

NEXOF-RA
NESSI Open Framework – Reference Architecture
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Deliverable D10.2
Assessment Criteria

Deliverable D10.2 defines the assessment criteria for the NEXOF-RA identifying the key aspects that require validation. The results of the assessment of the key requirements will be reported in D10.3.

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1 EXECUTIVE SUMMARY

Assessment criteria (also called fit criteria) are statements specifying the standards that must be met and the evidence that will be gathered to demonstrate the achievement of a requirement [1].

The purpose of this document is to provide assessment criteria that can be used within the deliverable “Assessment Report” (D10.3) to understand if the proposed reference architecture implements a given requirement of D10.1 or not. In other words, the assessment process determines whether or not the set of requirements addressed by the reference architecture subsumes the original requirements and the results are described the deliverable “Assessment Report” (D10.3).

The assessment criteria have been derived through the integration of three types of information:

- Assessment criteria for the scenarios in general stated by the authors of the relative scenario
- Assessment criteria for the requirements linked to the scenarios stated by the authors of the relative requirement
- The fit criteria linked to the requirements (see deliverable D10.1) stated by the authors of the relative requirement

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3 STATE OF THE ART IN REQUIREMENTS ASSESSMENT FOR SOFTWARE ARCHITECTURES

A classification of assessment methods for software architectures is [2]:

- Stakeholder-based assessment
- Expert-based assessment
- Quality-attribute assessment

Stakeholder-based assessment identifies the gaps between the requirements of the software architecture and the actual stakeholder priorities for these requirements. In a certain architecture, a requirement A could have a higher priority than requirement B. However, during the assessment, it may be discovered that for certain stakeholders the priority of requirement B is higher than the priority of requirement A. The most well known stakeholder-based assessment method is SAAM [3], which has evolved into the Architecture Trade-off Analysis Method (ATAM) [4].

Within expert-based assessment a team of experienced architects and designers assesses the software architecture designed by the project team to determine whether a system that is compliant to the reference architecture would fulfill its functional and quality requirements.

Stakeholder-based and expert-based assessments assess the entire software architecture for all its requirements in a qualitative way. A quality-attribute-oriented assessment aims to quantitatively estimate one specific quality attribute (e.g., maintainability, performance, reliability, security, etc.)

Within NEXOF-RA, an expert-based assessment procedure will be applied to determine the match between the requirements stated in D10.1 and the proposed reference architecture, this means, a qualitative assessment process will be adopted based on a justified rationale.

4 ASSESSMENT CRITERIA

D10.1 defines architectural constraints arising from scenarios that must be supported by the NEXOF-RA architecture. Checking and testing conformance to these will form the basis for assessing how well the architecture meets its requirements.

The assessment will be performed for each scenario and requirement. The following aspects will be evaluated within the expert-based assessment:

- Evaluation of the feasibility of each scenario within the proposed reference architecture
- Evaluation of the feasibility of each requirement within the proposed reference architecture
- Evaluation if all requirements of the deliverable “Requirements Report” (D10.1) have been taken into consideration
- Evaluation if architectural patterns exist that are not directly attributable to any scenario

Together with each evaluation a coverage analysis will be performed, in which the links between the analysed scenario or requirement to the building blocks of the proposed reference architecture will be described and discussed.

The validation process then consists of

- Identifying the NEXOF-RA concepts used for the realization of a particular use case step in the scenarios and
- The justification that the respective concepts are sufficient to meet the functional and non-functional needs of the considered use case step.

The following subsections delineate the assessment criteria adopted for each scenario. The assessment criteria point out architectural constraints, properties, and features against which the reference architecture will be checked.

4.1 Service procurement (S1)

The assessment criteria for this scenario are the following:

- **Uniform representation:** A uniform representation is required for services of different types.
The intent here is that services based on different technologies and offered by different providers to different target markets can be directly compared.
The assessment criterion is that there exists a uniform high-level representation (syntactic and semantic) for all services defined in NEXOF-RA, including both functional and non-functional characteristics. Alternative representations may be accommodated but in these cases it must be possible to map these to a canonical form at an appropriate level

of abstraction. In addition, procedures for extending this representation to accommodate specific services must be specified.

- **Decentralization:** NEXOF-RA must be decentralized. Services built on top of NEXOF may be centralized but framework services should not require centralized implementation.

Major functional components (directories, repositories, execution environments) can be owned and controlled by independent stakeholders but it must be possible for their functionality to be combined via federation.

Different policies for access and use of NEXOF functional components must be supported so that visibility and sharing of information or services can be controlled.

The assessment criterion is that it is possible to differentiate between and separate usages of a functional component based on criteria defined by the component owner.

- **Representation of service level agreements:** There is a requirement for a standard representation of service level agreements (SLA).

There must be a means for a service consumer to obtain information about service offerings that may meet his needs in a form that permits direct comparison.

The assessment criterion is that NEXOF-RA defines service terms and metrics in a way that can accommodate all services, with defined procedures for specialization.

NEXOF-RA must also specify protocols for negotiation and monitoring of SLAs, applicable to services of different types.

Semantics associated with the use of SLAs must also be described in a way that can support selection of services from a range of options and verification of performance against SLA terms.

- **Cross certification:** The assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

4.2 Service lifecycle support (S2)

The assessment criteria for this scenario are the following:

- **Monitoring and control:** A consistent and uniform approach to monitoring and control is required for all services.

Management information models for each service must be exposed externally if a service consumer is to be able to manage the service. This must include information about the state of the service and also about the mechanisms available for its configuration by the consumer.

The assessment criterion is that irrespective of the internal details of the service, NEXOF must specify how management interfaces are presented to service consumers in a uniform way, with defined procedures for specialization to fit with the characteristics of different services.

- **Deployment of services:** Flexible and dynamic deployment of services into the service ecosystem must be supported.
The assessment criteria are that it must be possible for a service provider to introduce a new service without interfering with services already deployed. NEXOF must provide a way of describing the deployment of a new service, including its properties, dependencies and constraints arising from aspects such as performance, security and regulatory policies.
Deployment procedures need to address integration with NEXOF infrastructure facilities (such as registry and management) without impacting already running services.
- **Decommissioning and removal of services:** NEXOF-RA must support decommissioning and removal of services with predictable consequences for all actors.
The assessment criteria are that the provider of a service should be able to assess the impact of withdrawing a service on its users, who may include indirect users if the service is used as a component of other services.
It should be possible for the user of a service to be notified of the withdrawal of a service in a timely way so that a replacement can be found and incorporated.
- **Consistent service description:** The architecture must provide a consistent way to describe functional and non-functional characteristics of services. The assessment criterion of this requirement will be to evaluate if an automated matching of customer requirements to provider offerings will be possible.

4.3 Management services for grid and service platforms (S3)

The assessment criteria for this scenario are the following:

- **Interoperability standards:** For the intended architecture, the interoperability standards must be explained in the architectural (blueprint) documentation.
The assessment criterion is that it must be made clear which components use the interoperability standards and how they do it. Whereas some interoperability standards might be domain independent, others might deal with domain-specific issues. It must be verified whether the domain-specific interoperability only reflects the internal (domain specific) services.
A clear identification whether these standards are within single architectural layers or between different layers is required.
For case in which interoperability is based on the use of specific technical standards, the use of these standards must be described. (e.g. IEEE standards, agent standards (e.g. FIPA, ACL) and web service standards, as defined by W3C and OASIS).
In case the communication protocols play a significant role with respect to the interoperability, it must be explained how these protocols are used by the components of the architecture.
If relevant, the descriptions must include aspects of:

- Heterogeneity of the components in the architecture
- Dynamics of the components in the architect
- Distributed aspects of the architecture
- Multi organizational aspects (multiple domains)
- **Security mechanisms:** The assessment criteria are that the security mechanisms of the intended architecture must be described in architectural, functional and technical terms. Specific answers must be given to questions like “how is identity management arranged?” (for example, through the use of digital certificates), “which standards are used?” (e.g. FIPS201).

In case the service platform involves services governed by multiple organizations, the identity management aspects must be explained in terms of multiple organizational domains.

The descriptions must include reflections about scalability and dynamics of the intended architecture/system.

4.4 PhiMas: personal health information monitor and alert service (S4)

The assessment criteria for this scenario are the following:

- **Location based routing:** The routing of a service request depends on the location of the end user. The assessment of this requirement will be to evaluate if a request can be routed to the most locally perceived service.
- **Identity management:** Since the information contains personal and medical data, it must be assured that the identity of the users can be assured. The assessment criterion is that NEXOF-RA provides a safe and extensible solution for identity management. This should be part of its security services.

4.5 Collaborative e-learning scenario (S5)

The assessment criteria for this scenario are the following:

- **Customization:** This scenario is focused on the ability to provide a collaborative environment with several user-oriented services available (among which the training service is the most important). The assessment of this requirement will be to evaluate the abilities to customize the services according the user’s preferences, capabilities, etc. and to correlate these services by several points of view (i.e. on semantic or technical basis).
- **Service integration:** This scenario requires a semantic integration of services. The assessment of this requirement will be to evaluate if the architecture provides ways to semantically describe, search, classify, and analyze the exchanged information (Here services refer mainly to collaborative services, i.e. blogs, forums, chat, video-conf, etc. So, “exchanged information” refers right to data exchanged during a chat or a video-conf, as well as between a chat and SMS, e.g., in case of interoperating services).

- **Cross certification:** The assessment of this requirement will be that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

4.6 Deployment and configuration of a generic platform (e.g. an e-Learning one) (S6)

The assessment criteria for this scenario are the following:

- **Deployment, configuration and management of services:** The assessment of this requirement is to evaluate if the deployment and the configuration of new “pieces of software” is quick, easy, and the following management too. This task is usually referred to technical aspects, but often other most significant aspects are underestimated. For instance, an added value could be considered the ability to model and fit the organizational and/or business structure of the hosting environment.
- **Integration with legacy applications:** The assessment of this requirement is to evaluate if the architecture provides a way to interact with already running applications.
- **Adaptive deployment:** The assessment of this requirement is to evaluate if the architecture provides different models of deployment, without (or with reduced) users' intervention.

4.7 e-Health: complex diagnostic workflow (S7), e-Health: assisted living (S8)

The assessment criteria for these scenarios are the following:

- **Technical interoperability:** The goal of technical interoperability is to achieve the collaboration of services hosted on different NEXOF-compliant platforms.
In the scenario S7, the example of retrieving medical data stored at different hospitals is given. Scenario S8 addresses the same requirement by stating the need to exchange information with different devices.
The assessment criterion is the specification of interoperability means as, for instance, interoperable protocols, rules for interoperability, syntactic and semantic mapping of information/data, interoperability standards, etc.
- **Device integration:** The goal of device integration is the seamless interworking of devices with an according configuration of the respective interaction mechanisms.
The scenario S7 describes the typical complex medical examination of a patient where several devices in different locations have to communicate and exchange medical data. In scenario S8, the integration of monitoring devices with enterprise software in a home health care situation is described.
In practice, there exists already a variety of domain specific standards or best practices for device handling (as, for instance, in the healthcare

domain frameworks like Microsoft's CHF (Connected Health Framework) and the Eclipse OpenHealthFramework, or standards like BACnet (Building Automation and Control Networks) and OPC UA (Object Linking and Embedding for Process Control Unified Architecture)).

There are also emerging standards like SODA (Service Oriented Device Architecture). Domains with well fitting standards and best practices will not abandon them for upcoming generic integration technologies; other domains will develop their own best practices and standards. Thus, the assessment criterion for this requirement will be how successful the NEXOF reference architecture will develop integration mechanisms for the different domain specific standards.

- **Distributed Workflow:** The requirement of scenario S7 to integrate workflows from different stakeholders is a complex high-level requirement that entails many issues, as, for instance, federated identities, transactions, trust, and security.

The assessment criterion is thus that NEXOF RA provides conceptual solutions how to integrate workflows seamlessly – with particular consideration of workflows spanning across different domains. And of course, there are the various assessment criteria for the above-cited related, more detailed requirements.

- **Stateful, device-adaptive service transfer:** Stateful and adaptive service transfer is important in an environment, where a workflow requires working with the same service on different devices.

The scenario S7 states this as a situation occurring in complex medical examinations where different devices are necessary to identify the patient's health problem. In such a case, different devices usually provide different capabilities to display data.

The related assessment criteria are the NEXOF specifications of state preservation and scalability issues, in particular in the context of data representation.

- **Dependability for device integration:** The requirement states the need to dependably integrate embedded devices, that is, critical non-functional requirements of the devices (as, for instance, performance, reliability and availability) extend themselves into the distributed non-embedded applications that employ the devices as actuators or sensors.

From Scenarios S7 and S8, the need for this extension is derived: it is not sufficient to have dependable sensors that produce due alarms in a health-critical situation, it is essential as well to process the alarms and the respective data from the sensors in an equally dependable way.

Assessment criteria for this requirement are based on the dependability specifications of the NEXOF-compliant platforms, in particular with respect to reliability and availability. This covers both, the dependability of the applications as well as the integration of the embedded devices and application parts.

Particular emphasis is on communication and storage mechanisms.

- **Privacy and security compliance:** The assessment criterion for this requirement is that the architecture must support the compliance analysis according to the HIPAA standard.

4.8 Traffic management: large scale emergency handling (S9)

The assessment criteria for this scenario are the following:

- **Adaptability:** This requirement stresses the need to flexibly adapt to new and unforeseen situations.
The scenario S9 induces this requirement with the demand to adapt flexibly to changed situations in traffic emergencies where, as a consequence, traffic control systems have to change their strategy drastically.
Assessment criteria for this requirement are the NEXOF specifications of configuration and deployment mechanisms, which are to be used in compliant platforms to introduce/replace services.
A particular issue is that the NEXOF infrastructure management specifications have to ensure that the newly configured services can be executed without disrupting the not-involved part of the system (avoidance of unwanted service interaction).
A particular challenge is the need to perform the adaptation/reconfiguration in a heterogeneous environment.
- **Rapid reconfiguration:** This requirement is closely related to adaptability and states that the there demanded adaptability can be performed in a given (short) time span.
The scenario S9 bases this requirement on the need to react quickly in the case of an emergency traffic condition. Since the direct testing of the performance of NEXOF reconfiguration mechanisms is out of scope, it becomes necessary to base the assessment of this requirement on the analysis of the performance related aspects of the reconfiguration and deployment mechanisms.
- **Secure deployment process:** The requirement is about the security and authorization of the reconfiguration / deployment process.
In scenario S9, the (rapid) reconfiguration triggered by the emergency traffic situation needs to be secure in the sense that no harmful modification of the incoming sensor data, the outgoing traffic control information or the traffic control strategies may occur.
The assessment criterion is the NEXOF security specification where the authorization process has to be defined. This includes the mechanisms, which identify the authorization for reconfiguration and deployment actions.

4.9 Crisis management system of systems (S10), Effective and efficient collaborative decision making (S11)

There are a number of challenges described in the Crisis management system of systems (S10) and Effective and efficient collaborative decision making (S11) scenarios introduced by Thales in D10.1. This includes:

- Taming complexity of such systems
- Shared situational awareness and understanding,
- Collaborative and Contextual Interaction
- Efficient collaborative decision-making
- ...

In terms of functionality it means an SOA architecture that allows for additional agility to these transportation systems through the identification of proper services, the utilisation of service registry at run-time and the use of business processes.

The assessment criteria for this scenario are the following:

- **Process modelling:** the assessment criterion is that the architecture must provide tools and techniques to support (potentially cross-domain) collaborative business process modelling, capture and management It also includes the capacity to annotate Business Process and re-use of Business Process and/or Business Process fragments.
- **Interoperability:** the assessment criterion is that the architecture should support and demonstrate the capacity to integrate several different classes of system (real-time, information, communication, security, etc.). As such Reference architecture documents must clearly describe which interoperability standards have been adopted and implemented, and which kinds of systems have adopted these standards. In case the communication protocols play a significant role with respect to the interoperability, it must be explained how these protocols are used by the components of the architecture.
- **Networking:** the assessment criterion is that the architecture must provide methodology and tools for design and run-time implementation of technical properties such as network bandwidth, dependability, availability, security
- **Registries:** the assessment criterion is that the architecture must support pluggable domain-specific service registries, cross-domain modelling and large scale management tools
- **Domain-aware service publication:** the assessment criterion is that the architecture must specify the functionality and interface support that should be provided by domain-aware service registries including a programmable access paradigm (API) for publishing a service in such a registry
- **Business activity annotations:** the assessment criterion is that the architecture must specify the functionality and interface support that should be provided by tools that enable extended business process capability by allowing for more expressive business activity annotations.
- **Service capabilities:** the assessment criterion is that the architecture must specify the service capabilities and interfaces that large scale management tools should support including what support for service registries they must provide
- **Responsiveness and adaptability:** the assessment criterion here is the ability to dynamically discover and connect distributed components and systems
- **Cross certification:** the assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary

paths of certification authorities in infrastructures operated by different organizations.

- **Trust, Security/Privacy & Resilience/Continuity:** the assessment criterion is that the architecture must provide capabilities for fault tolerance and real time reconfiguration and that high level services be implemented to:
 - manage the security,
 - define, put in place and survey the system configuration and reconfiguration,
 - decide on the aspect of maintenance activities, allow simulation and replay.

4.10 e-Commerce information sharing (S12)

There are a number of challenges described in the e-Commerce scenario, which requires distributed and remote systems to work together. In terms of functionality it means that systems must communicate with each other and with underlying platform services. Thus, it is vital to support information exchange in a distributed way. The assessment criteria for this scenario are the following:

- **Messaging interfaces:** The assessment criteria are the following:
 - The architecture must specify interfaces for messaging channels and routers.
 - The architecture must describe interfaces for messages transformation because different systems have inconsistent ways of capturing information (including formats and semantics).
 - The architecture should designate interfaces for mapping services that can provide an input for message transformers.
- **Publication of services:** The assessment criterion is that NEXOF must provide all necessary facilities to add and replace services at any time. The architecture must provide an API for publishing a service.
- **Service discovery:** the assessment criterion is that NEXOF must expose an interface for searching for services based on modern service meta data description standards.
- **Connectivity:** The assessment criterion is that the architecture must support pluggable connectors of specialized types that can be assigned to different implementations compliant with a connector type at any moment of time.
- **Integration of services:** The assessment criterion is that the architecture must provide a precise way of integrating 3rd party services graphically and logically.
- **Monitoring of services:** The assessment criterion is that the architecture must support the notification of service consumers when a service fails or becomes unavailable.
- **Security:** The assessment criterion is that the architecture must support that all communication and data exchange will be performed in a secure way.

- **Cross certification:** The assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

4.11 Mobile office for an owner of a micro-enterprise (S13)

This scenario raises several new requirements. One of them asks for the monitoring of services' activities based on the user's access rights. The fulfillment of this scenario can be validated against several assessment criteria:

- **Access rights:** The assessment criterion is that NEXOF must support management of the users' access rights.
- **Monitoring:** The assessment criterion is that the architecture must define monitoring service being a part of a platform.
The architecture should enforce that every service deployed on a platform has to implement monitoring interface.
- **Usability:** One of the usability requirements claims that NEXOF should allow end-users to compose services in workflows in a friendly way. Fulfillment of this requirement is proved if the architecture allows the user to specify services with the help of graphical user interfaces (GUIs) that are capable of transforming the user input into code executable on the platform.

4.12 Safety at work in the construction sector (S14)

The assessment criteria for this scenario are the following:

- **Support for human specific communication “protocols”:** There is a requirement for understanding different human specific communication “protocols”, e.g. spoken language and gestures. In order to assess the support of this requirement in the architecture we need to check whether NEXOF has to allow for accommodating special devices and software that can transform those distinct forms of communication into executable sequence of commands.
- **Information as a service:** It should be possible to expose information as a service, e.g. provide access to the information about workers, equipment, etc. Architecture that meets this demand needs to have certain wrappers that can grant information the ability to be visible across a platform. In other words, NEXOF has to describe services that can be used as access points for the information of different nature combined from different resources.

4.13 e-Government online application submission service (S15)

The assessment criteria for this scenario are the following:

- **Non-repudiability of data transfer:** The assessment criterion is that the architecture must support the logging of the transmission of data so that it

proves that the sender submitted the message and that the receiver received it.

Moreover, it must be possible that both parties receive a confirmation of the data submission.

- **Monitoring of services:** The assessment criterion is that the architecture must support the notification of service consumers when a service fails or becomes unavailable.
- **Security:** The assessment criterion is that the architecture must support all security mechanisms to guarantee confidentiality, and that the sender can certify his identity (electronic signature).
- **Cross certification:** The assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

4.14 e-Government online fee visualization and payment Service (S16)

The assessment criteria for this scenario are the following:

- **Monitoring of services:** The assessment criterion is that the architecture must support the notification of service consumers when a service fails or becomes unavailable.
- **Service integration:** To integrate data (in this case data about types of fees and taxes) coming from different organizations, a semantic integration of services is necessary. The assessment of this requirement will be to evaluate if the architecture provides ways to semantically describe, search, classify, and analyze the exchanged information.
- **Cross certification:** The assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

4.15 Assisted Industrial Maintenance (using 3D virtual environments) (S17)

The assessment criteria for this scenario are the following:

- **Integration of interactive applications:** In this case, the goal is to integrate 3D distributed interactive applications. There exist already 3D solutions, de facto standards like Second Life and industrial standards for 3D developments from the realm of Computer Aided Design (CAD). NEXOF cannot develop its own standards on this topic; however, the assessment criterion will be how effective the integration mechanisms of the NEXOF reference architecture will be for the respective standards and solutions.

- **High Dependability:** The scenario states that remote maintenance is costly and may be, in particular in emergency cases, even critical. Thus, the 3D visualization and the transmission of the necessary data have to be highly dependable. The Assessment criteria for this requirement are based on the dependability specifications of the NEXOF-compliant platforms, in this case with particular respect to high reliable data transmissions.
- **Priority management:** From the requirement of high dependability in particular in emergency cases, the scenario derives also the requirement for high priority processing and data transmission. The Assessment criteria for this requirement are the efficiency and, in particular, the reactivity and flexibility of the NEXOF-RA management with respect to prioritization of computational tasks and data communication.
- **Cross certification:** the assessment criterion is that the architecture must provide a way to implement a cross-certification service. In this way one certification authority is able to certify another certification authority's public key, making it possible to build chains of trust through arbitrary paths of certification authorities in infrastructures operated by different organizations.

5 ASSESSMENT QUESTIONNAIRE

The following template will be used to assess the scenario and requirement fulfillment.

Scenario/Requirement ID: _____

NEXOF-RA concepts used for the realization: _____

Justification that the above concepts are sufficient to meet the given scenario/requirement:

PoC (Proof of concepts) that assess that this scenario/requirement:

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