Understand, manage and love certificates in z/OS and USS

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Agenda

- General basics
  - Where/what are certificates used for?
- How is it used/realized?
- Real examples from the ZOWE ecosystem,
  - as well as z/OSMF, UMS, SQLDI, Db2
- Managing certificates in USS and z/OS
- Analyzing certificate issues

General Basics

- Like an official identity card in the analog world, a certificate reliably proves an identity in the digital world to
  - Protect from fake identities
  - Refer to an authority that proves the identity
  - Acknowledge the data by the electronic signature of the authority
  - Relate a public key (owner) to an identity
  - Associate a public key to the identity data of
    - a person
    - an organization
    - a device

General Basics

- Digital certificates, or public key certificates, or identity certificates are used to **identify** and **validate** an unknown origin and to **communicate securely** with it

1. It includes information about the owner/<u>subject</u>,
   plus typically a certificate of the entity/<u>issuer</u>
   that has verified the owner/subject

2. It includes a public key that allows asymmetric, one-way encryption
   - The public key is intended to be shared
     - A Public key enables anybody to encrypt content
     - Only the corresponding private key of a public/private key pair can decrypt the content

General Basics

Conclusion:

→ A certificate is an electronic document used to

1. prove an identity and
2. to provide a key

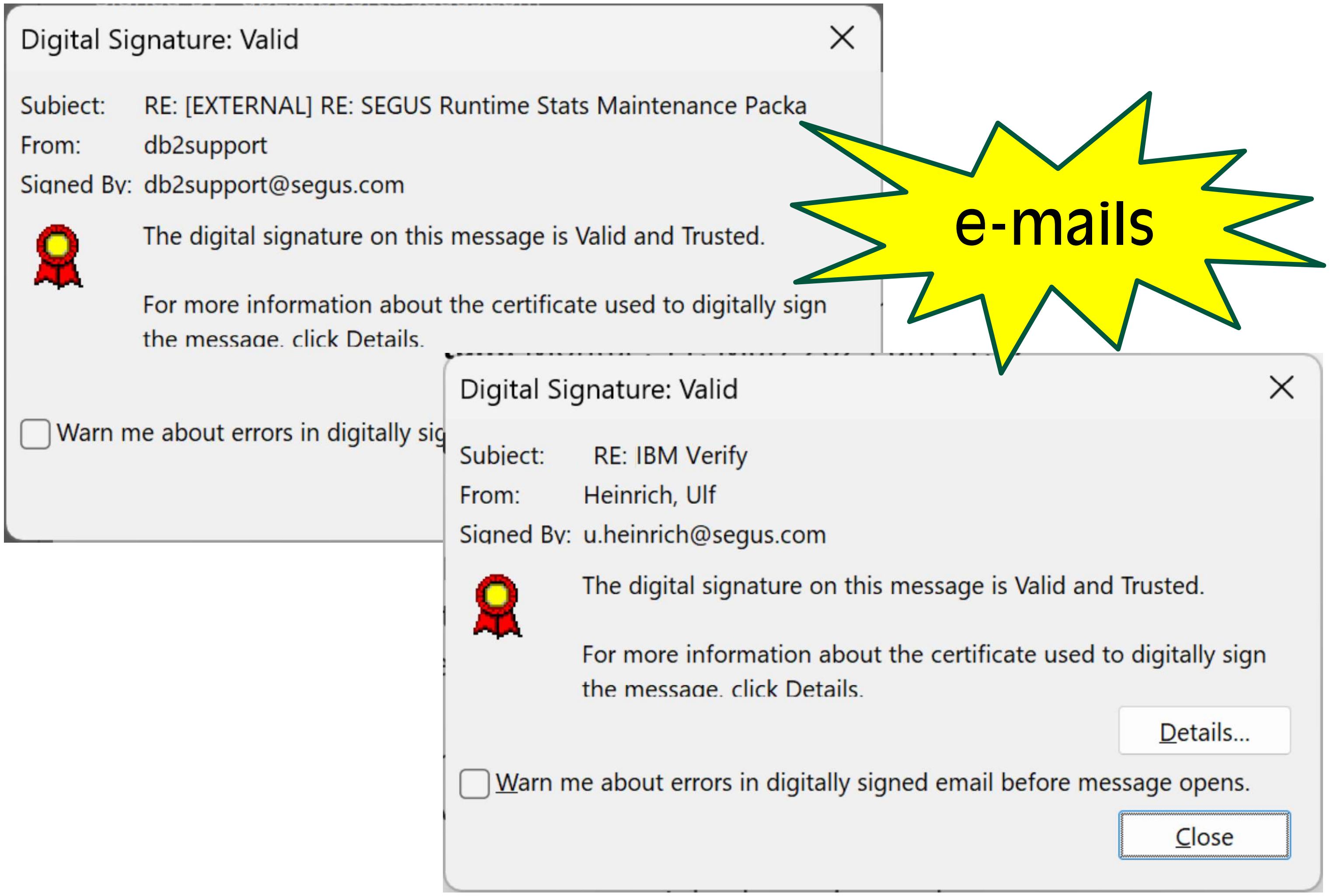
which is part of the document

→ Once a certificate is verified to be trustworthy the validity proves

- sender/integrity of an e-mail (S/MIME)
- authenticity of a payment card for transactions (EMV)
- owner/integrity/genuine of apps/binaries (code signing)
- Document, eID, role, …
- device (domain/host/IP) (TLS/SSL)

- Further, the public key can be used for secure communication with a
  - Person, or organization (e.g. e-mail, messaging)
  - Device (https, ftps, sftp, ssh, VPN, RDP…)

Where/what are certificates used for?


Digital Signature: Valid

Subject: RE: [EXTERNAL] RE: SEGUS Runtime Stats Maintenance Packa

From: db2support

Signed By: db2support@segus.com

The digital signature on this message is Valid and Trusted.

For more information about the certificate used to digitally sign the message, click Details.

Warn me about errors in digitally sig

Digital Signature: Valid

Subject: RE: IBM Verify

From: Heinrich, Ulf

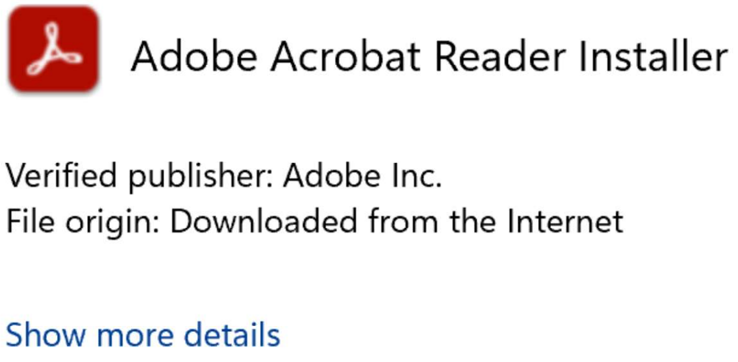
Signed By: u.heinrich@segus.com

The digital signature on this message is Valid and Trusted.

For more information about the certificate used to digitally sign the message, click Details.

Details...
Warn me about errors in digitally signed email before message opens.
Close
e-mails

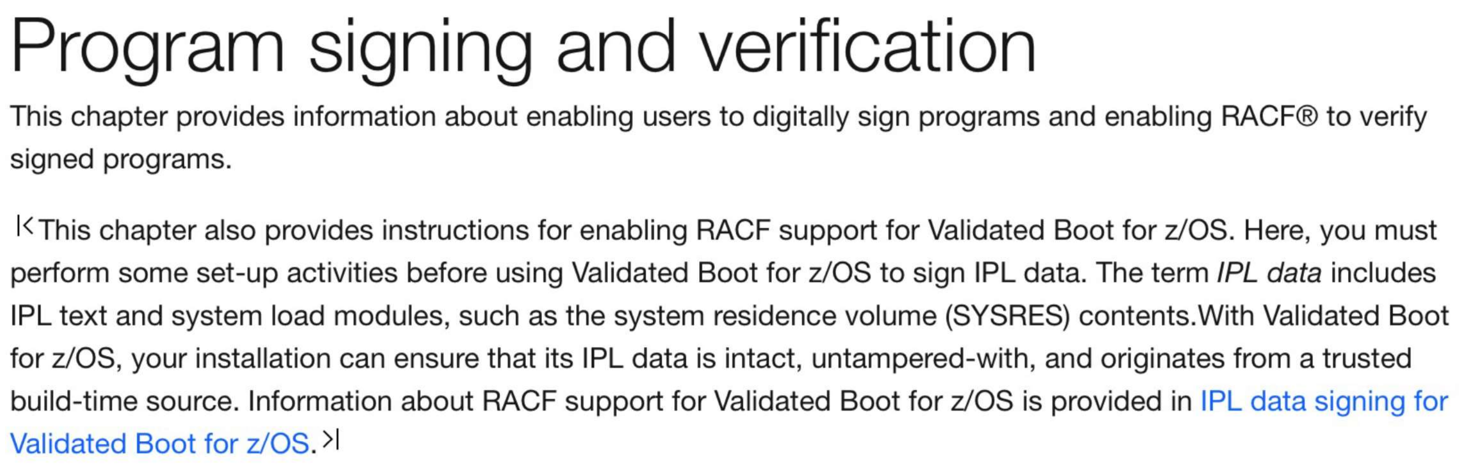
Where/what are certificates used for?



Adobe Acrobat Reader Installer

Verified publisher: Adobe Inc.
File origin: Downloaded from the Internet

Show more details

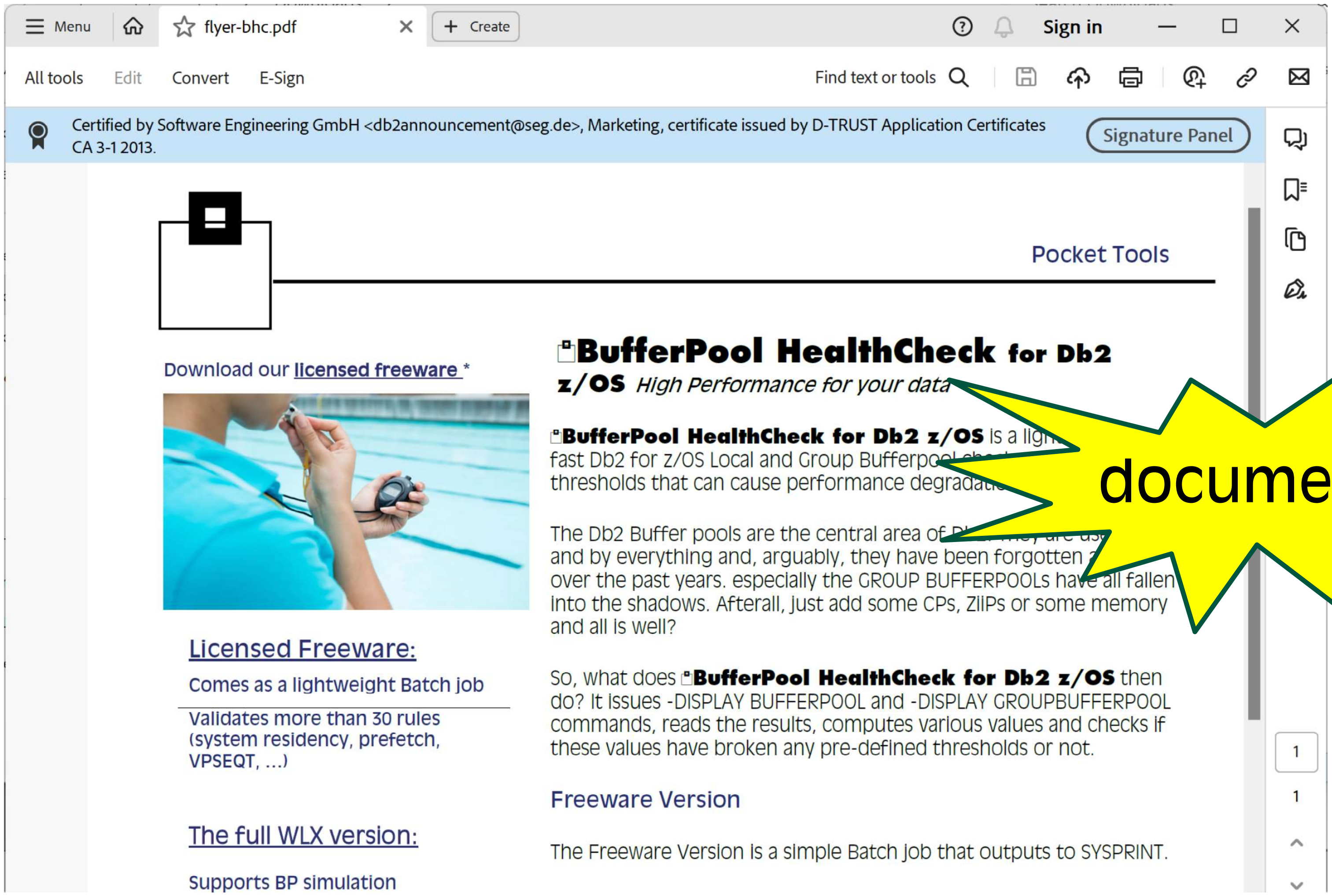


Program signing and verification

This chapter provides information about enabling users to digitally sign programs and enabling RACF® to verify signed programs.

|<This chapter also provides instructions for enabling RACF support for Validated Boot for z/OS. Here, you must perform some set-up activities before using Validated Boot for z/OS to sign IPL data. The term *IPL data* includes IPL text and system load modules, such as the system residence volume (SYSRES) contents.With Validated Boot for z/OS, your installation can ensure that its IPL data is intact, untampered-with, and originates from a trusted build-time source. Information about RACF support for Validated Boot for z/OS is provided in IPL data signing for Validated Boot for z/OS.>|

Where/what are certificates used for?



Certified by Software Engineering GmbH <db2announcement@seg.de>, Marketing, certificate issued by D-TRUST Application Certificates CA 3-1 2013.

Pocket Tools

Download our licensed freeware *

Licensed Freeware:

Comes as a lightweight Batch job

Validates more than 30 rules (system residency, prefetch, VPSEQT, …)

The full WLX version:

Supports BP simulation

BufferPool HealthCheck for Db2 z/OS *High Performance for your data*

BufferPool HealthCheck for Db2 z/OS is a ligh… fast Db2 for z/OS Local and Group Bufferpool che… thresholds that can cause performance degradati…

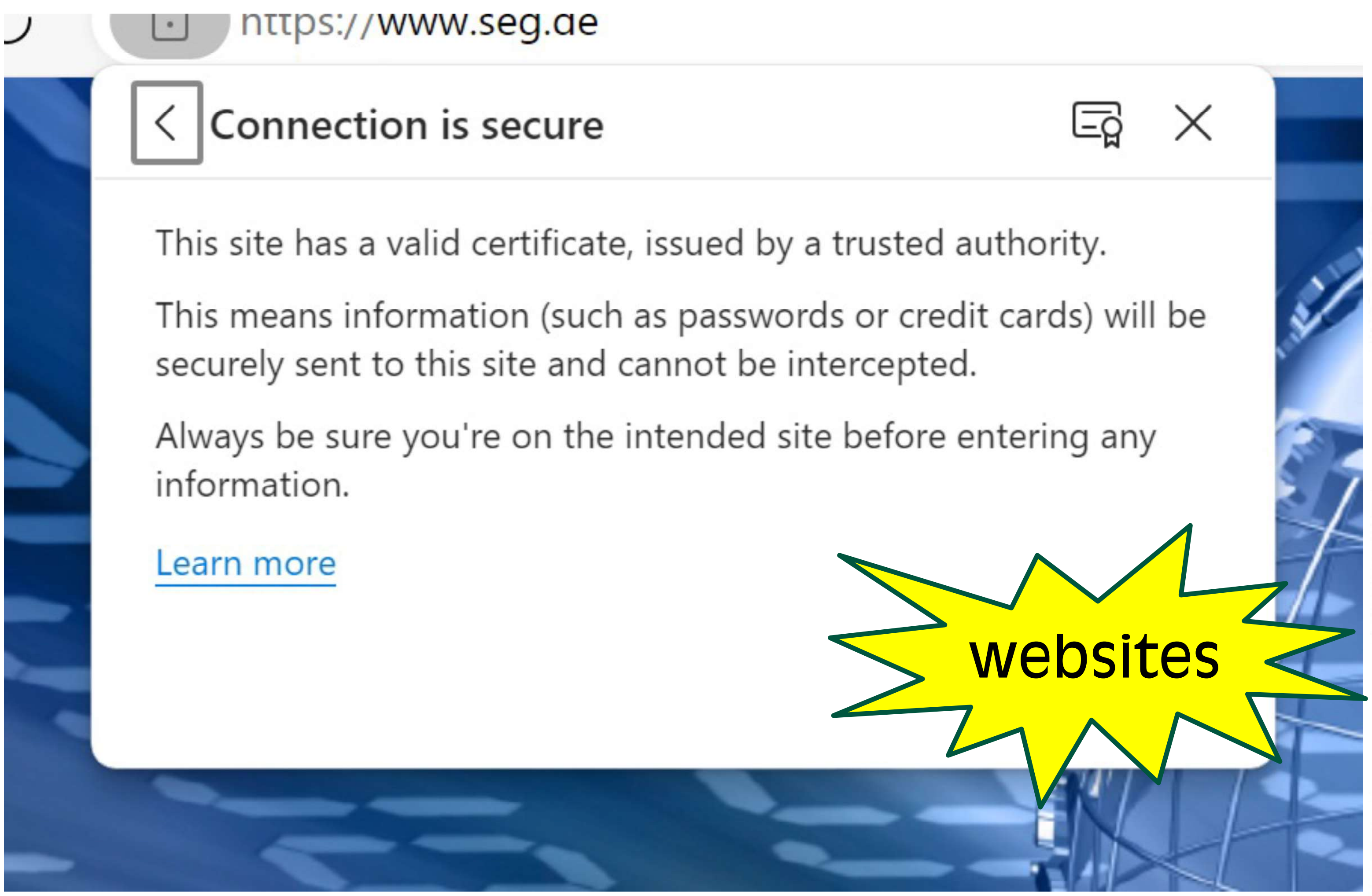
The Db2 Buffer pools are the central area of D… and by everything and, arguably, they have been forgotten … over the past years. especially the GROUP BUFFERPOOLs have all fallen into the shadows. Afterall, just add some CPs, zIIPs or some memory and all is well?

So, what does **BufferPool HealthCheck for Db2 z/OS** then do? It issues -DISPLAY BUFFERPOOL and -DISPLAY GROUPBUFFERPOOL commands, reads the results, computes various values and checks if these values have broken any pre-defined thresholds or not.

Freeware Version

The Freeware Version is a simple Batch job that outputs to SYSPRINT.

Where/what are certificates used for?



https://www.seg.de

Connection is secure

This site has a valid certificate, issued by a trusted authority.

This means information (such as passwords or credit cards) will be securely sent to this site and cannot be intercepted.

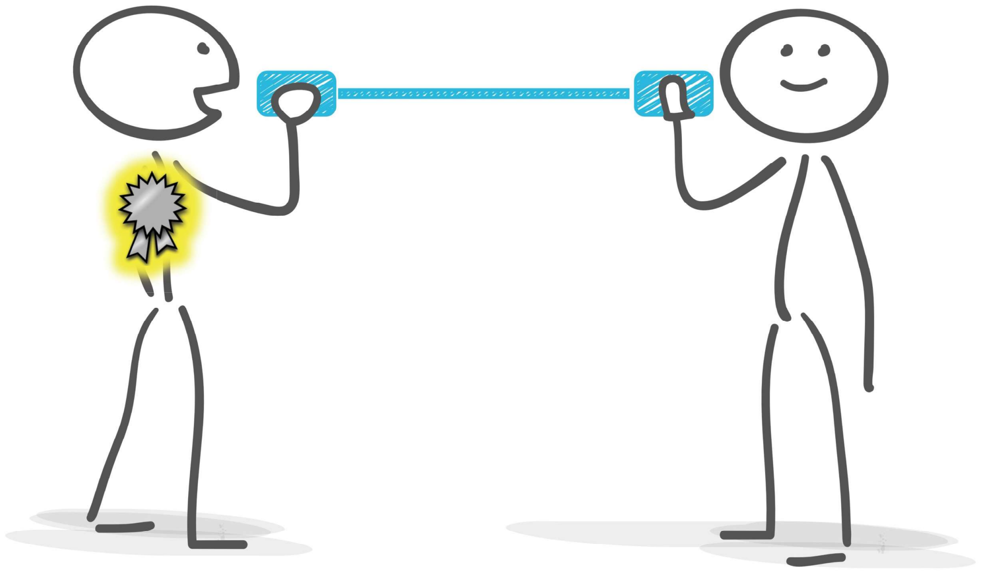
Always be sure you're on the intended site before entering any information.

Learn more

Where/what are certificates used for?

The technology is always the same, but today we focus on secure client – server communication:

1. Assure that a subject is really the one it supposes to be.
2. Assure that the information exchanged isn‘t manipulated.
3. Assure that the communication is treated confidentially.



How is it used/realized?

Let’s have a closer look at secure client – server communication:

- A standardized process,…
  - 1987 Secure Data Network System (SDNS) project initiated
  - 1996 using SSL 3.0 under governance of the IETF to develop internet-standards
  - since 1999 continuously enhanced as transport layer security (TLS)
- … that anybody understand/supports
  - Any current client (e.g. browser, desktop, smartphone) and server (e.g. mail, web, database) supports secure communication via the X.509 based mechanisms
    - TLS handshake
    - TLS record

How is it used/realized?

Secure client – server communication starts with a secure connection request, (e.g. http**s**, ftp**s**, …) and often requires to specify a secure port:

https://s0w1.dus.seg.de:**10443**/zosmf

1. Connection request from a client to a server
2. Server replies with its certificate
3. Verification of the replying server and its trustworthiness by the client
4. Connection dependent handshake of the encryption between client and server

Optionally: Certificate authentication of the client
Verification of the client by the server

5. Start encrypted communication

How is it used/realized?

After we've received the certificate (including a key) from a server how is the information verified to guarantee its identity?

- **A certificate alone does not guarantee the identity shown, nor its trustworthiness!**
  - An identity can only be proved by a trusted entity
  - Trustworthiness can only be judged by the communication partner

- So, how can a client know if the communication partner is safe and trustworthy?
  1. Either the provided certificate is individually categorized trustworthy,
  2. or a superior certificate authority (CA) is trusted that confirms the identity shown (certificate chain)

This is the major concept used throughout X.509-based TLS.

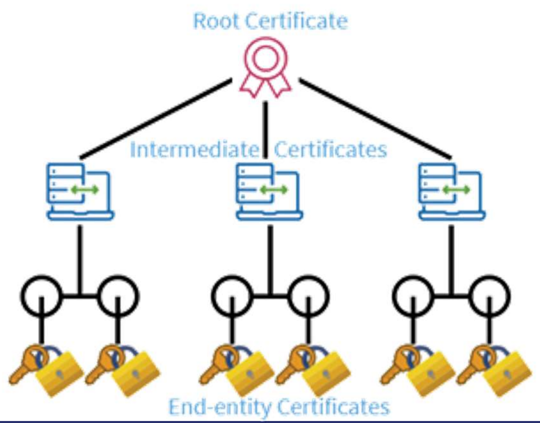
How is it used/realized?

Who is a *superior certificate authority* (CA)?

- Higher instance in a certificate chain of trust (intermediate, or root)
  - Reputable, commonly trusted organizations*
    - May assign limited duties to external identity authorities
  - Companies usually have an "internal" CA to simplify certificate management
- Validates the content of a certificate (signing request - CSR) and can issue/revoke certificates inheriting trustworthiness

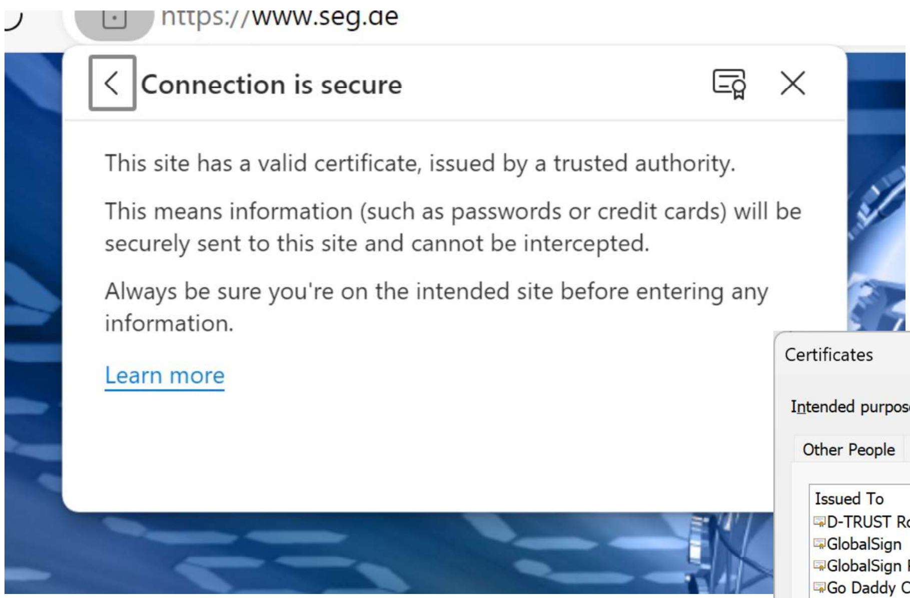
  → **Certificates signed by a trusted CA are automatically trusted!**

*The Certification Authority Browser Forum (CA/Browser Forum) is a voluntary gathering of certificate Issuers and suppliers of internet browser software and other applications that use certificates.



How is it used/realized?

Who is a *superior certificate authority* (CA)?



https://www.seg.de

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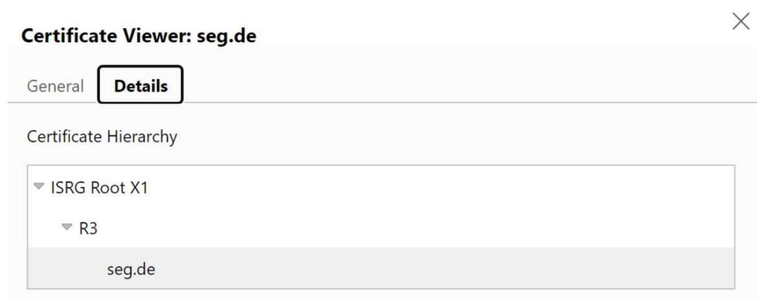
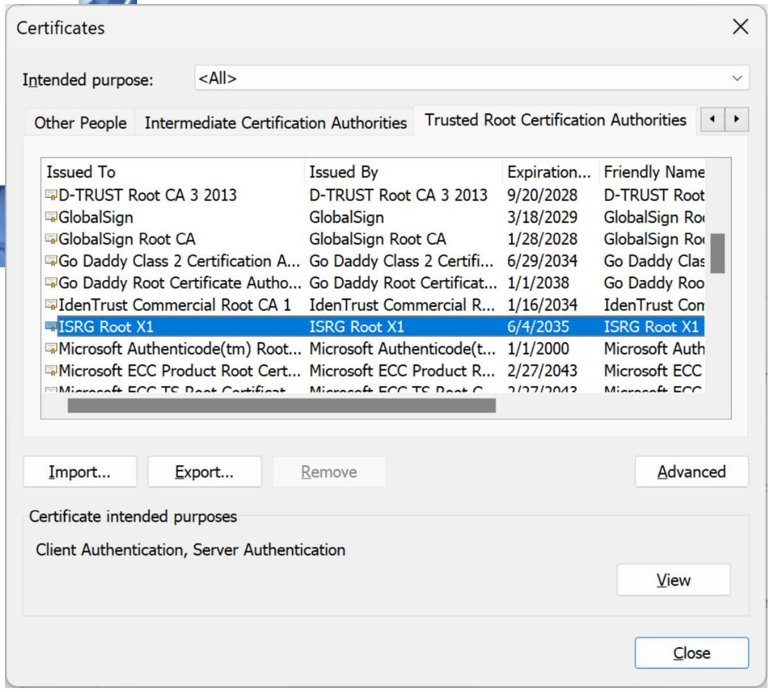


Certificate Viewer: seg.de

General | **Details**

Certificate Hierarchy

- ISRG Root X1
  - R3
    - seg.de



Certificates

Intended purpose: <All>

Other People | Intermediate Certification Authorities | Trusted Root Certification Authorities

Issued To	Issued By	Expiration...	Friendly Name
D-TRUST Root CA 3 2013	D-TRUST Root CA 3 2013	9/20/2028	D-TRUST Root
GlobalSign	GlobalSign	3/18/2029	GlobalSign Ro
GlobalSign Root CA	GlobalSign Root CA	1/28/2028	GlobalSign Ro
Go Daddy Class 2 Certification A...	Go Daddy Class 2 Certifi...	6/29/2034	Go Daddy Clas
Go Daddy Root Certificate Autho...	Go Daddy Root Certificat...	1/1/2038	Go Daddy Roo
IdenTrust Commercial Root CA 1	IdenTrust Commercial R...	1/16/2034	IdenTrust Con
ISRG Root X1	ISRG Root X1	6/4/2035	ISRG Root X1
Microsoft Authenticode(tm) Root...	Microsoft Authenticode(t...	1/1/2000	Microsoft Auth
Microsoft ECC Product Root Cert...	Microsoft ECC Product R...	2/27/2043	Microsoft ECC
Microsoft ECC TS Root Certificat...	Microsoft ECC TS Root C...	2/27/2043	Microsoft ECC

Import... | Export... | Remove | Advanced

Certificate intended purposes

Client Authentication, Server Authentication

View

Close

How is it used/realized?

Besides the verification of an identity we want to initiate the secure connection, but

- Client and server may not know each others yet
- Communicating securely requires that both parties are able to encrypt and to decrypt the information sent/received

BUT:

- Without a common (symmetric) encryption key, no encryption!
- If they'd negotiate a key to start encryption, it would need to be unencrypted and someone else on the network could use a network sniffer, steal the key and compromise the encryption

The solution:

→ Client and server negotiate the symmetric encryption key using asymmetric encryption

How is it used/realized?

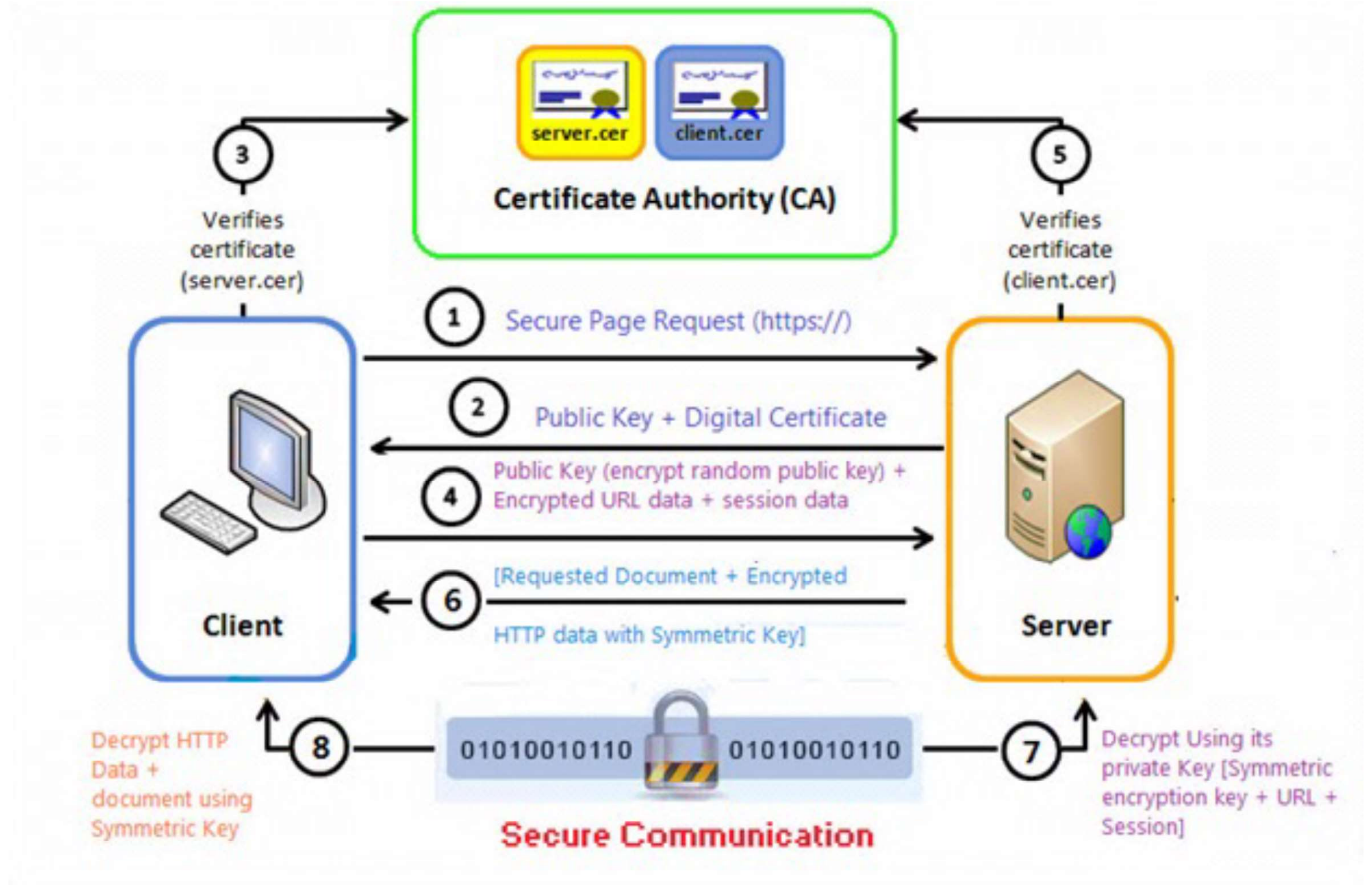
- TLS encryption is based on X.509 certificates that identify the owner and provide the public key from a public/private key pair
- The public key coming with this certificate can be used to initiate asymmetric encrypted communication
  - Therefore, the *public* key provided along with the certificate at connection request is used by the recipient to check integrity and create and return an encrypted pre-master-key
  - The encrypted pre-master-key can only be decrypted with the appropriate *private* key, which is then used for the further encryption

  → Public key can encrypt, but only private key can decrypt (asymmetric encryption)
- Due to the fact that the private key should never ever be accessible by someone else but the owner, certificates are typically generated manually by the owner, or as part of an installation by the owner (like ZOWE does):
  - E.g.:

```
openssl req -x509 -newkey rsa:4096 -keyout key.pem
out cert.pem OR certsigreq.csr -days 365
```

How is it used/realized?

TLS overview:


server.cer
client.cer
Certificate Authority (CA)
3
Verifies certificate (server.cer)
5
Verifies certificate (client.cer)
1
Secure Page Request (https://)
2
Public Key + Digital Certificate
4
Public Key (encrypt random public key) + Encrypted URL data + session data
6
[Requested Document + Encrypted HTTP data with Symmetric Key]
Client
Server
8
Decrypt HTTP Data + document using Symmetric Key
01010010110
01010010110
7
Decrypt Using its private Key [Symmetric encryption key + URL + Session]
Secure Communication

How is it used/realized?

z/OSMF, ZOWE and Db2 work exactly this way:

1. Connection request against z/OSMF, ZOWE, Db2 (secure port!)
2. Reply by z/OSMF, ZOWE, Db2 with its certificate (incl. certificate chain with a certificate authority if applicable)
3. Trustworthiness verification of the certificate, resp. of the root/intermediate certificate authority
4. Generation and return of the pre-master-key by the client using the servers public key
5. Generation of the encryption of an individual connection and start of the encrypted communication
   - Manipulation can be detected by an individual message authentication code

Real examples from the ZOWE ecosystem

- The standardized certificate based on TLS is used
- Certificates are managed either in a KEYSTORE/TRUSTSTORE, or…
  - https://docs.zowe.org/stable/user-guide/configure-certificates-keystore
- by RACF KEYRINGs
  - https://docs.zowe.org/stable/user-guide/configure-certificates-keyring

- More detailed information about certificate generation/management for application development extending ZOWE is available at
  - https://docs.zowe.org/stable/extend/extend-apiml/onboard-plain-java-enabler/#api-security

Reminder: It‘s all about trustworthiness!

Real examples from the ZOWE ecosystem

- The certificate store is specified in the ZOWE configuration (zowe.yaml, formerly instance.env), as a java keystore/truststore, or…

```
certificate:
  keystore:
    type: PKCS12
    file: /zowe/keystore/localhost/localhost.keystore.p12
    password: password
    alias: localhost
  truststore:
    type: PKCS12
    file: /zowe/keystore/localhost/localhost.truststore.p12
    password: password
pem:
    key: /zowe/keystore/localhost/localhost.key
    certificate: /zowe/keystore/localhost/localhost.cer
    certificateAuthorities: /zowe/keystore/local_ca/local_ca.cer
verifyCertificates: STRICT
```

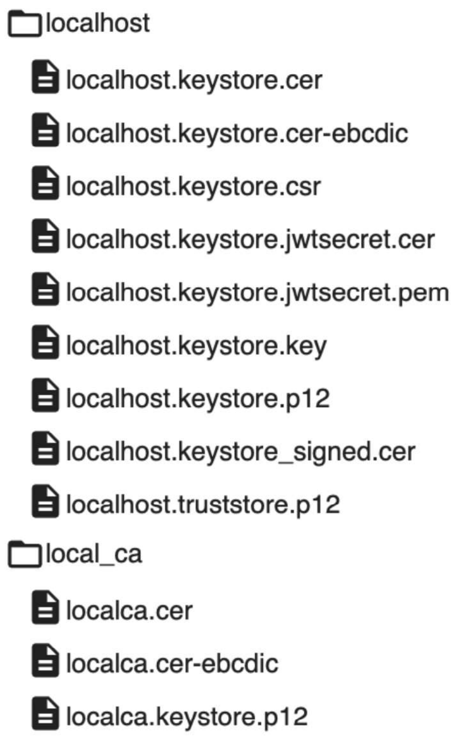
Real examples from the ZOWE ecosystem

- … as a RACF keyring

```
certificate:
  keystore:
    type: "JCERACFKS"
    file: "safkeyring:////ZWESVUSR/ZOWEKEYS"
    password: "password"
    alias: "ZWESRV"
  truststore:
    type: "JCERACFKS"
    file: "safkeyring:////ZWESVUSR/ZOWEKEYS"
    password: "password"
  pem:
    key: ""
    certificate: ""
    certificateAuthorities:
"safkeyring:////ZWESVUSR/ZOWEKEYS&SEGROOTCA"
verifyCertificates: "STRICT"
```

Real examples from the ZOWE ecosystem

- KEYSTORE:
  - Stores its own certificate
- TRUSTSTORE
  - Stores trusted certificates



localhost
- localhost.keystore.cer
- localhost.keystore.cer-ebcdic
- localhost.keystore.csr
- localhost.keystore.jwtsecret.cer
- localhost.keystore.jwtsecret.pem
- localhost.keystore.key
- localhost.keystore.p12
- localhost.keystore_signed.cer
- localhost.truststore.p12

local_ca
- localca.cer
- localca.cer-ebcdic
- localca.keystore.p12

- RACF KEYRING
  - Stores both

```
Ring:
ZOWEKEYS

Certificate Label Name              Cert Owner   USAGE     DEFAULT
--------------------------------    -----------  --------  --------
SEGROOTCA                           CERTAUTH     CERTAUTH  NO
ZWESRV                              ID(ZWESVUSR) PERSONAL  YES
```

Real examples from UMS and z/OSMF

- IBM Unified Management Server uses ZOWE's keystore/truststore/keyring by default, unless you specify something else in UMS's parmlib member

```
   certificate:
          allowSelfSigned: true
          truststore:
            location: "safkeyring:////ZWESVUSR/IZPRING"
            type: "JCERACFKS"
          keystore:
            location: "safkeyring:////ZWESVUSR/IZPRING"
            type: "JCERACFKS"
            alias: "UMSSRV"
```

- For z/OSMF you can specify the RACF keyring in the IZU PARMLIB member

```
  (…)
 KEYRING_NAME('ZOSMFKEYS')
  (…)
```

Real examples from SQLDI and Db2

- For SQL Data Insights you are prompted to specify the RACF keyring when running the installation script sqldi.sh

```
Enter your keystore information > SQLDIID.SQLDIKEYRING
```

- For Db2 you have to configure the TLS setup via PAGENT

```
TTLSRule DD10SecureServer
{ LocalPortRange 15151
  JobName DD10DIST
  Direction Inbound
  TTLSGroupActionRef DD10SecureGrpAct
  TTLSEnvironmentActionRef DD10SecureEnvAct
  TTLSConnectionActionRef  DD10SvrAuthConn
}
TTLSGroupAction DD10SecureGrpAct
{ TTLSEnabled On
  Trace 15
}
TTLSEnvironmentAction DD10SecureEnvAct
{ TTLSKeyRingParms
  {     Keyring SEGDB2KEYRING
  }
  (…)
```

Managing certificates in USS and z/OS

How to manage keystores, truststores, keyrings?

- A keystore/truststore can be managed using the keytool

```
>keytool
Key and Certificate Management Tool
Commands:
 -certreq             Generates a certificate request
 -changealias         Changes an entry's alias
 -delete              Deletes an entry
 -exportcert          Exports certificate
 -exportseckey        Export a batch of secret keys
 -genkeypair          Generates a key pair
 -genseckey           Generates a secret key
 -gencert             Generates certificate from a certificate request
 -importcert          Imports a certificate or a certificate chain
 -importpass          Imports a password
 -importkeystore      Imports one or all entries from another keystore
 -importseckey        Import a batch of secret keys
 -keypasswd           Changes the key password of an entry
 -list                Lists entries in a keystore
 -printcert           Prints the content of a certificate
 -printcertreq        Prints the content of a certificate request
 -printcrl            Prints the content of a CRL file
 -storepasswd         Changes the store password of a keystore
```

Managing certificates in USS and z/OS

How to manage keystores, truststores, keyrings?

- A keyring can be managed using RACF
  - Services option menu

```
                          RACF - SERVICES OPTION MENU
OPTION ===>
SELECT ONE OF THE FOLLOWING:
   1  DATA SET PROFILES
   2  GENERAL RESOURCE PROFILES
   3  GROUP PROFILES AND USER-TO-GROUP CONNECTIONS
   4  USER PROFILES AND YOUR OWN PASSWORD
   5  SYSTEM OPTIONS
   6  REMOTE SHARING FACILITY
   7  DIGITAL CERTIFICATES, KEY RINGS, AND TOKENS
  99  EXIT
```

  - RACDCERT (Manage RACF digital certificates)

    “Use the RACDCERT command to install and maintain digital certificates, key rings, and digital certificate mappings in RACF."

Managing certificates in USS and z/OS

- Using KEYSTORE/TRUSTSTORE with self-signed certificates might be ok for testing,
  - 👍 Easy setup without additional RACF
  - 👍 Unix/USS OPENSSL and KEYTOOL usage as usual
  - 👎 Has to be trusted by the ZOWE user
  - 👎 No centralized certificate management

- but at the end, a RACF KEYRING with company CA-signed certificates is a better choice
  - 👍 Centralized z/OS/USS certificate management
  - 👍 Implicitly trusted for all employers
  - 👎 Requires RACDCERT knowledge and authorization
  - 👎 Some (Db2) require additional PAGENT definition

Managing certificates in USS and z/OS

RACDCERT example of a certificate + company CA

1. Create a company CA to make any of your certificates trustworthy

```
//GENCACRT EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD DDNAME=RACF
//RACF     DD DATA,DLM=$$,SYMBOLS=JCLONLY
   RACDCERT GENCERT CERTAUTH +
            SUBJECTSDN( +
              CN('SOFTWARE ENGINEERING ROOT CA') +
              OU('DEVELOPMENT') +
              O('SOFTWARE ENGINEERING GMBH') +
              L('DUESSELDORF') +
              SP('NORTH RHINE WESTPHALIA') +
              C('DE')) +
            SIZE(2048) +
            NOTAFTER(DATE(2033-01-07)) +
            WITHLABEL('SEGROOTCA') +
            KEYUSAGE(CERTSIGN)
$$
```

Managing certificates in USS and z/OS

RACDCERT example of a certificate + company CA

2. Create a certificate signed with the CA created before

```
//GENSVCRT EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD DDNAME=RACF
//RACF     DD DATA,DLM=$$,SYMBOLS=JCLONLY
   RACDCERT GENCERT ID(IZUSVR1) +
            SUBJECTSDN( +
              CN('ZOSMF MANAGEMENT SERVICE') +
              OU('DEVELOPMENT') +
              O('SOFTWARE ENGINEERING GMBH') +
              L('DUESSELDORF') +
              SP('NORTH RHINE WESTPHALIA') +
              C('DE')) +
            SIZE(2048) +
            NOTAFTER(DATE(2025-04-02)) +
            WITHLABEL('IZUSRV') +
            KEYUSAGE(HANDSHAKE) +
            ALTNAME(IP(192.168.9.98) +
                DOMAIN('S0W1.DUS.SEG.DE')) +
            SIGNWITH(CERTAUTH LABEL('SEGROOTCA'))
$$
```

Managing certificates in USS and z/OS

RACDCERT example of a certificate + company CA

3. Create a keyring for the certificates created

```
//GENSVCRT EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD DDNAME=RACF
//RACF     DD DATA,DLM=$$,SYMBOLS=JCLONLY
   RACDCERT ADDRING(ZOSMFKEYS) ID(IZUSVR1)
   SETROPTS RACLIST(DIGTRING) REFRESH
$$
```

Managing certificates in USS and z/OS

RACDCERT example of a certificate + company CA

4. Add the certificates created to the keyring created

```
//GENSVCRT EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD DDNAME=RACF
//RACF     DD DATA,DLM=$$,SYMBOLS=JCLONLY
   RACDCERT CONNECT(CERTAUTH LABEL('SEGROOTCA') +
            RING(ZOSMFKEYS)) +
            ID(IZUSVR1)
   RACDCERT CONNECT(ID(IZUSVR1) +
            LABEL('IZUSRV') +
            RING(ZOSMFKEYS) +
            USAGE(PERSONAL) DEFAULT) +
            ID(IZUSVR1)
$$
```

Managing certificates in USS and z/OS

RACDCERT example of a certificate + company CA

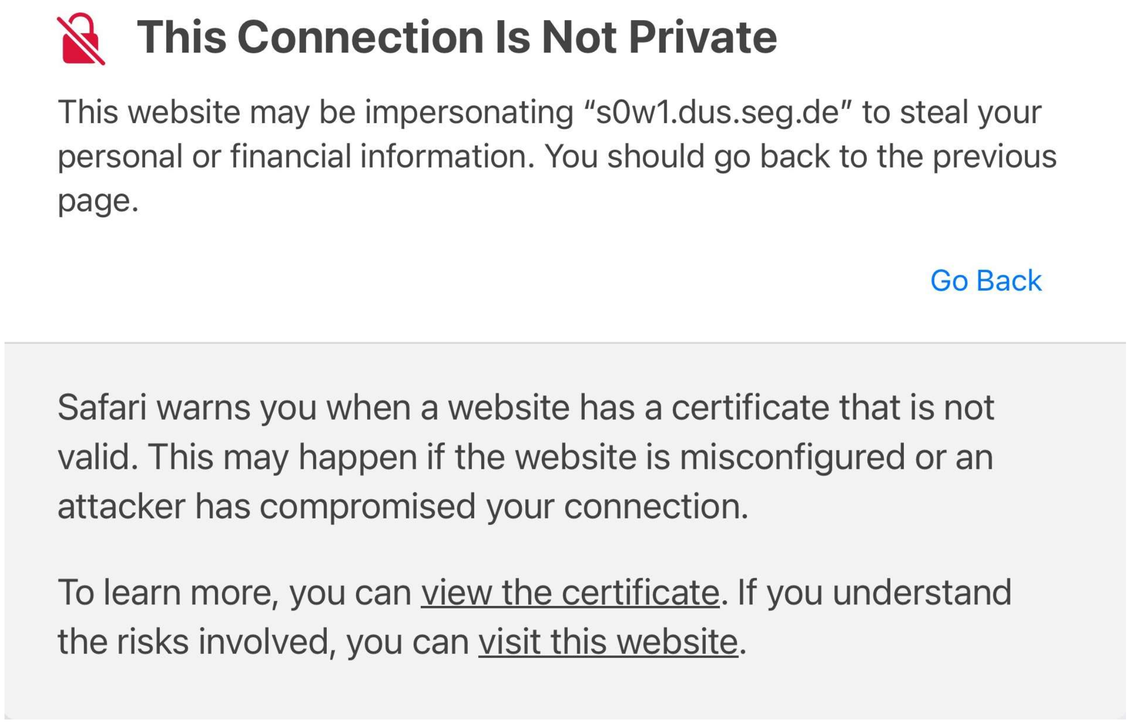
5. **Permit access to the keyring created**

```
//GENSVCRT EXEC PGM=IKJEFT01,REGION=0M
//SYSTSPRT DD SYSOUT=*
//SYSTSIN  DD DDNAME=RACF
//RACF     DD DATA,DLM=$$,SYMBOLS=JCLONLY
   RDEFINE RDATALIB IZUSVR1.ZOSMFKEYS.LST UACC(NONE)
   PERMIT IZUSVR1.ZOSMFKEYS.LST CLASS(RDATALIB) ID(IZUSVR1) +
          ACCESS(CONTROL)
/* Uncomment this command to allow other user to access key ring ... */
/* PERMIT IZUSVR1.ZOSMFKEYS.LST CLASS(RDATALIB) ID(<USER>) +         */
/*        ACCESS(READ)                                               */
   SETROPTS RACLIST(RDATALIB) REFRESH

   PERMIT IRR.DIGTCERT.LISTRING CLASS(FACILITY) ID(IZUSVR1) +
          ACCESS(READ)
   PERMIT IRR.DIGTCERT.LIST CLASS(FACILITY) ID(IZUSVR1) +
          ACCESS(READ)
   SETROPTS RACLIST(FACILITY) REFRESH
$$
```

Analyzing certificate issues

Trustworthy or not, that's the question!



This Connection Is Not Private

This website may be impersonating “s0w1.dus.seg.de” to steal your personal or financial information. You should go back to the previous page.

Safari warns you when a website has a certificate that is not valid. This may happen if the website is misconfigured or an attacker has compromised your connection.

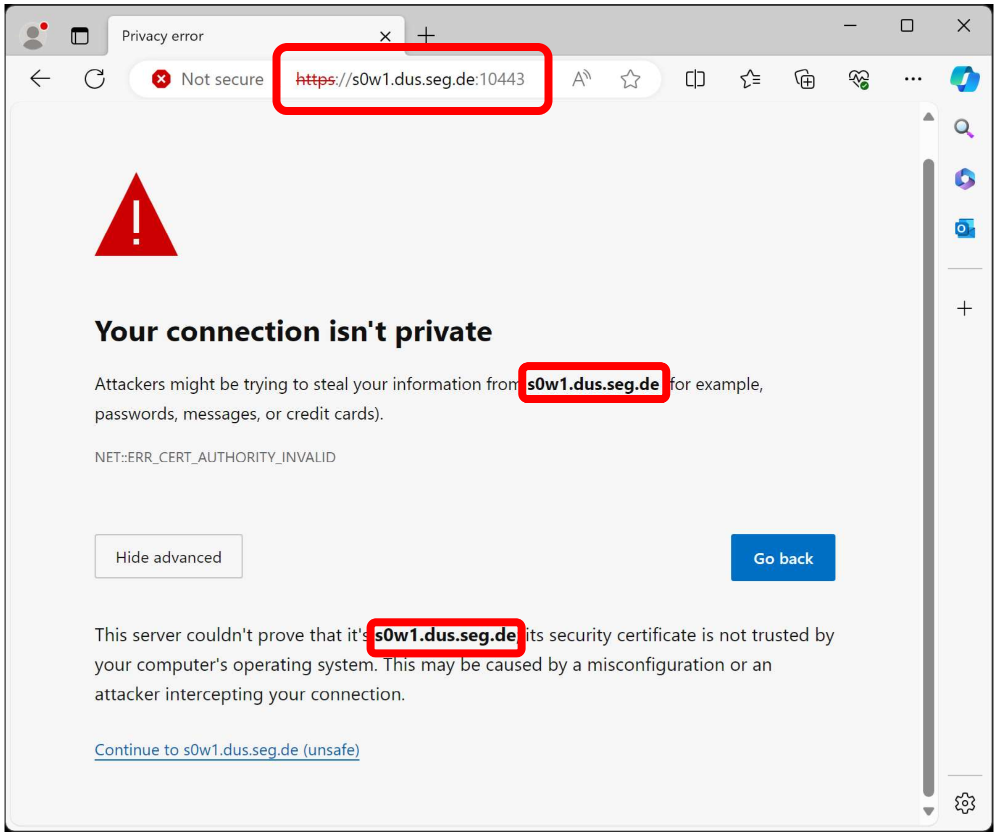
To learn more, you can view the certificate. If you understand the risks involved, you can visit this website.

How to fix this???

Analyzing certificate issues

Trustworthy or not, that's the question!

1. Make sure the host, or IP is correct!



Your connection isn't private

Attackers might be trying to steal your information from **s0w1.dus.seg.de** (for example, passwords, messages, or credit cards).

NET::ERR_CERT_AUTHORITY_INVALID

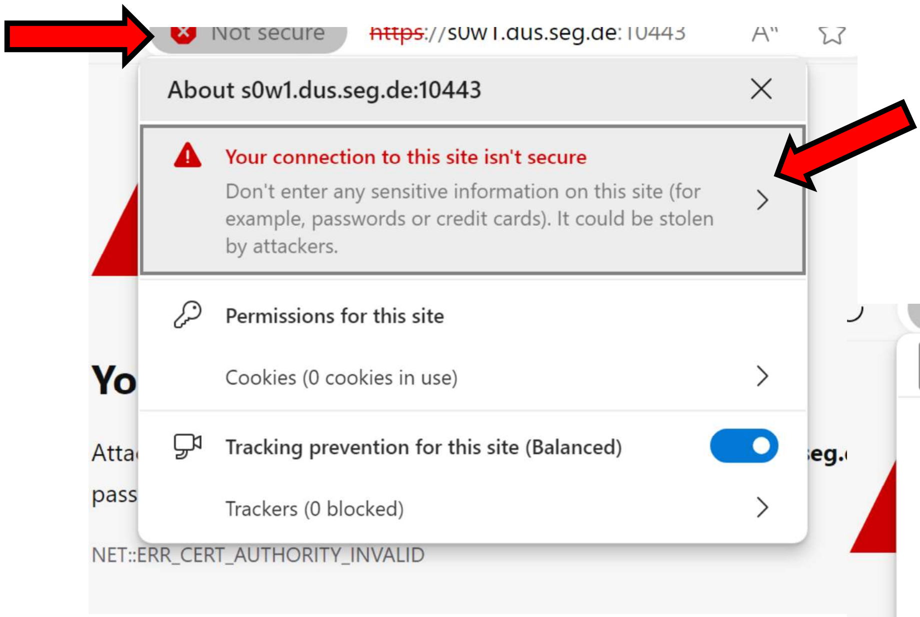
This server couldn't prove that it's **s0w1.dus.seg.de**; its security certificate is not trusted by your computer's operating system. This may be caused by a misconfiguration or an attacker intercepting your connection.

Continue to s0w1.dus.seg.de (unsafe)

Analyzing certificate issues

Trustworthy or not, that's the question!

2. Verify the certificate



Not secure ~~https~~://s0w1.dus.seg.de:10443

About s0w1.dus.seg.de:10443

Your connection to this site isn't secure

Don't enter any sensitive information on this site (for example, passwords or credit cards). It could be stolen by attackers.

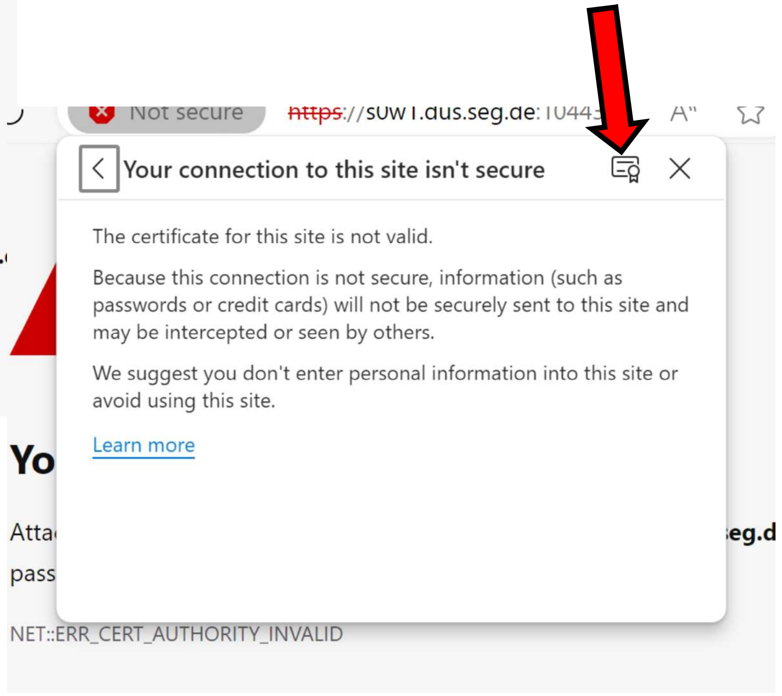
Permissions for this site

Cookies (0 cookies in use)

Tracking prevention for this site (Balanced)

Trackers (0 blocked)

NET::ERR_CERT_AUTHORITY_INVALID



Not secure ~~https~~://s0w1.dus.seg.de:10443

Your connection to this site isn't secure

The certificate for this site is not valid.

Because this connection is not secure, information (such as passwords or credit cards) will not be securely sent to this site and may be intercepted or seen by others.

We suggest you don't enter personal information into this site or avoid using this site.

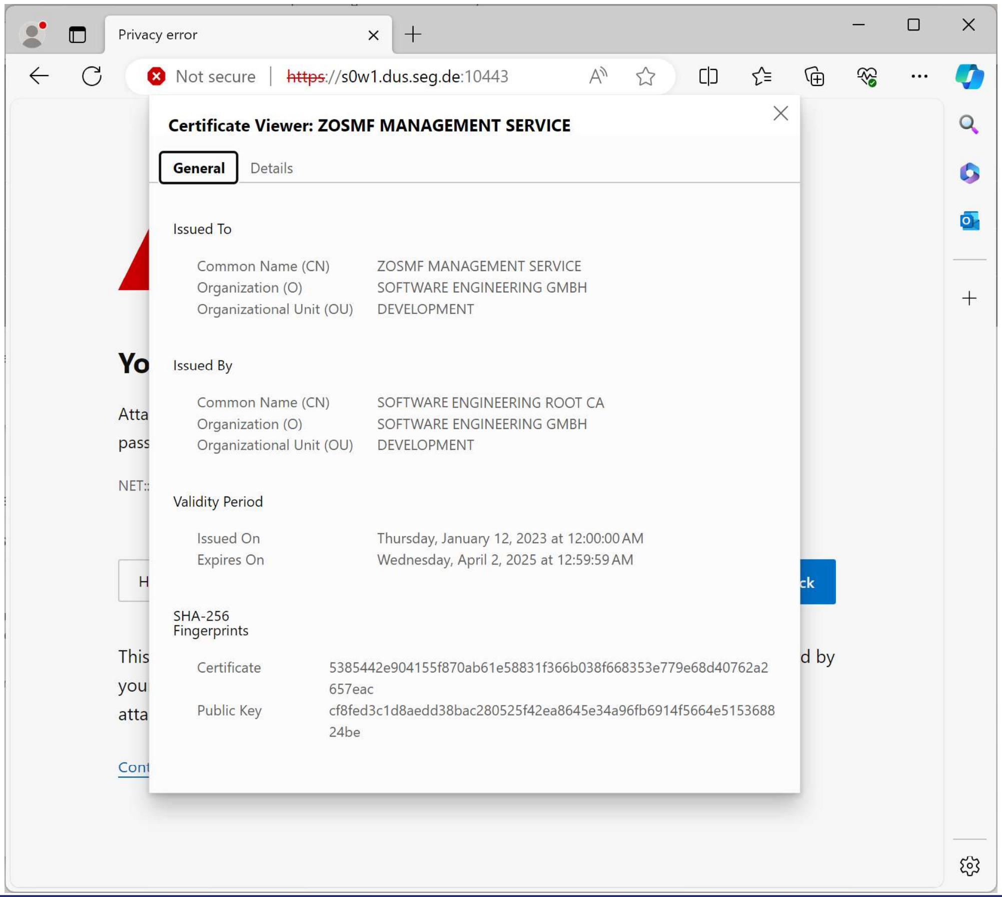
Learn more

NET::ERR_CERT_AUTHORITY_INVALID

Analyzing certificate issues

Trustworthy or not, that's the question!

2. Verify the certificate's content



Certificate Viewer: ZOSMF MANAGEMENT SERVICE

Issued To

Common Name (CN)	ZOSMF MANAGEMENT SERVICE
Organization (O)	SOFTWARE ENGINEERING GMBH
Organizational Unit (OU)	DEVELOPMENT

Issued By

Common Name (CN)	SOFTWARE ENGINEERING ROOT CA
Organization (O)	SOFTWARE ENGINEERING GMBH
Organizational Unit (OU)	DEVELOPMENT

Validity Period

Issued On	Thursday, January 12, 2023 at 12:00:00 AM
Expires On	Wednesday, April 2, 2025 at 12:59:59 AM

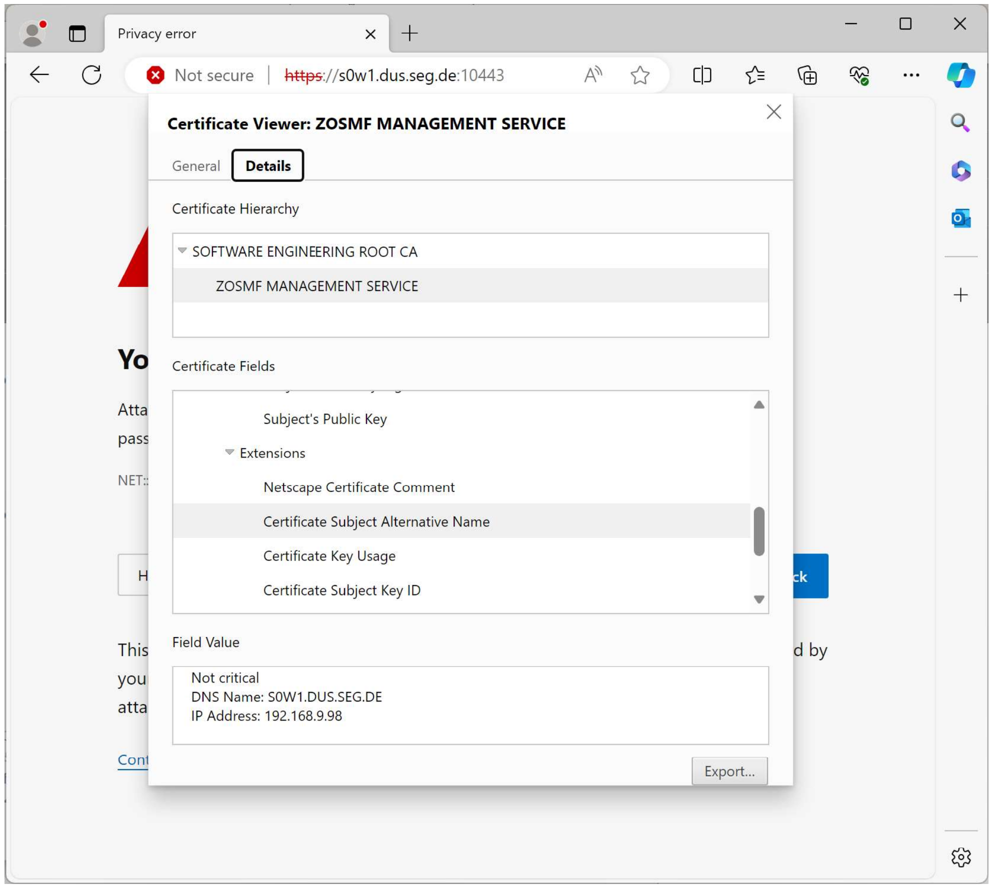
SHA-256 Fingerprints

Certificate	5385442e904155f870ab61e58831f366b038f668353e779e68d40762a2657eac
Public Key	cf8fed3c1d8aedd38bac280525f42ea8645e34a96fb6914f5664e515368824be

Analyzing certificate issues

Trustworthy or not, that's the question!

2. Verify the certificate's content



Privacy error

Not secure | https://s0w1.dus.seg.de:10443

Certificate Viewer: ZOSMF MANAGEMENT SERVICE

General **Details**

Certificate Hierarchy

- SOFTWARE ENGINEERING ROOT CA
  - ZOSMF MANAGEMENT SERVICE

Certificate Fields

- Subject's Public Key
- Extensions
  - Netscape Certificate Comment
  - Certificate Subject Alternative Name
  - Certificate Key Usage
  - Certificate Subject Key ID

Field Value

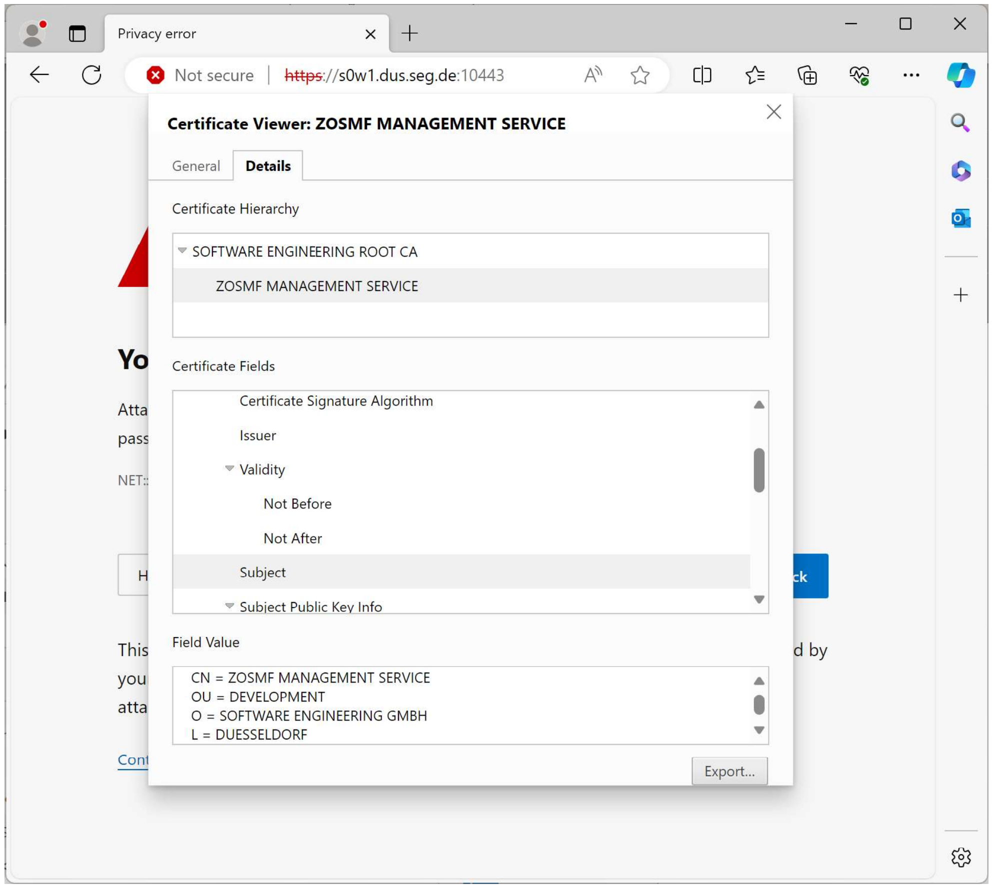
```
Not critical
DNS Name: S0W1.DUS.SEG.DE
IP Address: 192.168.9.98
```

Export...

Analyzing certificate issues

Trustworthy or not, that's the question!

2. Verify the certificate's content


Privacy error
Not secure
https://s0w1.dus.seg.de:10443
Certificate Viewer: ZOSMF MANAGEMENT SERVICE
General
Details
Export...

Certificate Hierarchy

- SOFTWARE ENGINEERING ROOT CA
  - ZOSMF MANAGEMENT SERVICE

Certificate Fields

- Certificate Signature Algorithm
- Issuer
- Validity
  - Not Before
  - Not After
- Subject
- Subject Public Key Info

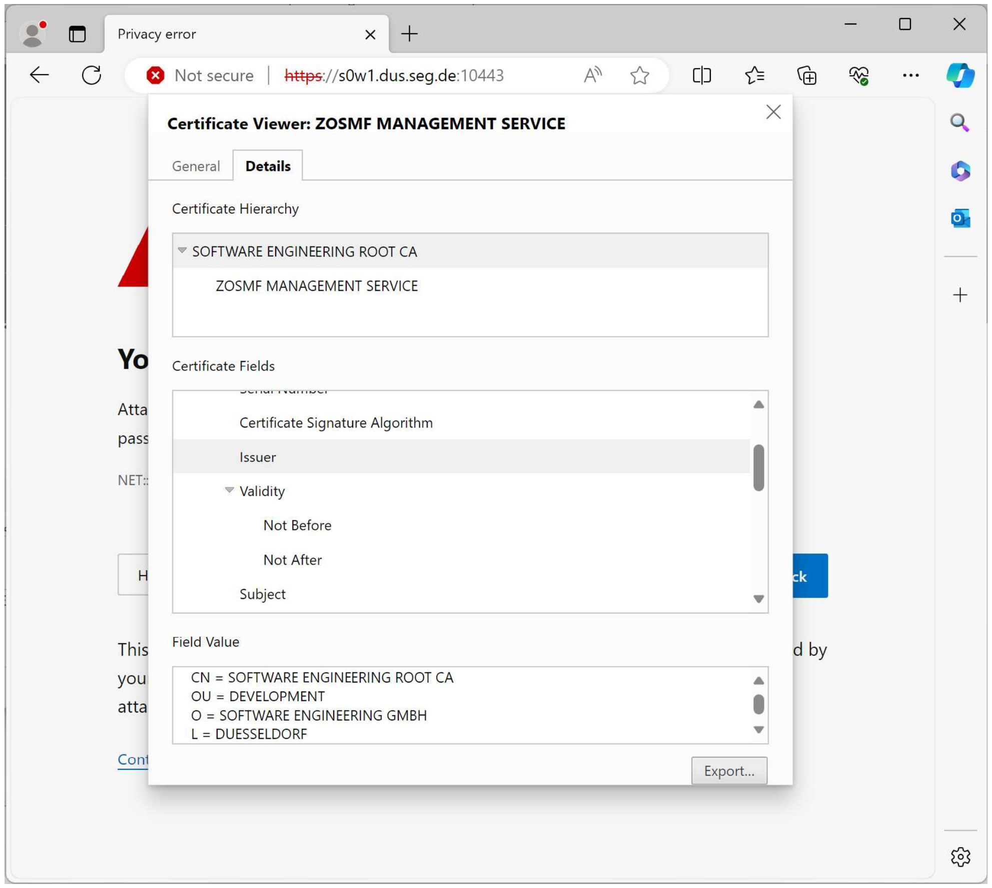
Field Value

```
CN = ZOSMF MANAGEMENT SERVICE
OU = DEVELOPMENT
O = SOFTWARE ENGINEERING GMBH
L = DUESSELDORF
```

Analyzing certificate issues

Trustworthy or not, that's the question!

2. Verify the certificate's content



Privacy error

Not secure | https://s0w1.dus.seg.de:10443

Certificate Viewer: ZOSMF MANAGEMENT SERVICE

General | **Details**

Certificate Hierarchy

- SOFTWARE ENGINEERING ROOT CA
  - ZOSMF MANAGEMENT SERVICE

Certificate Fields

- Certificate Signature Algorithm
- Issuer
- Validity
  - Not Before
  - Not After
- Subject

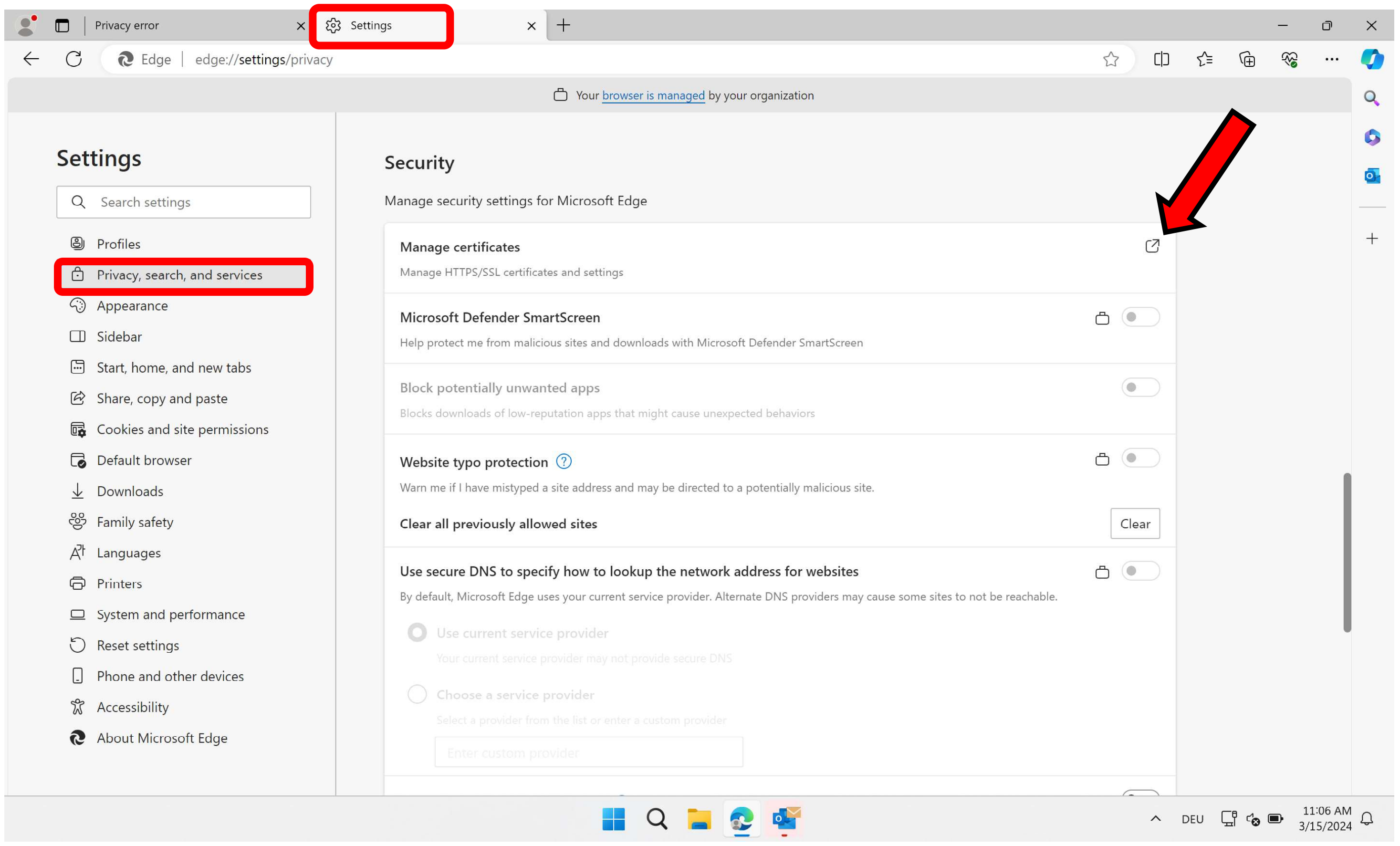
Field Value

```
CN = SOFTWARE ENGINEERING ROOT CA
OU = DEVELOPMENT
O = SOFTWARE ENGINEERING GMBH
L = DUESSELDORF
```

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted



Privacy error | Settings

edge://settings/privacy

Your browser is managed by your organization

Settings

- Profiles
- Privacy, search, and services
- Appearance
- Sidebar
- Start, home, and new tabs
- Share, copy and paste
- Cookies and site permissions
- Default browser
- Downloads
- Family safety
- Languages
- Printers
- System and performance
- Reset settings
- Phone and other devices
- Accessibility
- About Microsoft Edge

Security

Manage security settings for Microsoft Edge

Manage certificates
Manage HTTPS/SSL certificates and settings

Microsoft Defender SmartScreen
Help protect me from malicious sites and downloads with Microsoft Defender SmartScreen

Block potentially unwanted apps
Blocks downloads of low-reputation apps that might cause unexpected behaviors

Website typo protection
Warn me if I have mistyped a site address and may be directed to a potentially malicious site.

Clear all previously allowed sites — Clear

Use secure DNS to specify how to lookup the network address for websites
By default, Microsoft Edge uses your current service provider. Alternate DNS providers may cause some sites to not be reachable.

Use current service provider
Your current service provider may not provide secure DNS

Choose a service provider
Select a provider from the list or enter a custom provider

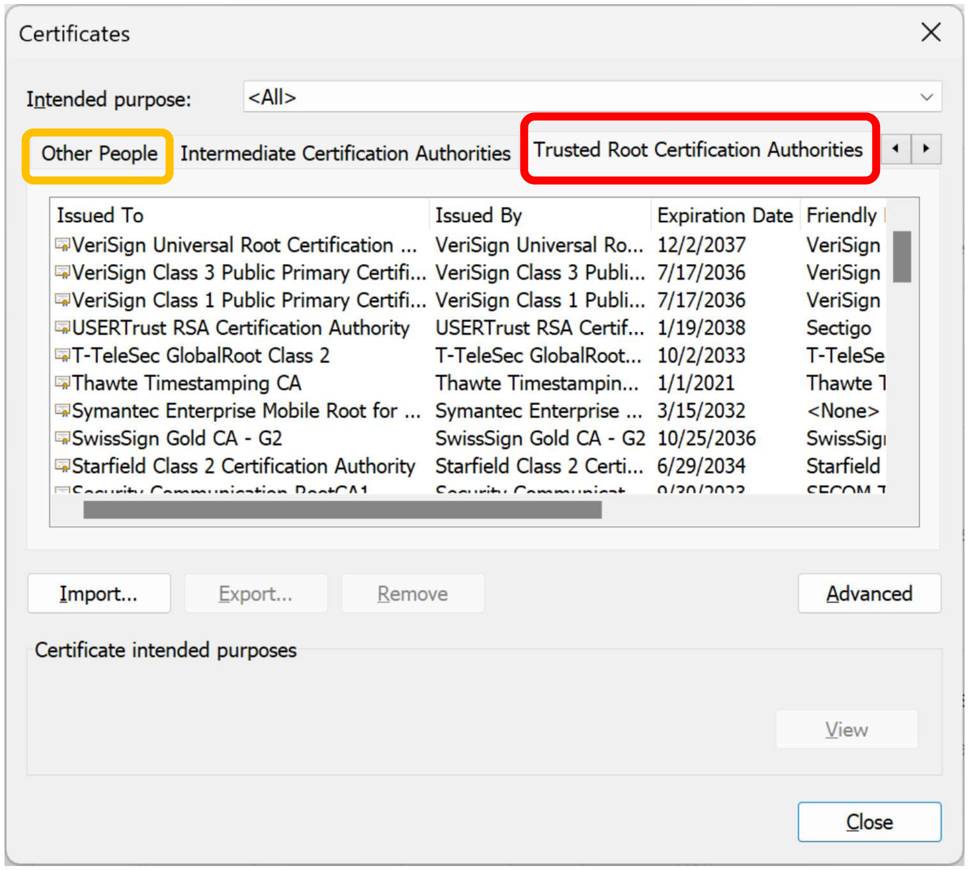
Enter custom provider

DEU 11:06 AM 3/15/2024

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted



Certificates

Intended purpose: <All>

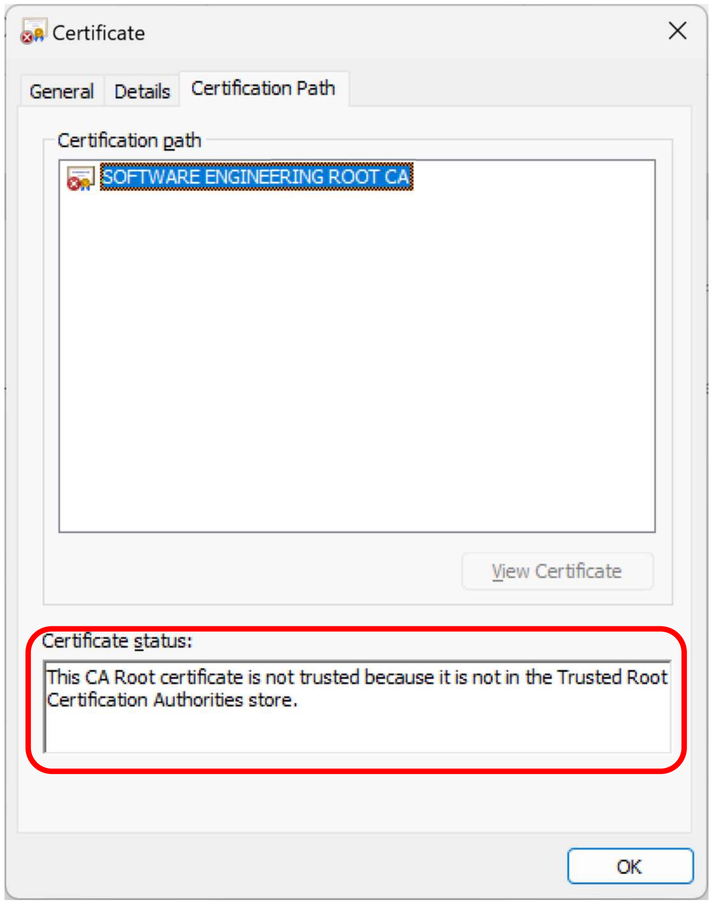
Other People | Intermediate Certification Authorities | Trusted Root Certification Authorities

Issued To	Issued By	Expiration Date	Friendly
VeriSign Universal Root Certification ...	VeriSign Universal Ro...	12/2/2037	VeriSign
VeriSign Class 3 Public Primary Certifi...	VeriSign Class 3 Publi...	7/17/2036	VeriSign
VeriSign Class 1 Public Primary Certifi...	VeriSign Class 1 Publi...	7/17/2036	VeriSign
USERTrust RSA Certification Authority	USERTrust RSA Certif...	1/19/2038	Sectigo
T-TeleSec GlobalRoot Class 2	T-TeleSec GlobalRoot...	10/2/2033	T-TeleSe
Thawte Timestamping CA	Thawte Timestampin...	1/1/2021	Thawte T
Symantec Enterprise Mobile Root for ...	Symantec Enterprise ...	3/15/2032	<None>
SwissSign Gold CA - G2	SwissSign Gold CA - G2	10/25/2036	SwissSig
Starfield Class 2 Certification Authority	Starfield Class 2 Certi...	6/29/2034	Starfield

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



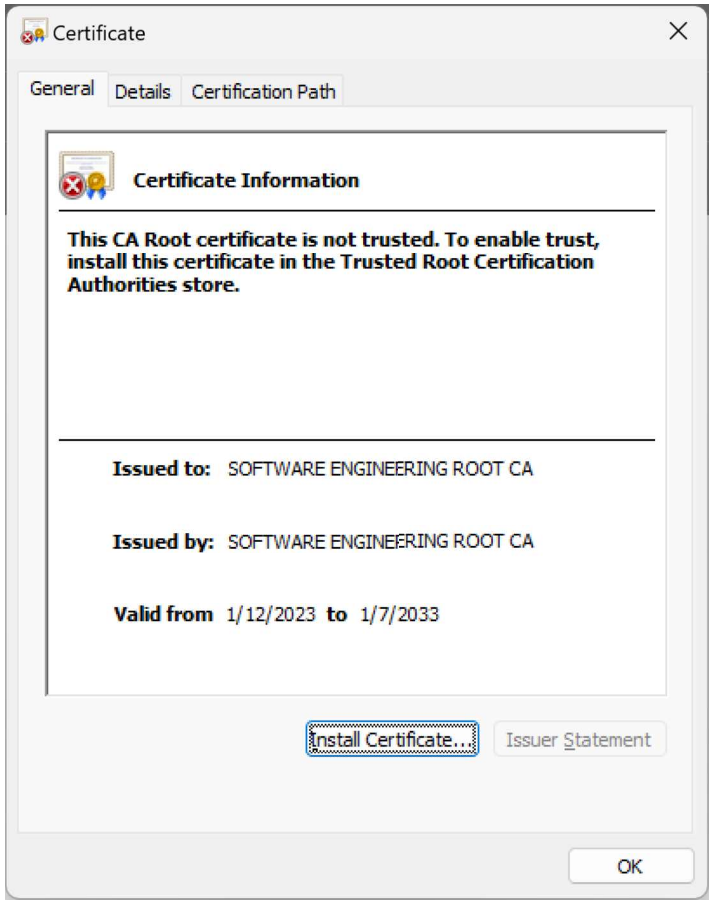
Certificate status:

This CA Root certificate is not trusted because it is not in the Trusted Root Certification Authorities store.

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



Certificate Information

This CA Root certificate is not trusted. To enable trust, install this certificate in the Trusted Root Certification Authorities store.

Issued to: SOFTWARE ENGINEERING ROOT CA

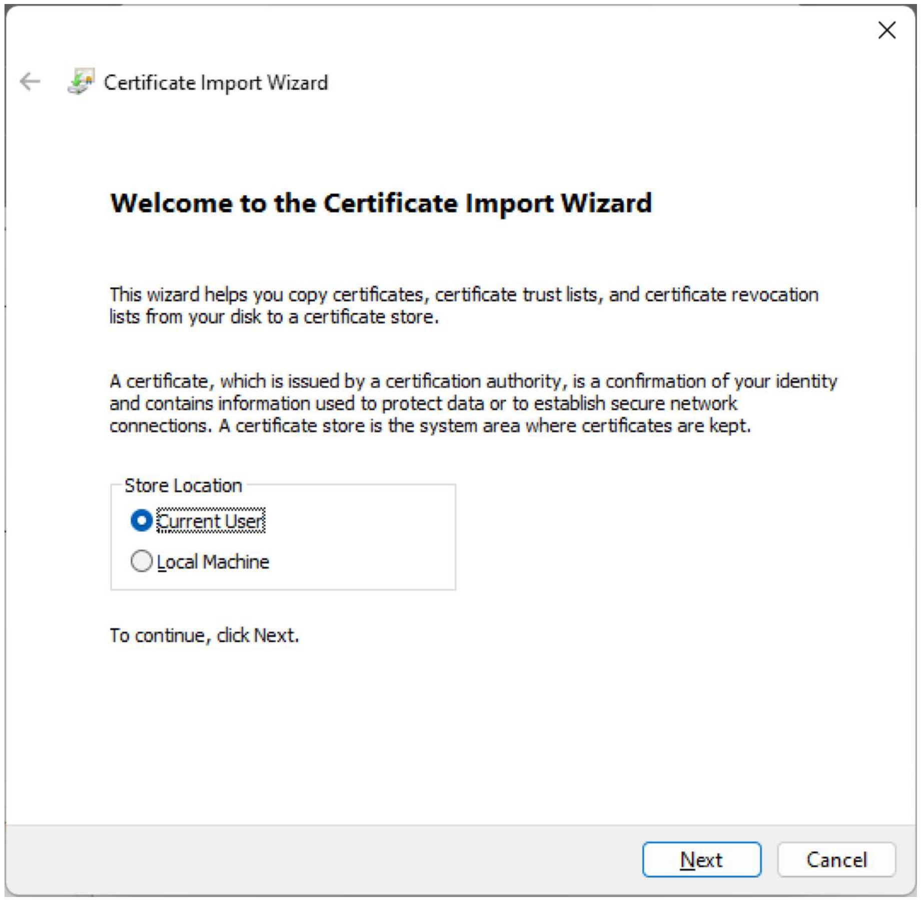
Issued by: SOFTWARE ENGINEERING ROOT CA

Valid from 1/12/2023 **to** 1/7/2033

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



Welcome to the Certificate Import Wizard

This wizard helps you copy certificates, certificate trust lists, and certificate revocation lists from your disk to a certificate store.

A certificate, which is issued by a certification authority, is a confirmation of your identity and contains information used to protect data or to establish secure network connections. A certificate store is the system area where certificates are kept.

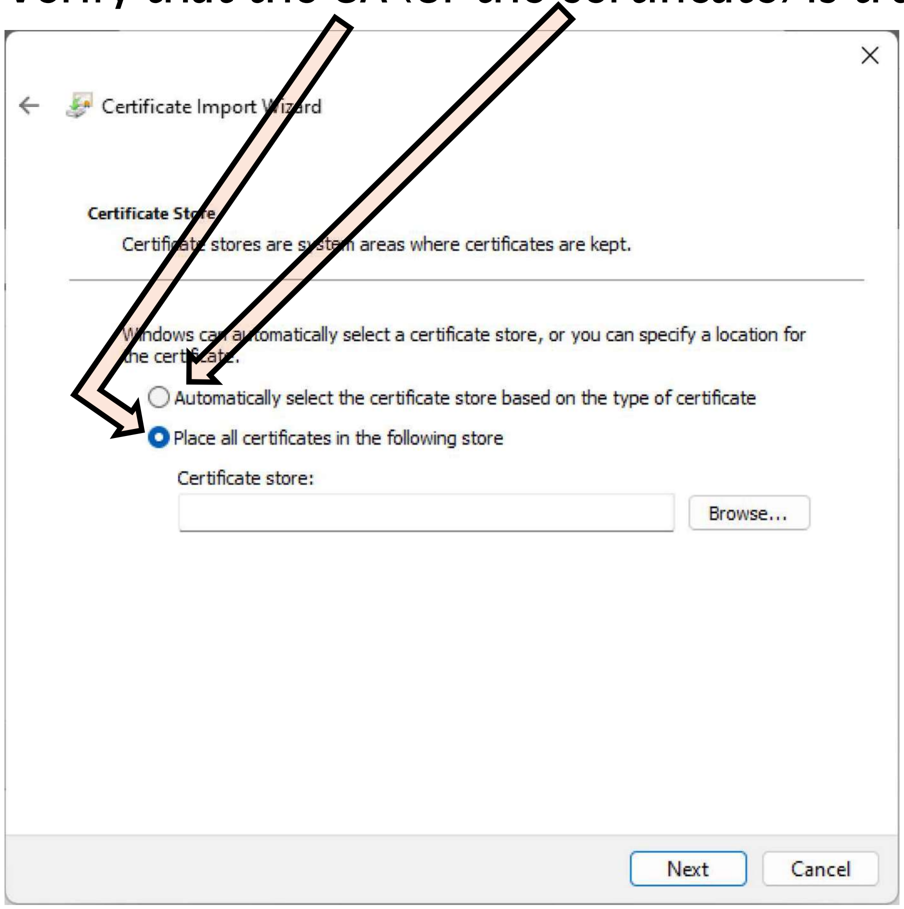
Store Location
- [✓ Current User]
- Local Machine

To continue, click Next.

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing


Certificate Import Wizard

Certificate Store

Certificate stores are system areas where certificates are kept.

Windows can automatically select a certificate store, or you can specify a location for the certificate.

( ) Automatically select the certificate store based on the type of certificate

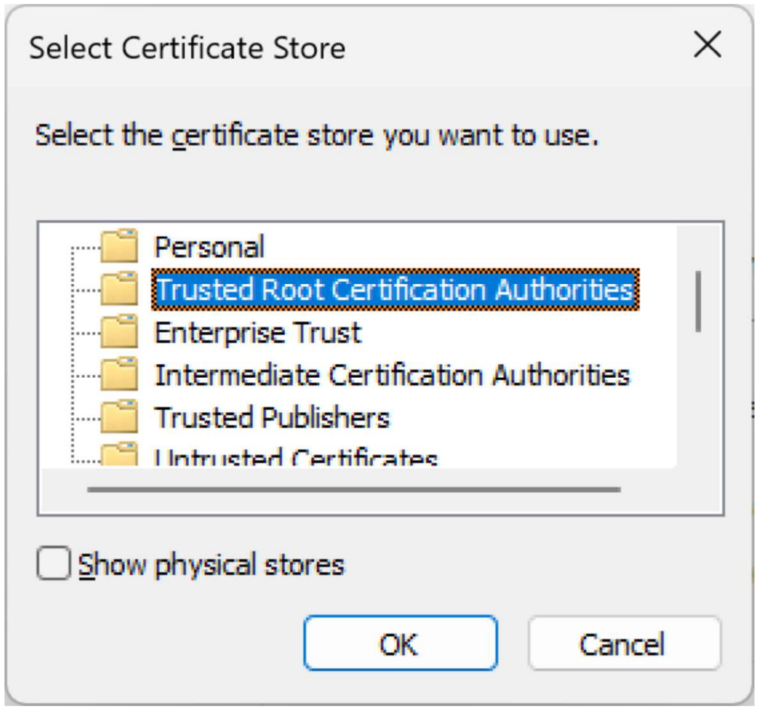
[✓ Place all certificates in the following store]

Certificate store:

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



Select Certificate Store

Select the certificate store you want to use.

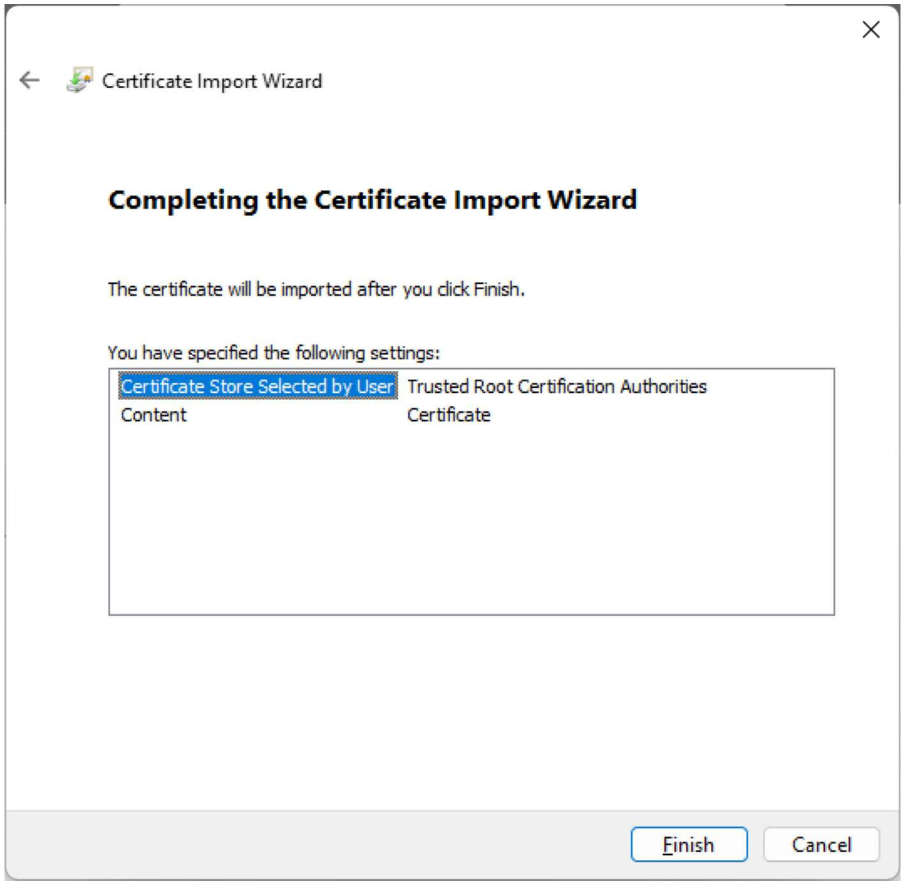
- Personal
- Trusted Root Certification Authorities
- Enterprise Trust
- Intermediate Certification Authorities
- Trusted Publishers
- Untrusted Certificates

☐ Show physical stores

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing


Certificate Import Wizard

Completing the Certificate Import Wizard

The certificate will be imported after you click Finish.

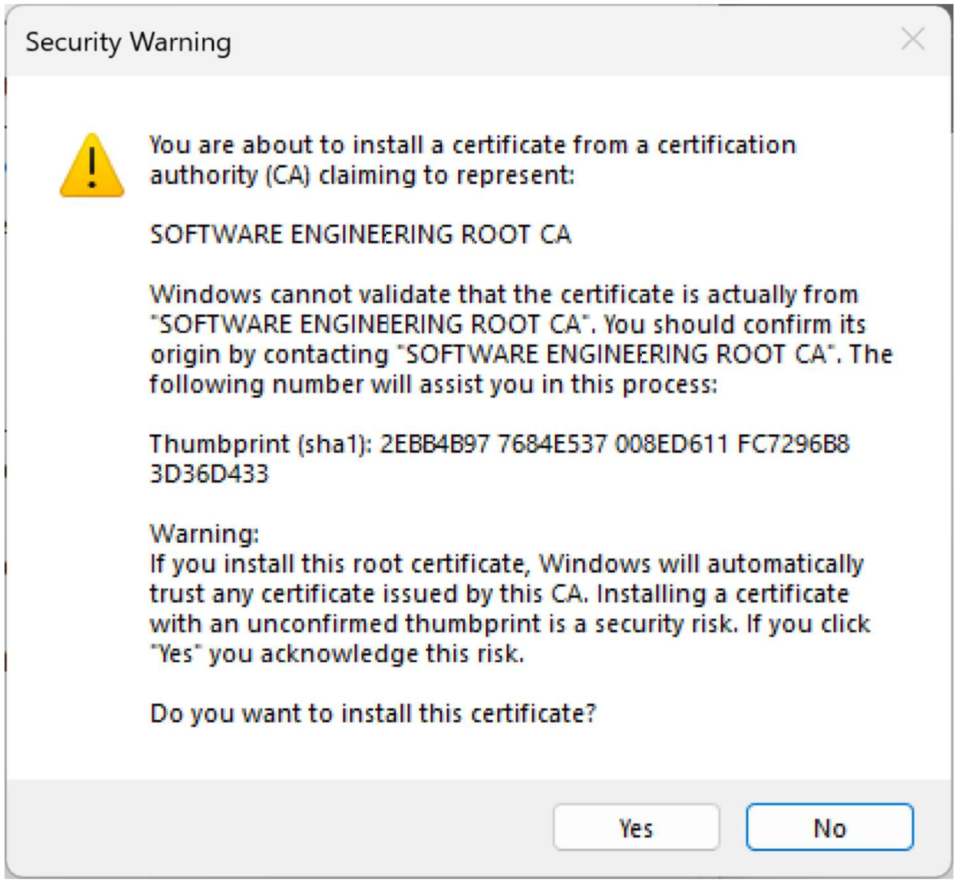
You have specified the following settings:

Certificate Store Selected by User	Trusted Root Certification Authorities
Content	Certificate

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



You are about to install a certificate from a certification authority (CA) claiming to represent:

SOFTWARE ENGINEERING ROOT CA

Windows cannot validate that the certificate is actually from "SOFTWARE ENGINEERING ROOT CA". You should confirm its origin by contacting "SOFTWARE ENGINEERING ROOT CA". The following number will assist you in this process:

Thumbprint (sha1): 2EBB4B97 7684E537 008ED611 FC7296B8 3D36D433

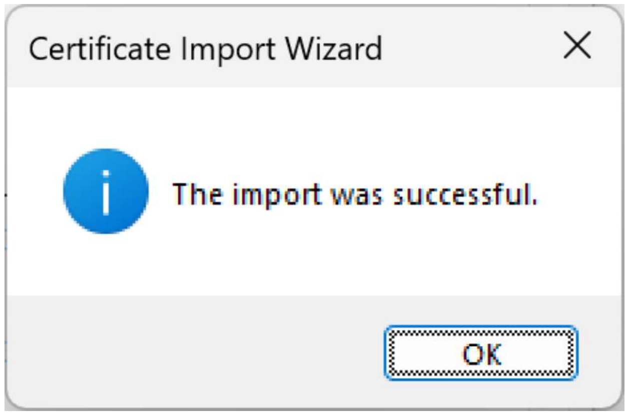
Warning:
If you install this root certificate, Windows will automatically trust any certificate issued by this CA. Installing a certificate with an unconfirmed thumbprint is a security risk. If you click "Yes" you acknowledge this risk.

Do you want to install this certificate?

Analyzing certificate issues

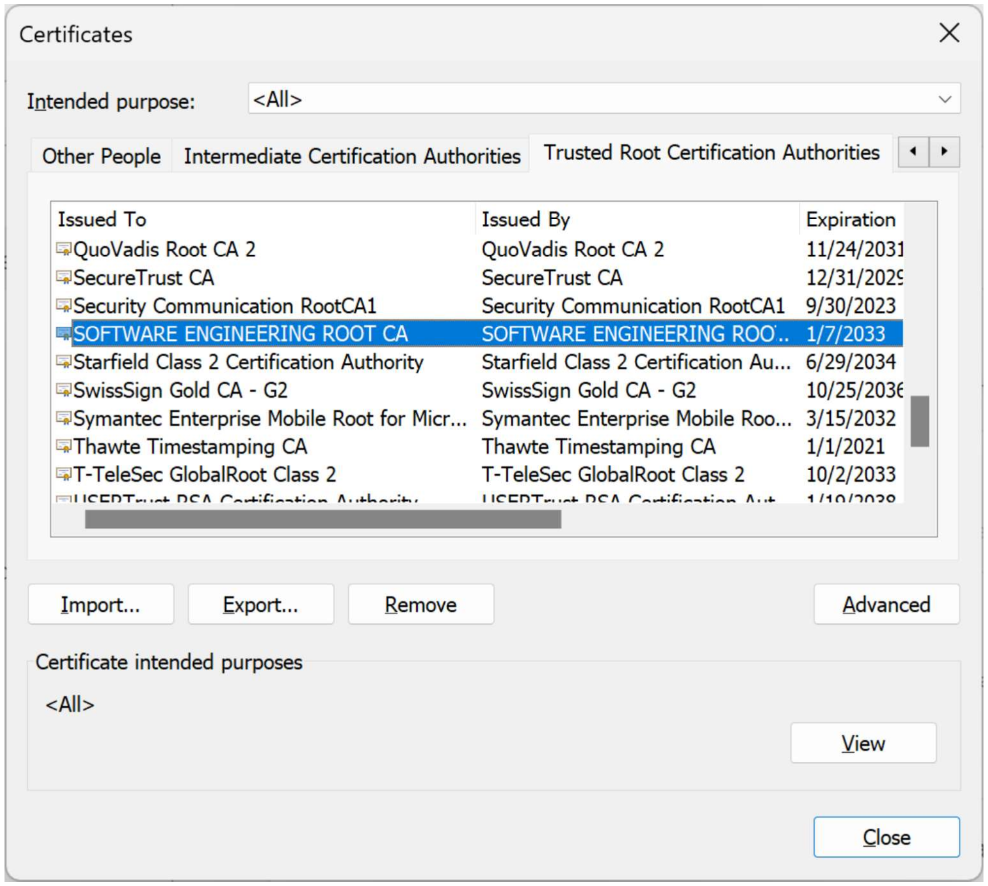
Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



Certificate Import Wizard

The import was successful.



Certificates

Intended purpose: <All>

Other People
Intermediate Certification Authorities
Trusted Root Certification Authorities

Issued To	Issued By	Expiration
QuoVadis Root CA 2	QuoVadis Root CA 2	11/24/2031
SecureTrust CA	SecureTrust CA	12/31/2029
Security Communication RootCA1	Security Communication RootCA1	9/30/2023
SOFTWARE ENGINEERING ROOT CA	SOFTWARE ENGINEERING ROO...	1/7/2033
Starfield Class 2 Certification Authority	Starfield Class 2 Certification Au...	6/29/2034
SwissSign Gold CA - G2	SwissSign Gold CA - G2	10/25/2036
Symantec Enterprise Mobile Root for Micr...	Symantec Enterprise Mobile Roo...	3/15/2032
Thawte Timestamping CA	Thawte Timestamping CA	1/1/2021
T-TeleSec GlobalRoot Class 2	T-TeleSec GlobalRoot Class 2	10/2/2033
USERTrust RSA Certification Authority	USERTrust RSA Certification Aut	1/19/2038

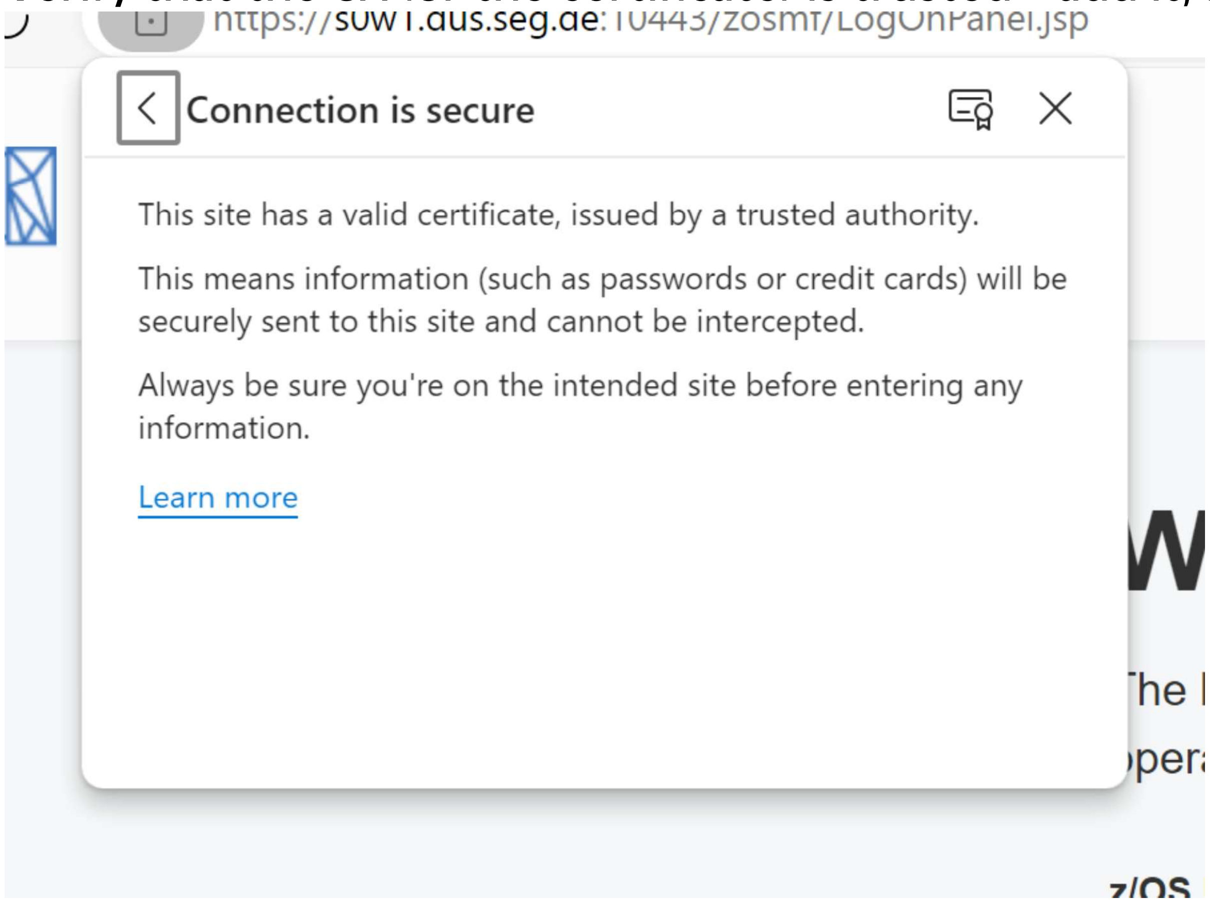
Certificate intended purposes

<All>

Analyzing certificate issues

Trustworthy or not, that's the question!

3. Verify that the CA (or the certificate) is trusted – add it, if missing



https://s0w1.dus.seg.de:10443/zosmf/LogOnPanel.jsp

Connection is secure

This site has a valid certificate, issued by a trusted authority.

This means information (such as passwords or credit cards) will be securely sent to this site and cannot be intercepted.

Always be sure you're on the intended site before entering any information.

Learn more

Analyzing certificate issues

Trustworthy, or not, that's the question!

But what can you do if it’s not a browser client, but an API, like a RESTful service?

→ OPENSSLs tls debugging is your friend!

Analyzing certificate issues

```
openssl s_client -connect s0w1.dus.seg.de:15151 -tlsextdebug
CONNECTED(00000005)
TLS client extension "renegotiation info" (id=65281), len=1
0001 - <SPACES/NULS>
depth=1 C = DE, ST = NORTH RHINE WESTPHALIA, L = DUESSELDORF, O =
SOFTWARE ENGINEERING GMBH, OU = DEVELOPMENT, CN = SOFTWARE
ENGINEERING ROOT CA
verify error:num=19:self signed certificate in certificate chain
verify return:0
write W BLOCK
---
Certificate chain
 0 s:/C=DE/ST=NORTH RHINE WESTPHALIA/L=DUESSELDORF/O=SOFTWARE
ENGINEERING GMBH/OU=DEVELOPMENT/CN=DB2 SECURE DISTRIBUTION SERVICE
   i:/C=DE/ST=NORTH RHINE WESTPHALIA/L=DUESSELDORF/O=SOFTWARE
ENGINEERING GMBH/OU=DEVELOPMENT/CN=SOFTWARE ENGINEERING ROOT CA
 1 s:/C=DE/ST=NORTH RHINE WESTPHALIA/L=DUESSELDORF/O=SOFTWARE
ENGINEERING GMBH/OU=DEVELOPMENT/CN=SOFTWARE ENGINEERING ROOT CA
   i:/C=DE/ST=NORTH RHINE WESTPHALIA/L=DUESSELDORF/O=SOFTWARE
ENGINEERING GMBH/OU=DEVELOPMENT/CN=SOFTWARE ENGINEERING ROOT CA
---
```

Analyzing certificate issues

Server certificate

```
-----BEGIN CERTIFICATE-----
MIIEgDCCA9igAwIBAgIBBDANBgkqhkiG9w0BAQsFADCBpDELMAkGA1UEBhMCREUx
HzAdBgNVBAgTFk5PUlRIIFJISU5FIFdFU1RQSEFMSlHjjO85BgNVBAcTC0RVRVNT
RUxET1JGMSIwIAYDVQQKExlTT0ZUV0FSRSBFTkdJTkVFUklORyBHTUJIMRQwEgYD
VQQLEwtERVZFTE9QTUVOVDEkMCIGA1UEAxMbU09GVFdBUkUgRU5HSU5FUklORyBS
T09UIENBMB4XDTIzMDExNTIzMDAwMFoXDTI1MDQwMTIyNTk1OVowgagxCzAJBgNV
BAYTAkRFMR8wHQYDVQQIExZOT1JUSCBSSElORSBXRVNUUEhBTElBMRQwEgYDVQQH
EwtEVUVTU0VMRE9SRjEiMCAGA1UEChDGC09GVFdBUkUgRU5HSU5FRVJJTkcgR01C
SDEUMBIGA1UECxMLREVWRUxPUE1FTlQxKDAmBgNVBAMTH0RCMiBTRUNVUkUgRElT
VFJJQlVUSU9OIFNFUlZJQ0UwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIB
AQD70x0TZ5WsqsK6ZTy3b+Ry+xIcMTawO1+OeVG04dOPvrZEtVsvicS74vdllilB
I1OYncHNZ9/3E8RwxTv5qSxG4KW6PKsgd2Qpk7iBP4rMXKkrvp8rEp00OW0LgPur
4sCtQpEytfYps/AFhNwPoT1hK1hZkXjywILn7/sJ3t9zYCesDDUJlEJkywaO8U/V
vgLh0SsEq2aUlaxSYhyc4KAPsdencU0QuzSZhbwMyA+4i0eSK4fgOsGUmSoACVc4
Tg0qvFLF6iTcPEXW9XNJqlVGqg1RaWuNwKG00Z0lETZUbAVZsam4exiYnRUiT6J9
oyPfzQnB8+w59ir2Jx3p8wfbAgMBAAGjgbYwgbMwPwYJYIZIAYb4QgENBDIWMEdl
bmVyYXRlZCBieSB0aGUgU2VjdXJpdHkgU2VydmVyIGZvciB6L09TIChSQUNGKTAg
BgNVHREEGTAXgg9TMFcxLkRVUy5TRUcuREWHBMCoCWIwDgYDVR0PAQH/BAQDAgWg
MB0GA1UdDgQWBBQlyjuoy6SipU3H23fH7cpw+ALB0zAfBgNVHSMEGDAWgBT/MgiN
4im65Gpt4iPBBGhEz1XpXzAhffEdq2iG9w0BAQsFAAOCAQEAkDFU531SDp3lG1jH
IPdA6w9MeJx344sgd/K4LPzfIGuzmmuHZrAHCHZNaA64BBMogeGOV2zoxenwf07A
CIeTQpqE19TuNH2vyrulMd8p4c6VwUjto/N+GXobE3WmNt5nrdGLOIqrxutwmiMD
2HElOlIh7unsVqq24qfDczxHNVLapJlYy4gXiqC/UG8055GhjIwEaMvfEQ82GhcI
v1pekhL7hK0p8xGOAYQVBUM0MrpVBCSiFYdVs2hPaTA86QcyngT9CGNrXf2JeTgk
FIzH7h3nLdCRZd9KXQATQ5b24a9OXGzC6bKgiSD9unxWI8DYxBXOx3G3kufaXn2X
kOE/EQ==
-----END CERTIFICATE-----
```

Analyzing certificate issues

Base 64 encoded certificates can be decoded using OPENSSL:

```
Certificate: Data: Version: 3 (0x2) Serial Number: 4 (0x4) Signature Algorithm: sha256WithRSAEncryption
Issuer: C=DE, ST=NORTH RHINE WESTPHALIA, L=DUESSELDORF, O=SOFTWARE ENGINEERING GMBH, OU=DEVELOPMENT,
CN=SOFTWARE ENGINEERING ROOT CA Validity Not Before: Jan 15 23:00:00 2023 GMT Not After : Apr 1 22:59:59
2025 GMT Subject: C=DE, ST=NORTH RHINE WESTPHALIA, L=DUESSELDORF, O=SOFTWARE ENGINEERING GMBH,
OU=DEVELOPMENT, CN=DB2 SECURE DISTRIBUTION SERVICE Subject Public Key Info: Public Key Algorithm:
rsaEncryption Public-Key: (2048 bit) Modulus: 00:fb:d3:1d:13:67:95:ac:aa:c2:ba:65:3c:b7:6f:
e4:72:fb:12:1c:31:36:b0:3b:5f:8e:79:51:b4:e1: d3:8f:be:b6:44:b5:5b:2f:89:c4:bb:e2:f7:65:96:
29:41:23:53:98:9d:c1:cd:67:df:f7:13:c4:70:c5: 3b:f9:a9:2c:46:e0:a5:ba:3c:ab:20:77:64:29:93:
b8:81:3f:8a:cc:5c:a9:2b:be:9f:2b:12:9d:34:39: 6d:0b:80:fb:ab:e2:c0:ad:42:91:32:b5:f6:29:b3:
f0:05:84:dc:0f:a1:3d:61:2b:58:59:91:78:f2:c0: 82:e7:ef:fb:09:de:df:73:60:27:ac:0c:35:09:94:
42:64:cb:06:8e:f1:4f:d5:be:02:e1:d1:2b:04:ab: 66:94:95:ac:52:62:1c:9c:e0:a0:0f:b1:d7:a7:71:
4d:10:bb:34:99:85:bc:0c:c8:0f:b8:8b:47:92:2b: 87:e0:3a:c1:94:99:2a:00:09:57:38:4e:0d:2a:bc:
52:c5:ea:24:dc:3c:45:d6:f5:73:49:aa:55:46:aa: 0d:51:69:6b:8d:c0:a1:b4:d1:9d:25:11:36:54:6c:
05:59:b1:a9:b8:7b:18:98:9d:15:22:4f:a2:7d:a3: 23:df:cd:09:c1:f3:ec:39:f6:2a:f6:27:1d:e9:f3: 07:db
Exponent: 65537 (0x10001) X509v3 extensions: Netscape Comment: Generated by the Security Server for z/OS
(RACF) X509v3 Subject Alternative Name: DNS:S0W1.DUS.SEG.DE, IP Address:192.168.9.98 X509v3 Key Usage:
critical Digital Signature, Key Encipherment X509v3 Subject Key Identifier:
25:CA:3B:A8:CB:A4:A2:A5:4D:C7:DB:77:C7:ED:CA:70:F8:02:C1:D3 X509v3 Authority Key Identifier:
FF:32:08:8D:E2:29:BA:E4:6A:6D:E2:23:C1:04:68:44:CF:55:E9:5F Signature Algorithm: sha256WithRSAEncryption
Signature Value: 90:31:54:e7:7d:52:0e:9d:e5:1b:58:c7:20:f7:40:eb:0f:4c:
78:9c:77:e3:8b:20:77:f2:b8:2c:fc:df:20:6b:b3:9a:6b:87:
66:b0:07:08:76:4d:68:0e:b8:04:13:28:81:e1:8e:57:6c:e8:
c5:e9:f0:7f:4e:c0:08:87:93:42:9a:84:d7:d4:ee:34:7d:af:
ca:bb:a5:31:df:29:e1:ce:95:c1:48:ed:a3:f3:7e:19:7a:1b:
13:75:a6:36:de:67:ad:d1:8b:38:8a:ab:c6:eb:70:9a:23:03:
d8:71:25:3a:52:21:ee:e9:ec:56:aa:b6:e2:a7:c3:73:3c:47:
35:52:da:a4:99:58:cb:88:17:8a:a0:bf:50:6f:34:c3:b8:d0:
33:1c:04:68:cb:df:11:0f:36:1a:17:08:bf:5a:5e:92:12:fb:
84:ad:29:f3:11:8e:01:84:15:05:43:34:32:ba:55:04:24:a2:
15:87:55:b3:68:4f:69:30:3c:e9:07:32:9e:04:fd:08:63:6b:
5d:fd:89:79:38:24:14:8c:c7:ee:1d:e7:2d:d0:91:65:df:4a:
5d:00:13:43:96:f6:e1:af:4e:5c:6c:c2:e9:b2:a0:89:20:fd:
ba:7c:56:23:c0:d8:c4:15:ce:c7:71:b7:92:e7:da:5e:7d:97: 90:e1:3f:11
```