Security requirement

Web Services

Deutsche Telekom Group

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Summary
This security document has been prepared based on the general security policies of the Group and is aimed at all systems that support interoperable interactions from application to application over a network.
In addition to the Group specifications, the recommendations of the Open Web Appliaction Security Project are also included as an industry standard.

Table of Contents

1. Introduction

The security requirement is used as a basis for an approval in the PSA process, among other things. It also serves as an implementation standard for units which do not participate in the PSA process. These requirements shall be taken into account from the very beginning, including during the planning and decision-making processes. When implementing these security requirements, the precedence of national, international and supranational law shall be observed.

If compliance with the described requirements can not be achieved or is only partially feasible in individual cases, a risk assessment must be carried out together with a Security and / or Data Privacy Expert (in accordance with the relevant requirement) and possible alternative protective measures agreed.

2. General requirements

Req 1	Software and hardware of the system must be covered by security vulnerability support from the supplier.

Only software and hardware products for which there is security vulnerability support by the supplier may be used in a system.

Such support must include that the supplier

- continuously monitors and analyzes the product for whether it has been affected by security vulnerabilities,
- informs immediately about the type, severity and exploitability of vulnerabilities discovered in the product
- timely provides product updates or effective workarounds to remedy the vulnerabilities.

The security vulnerability support must be in place for the entire period in which the affected product remains in use.

Support phases with limited scope of services
Many suppliers optionally offer time-extended support for their products, which goes beyond the support phase intended for the general market, but is often associated with limitations. Some suppliers define their support fundamentally in increments, which may include limitations even during the final phase before the absolute end date of regular support.
If a product is used within support phases that are subject to limitations, it must be explicitly ensured that these restrictions do not affect the availability of security vulnerability support.

Open Source Software and Hardware
Open Source products are often developed by free organizations or communities; accordingly, contractually agreed security vulnerability support may not be available. In principle, it must also be ensured here that the organization/community (or a third party officially commissioned by them) operates a comprehensive security vulnerability management for the affected product, which meets the above-mentioned criteria and is considered to be reliably established.

Motivation: Hardware and software products for which there is no comprehensive security vulnerability support from the supplier pose a risk. This means that a product is not adequately checked to determine whether it is affected by further developed forms of attack or newly discovered vulnerabilities in technical implementations. Likewise, if there are existing security vulnerabilities in a product, no improvements (e.g. updates, patches) are provided. This results in a system whose weak points cannot be remedied, so that they remain exploitable by an attacker in order to compromise the system or to adversely affect it.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.01-1/7.0

Req 2	The software used must be obtained from trusted sources and checked for integrity.

The software used on the system must be obtained from trusted sources and checked for integrity before installation.

This requirement applies to all types of software:
- Firmware and microcode for hardware components
- Operating systems
- Software Libraries
- Application Software
- Pre-integrated application solutions, such as software appliances or containers

as well as other software that may be used.

Trusted Sources
Trusted sources are generally considered to be:
- the official distribution and supply channels of the supplier
- third party distributors, provided they are authorized by the supplier and are a legitimate part of the supplier´s delivery channels
- internet downloads, if they are made from official provisioning servers of the supplier or authorized distributors
(1) If the provisioning server offers various forms of downloads, those protected by encryption or cryptographic signatures must be preferred to those without such protection.
(2) If the provisioning server secures the transport layer using cryptographic protocols (e.g. https, sftp), the associated server certificates or server keys/fingerprints must be validated with each download to confirm the identity of the provisioning server; if validation fails, the download must be cancelled and the provisioning server has to be considered an untrusted source.

Integrity Check
The integrity check is intended to ensure that the received software is free of manipulation and malware infection. If available, the mechanisms implemented by the supplier must be used for checking.
Valid mechanisms are:
- physical seals or permanently applied certificates of authenticity (if the software is provided on physical media)
- comparison of cryptographic hash values (e.g. SHA256, SHA512) of the received software against target values, which the supplier provides separately
- verification of cryptographic signatures (e.g. GPG, certificates) with which the supplier provides its software

In addition, a check of the software using an anti-virus or anti-malware scanner is recommended (if the vendor has not implemented any of the aforementioned integrity protection mechanisms for its software, this verification is mandatory).

Extended integrity checking when pulling software from public registries
Public registries allow developers to make any of their own software projects available for use. The range includes projects from well-known companies with controlled development processes, as well as from smaller providers or amateur developers.
Examples of such registries are:
- Code registries (e.g. GitHub, Bitbucket, SourceForge, Python Package Index)
- Container registries (e.g. Docker Hub)

Software from public registries must undergo an extended integrity check before deployment.
In addition to the integrity check components described in the previous section, the extended check is intended to explicitly ensure that the software actually performs its function as described, does not contain inherent security risks such as intentionally implemented malware features, and is not affected by known security vulnerabilities. If the software has direct dependencies on third-party software projects (dependencies are very typical in open source software), which must also be obtained and installed for the use of the software, these must be included in the extended integrity check.

Suitable methods for an extended integrity check can be, for example:

- Strict validation of project/package names (avoidance of confusion with deliberately imitated malicious software projects)
- dynamic code analysis / structured functional checks in a test environment
- static code analysis using a linter (e.g. Splint, JSLint, pylint)
- Examination using a security vulnerability scanner (e.g. Qualys, Nessus)
- Examination using a container security scanner (e.g. JFrog Xray, Harbor, Clair, Docker Scan)
- Examination using an SCA (Software Composition Analysis) tool or dependency scanner (e.g. OWASP Dependency Check, Snyk)

The test methods must be selected and appropriately combined according to the exact form of software delivery (source code, binaries/artifacts, containers).

Motivation: Software supply chains contain various attack vectors. An attacker can start at various points to manipulate software or introduce his own routines and damage or control the target environment in which the software is subsequently used. The attack can occur on the transport or transmission path or on the provisioning source itself. Accordingly, an attack is facilitated if software is not obtained from official and controlled sources or if an integrity check is omitted.
There is a particular risk for software obtained from public registries, as these are open to anyone for the provision of software projects. Perfidious attack methods are known, in which the attacker first provides completely inconspicuous, functional software for a while and as soon as it has established itself and found a certain spread, deliberately hidden malicious code is integrated in future versions. Other methods rely on similar-sounding project names for widely used existing projects or overruling version numbers to inject manipulated software into any solutions based on them.

Implementation example: Obtain the software via the official delivery channels of the supplier. Upon receipt of the software, immediately check for integrity using cryptographic checksums, as provided by the supplier, as well as scan for any infections by known malware using anti-malware / anti-virus scanners. Storage of the tested software on an internal, protected file storage and further use (e.g. rollout to the target systems) only from there.

For this requirement the following threats are relevant:
- Unauthorized modification of data
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.01-2/7.0

Req 3	Basic security functionality for externally accessible web services must be implemented in the DMZ and be protected with a web service gateway depending on the criticality.

A DMZ is a zone where all external traffic is terminated.
Databases and applications are located in the MZ, therefore in a zone where no direct external access is possible.

The following functions must be realized in the access and validation tier (DMZ):

- authentication and authorization for the access (i.e. is the consumer of the web service allowed for access)
- basic validation based on the given description such as WSDL, JSON schema or XSD
- pre- and postprocessing tasks (such as terminating an TLS encryption or security relevant logging)
- termination of tcp connections and preventing all direct access to web service end points in the MZ
- limit the maximum connections

To ensure these functionalities a web service gateway should always be used.

Motivation: All measures must be taken in the DMZ to protect the services in the MZ against attacks.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.02-3/7.0

Req 4	If data requiring special protection is processed in a web service, this data must be individually protected by using end-to-end mechanisms at the application level (end-to-end), such as XML encryption.

Since transport encryptions are already terminated on outer layers, as well as possible payload logging and "hop by hop" communication, a pure transport encryption in most cases does not offer sufficient protection for particularly confidential data.

Examples of data requiring special protection are Medical data, Criminal records, Bank details of a person, Quarterly figures before publication and Draft contracts with high financial volume.

Motivation: Due to the special need for protection, confidentiality protection is required for certain data even if they are encrypted for transport or transmitted via secure networks.

For this requirement the following threats are relevant:
- Unauthorized access or tapping of data
- Unauthorized modification of data

For this requirement the following warranty objectives are relevant:

ID: 3.02-4/7.0

Req 5	A web service must be protected from manipulation / replay attacks while on the unprotected communication path.

This can be accomplished through the use of XML-signatures on the application layer, timestamps / session IDs / tokens or TLS on the transport layer, or other appropriate mechanisms (e.g., VPN).

Motivation: Non-repudiation mechanisms are assumed to become more and more accepted in legal proceedings as well as for accounting and auditing purposes.
Therefore, it is highly desirable to not rely on TLS as ephemeral integrity protection mechanism on the transport layer, but rather to solve this issue more appropriately on the application layer with durable XML signatures.
Due to the different time scales and goals pursued with XML signatures, as compared to TLS integrity protection, the use of a special purpose public/private key pair for signatures becomes inevitable.
XML signatures are the only mechanism that allows to prove to an external third party (e.g., a legal entity such as a court) the fact that a message was received from a particular entity.
The timestamp and/or message identifier can be used to counter replay attacks.
The requirement to sign the entire XML message / SOAP Body is important to counter some sophisticated attacks on the XML-signature.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data

- Unauthorized modification of data
- Unauthorized use of services or resources
- Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:
- Integrity

ID: 3.02-5/7.0

Req 6	Only the minimal set web services must be made available to the public.

In particular, when exposing an internal web service to external partners or when extending a legacy application with a web service frontend, care must be taken to only expose required Web Services.

Motivation: By offering only the minimal required set of web services, the attack window can be reduced.

Implementation example: On internet web service gateways, only those web services may be made available that are required.
The same applies, for example, to the outbound connections of a container namespace.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources

For this requirement the following warranty objectives are relevant:

ID: 3.02-6/7.0

3. Authentication and authorization

Req 7	Every provider and consuments of a web service must authenticated and authorise each other when transmitting data requiring protection.

The Provider of a web service must ensure that the consumer is auhorised to access this web service and to receive this data or use these functions.
The consumer must ensure that he is interacting with the correct supplier.

Authorization checks must be considered in every function. It is not allowed to rely on a special trust status due to the authentication of a device at network level or connections from e.g. the same network or namespace.

The authorization check must ensure that the consumer only receives the data he is allowed to receive.

Motivation: In order to prevent unpermitted usage of resources or output of data, a proper authentication and authorization is necessary.
Access to a weather web service that does not require protection, does not require authentication or authorization.

Implementation example: To grant general authorizations for the access to a web service a certificate-based authentication is suitable.
To grant an authorization at data field level, JW tokens with individual "claims" are suitable, for example, in combination with filters in order to issue only those data fields that are authorized for the consumer.

The JW token or certificate must be verified by each function / container / microservice.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Denial of executed activities

For this requirement the following warranty objectives are relevant:

ID: 3.02-7/7.0

Req 8	The mechanism to authenticate and authorize must rely on strong cryptographic algorithms / frameworks.

Strong cryptographic frameworks/algorithms in this context are e.g. XML signature or TLS client certificates with adequate algorithms like SHA3- / SHA2 hashes and ECDSA / RSA signatures.
Additional examples are JW-, oAuth- and STS-tokens if transferred over tls.

Motivation: Weak algorithms can be broken by attackers and identities can be faked.

Implementation example: Certificates according to the certificate requirements for HTTPS:

JW Tokens:
- Hash procedure SHA 256 or higher
- no "none" algorithms ({"alg":"none"})
- ES, RS prefer algorithms over HS
- as short as possible lifetimes

For this requirement the following threats are relevant:
- Unauthorized access to the system

- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Denial of executed activities

For this requirement the following warranty objectives are relevant:

ID: 3.02-8/7.0

4. Validation

Req 9	All Web Service requests and responses must be validated by the Web Service provider and consumers against a detailed specification.

Each dataset submitted through a Web Service must match the expected data elements, expected length and/or expected range and whenever appropriate a formal specification describing the acceptable data.

If the expected data fields are not always definable, only expected data fields may be processed.

Motivation: The detailed specification (including regular definitions) allows a much better description of the data that is expected as data elements in the web service.

Implementation example: A complete web service description can be achieved using e.g. WSDL 2.0 or Swagger.

An example for data format descriptions are JSON schema or XML schema definitions.

An example for a formal definition are regular expressions, e.g. "([A-Za-z0-9]+[-._+&#%/=~])*[A-Za-z0-9]+@([-A-Za-z0-9]+[.])+[A-Zaz]{2,6}" to specify a valid e-mail address.
The base type "int" should be replaced by an application specific subtype which exactly defines the needed integer range.
Equivalently the base type "string" must be replaced by an application specific subtype which limits the string's length through "maxLength" and "minLength".

For this requirement the following threats are relevant:
• Unauthorized access or tapping of data
• Unauthorized modification of data
• Unauthorized use of services or resources
• Disruption of availability

For this requirement the following warranty objectives are relevant:

ID: 3.02-9/7.0

Req 10	If the web service does not contain a formal definition of the input data, black / white listings must be used to prevent illegal characters from being accepted.

Data that is not expected from the following parts of the application may have unexpected and undesired effects.
If the input data in the DMZ is properly sanitized, such attacks are made considerably more difficult.

Motivation: Black / whitelisting can effectively protect against certain types of attacks, such as SQL-, LDAP-, XML-, XPath-, XQuery-, code-, command injection.
The use of whitelisting is preferable to blacklisting because blacklists tend to become obsolete over time.

Implementation example: For web services that are run via a web server, the open source tool mod_security is a good solution.

For this requirement the following threats are relevant:
• Unauthorized access or tapping of data
• Unauthorized modification of data
• Unauthorized use of services or resources
• Disruption of availability

For this requirement the following warranty objectives are relevant:

ID: 3.02-10/7.0

5. REST

Req 11	Responses from REST web services must be based on HTTP status codes.

The HTTP protocol provides standardized codes for each status of a connection.

Further additional Information such as received data (payload) or technical details about the error may not be output but must be stored with an unique error reference in the log.
The error reference may be output.

Kategorie	Beschreibung
1xx: Informational	Communicates transfer protocol-level information
2xx: Success	Indicates that the client's request was accepted successfully
3xx: Redirection	Indicates that the client must take some additional action in order to complete their request
4xx: Client Error	Indicates that the client seems to have erred
5xx: Server Error	Indicates that the server seems to have erred

Motivation: The HTTP protocol already provides standardized codes for each status of a connection.
By using these status codes, informations requiring protection, such as error and system messages, are prevented from being included in the output.
The consumer of the Web service can also use these standardized codes to generically determine the cause of the error.
Reflecting the received data (payload) can lead to security gaps (especially in web applications).

Implementation example: An example of a few HTTP status codes and their meaning:

HTTP status code	Message	Description
200	OK	The request was processed successfully
400	Bad Request	The request is malformed
406	Not Acceptable	The content type requestst by the client in the accept-header is not offered by the web service
413	Payload to large	The request is larger than the server is willing or able to process

All HTTP status codes and their usage are specified in the RFC7231.

For this requirement the following threats are relevant:
• Unauthorized access or tapping of data
• Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.02-11/7.0

| Req 12 | Functionalities of REST web services must be based on HTTP methods. |

The HTTP protocol provides standardized methods that are required for all functionalities.
By using these methods a uniform and transparent authorization control is enabled, which is supported by web servers, reverse proxies and web service gateways.

Motivation: By using standardized methods, upstream layers such as web servers, reverse proxies and web service gateways are able to perform a basic validation of the requests.
This also ensures a common understanding for consumers of how a web service should be used.

Implementation example: Examples of the most common HTTP methods:

HTTP method	Description
GET	The GET method requests transfer the current selected resource
HEAD	The HEAD method is identical to GET, except that the server does not send the HTTP BODY of the response
POST	The POST method requests the processing of the transmitted data
PUT	The PUT method requests that the state of the target resource be created or replaced
DELETE	The DELETE method requests the removal of the target resource
PATCH	The PATCH method requests a set of changes described in the request

For this requirement the following threats are relevant:
• Unauthorized access or tapping of data
• Unauthorized modification of data
• Unauthorized use of services or resources

For this requirement the following warranty objectives are relevant:

ID: 3.02-12/7.0

| Req 13 | Confidential data must not be transferred in the URL. |

Confidential data may only be transferred outside the URL (e.g. HTTP-BODY, HTTP-HEADER).
When using HTTP headers, only fields that are not recorded in log files may be used.

Examples for confidential data are:

• API Keys
• Security Tokens (e.g. oAuth-, JW-Token)
• Passwords

Motivation: All data contained in the URL appears in log files of e.g. web server, reverse proxy and web service gateway.
Log files are often collected at a central location or transferred to SIEM systems for monitoring.
In order to make this possible and at the same time protect confidential data, it must not be transmitted in the URL.

For this requirement the following threats are relevant:
• Unauthorized access to the system
• Unauthorized access or tapping of data
• Unauthorized modification of data
• Unauthorized use of services or resources

For this requirement the following warranty objectives are relevant:

ID: 3.02-13/7.0

Req 14	Content types must be validated.

A REST request and response must match the intended content type in the header.
Otherwise this could cause misinterpretation at the consumer / provider side and lead to code-injection / code-execution.

Motivation: REST web services often allow multiple data formats for request and response.
The consumer must specify the data format of the request and the desired data format of the Web service response in the "Content-Type" and "Accept" headers.
The provider may only process the request if it supports the data format for the request and the response.

Implementation example: *Reject requests with unexpected or missing content type headers with HTTP code 415 "Unsupported Media Type".*

ID: 3.02-14/7.0

6. Signatures

Req 15	If a web service request is protected with signatures, the signature data must not be removed from the request by an intermediate processor.

The signature must be validated over the entire transmission path to guarantee the integrity and authenticity of the web service requests / responses.

Motivation: If this signature is removed, the integrity and authenticity of the web service is no longer guaranteed.

For this requirement the following threats are relevant:
* Unauthorized modification of data
* Unauthorized use of services or resources
* Denial of executed activities

For this requirement the following warranty objectives are relevant:

ID: 3.02-15/7.0

7. TLS

Req 16   TLS version 1.2 or 1.3 must be used.

User roles: Operation, Development, Integration

TLS (Transport Layer Security) is a protocol for the secure transmission of information over TCP/IP based connections and is the successor of SSL (Secure Socket Layer). TLS ensures the confidentiality, integrity and authenticity of the information or the communication partners.

TLS in version 1.2 [RFC 5246] and version 1.3 [RFC 8446] provides cipher suites with Authenticated Encryption Associated Data (AEAD). AEAD ensures the confidentiality as well as the integrity and authenticity of the transmitted information.

References:
[RFC 5246] T. Dierks, E. Rescorla: RFC 5246: The Transport Layer Security (TLS) Protocol Version 1.2, 2008
[RFC 8446] E. Rescorla: RFC 8446: The Transport Layer Security (TLS) Protocol Version 1.3, 2018

Motivation: The current version of TLS fixes previous known security vulnerabilities and attack surfaces on the TLS protocol handshake.

Implementation example: OpenSSL> protocol = tlsv1_3

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.50-40/7.0

Req 17   Only Perfect Forward Secrecy (PFS) TLS-cipher suites must be used according to the tables below.

User roles: Operation, Development, Integration

Cipher suites specify the cryptographic methods of a connection.

Perfect Forward Secrecy (short PFS, also Forward Secrecy) means that transmitted information cannot be decrypted afterwards, even if the long-term key of the communication partners is known.

In TLS v1.2 cipher suites are defined as follows: *TLS_AKE_WITH_Enc_Hash.*
Following, the meaning of the individual components is explained:
- *AKE (Authenticated Key Exchange)*: Key agreement mechanism with authentication for the handshake protocol.
- *Enc (Encryption)*: Encryption algorithm with mode of operation for the record protocol.
- *Hash*:Hash algorithm for HMAC used for key derivation. If *Enc* is not an AEAD encryption mechanism, HMAC is also used for integrity protection.

The following table lists the allowed cipher suites with PFS in TLS v1.2 as well as the reference specifications. The design philosophy of TLS v1.2 was followed, which is why the table contains only AEAD constructions.

Allowed cipher suites with PFS in TLS v1.2:

Priority	Cipher Suite	Reference specification
HIGH	TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	RFC 5289
HIGH	TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	RFC 5289
LOW	TLS_DHE_DSS_WITH_AES_256_GCM_SHA384	RFC 5288
LOW	TLS_DHE_RSA_WITH_AES_256_GCM_SHA384	RFC 5288
HIGH	TLS_ECDHE_ECDSA_WITH_CHACHA20POLY1305_SHA256	RFC 7905
HIGH	TLS_ECDHE_RSA_WITH_CHACHA20POLY1305_SHA256	RFC 7905
LOW	TLS_DHE_RSA_WITH_CHACHA20POLY1305_SHA256	RFC 7905
HIGH	TLS_ECDHE_ECDSA_WITH_AES_256_CCM	RFC 7251
LOW	TLS_DHE_RSA_WITH_AES_256_CCM	RFC 6655
HIGH	TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	RFC 5289
HIGH	TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	RFC 5289
LOW	TLS_DHE_DSS_WITH_AES_128_GCM_SHA256	RFC 5288
LOW	TLS_DHE_RSA_WITH_AES_128_GCM_SHA256	RFC 5288
HIGH	TLS_ECDHE_ECDSA_WITH_AES_128_CCM	RFC 7251
LOW	TLS_DHE_RSA_WITH_AES_128_CCM	RFC 6655

Furthermore, in legacy systems the cipher suites of the following table are allowed.
Additional cipher suites with PFS in TLS v1.2 with AES-CBC:

Priority	Cipher Suite	Reference specification
HIGH	TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	RFC 5289
HIGH	TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384	RFC 5289

LOW	TLS_DHE_DSS_ WITH_AES_256_CBC_SHA256	RFC 5246
LOW	TLS_DHE_RSA_ WITH_AES_256_CBC_SHA256	RFC 5246
HIGH	TLS_ECDHE_ECDSA_WITH_AES_1 28_CBC_SHA256	RFC 5289
HIGH	TLS_ECDHE_RSA_WITH_AES_128 _CBC_SHA256	RFC 5289
LOW	TLS_DHE_DSS_ WITH_AES_128_CBC_SHA256	RFC 5246
LOW	TLS_DHE_RSA_ WITH_AES_128_CBC_SHA256	RFC 5246

Remark on the cipher suites for TLS v1.2:
The table entries are sorted by the symmetric encryption mechanism (Enc). For the authenticated key agreement methods (AKE), mechanism based on elliptic curves (ECDHE_ECDSA) are preferred. DHE (discrete logarithm) key establishment ciphers are more vulnerable against DoS (DHeater) than ECDHE, thus ECDHE should be preferred. The "Priority" column defines which cipher suites are preferred, i.e. cipher suites with a priority of "HIGH" are preferable to those with "LOW".

In TLS v1.3 cipher suites are defined as follows: *TLS_AEAD_Hash.*
Following, the meaning of the individual components is explained:

- AEAD: Authenticated encryption mechanism for the record protocol.
- Hash: Hash algorithm for HMAC and HKDF in the handshake protocol.

The following table lists the allowed cipher suites with PFS in TLS v1.3 as well as the reference specifications.
Allowed cipher suites with PFS in TLS v1.3:

Cipher suites	Reference specification
TLS_AES_256_GCM_SHA384	RFC 8446
TLS_CHACHA20_POLY1305_SHA256	RFC 8446
TLS_AES_128_GCM_SHA256	RFC 8446
TLS_AES_128_CCM_SHA256	RFC 8446

Any cipher suites specified in the future that correspond to the requirements defined in this document can be used as well. For example, this applies for cipher suites that use a hash function from the SHA-3 family.

References:
[1] Bundesamt für Sicherheit in der Informationstechnik, TR-02102-2, version 2023-01
[2] https://ciphersuite.info/cs/?security=secure&sort=asc
[3] https://ciphersuite.info/cs/?singlepage=true&security=recommended#

Motivation: The usage of modern cipher suites with Perfect Forward Secrecy protects the transport security in TLS.

Implementation example: TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Disruption of availability

- Denial of executed activities
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.50-41/7.0

Req 18	For TLS, Diffie Hellman groups according to the table below must be used.

User roles: Operation, Development, Integration

The Diffie Hellman groups is used for key exchange with Perfect Forward Secrecy (PFS). Generally, a distinction is made between elliptic curve groups and finite field groups (mod p).

The following table contains the allowed Diffie Hellman groups.
Allowed Diffie Helman groups for use in TLS:

Diffie Hellman group	IANA-No.	Referenzspezifikation
brainpoolP512r1	33	RFC 7027
secp521r1	25	RFC 8422
x448	30	RFC 8422
brainpoolP384r1	27	RFC 7027
secp384r1	24	RFC 8422
brainpoolP256r1	26	RFC 7027
secp256r1	23	RFC 8422
x25519	29	RFC 8422
ffdhe4096	258	RFC 7919
ffdhe3072	257	RFC 7919

Remark on x448 and x25519:
x448 und x25519 are not (explicitly) recommended by BSI, but no weaknesses are known so far, and therefore they are to be classified as secure.

Remark on group 256:
Diffie Hellman group 256 (IANA-No.256) has a key length of 2048 bit [1] [2] and may only be used in legacy systems until the end of the **year 2025 [2]**. The group must be substituted by a stronger method (according to the enumeration above).

Remark on groups 256, 258 and 257:
Those groups are more vulnerable against the DHeater (DoS) attacks on server side than elliptic curve DH groups. Therefore, the brainpool and NIST (secp) groups should be preferred.

References:
[1] Bundesamt für Sicherheit in der Informationstechnik, TR-02102-2, Version 2023-01
[2] SOG-IS Crypto Evaluation Scheme: Agreed Cryptographic Mechanisms, v1.3, February 2023

Motivation: Standardized Diffie Hellman groups use secure parameters and speed up the key exchange.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data

- Unauthorized use of services or resources
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.50-42/7.0

| Req 19 | For TLS, digital certificates from an appropriate certification authority with a sufficient key length and limited validity must be used. |

User roles: Operation, Development, Integration

In TLS, digital certificates are used during the TLS handshake. TLS servers must use an appropriate TLS certificate. Clients need a certificate if mutual authentication is required.

TLS certificates for web servers that are accessible from the internet must be issued by public certification authorities that are classified as trustworthy by browsers and operating systems. These can be ordered, for example, via the service "TeleSec ServerPass" (please refer https://www.telesec.de/de/serverpass).

Regarding key lengths, validity and further configuration options, the Certificate Policy of the Certification Authority must be considered.

For web servers that are used exclusively for internal applications and are not accessible from the internet, digital certificates from a private (internal) Certification Authority can be used.

The minimal requirements according to the following table must be considered for each type of TLS certificates, this means also for client certificates:

Algorithm family	Key length	Hash algorithm
Elliptic Curve	250 bit	SHA-3, SHA-2 with an output length 256 bit
Digital Signature Algorithm (DSA)	3000 bit	SHA-3, SHA-2 with an output length 256 bit
RSA	3000 bit	SHA-3, SHA-2 with an output length 256 bit

Remarks on DSA and RSA certificates:
For DSA and RSA, key lengths smaller than 3000 bits may only be used in legacy systems [BSI TR 02102-1] until **end of the year 2025** [2] and should be substituted at the next opportunity. Because of the better performance, elliptic curve (EC-DSA) certificates shall be preferred (if supported and technically doable).
RSA-PKCS#1 v1.5 may only be used in legacy systems and should be (if feasible) substituted at the earliest opportunity [BSI TR 02102-1].

Restrictions on SHA-224/SHA-3-224:
SHA-224/SHA-3-224 may only be used in legacy systems and must be substituted by a stronger hash algorithm with an output length of at least 256 bits at the next opportunity.

The validity period of public TLS server certificates (issued by a certification authority, which issues certificates according to the specifications of the [CA/Browser Forum]) must not exceed 397 days. For other, internal TLS certificates, a validity period of 3 years should not be exceeded.

References:
[BSI TR 02102-1] Bundesamt für Sicherheit in der Informationstechnik: Cryptographic Mechanisms: Recommendations and Key Lengths, TR-02102-1, Version 2023-01

[1] Bundesamt für Sicherheit in der Informationstechnik, TR-02102-2, Version 2023-01
[2] SOG-IS Crypto Evaluation Scheme: Agreed Cryptographic Mechanisms, v1.3, February 2023
[CA/Browser Forum] https://cabforum.org/baseline-requirements-documents/

Motivation: Digital certificates form the basis of the authentication and build up trust. Without sufficiently strong authentication, man-in-the-middle attacks are possible.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized access or tapping of data
- Unauthorized modification of data
- Unauthorized use of services or resources
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

For this requirement the following warranty objectives are relevant:

ID: 3.50-43/7.0

8. Logging

Req 20	The system clock must be synchronized to an accurate reference time (Time Standard).

A time reference source must be used which provides a time signal based on the Coordinated Universal Time ("UTC" = "**U**niversal **T**ime **C**oordinated").

Please Note: The UTC-synchronized system time may be transformed to local time using a corresponding timezone configuration setup for any output of time information, as long as this timezone adjustment is fully accountable.

Systems belonging to the same security domain must synchronize to one and the same time reference source.

Motivation: Reference time synchronization may be a technical prerequisite for many time-dependent mechanisms, for example: Validation of Certificates; Authentication. It is also much-needed to generate exact timestamps for logged events, since without the often required time-related correlation in case of a Security Incident or during a Problem Analysis cannot be achieved.

Implementation example: some valid time reference sources:

- trustworthy NTP ("**N**etwork**T**ime**P**rotocol") Server on the IP network
- DCF77 radio signal received via a physically connected receiver
- GPS radio signal received via a physically connected receiver

For this requirement the following threats are relevant:
- Disruption of availability
- Denial of executed activities
- Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.01-32/7.0

Req 21	Events must be logged with an exact time stamp and trigger alarms depending on their criticality. The logging of users/user actions and payloads must be coordinated with data protection and data security.

Events must be given an event identifier according to their event type.

Security relevant events must be specially marked in order to be able to trigger alarms as required.
Suitable event identifiers are, for example „info", „error", „warning", „alert", „emergency".These event labels can be used to automatically trigger alarms and facilitate troubleshooting.
It is also possible to control deletion periods and log access authorizations based on these event labels.

Motivation: To ensure safe operation and error analysis, a logging, monitoring and alarming concept must be created. Safety-relevant events must be immediately forwarded to a suitable company, which can analyse the problem and take countermeasures.

Implementation example: The event identifier as well as the need for an alarm depends on the need for protection and the interface through which the web service is accessible.

A web service that can be accessed from the Internet is more likely to be subject to validation and authorization errors, so an alarm is not always appropriate. However, if this occurs with a web service that can only be accessed from trusted areas, e.g. from its own namespace, administrative special networks or M2M connections, this can be an indication of an intruder.

Likewise, the need for an alarm may depend on the frequency of the event.
An access attempt to access a resource without appropriate authorization or a validation error may be irrelevant if it oc-

curs once. If this happens frequently, it can be an indication of a targeted attack on the application or the application's functions are not working properly.

The following table gives examples of events, event identifiers, and also the log context to be stored.

Category	Event	Event Identifier	Log Context
Access	Access to the web service	info	Applications-, Container-ID, Authenticity, IP
Validation error	Incorrect data format	error, debug	Applications-, Container-ID, Authenticity, IP, Payload
	Incorrect encoding	error, debug	Applications-, Container-ID, Authenticity, IP, Payload
	incorrect daten elements	error, debug	Applications-, Container-ID, Authenticity, IP, Payload
	validation against formal definition fails	error, debug	Applications-, Container-ID, Authenticity, IP, Payload
	Incorrect range of values	error, debug	Applications-, Container-ID, Authenticity, IP, Payload
Output error	Datenbase / supplying systems not accessible	error, debug	Applications-, Container-ID, Authenticity, Request-ID, IP
	Error in the database records	error, debug	Applications-, Container-ID, Authenticity, Request-ID, IP
	Output incomplete	error, debug	Applications-, Container-ID, Authenticity, Request-ID, IP
Authorisation error	Access to resources without proper authorization	warning	Applications-, Container-ID, Authenticity, IP, Payload
	Signature validation error for JW Token	alert	Applications-, Container-ID, Authenticity, IP, Payload
	Perform actions that do not match the role / ACL	alert	Applications-, Container-ID, Authenticity, IP, Payload
Authentication error	Failed	warning	Applications-, Container-ID, IP
	Success	info	Applications-, Container-ID, IP
Privileged actions	Add / Delete of accounts	trace	Applications-, Container-ID, Authenticity, IP
	Change of privileges	trace	Applications-, Container-ID, Authenticity, IP
	Exporting data requiring protection	trace	Applications-, Container-ID, Authenticity, IP
	Import of daten	trace	Applications-, Container-ID, Authenticity, IP

	Change of configuration	trace	Applications-, Container-ID, Authenticity, IP
Runtime error	Crash / restart of the application / container	emergency	Applications-, Container-ID, Stacktrace
	connectivity problems	emergency	Applications-, Container-ID
	performance problems	alert	Applications-, Container-ID
	Virus detection e.g. file upload	alert	Applications-, Container-ID, Authenticity, IP

For this requirement the following threats are relevant:
• Denial of executed activities
• Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.02-21/7.0

Req 22	Security-relevant logging data must be forwarded to a separate log server immediately after it has been generated.

Logging data must be forwarded to a separate log server immediately after it has been generated. Standardized protocols such as Syslog, SNMPv3 should be preferred.

Motivation: If logging data is only stored locally, it can be manipulated by an attacker who succeeds in compromising the system in order to conceal his attack and any manipulation he has performed on the system. This is the reason why the forwarding must be done immediately after the event occurred.

For this requirement the following threats are relevant:
• Unauthorized modification of data
• Disruption of availability
• Denial of executed activities
• Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.01-35/7.0

Req 23	Applicable retention and deletion periods must be observed for security-relevant logging data that is recorded locally.

From an IT security perspective, local storage of security-relevant logging data on a system is not mandatory. Since the local storage can be damaged in the event of system malfunctions or manipulated by a successful attacker, it can only be used to a limited extent for security-related or forensic analyses. Accordingly, it is relevant for IT security that logging data is forwarded to a separate log server.

Local storage can nevertheless take place; for example, if local storage is initially indispensable when generating the logging data due to technical processes or if there are justified operational interests in also keeping logging data available locally.

The following basic rules must be taken into account when storing logging data locally:
• Security-related logging data must be retained for a period of 90 days.

(*This requirement only applies if no additional forwarding to a separate log server is implemented on the system and the logging data is therefore only recorded locally.*)

- After 90 days, stored logging data must be deleted immediately.

Deviances

Different retention periods and deletion periods may exist due to legal or regulatory requirements (especially in connection with personal data) or may be defined by contractual agreements. In these cases, the applicable periods must be agreed individually with a Project Security Manager (PSM) / Data Privacy Advisor (DPA) or are specified by them.

Motivation: Logging data is an immensely important IT security tool for preventing, detecting and clearing up system faults, security and data privacy incidents. On the other hand, the recording of logging data, like any other data processing, is also subject to legal and regulatory requirements. Accordingly, guidelines must be adhered to that reconcile the two.

Implementation example: Taking into account the current legal situation and applicable data privacy regulations, the following deletion periods for locally stored security-relevant logging data are implemented on an exemplary telecommunications system:

- Standard System Logs: Deletion after 90 days at the latest

- Logging of public IP addresses: Deletion (or anonymization) after 7 days at the latest

- Logging of the assignment of dynamic public IP addresses by the telecommunication solution: Deletion after 7 days at the latest

- Logging of non-billing-relevant call detail records: Deletion after 7 days at the latest

- Logging of the content of e-mail and SMS: Deletion after 24 hours at the latest

- Logging of the domain queries handled by the DNS server of the telecommunications solution: Deletion after 24 hours at the latest

For this requirement the following threats are relevant:
- Unauthorized access or tapping of data
- Denial of executed activities
- Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.01-34/7.0

Req 24	For security-relevant logging data that is forwarded to the separate log server, compliance with the applicable retention and deletion periods must be ensured.

The following basic rules must be taken into account:

- security-related logging data must be retained for a period of 90 days on the separate log server.

- after 90 days, stored logging data must be deleted immediately on the separate log server.

Deviances

Different retention periods and deletion periods may exist due to legal or regulatory requirements (especially in connection with personal data) or may be defined by contractual agreements. In these cases, the applicable periods must be agreed individually with a Project Security Manager (PSM) / Data Privacy Advisor (DSB) or are specified by them.

Log server under the responsibility of a third party

If the selected separate log server is not within the same operational responsibility as the source system of the loggin

data, it must be ensured that the responsible operator of the log server is aware of the valid parameters for the logging data to be received and that they are adhered to in accordance with the regulations mentioned here.

Motivation: Logging data is an immensely important IT security tool for preventing, detecting and clearing up system faults, security and data privacy incidents. On the other hand, the recording of logging data, like any other data processing, is also subject to legal and regulatory requirements. Accordingly, guidelines must be adhered to that reconcile the two.

Implementation example: Taking into account the current legal situation and applicable data privacy regulations, the following deletion periods for forwarded security-relevant logging data from an exemplary telecommunications system are implemented on the separate log server:

- Standard System Logs: Deletion after 90 days at the latest

- Logging of public IP addresses: Deletion (or anonymization) after 7 days at the latest

- Logging of the assignment of dynamic public IP addresses by the telecommunication solution: Deletion after 7 days at the latest

- Logging of non-billing-relevant call detail records: Deletion after 7 days at the latest

- Logging of the content of e-mail and SMS: Deletion after 24 hours at the latest

- Logging of the domain queries handled by the DNS server of the telecommunications solution: Deletion after 24 hours at the latest

For this requirement the following threats are relevant:
- Unauthorized access or tapping of data
- Denial of executed activities
- Unnoticeable feasible attacks

For this requirement the following warranty objectives are relevant:

ID: 3.01-36/7.0

Req 25	The system must provide logging data that is required to detect the system-specific relevant forms of attack in a SIEM.

The forms of attack that are typically to be expected for the present system must be systematically analyzed and identified.
The MITRE Attack Matrix (https://attack.mitre.org) can be used as a structured guide during such an identification.

It must be ensured that the system generates appropriate logging data on events that are or may be related to these identified forms of attack and that can be used to detect an attack that is taking place.

The logging data must be sent to a SIEM immediately after the system event occurs.
SIEM (Security Information & Event Management) solutions collect event log data from various source systems, correlate it and evaluate it automatically in real time in order to detect anomalous activities such as ongoing attacks on IT/NT systems and to be able to initiate alarms or countermeasures.
The immediate receipt of system events is therefore absolutely crucial for the SIEM to fulfill its protective functions.

Note:
The immediate need to connect a system to a SIEM is specifically regulated by the separate "Operation" security requirements catalogs.
If the present system does not fall under this need, the requirement may be answered as "not applicable".

Motivation: A SIEM as an automated detection system for attacks can only be effective if it continuously receives sufficient and, above all, system-specific relevant event messages from the infrastructures and systems to be monitored. General standard event messages may not be sufficient to achieve an adequate level of detection and only allow rudimentary attack detections.

Implementation example: An example system allows end users to log in using a username and password. One of the typical forms of attack for this system would be to try to discover and take over user accounts with weak or frequently used passwords by means of automated password testing (dictionary or brute force attack). The example system is configured to record every failed login event in system protocols ("logs"). By routing this logging data in parallel to a SIEM, the SIEM can detect in real time that an attack is obviously taking place, alert it and thus enable immediate countermeasures.

ID: 3.01-37/7.0