Security requirement

IT Virtualization

Deutsche Telekom Group

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Summary
Since the range of virtualization solutions is extremely broad, this document is valid for the following variants :

- Server virtualization
- Client virtualization
- Client-based virtualization solutions
- Desktop virtualization
- Application virtualization
- Application streaming
- Terminal services

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1. Introduction

This security document has been prepared based on the general security policies of the Group.

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 in 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.

Note:
Security requirements for "Containerisation with docker" can be found within security requirement
"3.67 Application Container and Container Orchestrator Security"

Since the range of virtualization solutions is extremely broad, this basic document is divided into several groups:

Chapter 2, Basic requirements

Chapter 3, Virtualization types and virtual systems

- Server virtualization
- Client virtualization
- Client-based virtualization solutions
- Desktop virtualization

Chapter 4, Terminal services and application publishing

- Application virtualization
- Application streaming
- Terminal services

To ensure a common understanding of the different virtualization techniques, these different types are described below.

Sever virtualization
brings an additional layer (the hypervisor) between the hardware and operating system (type 1 hypervisor), which is also a new attack surface, that must not be disregarded in construction and operation. In the case of safety problems of the virtualization layer (hypervisor), all the virtual machines located on the virtualization server are affected and may be at risk. Therefore vulnerabilities of a virtualization server must be regarded always prioritized.

Brief description:
Complete server instance (separate operating system) is running on the virtualization server

Product examples:
Citrix XenServer, VMware vSphere, Microsoft Hyper-V

Client virtualization
makes it possible to install a hypervisor on a client device (PC, laptop, etc.), on which virtual machines can be operated independently of each other. The hypervisor resides between the hardware and the operating system (Type 1 hypervisor), which distinguishes this form of virtualization from the form described below: 'client-based virtualization'.

It allows very different operating systems or operating environments to be operated concurrently on one and the same hardware base. This solution depends to a great degree on the hardware that is used, so that it can only be suitably deployed after performing a hardware compatibility analysis.

Brief description:
Complete client instance (separate operating system) is launched on the virtualization client (hypervisor).

Product examples:
XenClient, Qubes OS

Client based virtualization

make it possible to install virtual machines on a client device (PC, laptop, etc.), which can be operated simultaneously independently of each other.

The operating system running on the physical client resides between the hardware and (type 2) hypervisor for the virtual machines.

It allows very different operating systems or operating environments to be operated concurrently on one and the same hardware base.

Brief description:
Complete work environment (desktop incl. operating system) is launched on the client.

Product examples:
VMware Workstation/Fusion/Player, Microsoft Virtual PC, Oracle Virtual Box

Desktop virtualization / VDI (Virtual Desktop Infrastructure)

gives users the chance to install virtual machines on a server that can be operated independently of each other in parallel and used via a network connection from a terminal device.

In contrast to the form described below, application virtualization, this involves providing a complete desktop instead of specific individual applications. This increases the attack surface since more applications are available to the user, for example applications that were automatically supplied with the operating system.

Brief description:
Complete work interface (desktop including operating system) is launched on the server.

Product examples:
Citrix XenDesktop, VMware View

Application virtualization

in contrast to the form described above, desktop virtualization, involves providing a single application instead of a complete desktop. This decreases the attack surface since no additional applications are available to the user, for example those that are automatically supplied with the operating system. The application is launched on the virtualization server and only KVM (keyboard, video, mouse) transferred from/to the client. Data processing takes place on the server and is only displayed on the client.

Brief description:
Individual applications are launched on the server.

Product example:
Citrix XenApp, Docker

Note: The delivery of applications ("Application Publishing") SHOULD be preferred way than provisioning of a complete workplace environments ("VDI").

Application streaming

is transmitted on demand from a server to the client (streaming) and launched there. Data processing takes place on the client.

Product examples:
Microsoft APP-V, Novell ZAV, VMware ThinApp

Terminal Services

A typical application case for use of a terminal server in an administration environment involves setting up a jumphost access, where the user of this server is not granted direct access to the underlying environment and its systems. The transparent user access is terminated on the terminal server and a new session launched from there, with appropriate filters, authorizations and logging.

The following requirements refer to terminal service-specific parts of the operating system of servers or to the terminal server service itself.

Since a terminal server environment can be accessed with various systems, the following information uses the term “terminal” as a collective term for conventional workstation PCs, thin clients, mobile terminals, and other devices. Which terminals may be used to access terminal services, or which prerequisites these have to meet, is not part of these security requirements. A terminal server environment shall be adapted explicitly to the relevant use case. This adjustment also involves approving applications within the use case. Without clarifying the rules specific to the use case, users shall not be able to see any applications within a terminal server session, or to start them.

A list (white list) of the applications that are required (legitimate applications), including accesses and authorizations, shall be defined in the user case-specific role and authorization concept.

The following authorizations refer to the user rights on a terminal server. These authorization specifications are necessary in order to obstruct any manipulation of the applications or the operating system.

Product examples:
Microsoft TS, NoMachine

2. General requirements

Req 1	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 soft-

ware), which must also be obtained and installed for the use of the software, these must be included in the extended integrity check.

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

ID: 3.01-2/8.0

Req 2	Unnecessary services must be disabled.

After the installation of systems and software products, supplier-preset, local or network-accessible services are often active that are not required for the operation and functionality of the specific system in the intended operating environment.

However, in principle only the services actually required may be active on a system.

Accordingly, all services that are not required on a system must be completely disabled immediately after installation. It must be ensured that these services remain disabled even after the system is restarted.

Motivation: Active services that are not required unnecessarily increase the attack surface of a system and, as a direct consequence, the risk of a successful compromise. This risk can be further increased if - as is often observed with services that are not required - a targeted examination and optimization of the configuration with regard to security does not take place sufficiently.

For this requirement the following threats are relevant:
- Unauthorized use of services or resources
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-5/8.0

Req 3	The accessibility of activated services must be restricted.

In principle, a service provided must be completely deactivated on all interfaces of the system through which accessibility of the service is not required for the proper operation of the system. The deactivation is primarily to be implemented by a corresponding configuration of the service or operating system. In cases where the available configuration options do not allow deactivation on individual interfaces, a local filter ("Host Firewall") may instead be used on the system to block access to the service via unnecessary interfaces.

The accessibility of a service via the required interfaces must also be restricted to legitimate communication partners. The restriction must be implemented by a corresponding configuration of the service or operating system or by means of a local filter ("Host Firewall"). Alternatively, this task may be outsourced to a network-side filter element, provided that the system is located in a separate network segment and communication with this segment is only possible via the network-side filter element.

Motivation: By deactivating services on interfaces through which accessibility is not necessary, as well as by restricting possible communication partners, the attack surface offered by a system can be greatly reduced.

Implementation example: An SNMP service used to monitor a system is enabled exclusively on the dedicated management network interface of the system. A firewall also regulates that only the legitimate monitoring system of the infrastructure environment can reach this service.

For this requirement the following threats are relevant:
- Unauthorized use of services or resources
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-6/8.0

Req 4	Only required software may be used on the system.

In the installation routines for software provided by the supplier, individual components of the software are often preselected as standard installations, which are not necessary for the operation and function of a specific system. This also includes parts of software that are installed as application examples (e.g. default web pages, sample databases, test data), but are typically not used afterwards.

Such components must be specifically deselected (not installed) during the installation of the system or - if deselection during installation is not possible - removed immediately afterwards.

In principle, no software may be used that is not required for the operation, maintenance or function of the system.

Motivation: Vulnerabilities in a system's software are gateways for attackers. By uninstalling unnecessary components, the potential attack surfaces can be significantly reduced.

For this requirement the following threats are relevant:
- Unauthorized use of services or resources
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-3/8.0

Req 5	Known vulnerabilities in the software or hardware of the system must be fixed or protected against misuse.

Known vulnerabilities in software and hardware components must be fixed by installing available system updates from the supplier (e.g. patches, updates/upgrades). Alternatively, the use of workarounds (acute solutions that do not fix the vulnerability, but effectively prevent exploitation) is permissible. Workarounds should only be used temporarily and should be replaced by a regular system update as soon as possible in order to completely close the vulnerabilities.

Components that contain known, unrecoverable vulnerabilities must not be used in a system.

The treatment of newly discovered vulnerabilities must also be continuously ensured for the entire deployment phase of the system and implemented in the continuous operating processes of security patch management.

Motivation: The use of components without fixing contained vulnerabilities significantly increases the risk of a successful compromise. The attacker is additionally favored by the fact that, as a rule, not only detailed information on vulnerabilities that have already become known is openly available, but often also already adapted attack tools that facilitate active exploitation.

Implementation example: Following the initial installation of an operating system from an official installation medium, all currently available patches and security updates are installed.

Additional information:
The primary sources of known vulnerabilities in software/hardware are lists in the release notes as well as the security advisories from the official reporting channels of the supplier or independent CERTs. In particular, the reporting channels are sensibly integrated into continuous processes of security patch management for a system, so that newly discovered vulnerabilities can be registered promptly and led into operational remedial measures.
As a complementary measure to the detection of potentially still contained types of vulnerabilities that have in principle already become known, targeted vulnerability investigations of the system can be carried out. Particularly specialized tools such as automated vulnerability scanners are suitable for this purpose. Examples include: Tenable Nessus, Qualys Scanner Appliance.

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

ID: 3.01-10/8.0

Req 6	The system must be implemented robustly against unexpected inputs.

Data transferred to the system must first be validated before further processing to ensure that the data corresponds to the expected data type and format. This is intended to eliminate the risk of manipulation of system processes and states by appropriately constructed data content. Validation must be carried out for any data that is transferred to the system. Examples include user input, values in data fields, and log contents.

The following typical implementation mistakes must be avoided:
- lack of validation of the length of passed data
- Incorrect assumptions about the format of data
- lack of validation of received data for conformity with the specification
- Inadequate handling of protocol deviations in received data
- Insufficient limitation of recursion when parsing complex data formats
- Insufficient implementation of whitelisting or escaping to protect against inputs outside the valid value range

Motivation: An attacker can use specifically engineered data content to try to put a system that does not sufficiently validate received data before internal processing into an unstable state or to trigger unauthorized actions within the system. The damage potential of such attacks depends on the individual system, but has a theoretical range from uncontrolled system crashes to a controlled execution of specially injected code and the resulting complete compromise of a system.

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
- Unnoticeable feasible attacks

ID: 3.01-11/8.0

Req 7	The virtualization system must be configured, in accordance with the respective manufacturer or hardening guidelines 'security best practices'.

If internal hardening guidelines exist, the machines should be implemented as described. If hardening guidelines do not exist, the security best practices, that is, recommendations from the manufacturers of virtualization solutions (e.g. Citrix, VMware or Microsoft) should be implemented. This experience is based on many installations and tests of security-specific settings by the manufacturer. The implementation of the internal and the manufacturer guidelines is not necessary, but could be checked for every solution.

Motivation: Implementing the best practice settings from manufacturers that are adapted to Deutsche Telekom's needs will result in security settings that are based on years of practical experience. Settings are also made that may not have been considered as part of an individual project since they do not have any obvious or active relevance in the project.

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
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.35-7/7.0

Req 8	The virtualization software must have or must be configured only to meet the necessary functions for the request.

Motivation: The more line code software has, the more errors or security vulnerabilities it may contain and will have to be eliminated (errors per line of code).

Implementation example: There are hypervisors that differ in the fact that one version contains a console OS in the kernel (ESX) whereas another version (ESXi) from the same vendor does not. In this case, the hypervisor code base footprint is reduced from 2 GB (ESX) to 150 MB (ESXi). To get a hint for the different sizes of installation types, you can look at the sum of the data from the installation media or the installation file.

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

ID: 3.35-8/7.0

Req 9	The integrity of the virtualization software (hypervisor) must be checked before execution.

The hypervisor is a critical component and should be protected from manipulation. Regular checks at system reboot helps to detect changes and manipulation before they can take place. The usage of hardware supported technologies should be checked.
To be sure that the integrity of the software is certified before execution (installation), the installation media should be downloaded only from trustworthy sources (the manufacture website) and be checked by hashes (e.g. MD5, SHA256).

Motivation: Manipulations of the virtualization software affect all virtual machines running on this layer. Therefore, the hypervisor should be regularly checked and specially protected.

Implementation example: Such checks (file integrity monitoring) could be done with appropriate tools such as OSSEC or with support of hardware solutions such as Trusted Platform Module (TPM). The support of the hypervisor for the corresponding solution should be confirmed in advance by the manufacturer.

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

ID: 3.35-9/7.0

Req 10	Devices, software and hardware components that are not needed by the virtual machine must be disabled on the virtualization server.

In order to minimize the attack surface of the virtual machines, the virtual hardware or devices (e.g. virtual network cards, drivers) that are not needed for operation shall be disabled or deleted for the virtual machines on the virtual host system.

Motivation: Each additional device offers additional points of attack on the virtual system.

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

ID: 3.35-10/7.0

Req 11	The communication channel from the virtual machine to the virtualization server and vice versa must be restricted.

Virtualization software frequently uses special device drivers to offer virtual machines internal interfaces (API) for direct communication with the virtualization server. This makes it possible to exchange, for example, state and configuration information on the virtualized operating system (disk capacity, IP address), log messages, contents of the clipboard, performance data or instructions for disk expansion. This interface is not standardized and not sufficiently documented. It therefore represents a poorly calculable risk, and offers attackers additional ways of compromising the virtualization server or executing a denial of service attack from inside the virtual machine. Configuration of this communication channel shall be carried out on the virtualization server. It is not sufficient to disable the interface on the virtual machine by de-installing guest tools, since the malware itself may contain the program code it needs to communicate with the virtualization server.

The communication channel from the virtualization server to the virtual machines (API) is used to execute actions on

the virtual machines (restart, software installation, performance data of the virtual server, scripting, etc.) or to transfer data. This requires additional software (guest tools) which is executed with extremely high permissions to be installed on the virtual machine. Most critical are functions that permit virtualization server administrators to execute scripts on the virtual machines or virtualization server. These functions must be disabled.

Motivation: The direct interface between the virtual machines and the virtualization server is particularly critical, since it is difficult to control. It offers attackers additional points of attack against the virtualization server and shall therefore be restricted.

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
- Unnoticeable feasible attacks
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.35-11/7.0

Req 12	Virtualization solutions must be protected in such a way, that they do not circumvent any security mechanisms.

In virtualization solutions security mechanisms shall not be circumvented.

Other examples or keywords for this requirement are: local firewall, IDS/IPS, proxy restrictions, local ACLs, 'enforce to safe data encrypted on a external device'.

Motivation: Increase security by using all the existing security interfaces without bypassing them by shortening the communication paths.

Implementation example: This means, for example, firewalls that exist between two networks, however, could be circumvented by a direct communication between virtual machines on local interfaces.

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
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.35-12/7.0

Req 13	Stored data in need of protection must be protected against unauthorized access, modification and deletion.

The need for protection of stored data depends on its classification (e.g. according to applicable legal data privacy requirements, regulatory requirements, contractual obligations), the potential damage in the event of its misuse, and other relevant factors (e.g. the location of storage). The nature and extent of protective measures must be appropriately chosen.
Stored authentication attributes such as passwords, private keys, tokens or certificates etc. are generally considered to be in need of protection. Data that determines the functionality and security-relevant behavior of a system (e.g. system configuration files, operating systems and kernels, drivers) are also considered to be fundamentally in need of protection.

Compliance with the protection objectives of confidentiality, integrity and availability must be consistently guaranteed for stored data in need of protection. This also applies during only short-term storage (e.g. when storing in a web

cache or in a temporary folder within a data processing chain).

Basically, access to data in need of protection in a system must be fully regulated on the basis of technically implemented authorization assignments and controls.
If such technical access control alone is no longer sufficient to ensure the necessary protection requirements of stored data, or if its effectiveness cannot be consistently ensured, additional cryptographic methods (e.g. encryption, signing, hashing) must be implemented. Cryptographic methods used for the storage of data must be recognised and effective for this purpose and must not have any known vulnerabilities.

Motivation: The storage of data on a system without adequate protection enables an attacker to view, use, disseminate, modify or destroy it without authorization. This potentially opens up additional attack vectors on the immediate and connected other systems and can lead to significant failures, loss of control and damage as well as resulting penalties and loss of reputation towards customers and business partners.

Implementation example: [Example 1]
A system exports data for transport to mobile media. Since the system's technical access control at the file permission level no longer applies as soon as the mobile media is removed from the system, additional measures must be taken to protect the data. Before the system writes the data to the mobile media, it is encrypted accordingly using a suitable algorithm. The associated encryption key is exchanged on a separate channel so that the data can be decrypted and processed again in the legitimate target system. An attacker who takes possession of the mobile media, on the other hand, has no access to the data.

[Example 2]
Only cryptographic hashes of passwords generated with a secure password hashing method are stored in the local user database of a system. For the system, these hashes are sufficient to authenticate users when they log on to the system. However, if an attacker can copy the user database, he does not immediately come into possession of plaintext passwords with which he could log on to the system on behalf of the users.

[Example 3]
On a system, the configuration files of the Web server can only be written by the legitimate admin in which corresponding permissions have been set in the file system. The access control of the operating system kernel thus denies all other users of the system to make changes to the configuration files of the web server; including the web server service account itself, which also reduces the attack surface from the outside in case of vulnerabilities in the web server.

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

ID: 3.01-14/8.0

Req 14	Data in need of protection must be protected against unauthorized access and modification during transmission.

The need for protection of data to be transmitted depends on its classification (e.g. according to applicable legal data privacy requirements, regulatory requirements, contractual obligations), the potential damage in the event of its misuse, and other relevant factors (e.g. transmission via public networks). The nature and extent of the protective measures must be appropriately chosen.
Authentication attributes such as passwords or tokens etc. are generally considered to be in need of protection. Data that determines the functionality and security-relevant behavior of a system (e.g. updates & patches, configuration parameters, remote maintenance, control via APIs) are also considered to be fundamentally in need of protection.

Compliance with the protection objectives of confidentiality and integrity must be consistently guaranteed during the transmission of data in need of protection.

As a rule, this requires the implementation of cryptographic methods (e.g. encryption, signatures, Hashes).
Cryptographic methods may

- be applied directly to the data before transmission, which can make subsequent transmission acceptable even

via insecure channels
- be used on the transmission channel to create a secure channel and protect any kind of data passing through it
- or be implemented as a combination of both.

Cryptographic methods used for the transmission of data must be recognized and effective for this purpose and must have no known vulnerabilities.

Motivation: The transmission of data without adequate protection enables an attacker to intercept, use, disseminate, modify or remove it from transmission without authorization. This potentially opens up further attack vectors on the immediate target systems as well as connected other systems and can lead to significant failures, loss of control and damage as well as resulting penalty claims and reputational losses towards customers and business partners.

Implementation example: [Example 1]
Confidential documents are encrypted before they are sent by e-mail to the customer.

[Example 2]
An administrator configures a new cloud application over the Internet. Access is via a TLS-encrypted connection ("https").

[Example 3]
A system obtains automatic software updates from an update server. The update server delivers the software updates cryptographically signed. The system can thus validate the received software updates and reliably rule out that they have been manipulated during transmission.

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

ID: 3.01-15/8.0

3. Virtualization types and virtual systems

Req 15	The system must be protected against overload situations.

A system must have protective mechanisms that prevent overload situations as far as possible.
In particular, a partial or complete impairment of the availability of the system must be avoided.

Examples of possible protective measures are:

- Limiting the amount of memory (RAM) available per application
- Limiting the maximum sessions of a web application
- Limiting the maximum size of a dataset
- Limiting CPU resources per process
- Prioritizing processes
- Limiting the number or size of transactions by a user or from an IP address over time

Note:
A system can usually not protect itself against network-based attacks with extremely high data or packet rates, the so-called "Distributed Denial of Service" (DDoS) attacks. To defend against DDoS attacks, an upstream solution in the network layer is required.

Motivation: Attackers can try to use up the resources of a system with targeted resource-intensive or large-volume requests, so that the system can no longer fulfill its regular tasks or intended task volumes and the availability of the services offered is effectively disrupted. Limiting the maximum resources that can be used per request made to the system is a fundamental measure to reduce the impact of such denial-of-service (DoS) attacks.

For this requirement the following threats are relevant:
- Unauthorized use of services or resources
- Disruption of availability

ID: 3.01-12/8.0

Req 16	In overload situations, the system must behave in a predictable manner.

Even comprehensive native protections may not be able to prevent a system from becoming overloaded in extreme situations.

It must therefore be ensured that, in overload situations, the system does not switch to a state that overrides security-relevant functions or properties of the system. Performance losses (e.g. the reduction of the throughput of legitimate network packets or the number of answered server requests per period) are usually unavoidable in overload situations, but the regular functional behavior of the system must be fundamentally preserved.

In extreme cases, this can mean that a controlled shutdown of the system is more acceptable than continued operation in the event of uncontrolled failure of the security functions and thus the loss of system protection.

Motivation: By means of a denial-of-service attack, an attacker can try to overload a system in a targeted manner. If such a system then reacts unpredictably or fails its regular behavior, especially with regard to its security functions, this can open up an extended attack surface for the attacker on functions and data of the system and potentially endanger other linked systems.

Implementation example: A firewall that discards its filter rules in overload situations and forwards all packets without checking would not meet the requirement. In this case, blocking all packets by shutting down the firewall would be more acceptable than failing their regular task of protecting downstream systems.

For this requirement the following threats are relevant:
- Unauthorized use of services or resources
- Disruption of availability

- Unnoticeable feasible attacks

ID: 3.01-13/8.0

Req 17	If an service level agreement (SLA) exists for a system, a violation of the SLA by overbooking of resources must be prevented.

The virtualization server must prevent, that virtual machines could overbook resources and affect other virtual machines to fall below the threshold defined in the SLA. All resources (CPU, RAM, hard drive, network) shall therefore only be assigned statically (within limits) to the virtual machines. Changes to bookings should only be made following an administrator review or up to a threshold value that prevents disadvantages to other instances.

Motivation: A virtual machine that is compromised or contains a malfunction or administration error shall not prevent other virtual machines fulfilling their respective functions.

Implementation example: A limitation of the maximum transmitted data over an defined interface can have such a desired effect.

For this requirement the following threats are relevant:
- Disruption of availability

ID: 3.35-17/7.0

Req 18	Outputs and messages must not disclose information on internal structures of the system.

Information about the internal structures of a system, including the components used there, and corresponding implementation details are generally considered to be in need of protection.

In general, this concerns information on

- Product names and product identifiers of implemented system components
- Operating systems, middleware, backend software, software libraries and internal applications as well as their software versions
- installed service packs, patches, hotfixes
- Serial numbers of components as well as stored product licenses
- Database Structures

Typical examples of outputs and messages in which disclosure of such system information can potentially occur:

- Login windows and dialogs
- Error messages
- Status messages
- Banners of active network services
- System logs and log files
- Debug logs, stack traces

As far as it is technically feasible without impairing the function and operation of the system, the output of affected system information must always be deactivated.

Access to affected system information must only be possible for authorized users of the system. As a rule, this circle of authorized users is to be limited to administrators and operators of the system. Access for authorized monitoring and inventory systems within the operating environment is also permitted.

A permissible exception to these restrictions exists for specific individual system information, the disclosure of which is

technically mandatory for the intended function of the system in conjunction with third-party systems; For example, the presentation of supported protocols and their versions during the initial parameter negotiation in session setups between a client and a server.

Motivation: Information about the internal structures of a system can be used by an attacker to prepare attacks on the system extremely effective. For example, an attacker can derive any known vulnerabilities of a product from the software version in order to exploit them specifically during the attack on the system.

Implementation example: [Example 1]
Deactivation of the display of the product name and the installed version of a Web server in its delivered error web pages.

[Example 2]
Removal of the product name and the corresponding version string from the login banner of a deployed SSH server.

For this requirement the following threats are relevant:
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-9/8.0

Req 19	The system partition of virtual machines and copies must be encrypted.

Virtual machines are often stored in files on the virtualization server or SAN. It shall be ensured that no shadow copies or snapshots exist that are not encrypted. The encryption of the data partition of a virtual machine is defined by the data security level stored on the partition.

Motivation: It must be prevented that data can still be read form copies.

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

ID: 3.35-19/7.0

Req 20	The virtualization software must prevent virtual machines eavesdropping on packets in the network (promiscuous mode).

To prevent a virtual machine eavesdropping on network traffic, promiscuous mode shall be permanently disabled on all virtual machines. This setting should be centrally administered in the virtualization software of the host, to prevent a change by an administrative user of the virtual machine.

Motivation: This prevents a virtual machine eavesdropping on third-party network traffic.

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

ID: 3.35-20/7.0

Req 21	The virtualization software must prevent virtual machines sending data if its layer-2 address (MAC) changes and prevent virtual machines being able to receive data with faked layer-2 addresses (MAC).

Motivation: This prevents a virtual machine obtaining an IP address via DHCP, for example, which has firewall activation permissions, without having authorization to do so.

Implementation example: A cluster virtual machine for higher availability does not have to be compliant with this requirement.

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

ID: 3.35-21/7.0

Req 22	An effective change of the VLAN ID is not allowed to be done by the virtual machine.

The virtualization software must assign a dedicated VLAN for each virtual machine (-group). The configuration of the VLAN must be done by the virtualization server.

This requirement does not apply if each network interface of a virtual machine (-group) is assigned a exclusive physical network interface.

Motivation: Virtual machines could gain unauthorized access to networks that they cannot normally reach.

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

ID: 3.35-22/7.0

4. Terminal services and application publishing

Req 23	Communication between the user device and the terminal server must be encrypted.

The communication link between the user device (client) and the terminal server must be protected with continuously encryption which is considered to offer state of the art security. Encryption must be continuously activated from the start (logon) to the end (logoff) of the communication stream.

Motivation: State-of-the-art encryption must be used to prevent communication being eavesdropped or read (e.g. passwords or data) on the connection between client and server.

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

ID: 3.35-23/7.0

Req 24	Before a user session is mirrored or taken over, the access must be approved.

A user session must only be mirrored or taken over following explicit approval by the user who is logged on. Furthermore, the use of the mirroring or user session takeover functions must be agreed between Data Privacy and the employee representatives of the unit concerned (in Germany: the works council) before commissioning.

Motivation: To prevent unauthorized access to a user's terminal server session and, therefore, also to any company-critical data, the user concerned shall be given the option of protecting this data from third parties. This requirement results from the 'need-to-know' and 'need-to-see' principles of information and data protection.

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

ID: 3.35-24/7.0

Req 25	The assignment of local client drives and the access to interfaces and devices must be in accordance with the 'need to know'- and 'need to have' principle.

The integration of local drives of the user devices in a terminal server session must be assessed in function to the documented roles and authorization concept. In the normal case this function has to be disabled.

It must be ensured that users can access a terminal server session interfaces and only to the local user devices absolutely necessary. These components must be listed in roles and authorization concept. Examples of such interfaces and devices are:

- CD/DVD/BR drive
- Floppy drive
- external interfaces (such as USB, FireWire, Bluetooth, serial port or parallel port)
- Camera, microphone
- clipboard
- Network or local printer

Motivation: To stop a data transfer from internal data to external systems, the implementation of this requirement is strictly observed. To avoid unintended data transfer, this function is to be used on the terminal servers only in exceptional cases.

To reduce the potential attack surface of terminal server sessions, the interfaces must be disabled which are not necessary for the users job.

For this requirement the following threats are relevant:
- Unauthorized access or tapping of data
- Unauthorized use of services or resources
- Unnoticeable feasible attacks

ID: 3.35-25/7.0

Req 26	If only applications are deployed, the provision by 'application publishing' must preferably be implemented, to the provision of workplace environments ('VDI').

With terminal services in office communication networks, an application publishing (authorized starting of a terminal server application without access to the session desktop) must be preferred over provision of a complete desktop ('VDI').
In other environments, this measure may vary with an appropriate requirement by the use case.

Motivation: The 'application publishing' method ensures a smaller attack surface compared with 'OS streaming', since with the second method, the attacker is given access to the desktop.

Implementation example: An example of a 'application publishing' is the provision of a SAP client to use a back-end application.

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

ID: 3.35-26/7.0

Req 27	If applications are deployed virtually, it must be ensured that the manufacturer or developer supports the application running on virtualized platforms.

These applications must also be suitable for operation via application streaming and must not enable any control functions, monitoring or system configuration.

Motivation: To ensure that work is performed according to the law and to prevent any unwanted functions via application streaming, only legitimate applications (approved for use) may be installed.

Implementation example: Negative examples are (in office environments) programs for analyzing network traffic (sniffers) and programs for configuring devices or services (by cleartextprotocols such as telnet, etc.). These types of tools shall not be provided as a matter of course on workstation systems in office communication environments. The use of such applications in special environments shall be considered case by case.

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
- Unnoticeable feasible attacks

ID: 3.35-27/7.0

Req 28	It must be documented and ensured, that only legitimate applications (LA) can be started.

There must be no, not legalized applications (LA) which can be started by the user or application used by him. It may only be able to launch the LA for this user or use case applications (LA). Applications that are not legalized for the user, can be misused intentionally or unintentionally.

Motivation: Every unnecessary approval/ authorization & every unnecessary right increases the risk of a successful compromise.

Implementation example: To reduce a terminal server's attack surfaces, specific approvals (white lists) of the usable applications shall be established. This minimizes the possibility of exploiting security gaps in applications, since application startup is restricted to the corresponding user group (use case). In addition, this measure increases user friendliness and achieves improved license controls.

If only MS PowerPoint is provisioned for the user of a role (use case), this user shall not be able to start Internet Explorer, for example. Or, sniffer software, which analyzes network activity, shall only be used under certain circumstances and by certain individuals.

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

ID: 3.35-28/7.0

Req 29	Applications that are started by users or applications must be executed with minimal access permissions.

The launch of applications by users must be executed with low user rights. The user rights may not provide the possibility to change application on the server in any way, so this change would also apply to other users.

Users must have restricted permissions (such as 'Windows User Rights') in the terminal server session.

In order to minimize the effects of deliberate or accidental misconfiguration, users should just be able to see or to can change settings, that only affects themselves. This is especially true for applications to establish a connection to backend systems and having its own configuration .

Usually it is not necessary for users to start system releated programs. This includes applications to manage, troubleshoot and diagnose operating systems and -applications, even those with direct access to hardware components. Also, services must not be modified by the user (eg, start, stop).

Motivation: To prevent modifications to applications that are used by several users, it shall not be possible for the user of a use case to change or enhance an application.
To prevent changes to applications or systems, the terminal server environment by user, the user must have limited permissions in its session . This requirement is based on the principle of information and data protection 'need to have' and 'principle of least privilege'.

To hide information about backend systems and prevent misconfiguration by users, the configurations of the system environment and applications have to be protected against access and change. This is particularly true for configuration files of applications, as these often contain exact information about systems, that are useful to an attacker.

In order to prevent the reading or modifying the configurations of systems and devices by users, the start of programs providing such functionality is to deny. In special operating system or services provided by applications programs for managing, troubleshooting or diagnostics have to be protected .

Implementation example: An add-on added by a user to the internet explorer must not be automatically executed, if the Internet explorer is started by another user, because this represents a potential gateway for malware to infiltrate the

system and would enable the propagation of such malware.
It must not be possible for a user to view the current settings of the proxy server in the Internet Explorer or change.

No user is allowed to start command-line programs (such as PowerShell, cmd, etc.) or utilities (such as mmc, control, wmic, etc.), which are used to change the system or device configurations. The modification of services (eg, stopping antivirus programs) or their configuration (the change of the update server) must be prevented for a normal user. In environments outside of office communications platform the use of individual applications can be checked case by case in coordination with GIS or DIS.

System partition must be completely hidden for the user's view and may not be displayed even in a roundabout way. A change of server-specific files must also be prevented by appropriate file system permissions.

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

ID: 3.35-29/7.0

Req 30	It must be ensured that no additional operating system environments can be started within a terminal server session.

No additional operating system environments (virtual machines) shall be used on the application layer in the office network.

Motivation: The provision of an additional operating system running on the application layer would make it possible to undermine existing security mechanisms and to perform undesired, security-relevant actions. For this reason, such an instance shall not be operated on a terminal server.

Implementation example: No virtualization software (VMware Workstation, -Player or VirtualBox, etc.) must be installed on terminal servers. This requirement is additionally secured by a whitelist of approved applications.

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

ID: 3.35-30/7.0

Req 31	If a system can be used by multiple users at the same time, the start of applications must be logged and assigned to the user.

Sessions must be logged on the terminal service servers.

Motivation: Such events must be logged, in order to replicate a security incident in terms of who was active on the terminal server, with which application and when. Access to the log files must be restricted, according to existing regulations, in order to meet the requirements of the employee representatives.

Implementation example: If incidents in the form of denial of service attacks or brute force attacks etc. originate from a terminal server session or if misuse is conducted, a log must be available, so that the appropriate departments in the company can investigate in cases of misuse. In this way, wrongdoers can be determined and protective measures installed.

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

ID: 3.35-31/7.0

5. Operation

Req 32	The management software must support a administration separation for the virtual machines and the network.

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

ID: 3.35-32/7.0

Req 33	Virtual machines that contain sensitive data must be securely deleted at deactivation.

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

ID: 3.35-33/7.0

Req 34	The changeable configuration parameters which are necessary for the operation and safety must be monitored periodically.

In order to identify unauthorized changes to a configuration of a virtual machine or virtual host promptly, the configuration settings for the virtual environment (e.g. network settings, device configurations) must be monitored. This means for example, a unauthorized change in network settings for a VM or the unauthorized change of services used by the virtualization hosts as NTP.

Motivation: Ongoing monitoring of the configuration makes it possible to identify configuration errors and manipulation. Such monitoring can be carried out with suitable tools such as Veeam Reporter or Tripwire.

Implementation example: Such monitoring can be carried out with the support of appropriate management tools such as 'Veeam Reporter'.

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

ID: 3.35-34/7.0

Req 35	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

ID: 3.01-32/8.0

Req 36	Security-related events must be logged with an exact timestamp and a unique system reference.

Security-relevant are any events that may have an impact on the information security (confidentiality, integrity, availability) of a system or indicate its misuse. Systems must log the occurrence of security-related events.
In order to enable the assignment and evaluation of these events, they must be logged together with a unique system name (e.g. host name, IP or MAC address) and the exact time of occurrence ("time stamp"). At a minimum, the timestamp of a logged event must include the following information:

- date of the event (Year, Month, Day)
- time of the event (Hours, Minutes, Seconds)
- Timezone, those information belongs to

The security relevance of specific events depends on the type and function of the system as well as the data processed in it. Therefore, it is not possible to specify a uniform list of events that are relevant to security. Relevant events must be identified according to the system. The following list contains typical security-related events and is accordingly to be understood as a basic guide for the identification of security-relevant events for a particular system.

Security-related Event	Information to log to the event
Failed login attempts	• affected user account • number of failed attempts • source of access (IP address, client-ID/client-name, local console, ...)
System access via user accounts (including system accounts or technical user accounts)	• affected user account • Access start/end time (login/logout) • source of access (IP address, client-ID/client-name, local console, ...)
Modifications of user accounts (including system accounts or technical user accounts)	• user account used to make the modification • user account to which the modification was made • type of modification made (create, activate, deactivate, delete, password reset, ...)

Changes to role assignements/permissions of user accounts (including system accounts or technical user accounts)	• user account used to make the modification • user account to which the modification was made • name of the affected role, type of the affected permission • type of modification made (role/permission added, role/permission removed, ...)
Use/initiation of critical system functions	• user account used to make the use • name/type of system function used
Access to sensitive data processed in the system	• user account used to access the data • Name of the affected data field (the contents of the data field should not be logged to prevent data leakage via log files) • type of access (read, modify, delete, ...)
Abnormal increase in the utilization of system resources, such as memory, CPU, network, or disk access, over an extended period of time	• threshold of the affected system resource • duration of exceeding the threshold • threshold exceedance Depending on the individual system, sensible threshold values must be defined.
Other events that may provide evidence of attempted or successful attacks against the system ***)**	• individually depending on the type of event

***)** *This requires identifying the most important forms of attack that the system can typically expect and ensuring that events relevant to their detection are actually logged by the system. As a rule, this can only be guaranteed by the developer/manufacturer of the system.*

When logging, the applicable legal and operational regulations must be observed. The latter also include agreements that have been made with the company's social partners. Following these regulations logging of events is only allowed for a defined use case. Logging of events for doing a work control of employees is not allowed.

In addition - as for any data that is processed by a system - an appropriate protection requirement must also be taken into account and implemented for logging data; this applies to storage, transmission and access. In particular, if the logging data contains real data, the same protection requirements must be taken into account that is also used for the regular processing of this real data within the source system.

Motivation: Logging security-relevant events is a basic requirement for detecting ongoing attacks as well as attacks that have already occurred. This is the only way in which suitable measures can be taken to maintain or restore system security. Logging data could be used as evidence to take legal steps against attackers.

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

ID: 3.01-33/8.0

Req 37	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

ID: 3.01-34/8.0

Req 38	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

ID: 3.01-35/8.0

Req 39	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

ID: 3.01-36/8.0

Req 40	Security-relevant logging data must be provided to a security incident detection and response solution in near-real-time.

An acceptable detection and response solution for the purposes of this requirement must meet the following criteria:

- There is a continuous analysis and correlation of the logging data provided by connected IT/NT systems.
- The identification of threatening activities and ongoing attacks takes place on the basis of a continuously updated detection pattern database
- Integrated alerting processes trigger the initiation of countermeasures in the event of a find.

Such a solution is not the same as a log server in terms of its function. Accordingly, the provision to a detection and response solution must always be in addition to an existing forwarding to a log server. An exception exists if the log server used provides the logging data to a detection and response solution immediately after receipt. In this case, it is sufficient for the system to forward the logging data only to the log server.
The logging data must be provided to the detection and response solution within 5 minutes ("near-real-time") from the time it is generated in the system.

The specific technical interfaces and protocols to be supported for deployment are determined by the detection and response solution available in the system's operating environment as well as the technical basis of the system itself.

Motivation: IT/NT systems are constantly exposed to security threats and attacks. By means of a central analysis and the correlation of recorded system events of entire IT landscapes in almost real time, current threats and ongoing attacks can be detected even beyond system boundaries and appropriate countermeasures can be initiated promptly. The prompt delivery of logging data to the detection and response solution is essential for its effectiveness.

Implementation example: **Example 1:** A system based on a classic server collects security-relevant logging data in the operating system's local syslog or Windows Event Log. Logging data is continuously forwarded to a Security Information and Event Management (SIEM) for further analysis, intrusion detection, and alarm handling.

Example 2: An Endpoint Detection and Response (EDR) agent is running on a system. The EDR agent continuously forwards the security-related logging data it collects on the system to the central backend of the EDR solution, where further analysis, intrusion detection, and alarm handling takes place

Example 3: Systems designed on the basis of cloud-native functions generate logging data directly from these functions using the cloud's own logging and monitoring infrastructure. In such a system, the generation of security-relevant logging data is specifically activated in the corresponding configuration options of the cloud-native functions used. The resulting logging data is continuously transferred to a SIEM (Security Information and Event Management) for further analysis, intrusion detection and alarm handling. Some cloud providers already provide some attack pattern detection in the cloud's own monitoring infrastructure and generate specific cloud alerts from it. These are also transferred to the SIEM.

Example 4: A system is based on a SaaS ("Software as a Service") application from a cloud provider. Typically, in the SaaS model, the cloud provider is responsible for all operational aspects of the application, including security management. The cloud customer itself has no influence on the underlying technical infrastructure or the operation of the application. Based on contractual agreements, recognized certificates, and documented self-disclosures from the cloud provider, it is formally verified that the cloud provider has implemented a security incident detection and response solution. Some cloud providers also generate dedicated logging data about security-relevant activities within the separate customer tenants of their SaaS application (e.g. changes to configuration settings, permission assignments or user accounts within the tenants) and make them available to cloud customers. These so-called audit logs are continuously transferred to a SIEM (Security Information and Event Management) for further analysis, attack detection and alarm handling.

For this requirement the following threats are relevant:
- Unnoticeable feasible attacks

ID: 3.01-37/8.0

5.1. Benutzerkonten

Req 41	User accounts must ensure the unique identification of the user.

Users must be identified unambiguously by the system.

This can typically be reached by using a unique user account per user.

So-called group accounts, which are characterized by the fact that they are used jointly by several people, must not be used. This also applies without restriction to privileged user accounts. Most systems initially have only a single user account with administrative privileges after the basic installation. If the system is to be administered by several persons, each of these persons must use a personal, individual user account to which appropriate administrative authorizations or roles are assigned

A special feature are so named technical user accounts. These are used for the authentication and authorization of systems among themselves or of applications on a system and can therefore not be assigned to a specific person. Such user accounts must be assigned on a per system or per application basis. In this connection, it has to be ensured that these user accounts can't be misused.
Ways to prevent misuse of such user accounts by individuals include:

- Configuration of a password that meets the security requirements and is known to as few administrators as possible.
- Configuring the user account that only a local use is possible and a interactive login isn't possible.
- Use of a technique for authentication of the specific user account with public and private key or certificates.
- Limiting the access over the network to legitimate systems.

Additional solution must be checked on their usability per individual case.

Motivation: Unambiguous user identification is mandatory to assign a user permissions that are necessary to perform the required tasks on the system. This is the only way to adequately control access to system data and services and to prevent misuse. Furthermore, it makes it possible to log activities and actions on a system and to assign them to individual users.

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

ID: 3.01-22/8.0

Req 42	User accounts must be protected with at least one authentication attribute.

All user accounts in a system must be protected against unauthorized use.

For this purpose, the user account must be secured with an authentication attribute that enables the accessing user to be unambiguously authenticated. Common authentication attributes are e.g.:

- passwords, passphrases, PINs (factor KNOWLEDGE: "something that only the legitimate user knows")
- cryptographic keys, tokens, smart cards, OTP (factor OWNERSHIP: "something that only the legitimate user has")
- biometric features such as fingerprints or hand geometry (factor INHERENCE: "something that only the legitimate user is")

The authentication of users by means of an authentication attribute that can be faked or spoofed by an attacker (e.g. telephone numbers, IP addresses, VPN affiliation) is generally not permitted.

In companies of Deutsche Telekom group where the MyCard or a comparable smartcard is available this should be a preferred authentication attribute.

If the system and the application scenario support it, multiple independent authentication attributes should be combined if possible in order to achieve an additional increase in security (so-called MFA or Multi-Factor-Authentication).

Motivation: User accounts that are not protected by appropriate authentication attributes can be abused by an attacker to gain unauthorized access to a system and the data and applications stored on 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
- Denial of executed activities

ID: 3.01-20/8.0

Req 43	Privileged user accounts must be protected with at least two authentication attributes from different factors.

A privileged user account is a user account with extended authorizations within a system. Extended authorizations enable access to configuration settings, functions or data that are not available to regular users of the system. In direct dependence on the special tasks that are carried out via a privileged user account within a system, the assigned extended authorizations can be specifically restricted or include completely unrestricted system access.

Examples of privileged user accounts:

- Accounts for administration, maintenance or troubleshooting tasks
- Accounts for user administration tasks (e.g. creating/deleting users; assigning permissions or roles; resetting passwords)
- Accounts that are authorized to legitimize, initiate or prevent business-critical processes
- Accounts that have access to data classified as SCD (Sensitive Customer Data) in the interests of Group Deutsche Telekom, its customers or the public
- Accounts that have extensive access to data defined as "personal" according to the EU-GDPR (e.g. mass retrieval of larger parts or the complete database)

A single authentication attribute for privileged user accounts with their extended authorizations is usually no longer sufficient.

In order to achieve an adequate level of protection, at least two mutually independent authentication attributes must be used. The authentication attributes must come from various factors (knowledge, ownership, inherence). A combination of authentication attributes of the same factor (e.g. two different passwords) is not permitted

This approach is commonly referred to as MFA (Multi-Factor Authentication).
A specific form of MFA is 2FA (2-factor authentication), which combines exactly two authentication attributes.

Motivation: Privileged user accounts represent an increased risk to the security of a system. If an attacker successfully compromises such a user account, he receives extensive authorizations with which he can bring the system or system parts under his control, disrupt system functions, view/manipulate processed data or influence business-critical processes. The combination of multiple authentication attributes of different types significantly minimizes the risk of a user account being compromised.

Implementation example: Very popular is 2FA in a variant consisting of an attribute that the user knows (factor KNOWLEDGE) and an attribute that the user possesses (factor OWNERSHIP).
Examples of such a 2FA are:

- smartcard (e.g. MyCard) plus PIN
- private key plus passphrase
- classic password plus hardware token for the generation of OTPs

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

ID: 3.01-21/8.0

Req 44	Predefined user accounts that are not required must be deleted or at least disabled.

On many systems, there are predefined but unused user accounts (e.g. "guest") after the initial installation.

These predefined user accounts must be deleted or at least disabled immedately after the initial installation; if these measures are not feasible, the corresponding user accounts must be blocked for remote access. In any case, disabled or blocked user accounts must also be provided with an authentication attribute (e.g. a password or an SSH key) so that unauthorized use of such a user account is prevented in the event of a misconfiguration.

Excempt from the requirement to delete or disable predefined user accounts are user accounts that are used exclusively for internal use on the corresponding system and that are required for the functionality of one or more applications of the system. Even for such a user account, it must be ensured that remote access or local login is not possible and that a user of the system cannot misuse such a user account.

Motivation: User accounts that are predefined by default in a product are typically common knowledge and can be targeted by an attacker for brute force and dictionary attacks. If these user accounts are not needed in a specific system, their existence represents an unnecessary attack surface. A particular risk is posed by predefined user accounts that are preconfigured without a password or with a well-known standard password. Such user accounts can be misused directly by an attacker if their security hardening was missed due to the unplanned use in the specific system.

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized use of services or resources
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-7/8.0

Req 45	Predefined authentication attributes must be changed.

After the takeover or initial installation of a system, there are usually predefined authentication attributes (e.g. passwords, SSH keys, SSL/TLS Certificates) in the system, as assigned by manufacturers, developers, suppliers or automated installation routines.

Such predefined authentication attributes must be changed to new, individual values immediately after the takeover or installation of the system.

Motivation: Values predefined by third parties in authentication attributes cannot be trusted because they do not represent a controlled secret. Affected authentication attributes can be misused by unauthorized persons to access and compromise systems. This risk is significantly increased if commonly known default values are used for authentication attributes (e.g. a default password for the administrator user account in a particular software product).

For this requirement the following threats are relevant:
- Unauthorized access to the system
- Unauthorized use of services or resources
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-8/8.0

Req 46	The permissions for users and applications must be limited to the extent necessary to fulfill their tasks.

The permissions on a system must be restricted to such an extent that a user can only access data and use functions that he needs in the context of his work. Appropriate permissions must also be assigned for access to files that are part of the operating system or applications or that are generated by the same (e.g. configuration and logging files).

In addition to access to data, applications and their components must also be executed with the lowest possible permissions. Applications should not be run with administrator or system privileges.

Motivation: If a user is granted too far-reaching permissions on a system, he can access data and applications to an ex-

tent that is not necessary for the fulfillment of the assigned tasks. This creates an unnecessarily increased risk in the event of abuse, in particular if the user or his user account is compromised by an attacker.
Applications with too far-reaching permissions can be misused by an attacker to gain or expand unauthorized access to data and system areas in need of protection.

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

ID: 3.01-23/8.0

Req 47	Sessions must be automatically terminated after a period of inactivity adapted to the intended use.

It is necessary that sessions on a system are automatically terminated after a specified period of inactivity.

For this reason, a time-out for sessions must be set. The time period to be selected here depends on the use of the system and, if applicable, the physical environment. For example, the time-out for an application in an unsecured environment must be shorter (a few minutes) than the time-out for an application used by operations personnel for system monitoring tasks in an access-protected area (60 minutes or more).

Motivation: For an open but unused session, there is a risk that an illegitimate user may take over and continue it unnoticed in order to exercise unauthorized access to the system and the data contained therein on behalf of the affected user.

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

ID: 3.01-18/8.0

Req 48	The system must allow users to log out of their current session.

The system must have a feature that enables the logged-in user to log out at any time. It must not be possible to resume a logged-out session without re-authenticating the user.

Motivation: A user must retain complete control over the sessions he has established in order to be able to terminate his access to a system at any time according to the situation and thus protect data and functions exposed via this access. In addition, the user must be able to assume that sessions specifically terminated by him cannot subsequently be resumed and continued by unauthorized third parties.

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

ID: 3.01-17/8.0

5.2. Authentifizierung

Req 49	If a password is used as an authentication attribute for technical accounts, it must have at least 30 characters and contain three of the following categories: lower-case letters, upper-case letters, digits and special characters.

Technical user accounts are characterized by the fact that they are not used by people. Instead, they are used to authenticate and authorize systems to each other or applications on a system.

A system must only use passwords for technical user accounts that meet the following complexity:

- Minimum length of 30 characters
- Comprising at least three of the following four character categories:
    - lower-case letters
    - upper-case letters
    - digits
    - special characters

Motivation: Due to their use in machine-to-machine (M2M) communication scenarios, technical user accounts are often equipped with privileges that can be of high interest to an attacker to compromise infrastructures. Without mechanisms of extensive compromise detection, the risk of a password being determined or broken by an attacker can increase significantly over time. A significant increase in password length counteracts these risks and can also be implemented particularly easily in M2M scenarios, since handling a very long password is not a particular challenge for a machine (as opposed to a person).

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

ID: 3.01-27/8.0

Req 50	If a password is used as an authentication attribute, it must have at least 12 characters and contain three of the following categories: lower-case letters, upper-case letters, digits and special characters.

A system may only accept passwords that comply with the following complexity rules:

- Minimum length of 12 characters.
- Comprising at least three of the following four character categories:
    - lower-case letters
    - upper-case letters
    - digits
    - special characters

The usable maximum length of passwords shall not be limited to less then 25 characters. This will provide more freedom to End Users when composing individual memorizable passwords and helps to prevent undesired behavior in password handling.

When a password is assigned, the system must ensure that the password meets these policies. This must be preferably enforced by technical measures; if such cannot be implemented, organizational measures must be established.
If a central system is used for user authentication [see also Root Security Requirements Document[i] "3.69 IAM (Identity Access Management) - Framework"], it is valid to forward or delegate this task to that central system.

Permissible deviation in the password minimum length

Under security-related criteria, conditions can potentially be identified for a system that enable the minimum password length to be reduced:

- It is generally permissible to reduce the minimum password length for systems that use additional independent authentication attributes within the authentication process in addition to the password (implementation of 2-Factor or Multi-Factor Authentication).
- Any reduction in the minimum password length must be assessed individually by a technical security advisor (e. g. a PSM from Telekom Security) and confirmed as permissible. In the assessment, the surrounding technical, organizational and legal framework parameters must be taken into account, as well as the system-specific protection requirements and the potential amount of damage in the event of security incidents.
- The absolute minimum value of 8 characters length for passwords must not be undercut.

Motivation: Passwords with the above complexity offer contemporary robustness against attacks coupled with acceptable user friendliness. Passwords with this level of complexity have proven their efficiency in practice. Trivial and short passwords are susceptible to brute force and dictionary attacks and are therefore easy for attackers to determine. Once a password has been ascertained it can be used by an attacker for unauthorized access to the system and the data on 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
- Denial of executed activities

ID: 3.01-26/8.0

Req 51	If a password is used as an authentication attribute, a protection against online attacks like brute force and dictionary attacks that hinder password guessing must be implemented.

Online brute force and dictionary attacks aim for a regular access interface of the system while making use of automated guessing to ascertain passwords for user accounts.

To prevent this, a countermeasure or a combination of countermeasures from the following list must be implemented:

- technical enforcement of a waiting period after a login failed, right before another login attempt will be granted. The waiting period shall increase significantly with any further successive failed login attempt (for example, by doubling the waiting time after each failed attempt)
- automatic disabling of the user account after a defined quantity of successive failed login attempts (usually 5). However, it has to be taken into account that this solution needs a process for unlocking user accounts and an attacker can abuse this to deactivate accounts and make them temporarily unusable
- Using CAPTCHA ("**C**ompletely**A**utomated**P**ublic**T**uring test to tell**C**omputers and**H**umans**A**part") to prevent automated login attempts by machines ("robots" or "bots") as much as possible. A CAPTCHA is a small task that is usually based on graphical or acoustic elements and is difficult to solve by a machine. It must be taken into account that CAPTCHA are usually not barrier-free.

In order to achieve higher security, it is often meaningful to combine two or more of the measures named here. This must be evaluated in individual cases and implemented accordingly.

Motivation: Without any protection mechanism an attacker can possibly determine a password by executing dictionary lists or automated creation of character combinations. With the guessed password than the misuse of the according user account is 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
- Denial of executed activities

ID: 3.01-25/8.0

Req 52	If a password is used as an authentication attribute, the reuse of previous passwords must be prevented.

A history of the previously used passwords must be recorded for each user account. When a password change is initiated for a user account, the new password must be compared with this password history. If the reuse of a password is detected, the password change must be rejected. This validation process must be implemented in the system on the basis of technical measures. If a central IAM system is used for user authentication, the implementation can be forwarded to the central IAM system or outsourced there [see also Root Security Requirements Document[i] "3.69 IAM (Identity Access Management) - Framework"].

In general, the password history should ensure that a password that has already been used can never be used again.

However, due to technical limitations, a password history cannot be recorded indefinitely in many IT/NT products. In this case, the following basic rules must be observed:

- a password that has already been used must not be reusable for a period of at least 60 days (measured from the point in time at which the affected password was replaced by another)
- in systems in which the period of at least 60 days cannot be implemented, the longest possible period must be configured. In addition, it must be confirmed by a Project Security Manager (PSM) that the configured period is still sufficient in the overall context of the system with regard to the security requirement.

Annotation:
Some IT/NT products do not offer any technical configuration parameters with which the password history can be linked directly to a time period, but only allow the definition of the number of passwords to be recorded. In such cases, the time period can alternatively be ensured by linking the following, usually generally available configuration parameters. Within the resulting policy, a user can only change his password once a day and, due to the number of passwords recorded, can reuse an old password effectively after 60 days at the earliest.

- Minimum Password Age: 1 day
- Password History: Record of the last 60 passwords used

With this implementation variant, it should be noted that the minimum age for the password should not be more than one day in order not to inappropriately restrict the user with regard to the fundamental need to be able to change the password independently at any time.

Motivation: Users prefer passwords that are easy to remember and often use them repeatedly over long periods of time when the system allows. From the user's point of view, the behavior is understandable, but effectively leads to a considerable reduction in the protective effect of this authentication parameter. With adequate knowledge of the user or information obtained from previous system compromises, an attacker can gain access to supposedly protected user accounts. Particularly in situations in which new initial passwords are assigned centrally as part of an acute risk treatment, but users change them immediately to a previous password for the sake of simplicity, there is a high risk that an attacker will resume illegal access. It is therefore important to prevent users from reusing old passwords.

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
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-28/8.0

Req 53	If a password is used as an authentication attribute, it must be changed after 12 months at the latest.

The maximum permitted usage period for passwords is 12 months.
If a password reaches the maximum permitted usage period, it must be changed.

For this purpose, the system must automatically inform the user about the expired usage period the next time he logs on to the system and immediately guide him through a dialog to change the password. Access to the system must no longer be permitted without a successfully completed password change.
For technical user accounts (M2M or Machine-2-Machine), which are used for the authentication and authorization of systems among themselves or by applications on a system, automated solutions must also be implemented to comply with the permitted usage period for passwords.

Alternatively, if such an automatic mapping of the process for changing the password cannot be implemented, an effective organizational measure must be applied instead, wich ensures a binding manual password change at the end of the permissible period of use.

Motivation: Unlike more modern authentication attributes, passwords are easier to attack. Without specific measures for reliable, technically automated detection of compromises, the risk of a password being discovered or broken by an attacker can increase considerably over time.

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
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-30/8.0

Req 54	If a password is used as an authentication attribute, users must be able to independently change the password anytime.

The system must offer a function that enables a user to change his password at any time.

When an external centralized system for user authentication is used, it is valid to redirect or implement this function on this system.

Motivation: The fact that a user can change his authentication attribute himself at any time enables him to change it promptly if he suspects that it could have been accessed by a third party.

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
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-29/8.0

Req 55	If passwords are used as an authentication attribute, those must be stored using a suitable and approved "Password Hashing" method to protect against offline-attacks like brute force or dictionary attacks.

This requirement relates to the storage of passwords in all types of user databases, as used in this system, in order to authenticate incoming access (local or remote) by users or other systems.

If an attacker obtains the copy of a user database of the system, he is able to bring it into a fully independent environment and utilize automatized dictionary or brute force attacks to determine contained passwords. Specialized tools in combination with high computing power allow for high cracking rates in a relatively short period of time, if protective measures are insufficient. Due to the independency from the source system, such an offline attack happens unnoticed.

The following countermeasure must be implemented, since this ensures best possible protection against offline attacks:

- passwords must be stored using a cryptographic one-way function (known as "Password Hashing") that is recognized as effective for this purpose and is classified as secure at the current state of the art.

Please Note: valid password hashing algorithms are described in Security Requirement Catalog "3.50 Cryptographic Algorithms and Security Protocols".

Explicitly NOT PERMISSIBLE is:

- to store passwords in cleartext
- to store passwords in any format which can be directly backcalculated
- to store passwords using reversible encryption

Please Note:
In this context, "directly backcalculatable formats" refers to those that simply encode the password, without involving a secret key in the transformation process. Since the password will no longer show up as original cleartext after it has been processed, those formats may easily be mistaken to provide confidentiality. Effectively, they do not offer any protection. The enconding is fixed and therefore an attacker can easily make use of it to compute the original cleartext password from the encoded string.
Examples for directly backcalculatable formats are: "base64", "rot13"
"Reversible" are all encryption methods which, using the appropriate key, enable encrypted content to be transformed back into the original content. Accordingly, with reversible encryption there is always the challenge of keeping the key secure and protecting it from unauthorized access. Reversibility is a required fundamental property in many areas of encryption applications, e.g. for transferring confidential messages, but it is counterproductive for storing passwords: a stored password must remain comparable by means of technical methods, but it must no longer be possible to convert it back into plain text in order to protect it as well as possible from unauthorized viewing.
Examples for reversible encryption are: "AES", "CHACHA20", "3DES", "RSA"

Motivation: Without protective measures, an attacker in possession of a user database copy is able to determine masses of contained passwords in short time by merely trying out character string combinations or making use of dictionaries. Passwords stored in cleartext or any backcalculatable format are fully defenseless to an offline attack. Once a password has been ascertained it can be used by an attacker for unauthorized access to the system and the data on 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
- Denial of executed activities
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-24/8.0

Req 56	If passwords are used as an authentication attribute, they must not be displayed in plain text during input.

Passwords must not be displayed in legible plain text on screens or other output devices while they are entered. A display while entering must not allow any conclusions to be drawn about the characters actually used in the password.

This requirement applies to all types of password input masks and fields.
Examples of this are dialogs for password assignment, password-based login to systems or changing existing passwords.

Exceptions:

- Within an input field, an optional plain text representation of a password is permitted, provided that this plain-text representation serves a valid purpose, exists only temporarily, has to be explicitly activated by the legitimate user on a case-by-case basis and can also be deactivated again immediately by the latter.
  A valid purpose would be, for example, to allow the legitimate user an uncomplicated visual check, if necessary, that he has entered the password correctly in a login dialog before finally completing the login.
  Such an optional plain text representation of a password must remain fully in the control of the legitimate user so that he can decide on its activation/deactivation according to the situation. In the default setting of the system, the plain text representation must be deactivated.
- The typical behavior on many mobile devices (smartphones) of displaying each individual character very briefly in plain text when entering a password - in order to make it easier for the user to control input - is fundamentally permissible there. However, the full password must never be displayed in plain text on the screen.

Motivation: In the case of a plain text display, there is a risk that third parties can randomly or deliberately spy on a password via the screen output while typing.

Implementation example: When displayed on the screen, each individual character is uniformly replaced by a "*" while entering a password.

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
- Attacks motivated and facilitated by information disclosure or visible security weaknesses

ID: 3.01-31/8.0

Req 57	The use of system functions that require protection as well as access to internal or confidential data must not be possible without prior authentication and authorization.

The use of functions of the system that require protection as well as access to data classified as internal or confidential must only be possible after the user has been uniquely identified and successfully authenticated by means of the user name and at least one authentication attribute. In addition, it must be verified that the user is authorized to access the affected functions and data within the user role assigned to him or her in the system.

An exception to this are functions and data that may be used publicly without restriction; for example, the area of a website on the Internet where only public information is provided.

Examples of features that require prior authentication include:

- Remote access to network services (such as SSH, SFTP, web services)
- Local access to the management console
- Local use of operating system and applications

Examples of authentication features that can be used:

- Passwords
- cryptographic keys or certificates (e.g., in the form of smart cards)

This requirement also applies without restriction to any machine access to the system (here the implementation is usually carried out by using so-called M2M - "Machine-to-Machine" - user accounts).

Motivation: The unambiguous authentication and authorization of access to a system are elementary to protect functions and data from misuse.

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

ID: 3.01-19/8.0