[GOST3431095] "Information technology. Cryptographic Data Security. Produce and check procedures of Electronic Digital Signature based on Asymmetric Cryptographic Algorithm.", GOST 34.310-95, Council for Standardization, Metrology and Certification of the Commonwealth of Independence States (EASC), Minsk, 1995. (In Russian)


6.2. Informative References


[RFEDSL]    Russian Federal Electronic Digital Signature Law, 10 Jan 2002 N 1-FZ.

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