

A Work Project, presented as part of the requirements for the Award of a Master's degree in
Management from the Nova School of Business and Economics.

**MODELING EUROPEAN DIRECTIVE 2022/2555 THROUGH ENTERPRISE
ARCHITECTURE**

MADALENA CABRITA PEREIRA

Work project carried out under the supervision of:

Professor Paulo Faroleiro

June 23, 2025

Abstract

Cybersecurity has become a significant concern for governments and societies worldwide. For this reason, the European Directive NIS2 has emerged as a key tool in assisting organizations in protecting themselves against growing cyber-attacks. The challenge, however, lies in implementing the Directive effectively, which results in inconsistent approaches to compliance.

This master's thesis proposes using Enterprise Architecture (EA) and ArchiMate to develop a Reference Architecture that provides organizations with a structured framework for achieving NIS2 compliance and enhancing their cybersecurity resilience.

Keywords: Enterprise Architecture, NIS2, ArchiMate, Cybersecurity

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209)

Table of Contents

Abstract	1
1. Introduction.....	3
2. Literature Review.....	4
2.1. Enterprise Architecture	4
2.2. TOGAF	5
2.3. ArchiMate	6
2.4. Network and Information Systems (NIS)	7
2.5. NIS1 & NIS2.....	8
2.6. Enterprise Architecture and Cybersecurity	9
3. Research Design.....	9
3.1. Research Methodology	9
3.2. Research Problem	10
3.2.1. Research Motivation	10
3.2.2. Research Questions	11
4. Proposal.....	11
4.1. Proposal- Relationship between NIS2 and EA artifacts	12
4.2. Proposal- NIS2 Metamodel and Reference Architecture.....	12
4.3. Proposal- Possibility of modeling NIS2	13
5. Design and Development	13
5.1. Design and Development- Relationship between NIS2 and EA artifacts.....	13
5.2. Design and Development- NIS2 Metamodel and Reference Architecture.....	14
5.3. Design and Development- Possibility of modeling NIS2.....	17
6. Demonstration.....	20
7. Evaluation	21
8. Conclusion	23
References.....	26
Appendices.....	30

List of Figures

Figure 1. NIS2 Metamodel	16
Figure 2. Viewpoint illustrating how Article 3 refers to Article 2.....	16
Figure 3. Paragraph of Article 2 that is referred to in Article 3	17
Figure 4. NIS2 Article 2.....	17
Figure 5. NIS2 Article 22.....	18
Figure 6. NIS2 Article 14.....	19
Figure 7. NIS2 Article 16.....	19
Figure 8. NIS2 Article 12.....	20
Figure 9. NIS2 Article 29.....	20

List of Acronyms

DSRM- Design Science Research Methodology
EA- Enterprise Architecture
NIS- Network and Information Systems
NIS1- Network and Information Systems Directive 2016/1148
NIS2- Network and Information Systems Directive 2022/2555
TOGAF- The Open Group Architecture Framework
ISO- International Organization for Standardization

1. Introduction

Technology unlocks endless opportunities and drives business transformation (Chen, Li, and Shahid 2024). However, it also increases the risk of cyber threats, affecting both organizations and individuals. According to the recent IBM X-Force Threat Intelligence Index 2024, "Europe was the most targeted region in the world in 2023, representing 32% of reported incidents" (IBM 2024). These breaches halt operations and compromise sensitive information, making robust cybersecurity more important than ever (Reed 2024).

In response, regulatory frameworks like the Directive (EU) 2022/2555 (NIS2), have been created to improve the resilience of network and information systems across the European Union (EU) (European Commission 2023). NIS2 sets legal requirements for risk management, incident reporting, and cooperation, requiring organizations to safeguard their systems and stakeholder information. (European Commission 2025-a). Yet, many organizations still struggle to understand and implement these requirements effectively (ENISA n.d.).

Thus, Enterprise Architecture (EA) – defined as “the practice that tries to describe and control an organization’s structure, processes, applications, systems, and technology in an integrated way” (Lankhorst et al. 2013) – appears as a valuable framework for supporting NIS2 compliance. EA provides a methodical and clear approach to tackle cybersecurity regulations, ultimately enhancing organizational readiness.

This thesis addresses the lack of actionable measures in the NIS2 Directive by proposing a NIS2 Reference Architecture. The study begins with a “**Literature Review**” on EA and NIS2, followed by the “**Research Design**”, which outlines the knowledge gap, research motivation, and methodology. The “**Proposal**” and “**Design and Development**” sections define and implement a NIS2 Metamodel as the foundation for the Reference Architecture. After the model is developed, the “**Demonstration**” and “**Evaluation**” assess its applicability and quality, while the “**Conclusion**” presents key findings, limitations, and future research.

2. Literature Review

2.1. Enterprise Architecture

In a world where enterprises face various challenges – from defining products and services, to managing business processes and Information Technology (IT) – EA provides a structured approach to articulate and guide an enterprise’s direction (Greefhorst and Proper 2011). It is “a coherent whole of principles, methods, and models that are used in the design of an enterprise’s organizational structure, business processes, information systems, and infrastructure” (Lankhorst et al. 2013, 3).

However, EA is not just a conceptual tool. It is a practical discipline, implemented through methods and frameworks that guide its application in real business change (Lankhorst et al. 2013). While methods provide the techniques and processes for developing and maintaining architecture throughout its life cycle, frameworks offer a structure for organizing the descriptive representations of enterprise management and systems development (Lankhorst et al. 2013).

The first considered method in EA was the Business Systems Planning (BSP). Developed by IBM in the early 1960s and introduced for internal use in the 80s, it was later adopted and promoted by various consulting firms (Kotusev 2016). This method introduced architecture as a formal description to align IT with business objectives, focusing on analyzing business processes, identifying information requirements, and defining data architectures to support organizational goals (Kotusev 2016).

Building on this, in 1987, John Zachman developed the first recognized Enterprise Architecture framework, the Zachman Architecture Framework (Lankhorst et al. 2013). Initially focused on the field of Information Systems, the framework has expanded to cover the entire organization (Scholtz et al. 2013). Represented as a bounded 6 x 6 matrix (Appendix 1), it describes an enterprise architecture through communication interrogatives (columns) and stakeholders’

perspectives, from high-level planning to detailed implementation (rows) (Zachman International 2008).

Over time, EA evolved to align business operations with information systems (Gampfer et al. 2018), offering “a holistic and consistent view of the organization rather than a view of a single application or information systems” (Niemi 2007). While this evolution has been important in managing organizational complexity, recent literature overlooks the connection between EA with emerging technologies such as AI, IoT, cloud computing, and data analytics. In response, The Open Group (n.d.-c) argues that to address these limitations, EA needs to adapt and integrate agile frameworks, dynamic modeling, and innovation-driven strategies.

2.2. TOGAF

After the Zachman Framework, other frameworks emerged, with TOGAF being the most cited and widely discussed in EA literature, often considered a “(...) *de facto* industry standard in EA practice” (Kotusev 2016, 33). TOGAF was introduced in 1995 by the U.S. Department of Defense and derived from the Technical Architecture Framework for Information Management (TAFIM), as a method to address inefficiencies in information system management (Defense Information Systems Agency Center 1996). After its initial development, TOGAF was further developed by The Open Group, a global consortium that develops technology standards and certifications (The Open Group n.d.-a).

While early versions focused on technical architecture (Lankhorst et al. 2013), from version 8 onwards, TOGAF established itself as a comprehensive enterprise architecture framework, encompassing strategy, processes, information, applications, and technology (Sonai et al. 2024). Versions 8 and 9 (Appendix 2) introduced four key elements: the Architecture Capability Framework; the Architecture Development Method (ADM), including guidelines and techniques; the Architecture Content Framework; and the Enterprise Continuum with TOGAF Reference Materials (Lankhorst et al. 2013).

With its most recent update, TOGAF version 10 consists of two parts (Appendix 3 and 4): the TOGAF Fundamental Content and the TOGAF Series Guides (The Open Group n.d.-f). This structure clarifies best practices, showing where to find enduring and universal concepts while underscoring where to look for new emerging ideas (The Open Group n.d.-e). It reflects the effort to ensure EA remains relevant and adaptable in a rapidly evolving business and technology landscape (The Open Group n.d.-d).

2.3. ArchiMate

The actionable component of the EA discipline is the modeling process. As Gampfer et al. (2018, 76) explain, “Enterprise Architecture modeling refers to the creation and management of architectural models” – specifically abstract, focused representations of real-world systems using formal graphical or textual languages (Lankhorst et al. 2013). To support this practice, several modeling languages have been developed, including ArchiMate, developed by the Open Group (Lankhorst et al. 2013). Aligned with EA frameworks, such as TOGAF (Jiang et al. 2024) (Appendix 5), ArchiMate enables enterprise architects to describe, analyze, and visualize the relationships across business domains – distinct areas of the enterprise that are being analyzed (Lankhorst et al. 2013). For this purpose, ArchiMate is structured along two dimensions (Appendix 6): layers and aspects (Yamamoto, Zhi, and Zhou 2019).

The layer dimension is based on a service-oriented principle – meaning higher layers utilize services provided by lower layers (Lankhorst et al. 2013) – and includes three core layers and two extension layers. The core layers are: the Business Layer which focuses on elements like business processes and roles; the Application Layer, which covers software applications, services, and interfaces; and the Technology Layer that includes system software (e.g., operating systems), and physical hardware (e.g., computers and network devices) (Jiang et al. 2024). The extension layers are: the Motivation Layer that “focuses on the motivations, goals, and requirements that drive the design and implementation of an enterprise’s architecture”

(ArchiMetric 2025); and the Implementation and Migration Layer that includes “modeling implementation programs and projects to support program, portfolio and project management” (The Open Group n.d.-b).

Regarding the aspect dimension, it classifies artifacts within layers as: Active Structure Aspects, structural elements responsible for executing behavior, such as business actors, application components, and devices; Behavior Aspects that define processes, functions, and services executed within the architecture, assigned to structural concepts displaying who or what performs the behavior (Lankhorst et al. 2013); and Passive Structure Aspects, objects on which behavior is performed, such as information objects in the Business Layer and data objects in the Application Layer (Lankhorst et al. 2013). It is important to note that the Motivation and the Implementation and Migration Layers are not included in the aspect dimension, (considered in Appendix 7).

Beyond layers and aspects, ArchiMate also facilitates communication with stakeholders through graphical notations (Aldea et al. n.d.), which emphasizes the role of “view” and “viewpoint” in the modeling process. While a view represents a stakeholder’s perspective of the EA (Lankhorst et al. 2013), a viewpoint defines the rules for creating a view (Lankhorst et al. 2013). Essentially, “a view is what you see, and a viewpoint tells you from where you are looking” (Lankhorst et al. 2013, 51). Because of their importance, managing views and viewpoints requires tools capable of organizing modeling and ensuring clear representation. To this end, organizations typically rely on software tools (Archi n.d.), one of which is Archi – an open-source, cross-platform solution that supports ArchiMate and allows enterprise architects to create, analyze, and communicate enterprise models effectively (Archi n.d.).

2.4. Network and Information Systems (NIS)

“As digital landscapes become increasingly complex, safeguarding sensitive information and systems against cyber threats has become a paramount concern for organizations” (Jiang et al.

2024, 1). Recognizing this growing risk of cyber threats, the European Commission introduced the Network and Information Systems (NIS), Directive (EU) 2016/1148, commonly referred to as NIS1, making “the first comprehensive EU legislation aimed at boosting cybersecurity of network and information systems to safeguard vital services for the EU’s economy and society” (European Commission 2025-a).

However, by the end of 2020, NIS1 was revealed to be insufficient. The wide divergence in its implementation, vague scope definitions, (European Commission 2022), weak supervision and enforcement (Negreiro 2023) and the lack of cross-sharing information among Member States were undermining cybersecurity coordination and increasing vulnerabilities (European Commission 2022).

To address these issues, the EU adopted NIS2, Directive (EU) 2022/2555, in December 2022 “setting out minimum rules regarding the functioning of a coordinated regulatory framework, (...) laying down mechanisms for effective cooperation (...), updating the list of sectors and activities subject to cybersecurity obligations and (...) providing effective remedies and enforcement measures” (European Commission 2022).

2.5. NIS1 & NIS2

NIS1 applied to Operators of Essential Services (OESs) and Digital Service Providers (DSPs), (Appendix 8) with Member States defining the covered entities (European Commission 2016). NIS2 replaces these with Essential Entities (EEs) and Important Entities (IEs) (Appendix 9), broadening the scope and eliminating Member States’ flexibility in designation (European Commission 2022).

To address inconsistent implementation across Member States (European Commission 2022), NIS2 standardizes requirements: stricter reporting deadlines; mandatory supply chain security; risk assessments, and EU-wide cybersecurity certification aligned with 5G cybersecurity frameworks for ICT suppliers (European Commission 2022).

For enforcement, NIS2 introduces harmonized compliance and penalty measures (European Commission 2022), strengthens cooperation among national authorities, expands the role of the Cooperation Group, and establishes the EU Cyber Crisis Liaison Organization Network (EU-CyCLONe) for cybersecurity emergencies (European Commission 2022). It also integrates the Computer Security Incident Response Teams (CSIRTs) into these structures and assigns the European Union Agency for Cybersecurity (ENISA) greater responsibility, including support to the Commission and maintaining the EU vulnerability database (European Commission 2022).

2.6. Enterprise Architecture and Cybersecurity

Although EA has a strategic role in structuring the enterprise, no research has been conducted to apply it to cybersecurity. Moreover, few studies mention the value of conceptual modeling, in particular enterprise modeling, for cybersecurity assessment and analysis (Jiang et al. 2024). One key issue is the limited specialized security expertise among enterprise architects, which hinders the effective modeling of cybersecurity risks (Jiang et al. 2024). Another limitation is the lack of standardized methods for validating EA models for cybersecurity assessment (Jiang et al. 2024), making it challenging to model regulatory obligations and conduct risk analysis (e.g., NIS2).

Overall, this creates a gap for combining cybersecurity regulations with EA frameworks, in a way compliance is handled proactively rather than being viewed as a constraint.

3. Research Design

3.1. Research Methodology

To develop the following sections of this thesis, the Design Science Research Methodology (DSRM) was used. This methodology originates from the concept of “sciences of the artificial”,

from Herbert A. Simon, which focuses on systems design to achieve specific goals – contrasting with natural sciences that describe the world as it is (Herbert A. 1996).

The DSRM is composed of six steps: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication (Peppers et al. 2007). These steps structure the Design Science Research (DSR) approach, which emphasizes “the creation of an innovative, proposal artifact for a specified problem domain” (Hevner et al. 2004, 82) and aims to address either “unsolved problems in unique or innovative ways or solved problems in more effective or efficient ways” (Hevner et al. 2004, 81).

As illustrated in Appendix 10, DSRM is applied throughout this thesis to ensure rigor with prior literature and provide consistency in artifact creation and evaluation (Peppers et al. 2007).

3.2. Research Problem

3.2.1. Research Motivation

As the literature revealed “the current threat and regulatory landscape pressures organizations to establish capabilities to prepare for and manage a cyber crisis effectively and efficiently” (Deloitte 2022). This means that not only do organizations need to mitigate security risks, but they are also pressured to meet regulatory frameworks. However, it is also mentioned that some divergencies occurred between organizations when trying to accurately integrate cybersecurity measures and requirements into their existing systems (White & Case 2024).

Among the most relevant regulations, the NIS2 Directive emerges offering guidance on managing cybersecurity threats but lacking specific details on how organizations must design their architecture in accordance with these regulations (ECSO 2025). This lack of practical guidance represents a key implementation gap – one that this thesis aims to address.

In this context, EA becomes a valuable tool, as it ensures that both business and IT elements are aligned to achieve operational and regulatory goals (Lankhorst et al. 2013), as “Enterprise

architects are uniquely positioned to design and define the architecture companies will need” (Forbes 2025).

EA and its tools, such as ArchiMate, can create a clear and structured model for NIS2 Directive compliance, supporting the description, analysis, and visualization of architecture within and across business domains (ArchiMate n.d.) – modeling the compliance architecture, outlining the required regulatory measures and identifying gaps, redundancies, and inefficiencies.

This thesis focuses on a country-wide perspective, examining how Member States and the legal bodies listed in the NIS2, such as CSIRTs and Competent Authorities, can utilize EA models to guide their cybersecurity compliance efforts. Furthermore, it aims to demonstrate how individual businesses can adopt similar models in their systems, processes, and IT infrastructure to stay compliant with NIS2 and enhance their overall cybersecurity position.

3.2.2. Research Questions

The main research question of this thesis is “How can NIS2 be integrated with Enterprise Architecture?”, yet the three sub-questions that follow were created to support it:

Q1: What are the key NIS2 concepts and their relationship with EA layers?

Q2: How can these concepts and relationships be represented in a Reference Architecture?

Q3: If each organization has its systems, processes, and infrastructures aligned with the Directive, can the NIS2 Reference Architecture serve as a reference model for NIS2 compliance?

4. Proposal

This section highlights the proposed steps that served as the foundation for developing the NIS2 Reference Architecture.

The proposal was to map NIS2 concepts and their relationships according to EA artifacts (Q1) using ArchiMate as the modeling language. After defining a pattern and preparing the artifacts,

the Reference Architecture for NIS2 compliance could be developed (Q2). Only then could it be demonstrated how the model can help organizations align their systems and infrastructures to meet NIS2 compliance – offering a practical and accessible implementation roadmap (Q3).

4.1. Proposal- Relationship between NIS2 and EA artifacts

Firstly, by choosing Archi as the modeling tool, a strategic method for linking NIS2 concepts with EA artifacts would need to be delineated.

While ArchiMate facilitates interoperability across different organizational sectors (Lankhorst et al. 2013) and simplifies NIS2 concepts, it does not inherently include concepts specific to the legal field. Thus, it would be necessary to adapt NIS2 concepts into the EA framework without losing the core meaning of the Directive and its key compliance terms.

4.2. Proposal- NIS2 Metamodel and Reference Architecture

Once the NIS2 concepts were mapped into EA concepts, the structure for the NIS2 Metamodel could be defined. However, only the Motivation Layer and the Business Layer would be used, due to the lack of internal organizational information to develop other layers.

The Metamodel would provide a foundation for the ArchiMate language, offering a layer-independent representation of its key elements (ArchiMetric 2023). It would connect NIS2 concepts with ArchiMate's motivational elements (such as stakeholders, goals, drivers, requirements and principles) and with its business elements (such as processes, functions, roles, actors, and objects).

After the NIS2 Metamodel was developed, the 46 articles of the Directive could be modeled using the Metamodel's core structure and artifacts, ensuring consistency and reducing the risk of misinterpretations.

Each article would be modeled separately, with a dedicated view. However, viewpoints could be created to highlight interconnections and emphasize that articles should not be interpreted

in isolation. To facilitate the reading process, relevant paragraphs that explain the interrelations between articles would be identified in each article, ensuring the model is easily navigable and more efficient for stakeholders to follow and understand the interconnected nature of the articles. Once this step was completed, the different elements could be consolidated into the NIS2 Reference Architecture.

4.3. Proposal- Possibility of modeling NIS2

After all this was done, it would be possible to demonstrate that NIS2 could be effectively modeled within the context of EA using ArchiMate.

With the Reference Architecture, organizations would gain a clear roadmap for implementing NIS2 requirements, making the compliance process more practical and achievable through actionable steps that the legal Directive itself does not explicitly outline.

5. Design and Development

5.1. Design and Development- Relationship between NIS2 and EA artifacts

Based on the previous proposal and TOGAF's approach (Appendix 5), the first step was understanding the meaning and purpose of each EA artifact within ArchiMate's Motivation and Business Layers. The next step involved identifying connections between these artifacts and NIS2 concepts, effectively creating a pattern of alignment (Appendix 7).

The Motivation Layer included the following artifacts: stakeholder, driver, assessment, goal, requirement, principle, constraint, and meaning. For example, the requirement artifact was applied to any NIS2 statement that included the word "shall", reflecting a mandatory obligation. Additionally, the stakeholder, driver, and assessment artifacts were modeled exclusively on Article 1, outlining the main ideas of NIS2. The remaining articles were modeled starting with the goal artifact and corresponding sub-goals, illustrating how each article contributes to the overall objective of NIS2 compliance.

Similarly, the Business Layer was modeled using a selected set of artifacts: a business actor, business role, business function, business process, business collaboration, business event, business object, and representation. For instance, a business process was defined as an activity or task performed to achieve an article’s sub-goal, and it was linked with a business function – a higher-level capability or behavior- operationalizing it to meet NIS2 guidelines.

With the relevant NIS2 elements mapped into motivational and business artifacts, the next step was determining their relationships (Appendix 11). This involved defining when and why to use each type of relationship in ArchiMate, ensuring a logical alignment of the concepts, and accurately depicting dependencies and interactions among the different legal elements.

5.2. Design and Development- NIS2 Metamodel and Reference Architecture

To begin the development of the Metamodel, the Motivation Layer (highlighted in purple) was prioritized as it “provides the foundation for the other layers” and plays a key role in guiding the design and implementation of the architecture across the other layers (ArchiMetric 2025). Given its foundational role, the Motivation Layer was positioned to the left of the Business Layer – rather than above it, as ArchiMate’s service-oriented principle typically suggests – to improve the visual readability of the models while preserving its conceptual support for the Business Layer.

As represented in Figure 1, the model begins with the stakeholders, since they are the ones who aim to achieve specific objectives. Their actions are influenced by a driver, a specific motivation, which is associated with an assessment that measures progress and success in achieving a defined goal. In this case, “Goal 1” (in Figure 1) represents the main objective, and aggregates several other sub-goals that support its achievement. To attain these goals, requirements define the specific actions that must be taken, while principles guide how those actions are carried out, though they do not always directly lead to goal achievement.

The relationships among these elements follow an ArchiMate logic: requirements can aggregate, associate, influence, and specialize other requirements, while principles aggregate, influence or specialize other principles. Requirements may also be related to principles, with requirements either being associated with or influenced by principles (see Appendix 11 to understand the connections). Constraints may also impact requirements or principles by establishing boundaries or limitations as detailed in Appendix 11. Finally, when the intention is to highlight the significance of a particular concept, meaning can be introduced by being linked to goals, principles, or requirements.

Once the Motivation Layer was completed, the Business Layer (highlighted in yellow) was developed as the layer that “describes how an organization performs in conformance with the Motivation Layer” (Werewka, Jamróz, and Pitulej 2014, 499). This layer operationalizes the Motivation Layer by identifying key business processes required to achieve the sub-goals.

Each business process is part of a larger business function, serving its intended purpose. That function is assigned to a business role, assigned to a business actor. A business actor assumes a unique business role that can be associated with numerous business functions, reflecting its various responsibilities or behaviors.

When a business process requires the cooperation of different business actors, a business collaboration is established to enable joint action. Business processes can be composed of other processes or trigger others. During execution, they access business objects, which are developed or leveraged as part of the process. These objects can be composed of other objects and linked to representations. When objects are exchanged between processes, a business event can be triggered – a one-time occurrence that leads to another business process, illustrating the interaction between processes (see Appendix 11 for more details).

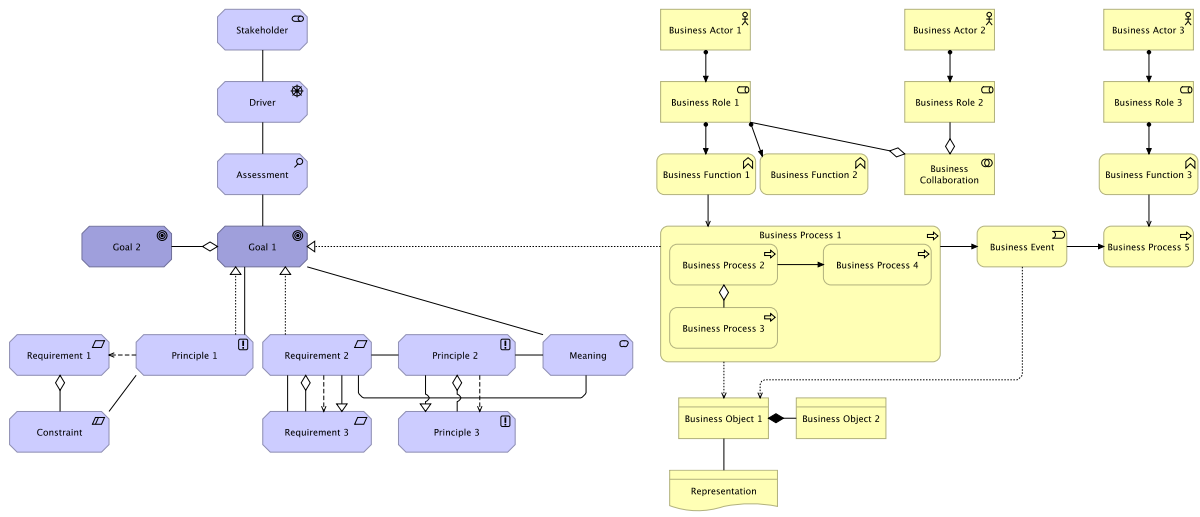


Figure 1. NIS2 Metamodel

Upon establishing the Metamodel, the 46 articles of NIS2 were modeled to form the NIS2 Reference Architecture. While these articles were based on the Metamodel, they provided more detailed representations, as the Metamodel itself only offers a “minimum set of architectural content to support traceability across artifacts”. (The Open Group 2013).

Once the modeling of the 46 articles was completed, it became necessary to address the interrelationships between them. To achieve this, specific viewpoints were created, each connecting articles to those explicitly referenced within them.

In Archi, each viewpoint is represented by a light blue box, as shown in Figure 2. Selecting a viewpoint reveals the related article, where the specific referenced element in the model can be located by searching for notations such as “P2(b)”, which in this case refers to paragraph two of the referred article, subparagraph b (as illustrated in Figure 3). For articles that were too extensive or complex to be clearly understood in a single representation, additional viewpoints were developed (for instance, Articles 14 and 15).

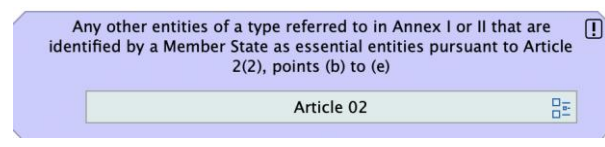


Figure 2. Viewpoint illustrating how Article 3 refers to Article 2

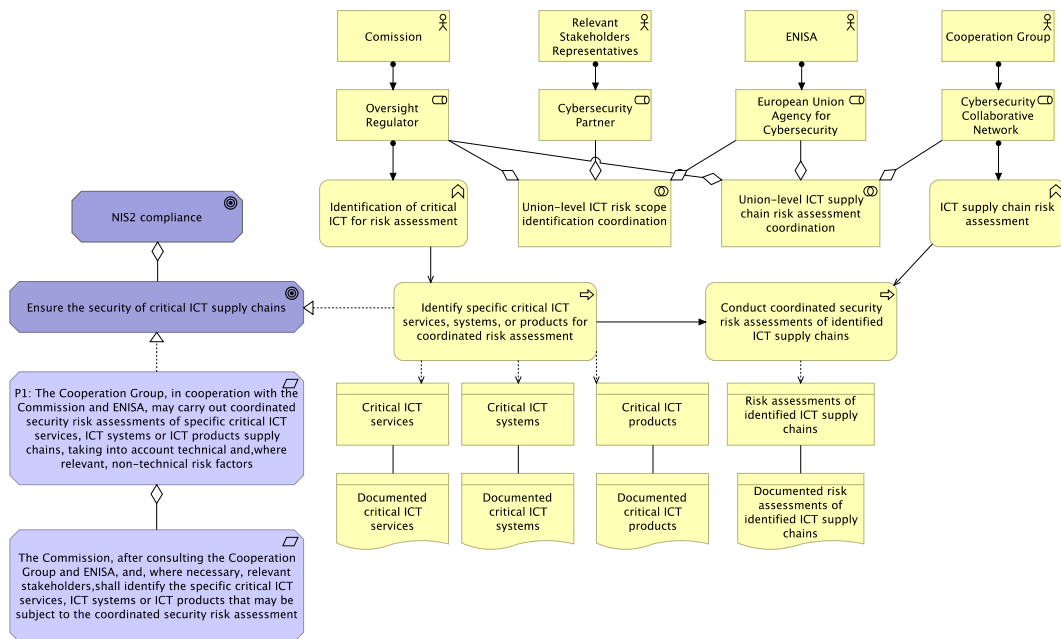


Figure 5. NIS2 Article 22

Supervisory and enforcement measures – almost non-existent under NIS1 – represent a significant improvement in NIS2. The Directive now provides national competent authorities with specific steps to ensure compliance among Essential and Important Entities (Appendix 12.32 and 12.33).

Additionally, the expanded importance of the Cooperation Group (Figure 6) and the establishment of the EU-CyCLONE (Figure 7) are also key developments for strengthening cross-border cooperation on cybersecurity issues, offering a more coordinated response to cybersecurity incidents, and facilitating the exchange of critical information on cyber threats and vulnerabilities.

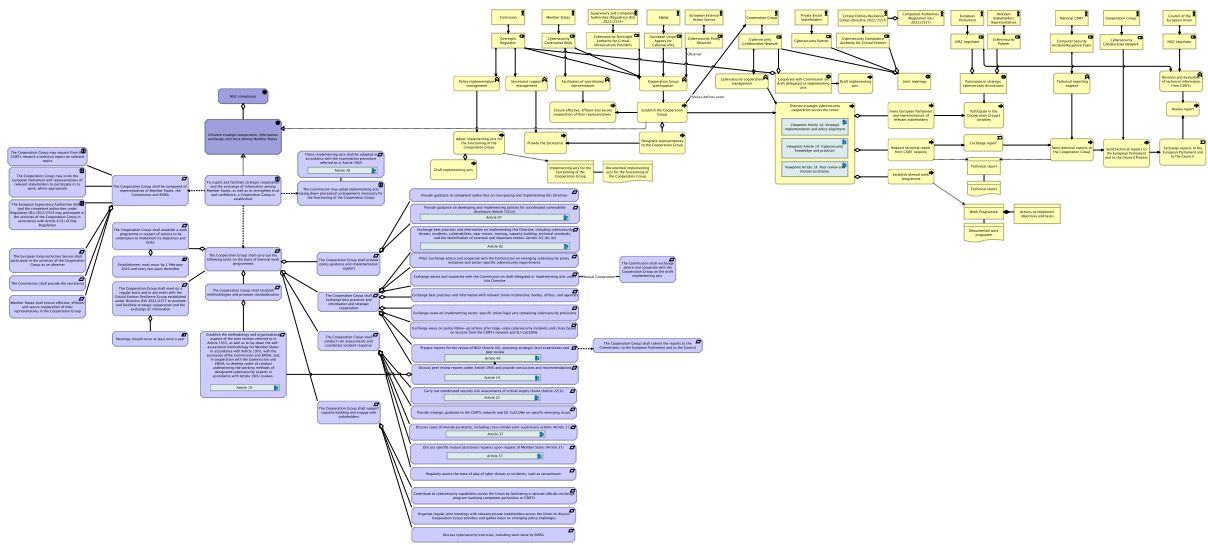


Figure 6. NIS2 Article 14

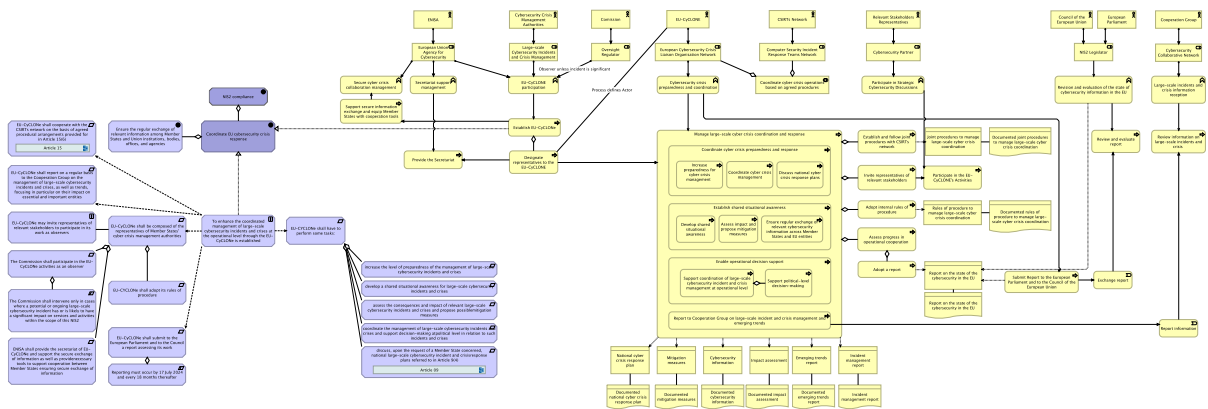


Figure 7. NIS2 Article 16

Finally, ENISA's involvement in creating and maintaining the Vulnerability Database (Figure 8) significantly strengthens the EU's cybersecurity system. The promotion of cybersecurity information-sharing arrangements (Figure 9) further reinforces these mechanisms, allowing Member States and covered entities to exchange knowledge, and ultimately enhance collective resilience.

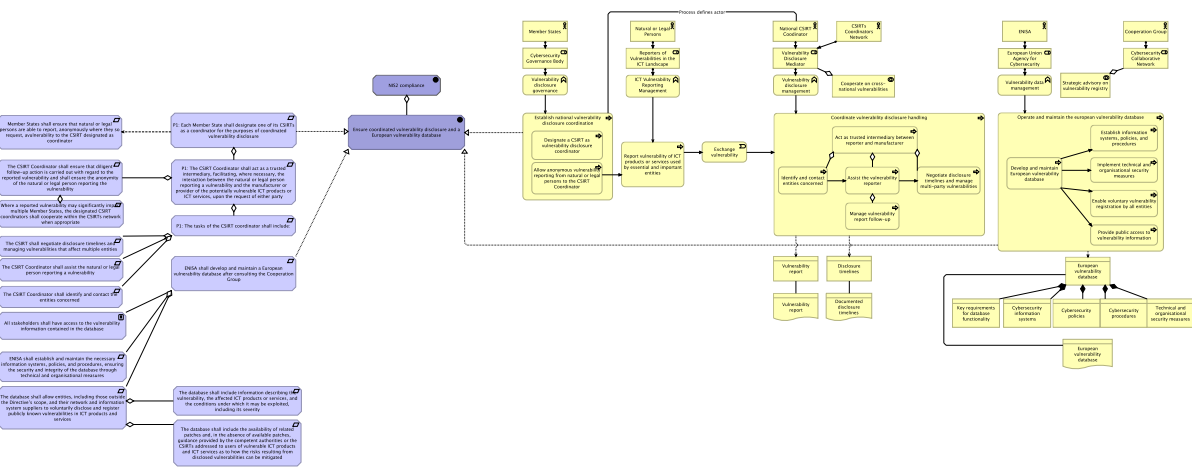


Figure 8. NIS2 Article 12

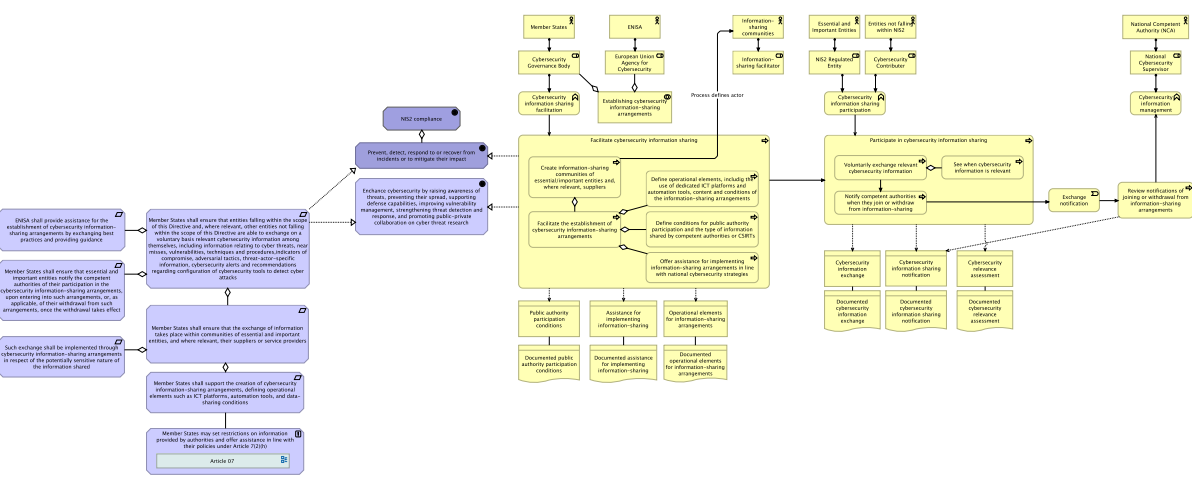


Figure 9. NIS2 Article 29

6. Demonstration

As illustrated in the previous section, NIS2 can be effectively modeled using ArchiMate. This tool transforms the legal document, which primarily serves as “a set of obligations”, into detailed, actionable steps.

The NIS2 Reference Architecture provides an organized representation of the Directive in a structured and visual manner that enhances understanding and provides stakeholders with a step-by-step implementation guide, making compliance easier. However, it is important to note that interpreting and applying the model requires careful reading, as most of the designed

relationships and responsibilities are very detailed and not always immediately visible at first glance.

Instead of focusing on a single enterprise, the NIS2 Reference Architecture was designed based on a country-wide perspective, encompassing all organizations and bodies covered under NIS2. This broader perspective acknowledges the complexity of NIS2 while demonstrating that it is still possible to model the Directive effectively. Moreover, it ensures each organization can tailor the NIS2 Reference Architecture to its context, since it has access to more internal details than those provided in the Directive.

As intended, this thesis demonstrated that a model that supports organizations' operational alignment with the Directive can be developed, making NIS2 adherence more accessible and feasible for everyone involved.

7. Evaluation

Although it was possible to demonstrate that a NIS2 Reference Architecture can be developed, it is essential to assess its validity. To do this, the “Moody and Shanks Framework” was applied. Originally designed to assess the quality of data models (Moody and Shanks 1994)- abstract representations used to manage and organize data efficiently (Sebastian-Coleman 2022)- The framework consisted of six quality factors: simplicity, completeness, flexibility, integration, understandability, and implementability. However, this thesis uses an updated version which includes two additional quality factors- integrity and correctness (Moody and Shanks 2003).

The application of these quality factors in the NIS2 Reference Architecture confirmed the following:

- **Simplicity** evaluates if the model contains “the minimum possible entities and relationships” (Moody and Shanks 2003, 624). For the NIS2 Reference Architecture,

simplicity is achieved by aligning the NIS2 articles with ArchiMate components, ensuring redundancy is minimized and focusing on the most relevant elements;

- **Completeness** refers to whether the model encompasses all user information and functional requirements (Moody and Shanks 1994). Since all 46 articles of NIS2 were modeled and mapped, the NIS2 Reference Architecture is complete;
- **Flexibility** is “defined as the ease with which the data model can cope with business and/or regulatory change” (Moody and Shanks 2003, 624). The NIS2 Reference Architecture provides a foundational structure that can be easily adjusted to accommodate changes in the regulatory environment or evolving organizational needs;
- **Integration** is defined as “the consistency of data defined in the data model with the rest of the organization’s data” (Moody and Shanks 1994, 104). The NIS2 Reference Architecture integrates seamlessly across the different bodies and organizations covered by the Directive, ensuring the model is actionable across different organizational layers;
- **Understandability** ensures the model can be easily understood (Schuette 1999). Given that the NIS2 Reference Architecture was built using ArchiMate and EA principles, it ensures it can be understood by stakeholders from different backgrounds, such as experts in cybersecurity, regulatory compliance, and enterprise architecture;
- **Implementability** refers to “the ease with which the data model can be implemented within time, budget, resource and technology constraints of the project” (Moody and Shanks 1994, 106). The NIS2 Reference Architecture identifies the most critical EA artifacts for NIS2 compliance and offers clear steps to align systems and processes for feasible implementation;
- **Integrity** relates to maintaining consistency of rules and relationships within the system (Schuette 1999). The NIS2 Reference Architecture clearly defines relationships

between the NIS2 concepts and EA artifacts, ensuring updates can be incorporated without impacting the architecture;

- **Correctness** assesses “whether the model conforms to the rules of data modeling technique” (Moody and Shanks 2003, 630). Since the NIS2 Reference Architecture was built using the ArchiMate and EA standards, it is both valid and reliable.

Overall, the NIS2 Reference Architecture meets all the essential criteria, demonstrating its ability to successfully guide organizations seeking to adopt a structured approach to NIS2 compliance.

8. Conclusion

“The digital transformation of society has expanded the threat landscape and is bringing about new challenges, which require adapted and innovative responses” (European Commission 2025-b). The NIS2 Directive is one such response, with the EU setting guidelines to strengthen organizations’ security postures against cyber threats (Deloitte 2022). However, many organizations often lack clear guidance and resources, and face missed deadlines for enforcement (McCann 2024).

This thesis explored how EA is increasingly used to model and manage business and IT assets and their interdependence (Jiang et al. 2024), by developing a NIS2 Reference Architecture to assist organizations in achieving compliance across different organizational contexts.

This research followed the DSRM, which proved to be effective in providing a clear, organized approach to identifying the research gap, designing a solution, and developing a relevant architecture. It began with a literature review to define the theoretical foundation and identify research gaps. Then, NIS2 concepts were mapped to EA artifacts, addressing the first research question, “What are the key NIS2 concepts and their relationship with EA layers?”. Following this, a NIS2 Metamodel was created, integrating both the Motivation and Business Layers,

answering research question two, “How can these concepts and relationships be represented in a Reference Architecture?”. Finally, this led to the NIS2 Reference Architecture, which modeled all 46 articles of NIS2 through corresponding views and integrated viewpoints – effectively addressing the third research question “If each organization has its systems, processes, and infrastructures aligned with the Directive, can the NIS2 Reference Architecture serve as a reference model for NIS2 compliance?”. Through this process, the main research question – “How can NIS2 be integrated with Enterprise Architecture?” – was answered, and the results demonstrated that EA can be incorporated with legal frameworks, providing structure, reducing complexity, and supporting compliance efforts.

However, some limitations emerged during the development of the NIS2 Reference Architecture:

- The lack of legal expertise affected the depth of interpretation of the architecture;
- Some views could have been better integrated or connected with others, simplifying stakeholder understanding;
- Organizing views by articles hindered relationship clarity in showing interconnections, and time constraints limited deeper refinement;
- The European Commission's lack of precision when creating the NIS2, including unclear roles and the absence of a clear timeline and flow in the Directive (e.g., one article mentions a CSIRT coordinator, but the formal designation of the role appears in a later article).

To further expand this work, future research could focus on:

- Restructuring the Reference Architecture with alternative views and incorporating more architecture layers, especially for single organizations, since they have internal knowledge for that;

- Conducting a gap analysis between NIS1 and NIS2 through EA modeling which could help businesses understand the required changes for compliance and the alignment between the different levels of the organization (Appendix 13);
- Involving EA experts in the EA modeling process since it will lead to a more harmonized and effective organization;
- Modelling the transposition of NIS2 into national laws for each Member State, which would provide a more concrete and applicable framework for implementation within enterprises;
- Modelling similar legal instruments such as the ISO/IEC 27000 family – a set of standards that offer guidelines focused on IT security, cybersecurity and privacy protection (ISO 2022) – and developing mechanisms capable of aligning and integrating different regulatory frameworks, since organizations are exposed to different compliance obligations simultaneously.

To summarize, this thesis was able to expand the understanding of EA and NIS2, demonstrating that integrating Enterprise Architecture with legal instruments offers a structured and practical approach for organizations to achieve compliance, strengthen cybersecurity, and improve overall operational alignment.

References

- Aldea, A, M. E Iacob, J van Hillegersberg, D Quartel, and H Franken. 2015. "Modelling Value with ArchiMate." In *Advanced Information Systems Engineering Workshops*, 375–88. Springer International Publishing.
https://link.springer.com/chapter/10.1007/978-3-319-19243-7_35.
- Archi. n.d. "Archi – Open Source ArchiMate Modelling." Accessed May 6, 2025.
<https://www.archimatetool.com/>.
- ArchiMate. n.d. *ArchiMate Modelling Tool- User Guide*.
- ArchiMetric. 2023. "Understanding the ArchiMate 3.2 Metamodel: A Guide to Behavior and Structure Elements - ArchiMetric." October 4, 2023.
<https://www.archimetric.com/understanding-the-archimate-3-2-Metamodel-a-guide-to-behavior-and-structure-elements/>.
- ArchiMetric. 2025. "Mastering ArchiMate Motivation Layer: A Comprehensive Guide with Practical Examples - ArchiMetric." February 3, 2025.
<https://www.archimetric.com/mastering-archimate-motivation-layer-a-comprehensive-guide-with-practical-examples/>.
- Chen, Aixia, Ling Li, and Waseem Shahid. 2024. "Digital Transformation as the Driving Force for Sustainable Business Performance: A Moderated Mediation Model of Market-Driven Business Model Innovation and Digital Leadership Capabilities." *Heliyon* 10 (8): 1–17.
<https://doi.org/10.1016/J.HELIYON.2024.E29509>.
- Defense Information Systems Agency Center. 1996. "Department of Defense Technical Architecture Framework for Information Management (TAFIM) (Version 3.0)." Reston: Defense Information System Agency.
- Deloitte. 2022. "Key Focus Areas for NIS2 Compliance." Deloitte. March 28, 2022.
<https://www.deloitte.com/se/sv/services/risk-advisory/perspectives/key-focus-areas-for-nis2-compliance.html>.
- ECISO. 2025. "White Paper: NIS2 Implementation: Challenges and Priorities - ECISO." January 10, 2025. <https://ecs-org.eu/?publications=white-paper-nis2-implementation-challenges-and-priorities>.
- ENISA. n.d. "SMEs Cybersecurity | ENISA." Accessed May 6, 2025.
<https://www.enisa.europa.eu/topics/awareness-and-cyber-hygiene/smes-cybersecurity>.
- European Commission. 2016. "Directive (EU) 2016/1148 of the European Parliament and of the Council." Official Journal of the European Union.
- European Commission. 2022. "Directive (EU) 2022/2555 of the European Parliament and of the Council." Official Journal of the European Union.
- European Commission. 2023. "Directive on Measures for a High Common Level of Cybersecurity across the Union (NIS2 Directive) - FAQs | Shaping Europe's Digital Future." June 29, 2023. <https://digital-strategy.ec.europa.eu/en/faqs/directive-measures-high-common-level-cybersecurity-across-union-nis2-directive-faqs>.
- European Commission. 2025.-a "NIS2 Directive: New Rules on Cybersecurity of Network and Information Systems | Shaping Europe's Digital Future." January 15, 2025. <https://digital-strategy.ec.europa.eu/en/policies/nis2-directive>.
- European Commission. 2025.-b "The Cybersecurity Strategy | Shaping Europe's Digital Future." April 4, 2025. <https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-strategy>.

- Forbes. 2025. “Why Enterprise Architecture Is Having A Moment.” July 2025. <https://www.forbes.com/sites/sap/2025/03/07/why-enterprise-architecture-is-having-a-moment/>.
- Gampfer, Fabian, Andreas Jürgens, Markus Müller, and Rüdiger Buchkremer. 2018. “Past, Current and Future Trends in Enterprise Architecture—A View beyond the Horizon.” *Computers in Industry* 100:70–84.
- Greefhorst, Danny, and Erick Proper. 2011. *Architecture Principles: The Cornerstones of Enterprise Architecture*. Netherlands: Springer.
- Herbert A., Simon. 1996. *The Sciences of the Artificial*. 3rd ed. https://monoskop.org/images/9/9c/Simon_Herbert_A_The_Sciences_of_the_Artificial_3rd_ed.pdf.
- Hevner, Alan, Jinsoo, Park, March, Salvatore, and Ram Sudha. 2004. “Design Science in Information Systems Research.” *MIS Quarterly* 28 (1): 75–105. <https://www.researchgate.net/publication/201168946>.
- IBM. 2024. “IBM Report: Cybercriminals Intensify Attacks on User Identities in the UK, Complicating Recovery Efforts for Enterprises.” February 21, 2024. <https://uk.newsroom.ibm.com/IBM-Report-Cybercriminals-Intensify-Attacks-on-User-Identities-in-the-UK-Complicating-Recovery-Efforts-for-Enterprises>.
- ISO. 2022. “ISO/IEC 27005:2022 - Guidance on managing information security risks.” Accessed May 20, 2025. <https://www.iso.org/standard/80585.html>.
- Jiang, Y, M. A Jeusfeld, M Mosaad, and N Oo. 2024. “Enterprise Architecture Modeling for Cybersecurity Analysis in Critical Infrastructures — A Systematic Literature Review.” *International Journal of Critical Infrastructure Protection*, 1–16.
- Kotusev, Svyatoslav. 2016. “The History of Enterprise Architecture: An Evidence-Based Review.” *Journal of Enterprise Architecture* 12 (1): 29–37. <https://www.researchgate.net/publication/308936998>.
- Lankhorst, Marc, Jan Dietz, Erik Proper, José Tribolet, Terry Halpin, Jan Hoogervorst, Martin Op ’t Land, Ronald G Ross, and Robert Winter. 2013. *Enterprise Architecture at Work- Modelling, Communication and Analysis*. 3rd ed. Netherlands: Springer.
- McCann, Kristian. 2024. “NIS2 Enters Law: What EU-Operating Enterprises Need to Know | Cyber Magazine.” October 17, 2024. <https://cybermagazine.com/articles/nis2-enters-law-what-enterprises-need-to-know>.
- Moody, Daniel L., and Graeme G. Shanks. 1994. “What Makes a Good Data Model? Evaluating the Quality of Entity Relationship Models.” In *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 881 LNCS: 94-111. Springer, Berlin, Heidelberg. https://doi.org/10.1007/3-540-58786-1_75.
- Moody, Daniel L, and Graeme G Shanks. 2003. “Improving the Quality of Data Models: Empirical Validation of a Quality Management Framework.” In *Information Systems*, 28(6): 619–650.
- Negreiro, Mar. 2023. *The NIS2 Directive- A High Common Level of Cybersecurity in the EU*. European Parliamentary Research Service.
- Niemi, Eetu. 2007. “Enterprise Architecture Stakeholders- a Holistic View.” In *Americas Conference on Information Systems*, 1–9. Association for Information Systems (AIS). <http://aisel.aisnet.org/amcis2007/41>.
- Peffers, Ken, Tuure Tuunanen, Marcus A. Rothenberger, and Samir Chatterjee. 2007. “A Design Science Research Methodology for Information Systems Research.” *Journal of Management Information Systems* 24 (3): 45–77. <https://doi.org/10.2753/MIS0742-1222240302>.

- Reed, Jonathan. 2024. "Cybersecurity Dominates Concerns among the C-Suite, Small Businesses and the Nation | IBM." November 15, 2024. <https://www.ibm.com/think/insights/cybersecurity-dominates-concerns-c-suite-small-businesses-nation>.
- Scholtz, Brenda, Andre Calitz, Anthea Connolley, Port Elizabeth, and South Africa. 2013. "An Analysis of the Adoption and Usage of Enterprise Architecture." In *Proceedings Iof the First International Conference on Enterprise Systems: ES 2013*, 1–9. Cape Town: IEEE.
- Schuette, Reinhard. 1999. "Architectures for Evaluating the Quality of Information Models - A Meta and an Object Level Comparison." In *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 1728:490–505. Springer Verlag. https://doi.org/10.1007/3-540-47866-3_33.
- Sebastian-Coleman, Laura. 2022. "Core Data Quality Management Capabilities." In *Meeting the Challenges of Data Quality Management*, 187–228. Elsevier. <https://doi.org/10.1016/B978-0-12-821737-5.00009-2>.
- Sonai Muthu Anbananthen, Kalaiarasi, Saravanan Muthaiyah, Sabareswari Thiyagarajan, Baarathi Balasubramaniam, Yunus Bin Yousif, Suraya Mohammad, and Khairul Shafee Kalid. 2024. "Evaluating Enterprise Architecture Frameworks for Digital Transformation in Agriculture." *Journal of Human, Earth, and Future* 5 (4): 761–72. www.HEFJournal.org.
- The Open Group. 2013. "Redefining Traceability in Enterprise Architecture and Implementing the Concept with TOGAF 9.1 and/or ArchiMate 2.0 - The Open Group Blog." September 12, 2013. <https://blog.opengroup.org/2013/09/12/redefining-traceability-in-enterprise-architecture-and-implementing-the-concept-with-togaf-9-1-andor-archimate-2-0/>.
- The Open Group. n.d.-a. "About Us - What We Do | Www.Opengroup.Org." Accessed May 18, 2025. <https://www.opengroup.org/about-us/what-we-do>.
- The Open Group. n.d.-b. "Implementation and Migration Layer." Accessed May 6, 2025. <https://pubs.opengroup.org/architecture/archimate3-doc/ch-Implementation-and-Migration-Layer.html>.
- The Open Group. n.d.-c. "The O-AATM Standard | Www.Opengroup.Org." Accessed May 6, 2025. <https://www.opengroup.org/AgileArchitecture>.
- The Open Group. n.d.-d. "The Open Group Announces Launch of the TOGAF® Standard, 10th Edition | Www.Opengroup.Org." Accessed May 6, 2025. <https://www.opengroup.org/open-group-announces-launch-togaf-standard-10th-edition>.
- The Open Group. n.d.-e. "TOGAF® Series Guides | Www.Opengroup.Org." Accessed May 6, 2025. <https://www.opengroup.org/togaf/series-guides>.
- The Open Group. n.d.-f. "What Is New in the TOGAF® Standard, 10th Edition? | Www.Opengroup.Org." Accessed May 6, 2025. <https://www.opengroup.org/togaf/new-version>.
- Werewka, Jan, Krzysztof Jamróz, and Dariusz Pitulej. 2014. "CCIS 424 - Developing Lean Architecture Governance at a Software Developing Company Applying ArchiMate Motivation and Business Layers." In *Communications in Computer and Information Science*, 492–503. https://doi.org/10.1007/978-3-319-06932-6_48#page-2.
- White & Case. 2024. "NIS 2 Directive: Navigating the Challenges of Implementation, Impact, and Scope." White & Case LLP. June 24, 2024.

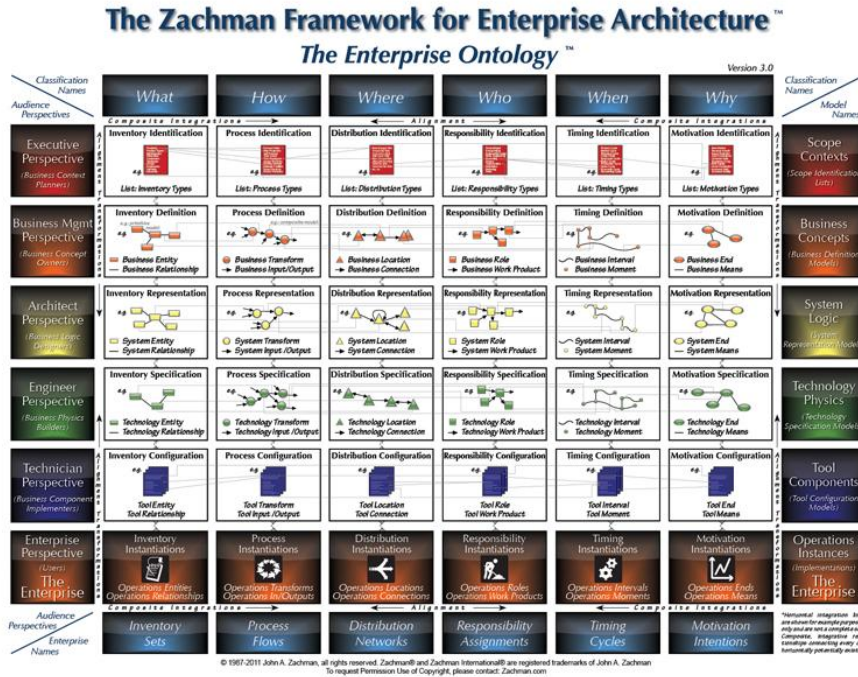
<https://www.whitecase.com/insight-webinar/nis-2-directive-navigating-challenges-implementation-impact-and-scope>.

Yamamoto, S, Q Zhi, and Z Zhou. 2019. "Aspect Analysis towards ArchiMate Diagrams." In *Proceedings of the 23rd International Conference on Knowledge-Based and Intelligent Information & Engineering Systems*, 159:973–80. Elsevier. <https://www.sciencedirect.com/science/article/pii/S1877050919314607>.

Zachman International. 2008. "About the Zachman Framework." Zachman International- Enterprise Architecture. 2008. <https://zachman-feac.com/zachman/about-the-zachman-framework>.

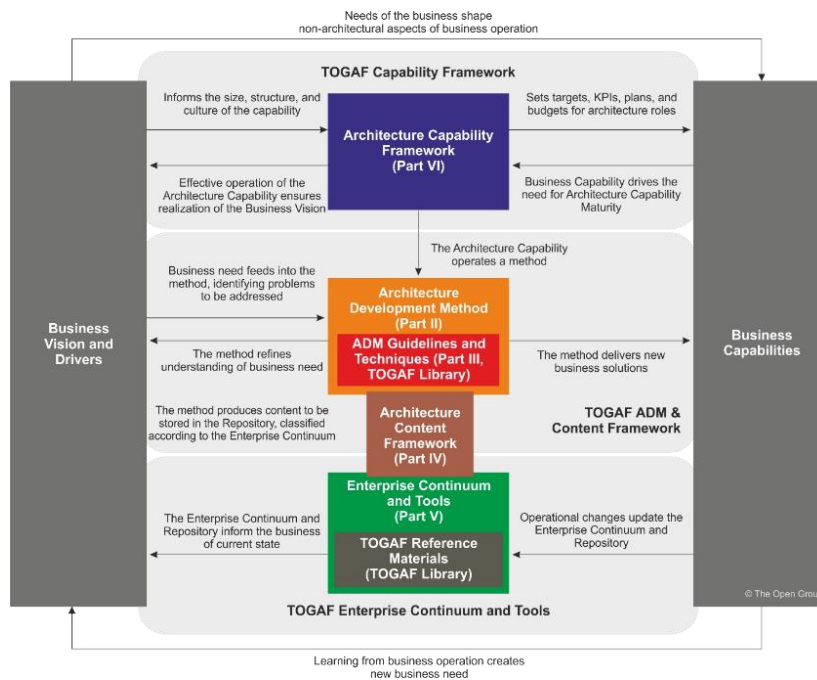
Appendices

Appendix 1. Zachman Framework



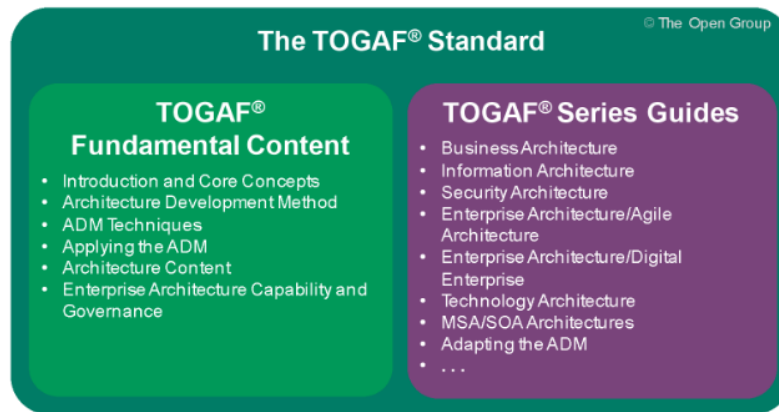
(Source: “About the Zachman Framework - Zachman International - FEAC Institute.” n.d. Accessed May 9, 2025. <https://zachman-feac.com/zachman/about-the-zachman-framework>.)

Appendix 2. TOGAF Version 9 Scheme



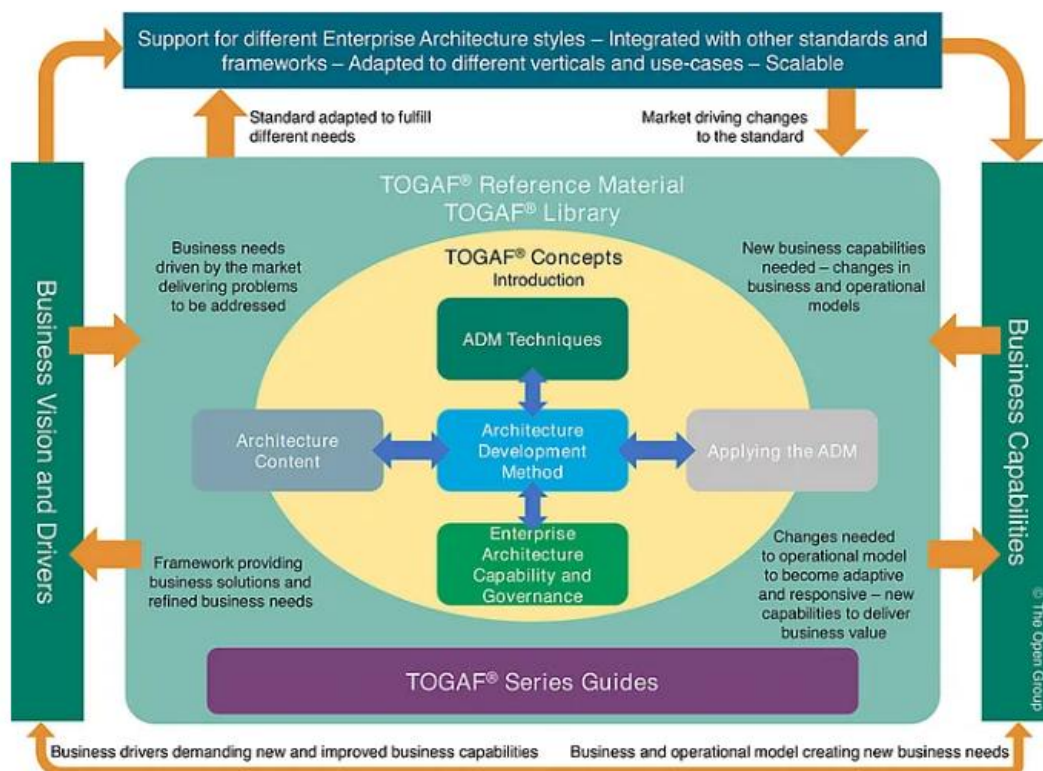
(Source: Generoso, Tiago. 2023. “TOGAF 9 vs. TOGAF 10: What’s New and Different?” | by Tiago Dias Generoso | Dev Genius.” October 17, 2023. <https://blog.devgenius.io/togaf-9-vs-togaf-10-whats-new-and-different-bc2260200275>.)

Appendix 3. TOGAF Version 10



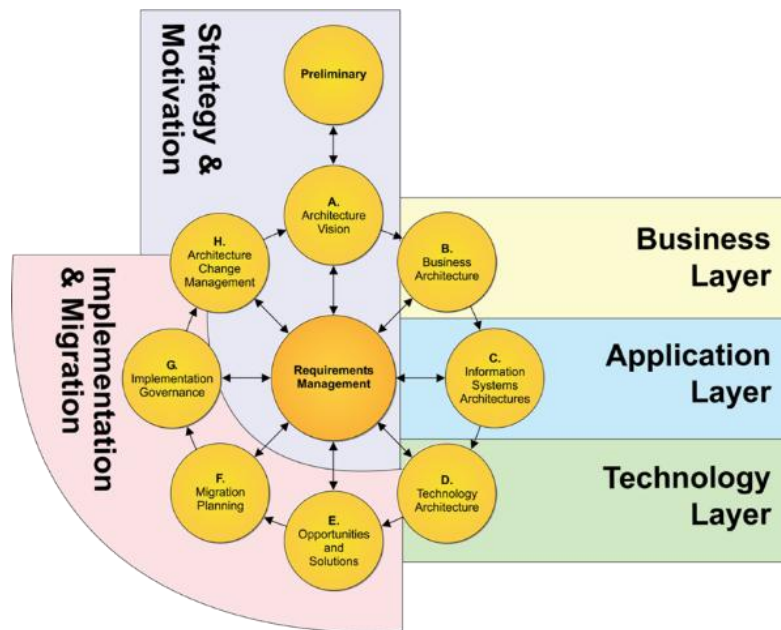
(Source: “TOGAF 10: The Next Level of Enterprise Architecture Framework - Visual Paradigm Guides.” 2023. March 14, 2023. <https://guides.visual-paradigm.com/togaf-10-the-next-level-of-enterprise-architecture-framework/>.)

Appendix 4. TOGAF Version 10 Scheme



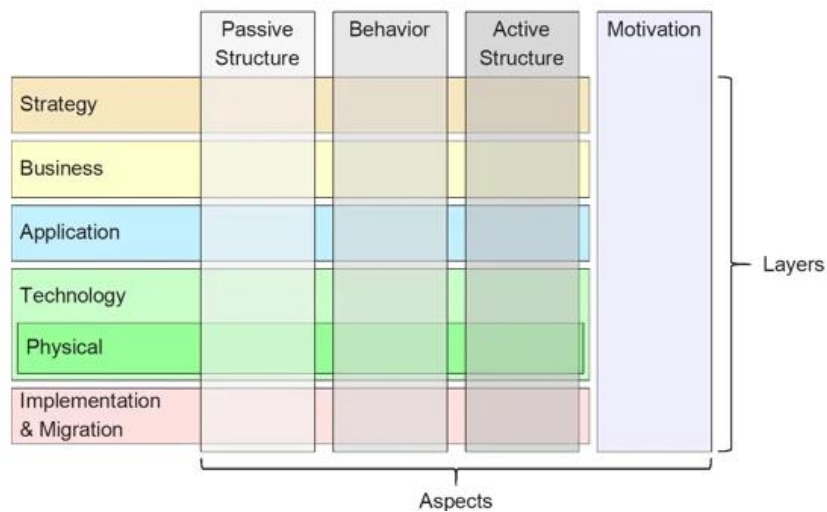
(Source: Generoso, Tiago. 2023. “TOGAF 9 vs. TOGAF 10: What’s New and Different? | by Tiago Dias Generoso | Dev Genius.” October 17, 2023. <https://blog.devgenius.io/togaf-9-vs-togaf-10-whats-new-and-different-bc2260200275>.)

Appendix 5. Correspondence between the ArchiMate Language and the TOGAF ADM



(Source: “What Is ArchiMate? Key Components & Comparisons | LeanIX.” n.d. Accessed May 9, 2025. [https://www.leanix.net/en/wiki/ea/what-is-archimate.](https://www.leanix.net/en/wiki/ea/what-is-archimate))

Appendix 6. ArchiMate Framework



(Source: “What Is ArchiMate? Key Components & Comparisons | LeanIX.” n.d. Accessed May 9, 2025. [https://www.leanix.net/en/wiki/ea/what-is-archimate.](https://www.leanix.net/en/wiki/ea/what-is-archimate))

Appendix 7. EA Artifacts

Architecture Layers	EA Artifacts	Aspect Designation	Rationale for Aligning EA Artifacts with NIS2 Concepts
Motivation	Stakeholder	-	Used for the European Parliament and for the Council of the European Union as they are the entities responsible for ensuring NIS2 compliance across the EU.
	Driver	-	The internal condition that motivates stakeholders to achieve their goal. In the Reference Architecture the main driver is the high common level of cybersecurity across the EU, that ultimately supports another driver, the improved internal market functioning.
	Assessment	-	Defined as the method for evaluating cybersecurity performance in Member States, which serves to determine how well the driver is being applied.
	Goal	-	Represents the desired state for the stakeholders, with the primary goal being NIS2 compliance. Intrinsic, smaller goals are also defined, as collectively they contribute to the accomplishment of the main one.
	Requirement	-	Any statement in NIS2 that includes the word 'shall' or that is identified as an obligation.
	Principle	-	Whenever NIS2 contains a statement suggesting an option rather than a demand, such as a guideline that applies universally but does not require immediate action. Additionally, principles are also used to represent implied philosophical ideas, or universal statements conveyed throughout the NIS2.
	Constraint	-	Used to limit the scope of requirements and principles, restricting their execution, by narrowing the options for

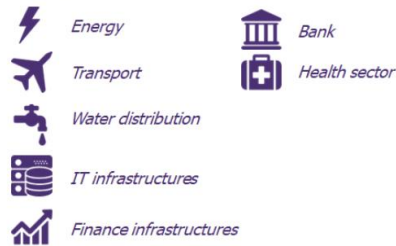
			compliance in case of the requirements, or possible adherence in case of principles.
	Meaning	-	Illustrates the interpretation of a specific concept, such as a definition.
Business	Business Actor	Active Structure	Represents the entity responsible for a specific business role, performing various business functions to carry out different business processes.
	Business Role	Active Structure	Defined as the generic responsibility or position that an entity assumes. It encompasses various tasks, represented by the business functions.
	Business Function	Behavioral	According to the business processes it supports, a business function represents an organizational capability or behavior that aggregates a collection of specific tasks (business processes) within a business role. Thus, different business functions can be carried out by the same business role.
	Business Process	Behavioral	Defines an activity or task performed to achieve a goal.
	Business Collaboration	Active Structure	Illustrates the cooperation between different business actors required to execute a specific business process.
	Business Event	Behavioral	Used to facilitate the transition between processes performed by different business actors, used as a one-time occurrence.
	Business Object	Passive Structure	Represents a tangible or intangible concept that needs to be developed, exchanged, or delivered because of a business process.
	Representation	Passive Structure	Represents the concrete form of the information conveyed by business objects. It can be abstract or tangible. When the directive explicitly mentions a “report” for example, the representation is a report, as the business object. In cases

			where the form is not specified such as “enforcement measures”, it is modeled as a document, reflecting the lack of clarity on the required format.
--	--	--	---

Appendix 8. Entities covered under NIS1

WHAT SCOPE?

OES: Operator of Essential Services



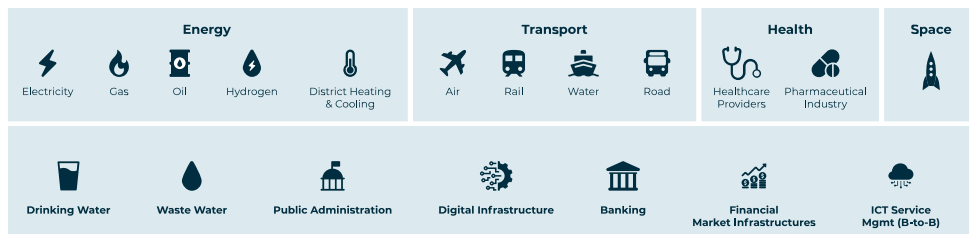
DSP: Digital Service Providers



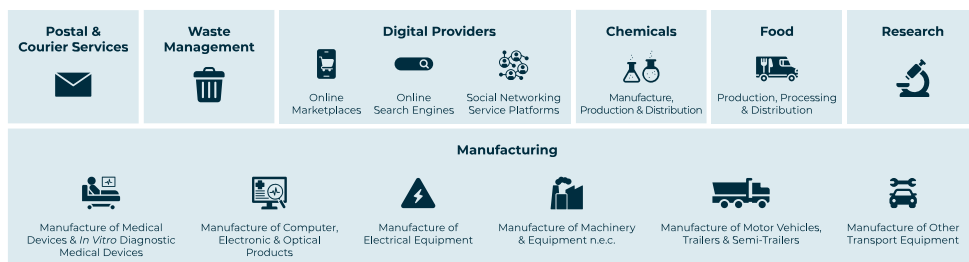
(Source: “The EU NIS Directive: How Can You Prepare for It? - Risk Insight.” n.d. Accessed May 9, 2025. <https://www.riskinsight-wavestone.com/en/2017/12/the-eu-nis-directive-what-are-the-issues-and-how-can-you-prepare-for-it/>.)

Appendix 9. Entities covered under NIS2

Essential Business Sectors

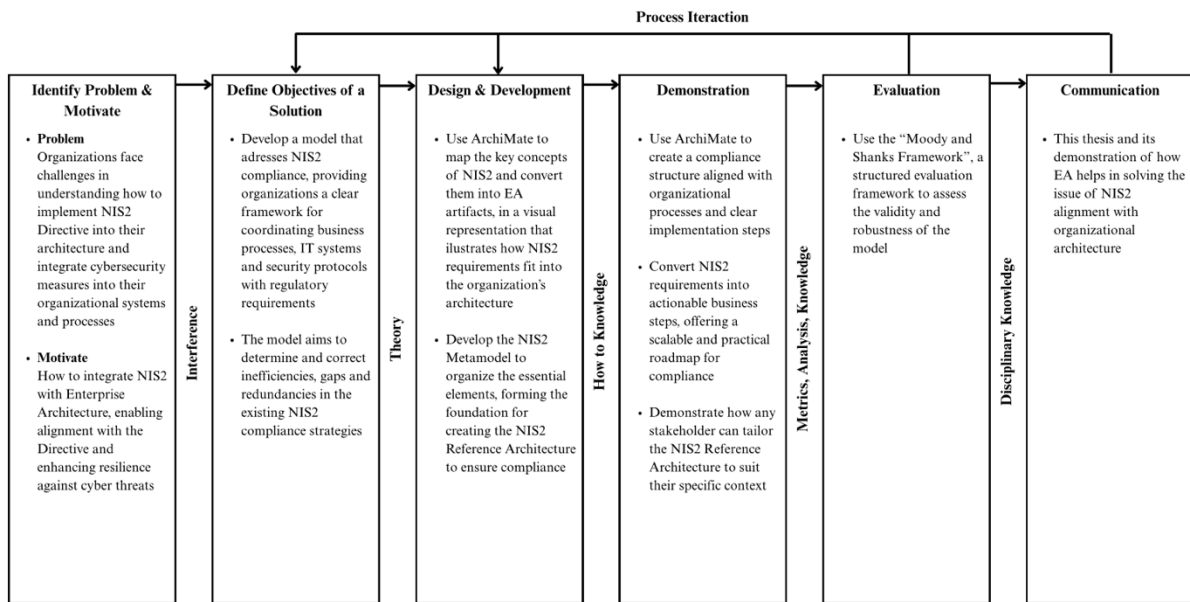


Important Business Sectors



(Source: “NIS2 Directive | What Is NIS2 Compliance? | EU Regulation.” 2024. 2024. <https://www.datacore.com/blog/nis2-directive/>.)

Appendix 10. DSRM for NIS2 Modeling



Appendix 11. Rationale for EA Artifacts Relations

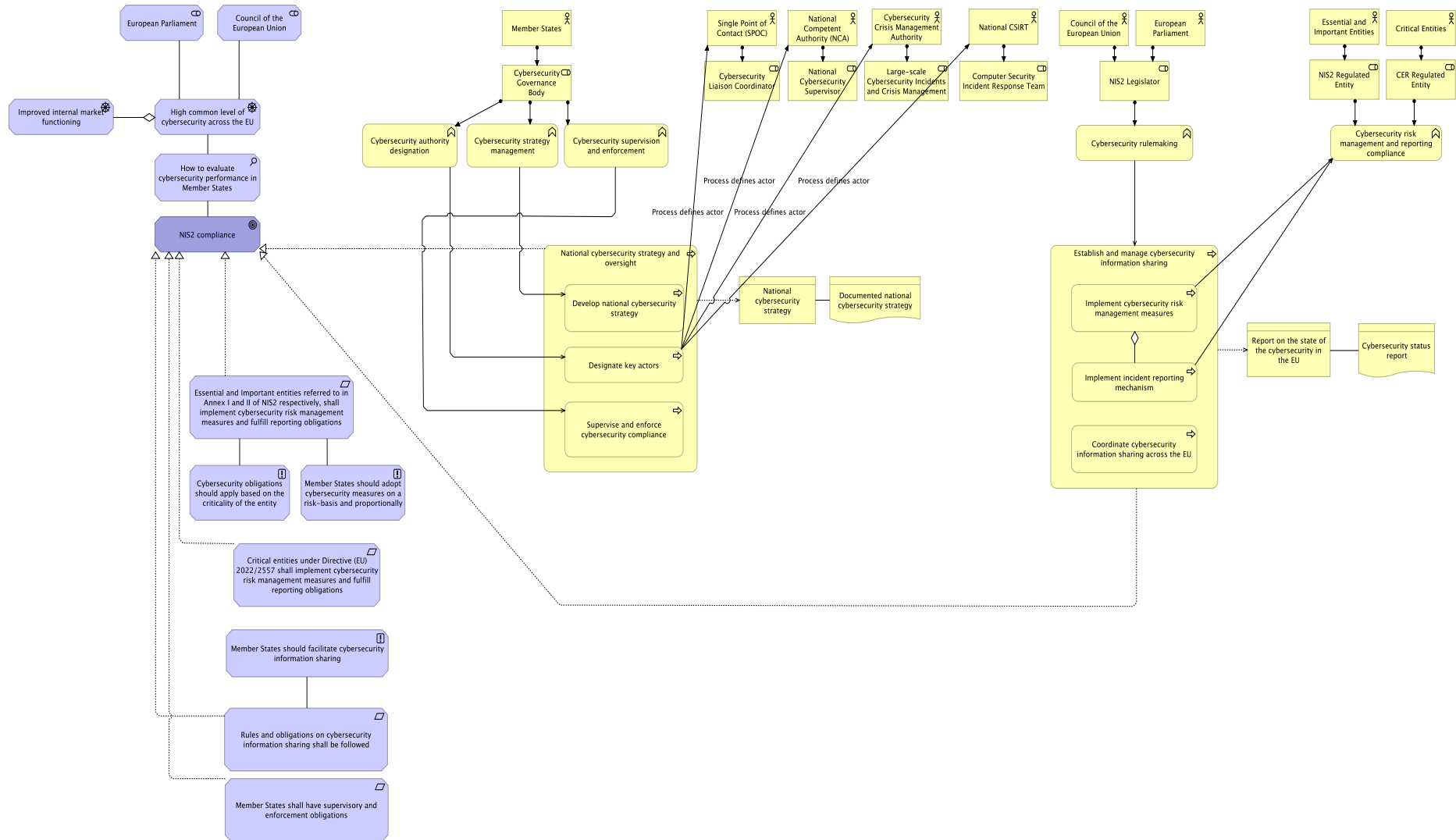
Related EA Artifacts	Relation Name	Rationale for Relation
Stakeholder – Driver	Association	The stakeholder has a reason to act.
Driver – Assessment	Association	The effectiveness of a driver needs to be measured.
Assessment – Goal	Association	The result of the assessment is linked with the goal's achievement.
Goal – Goal	Aggregation	To achieve a primary goal, other sub-goals need to be achieved.
Goal – Requirement	Realization	A requirement is a necessary condition to achieve a goal.
Goal – Principle	Association	A principle is linked to a goal, but it does not directly enable its achievement.
	Realization	A principle is a necessary condition for achieving a goal, as it drives the approach to accomplish it.
Requirement – Requirement	Association	A requirement can be linked with another, yet remain independent.
	Aggregation	To achieve a primary requirement, other sub-requirements need to be achieved.

	Influence	A requirement can lead to another requirement, with the second one depending on the first, and both occurring at different times.
	Specialization	A requirement can have a more specific or refined version, representing a special case.
Principle – Principle	Aggregation	To achieve a primary principle, other sub-principles need to be achieved.
	Influence	A principle can lead to another principle, with the second one depending on the first, and both occurring at different times.
	Specialization	A principle can have a more specific or refined version, representing a special case.
Principle – Requirement	Influence	When a goal is realized by a principle, the principle influences the compliance with the requirement, meaning that the principle created a requirement, at different moments.
	Association	When a goal is realized by a requirement, the requirement is associated with a goal, meaning there is a principle behind the requirement; A principle can be derived from interpreting a requirement.
Requirement – Constraint	Aggregation	A requirement inherently contains a constraint that limits its scope.
Principle – Constraint	Association	A principle is linked with a constraint that limits its scope.
Goal – Meaning	Association	A goal can have specific concepts that need to be interpreted.
Requirement – Meaning	Association	A requirement can have specific concepts that need to be interpreted.
Principle – Meaning	Association	A principle can have specific concepts that need to be interpreted.
Business Process – Goal	Realization	A business-process is a necessary condition for achieving a goal, as it is the practical action to accomplish it.

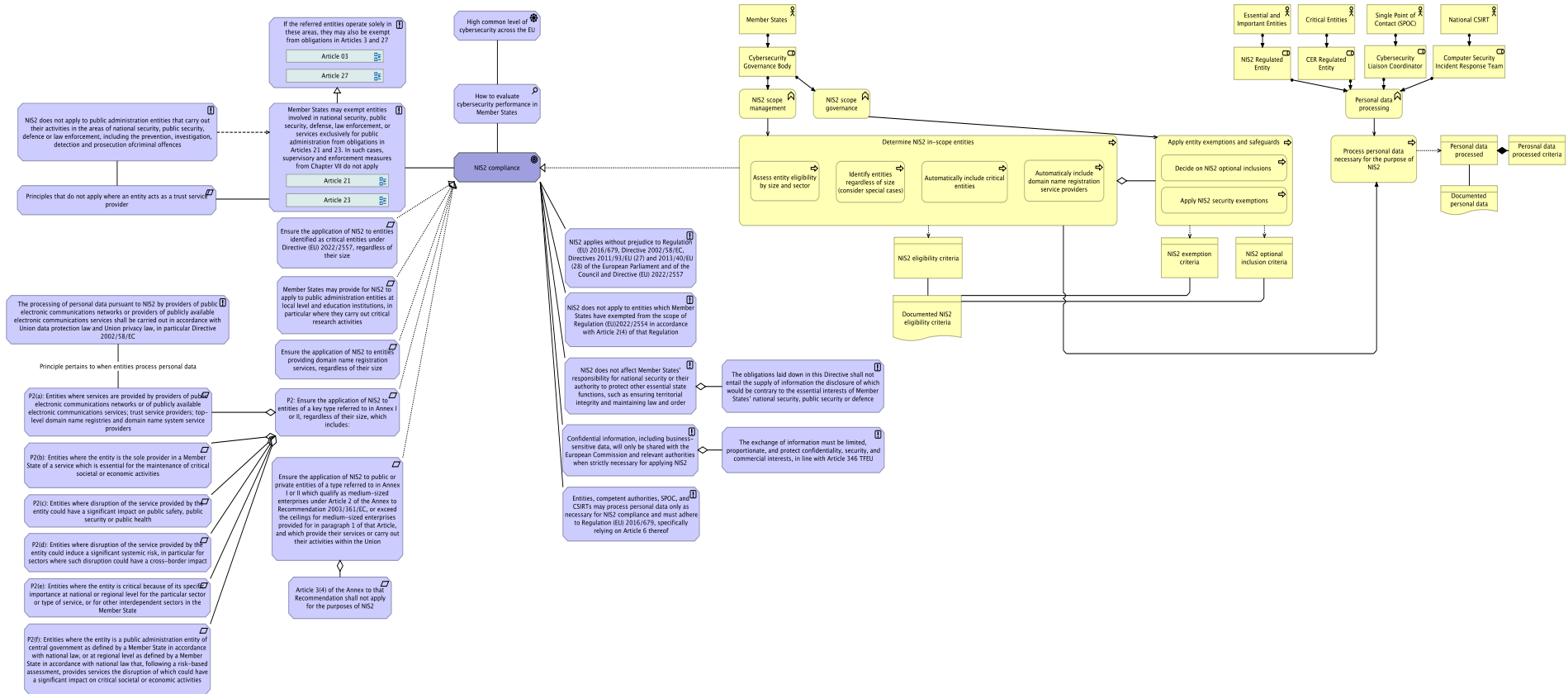
Business Process – Business Process	Triggering	A business process “activates” another business process, with the second one occurring after the first.
	Aggregation	To perform a primary business process, several sub-processes must also be carried out.
Business Process – Business Object	Access	A business object is utilized and leveraged, meaning it is developed or used as part of the process.
Business Object – Business Object	Composition	A business object consists of other business objects.
Business Object – Representation	Association	A business object has its own form of representation.
Business Process – Business Event	Triggering	A business process initiates a business event, with the event occurring because of the process.
Business Event – Business Object	Access	A business object is utilized and leveraged, meaning it is used as part of the business event.
Business Event – Business Process	Triggering	A business event initiates a business process, with the process occurring because of the event.
Business Function – Business Process	Serving	A business function provides the necessary functionality for a business process, enabling the process to occur.
Business Role – Business Function	Assignment	A business function is allocated to a business role.
Business Collaboration – Business Role	Aggregation	A business collaboration exists when multiple business roles are involved, implying that a business collaboration entails different business roles working together.
Business Actor – Business Role	Assignment	A business actor is allocated to a business role.

Appendix 12 NIS2 Reference Architecture

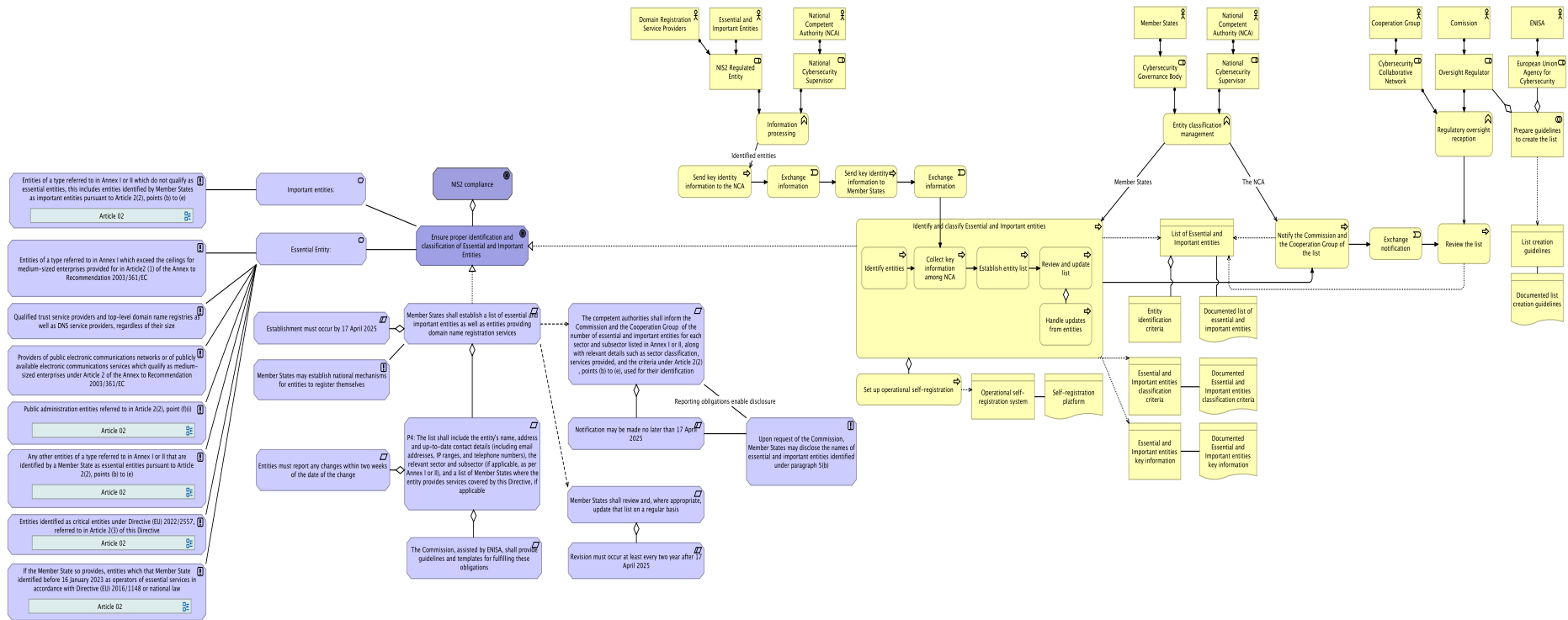
Appendix 12.1. NIS2 Article 1



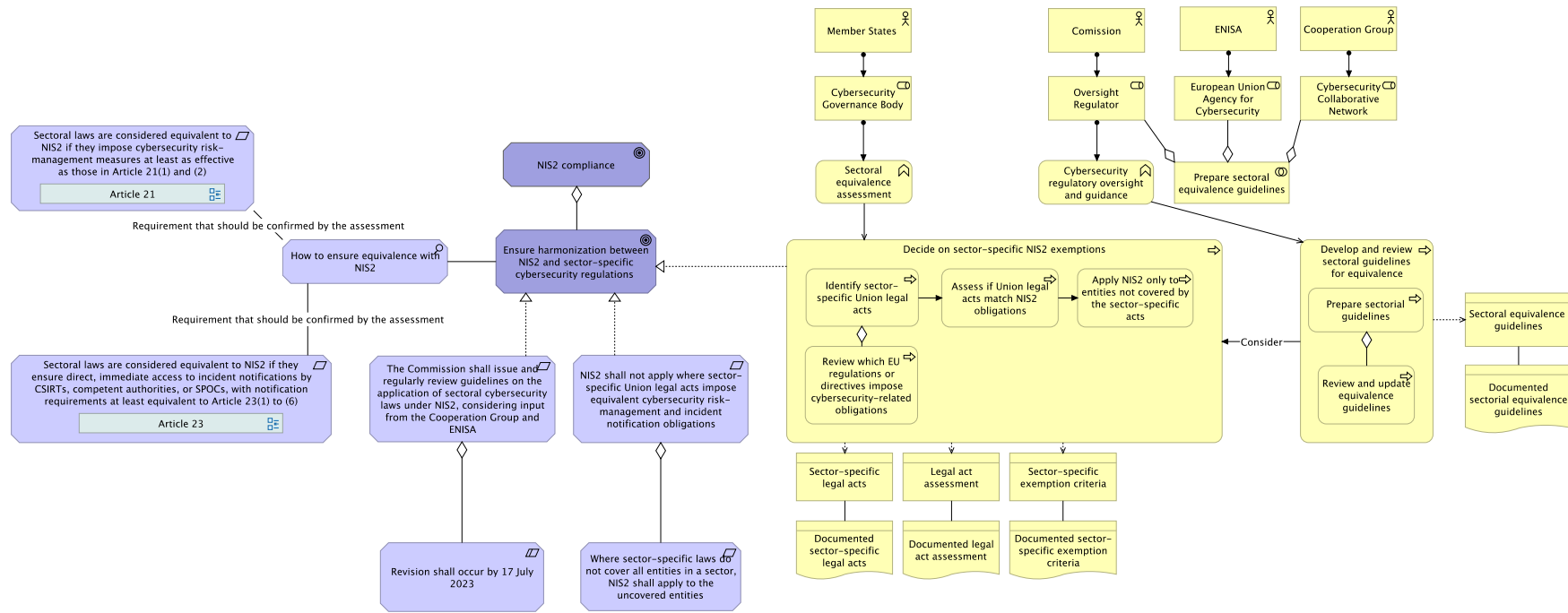
Appendix 12.2. NIS2 Article 2



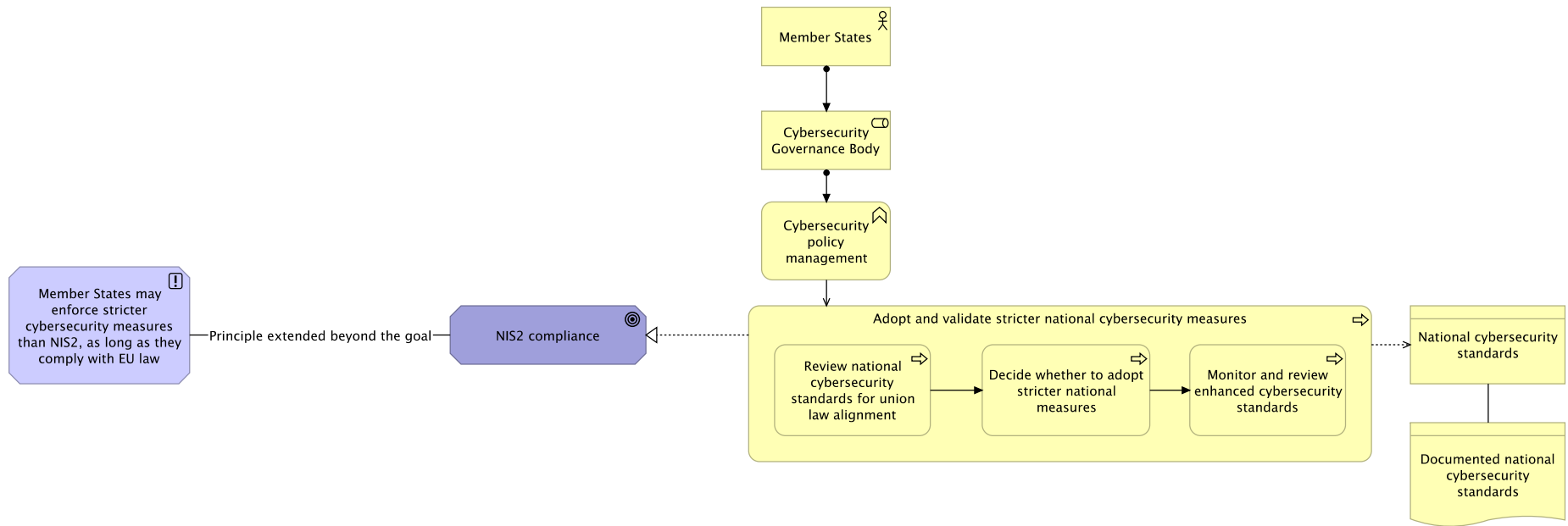
Appendix 12.3. NIS2 Article 3



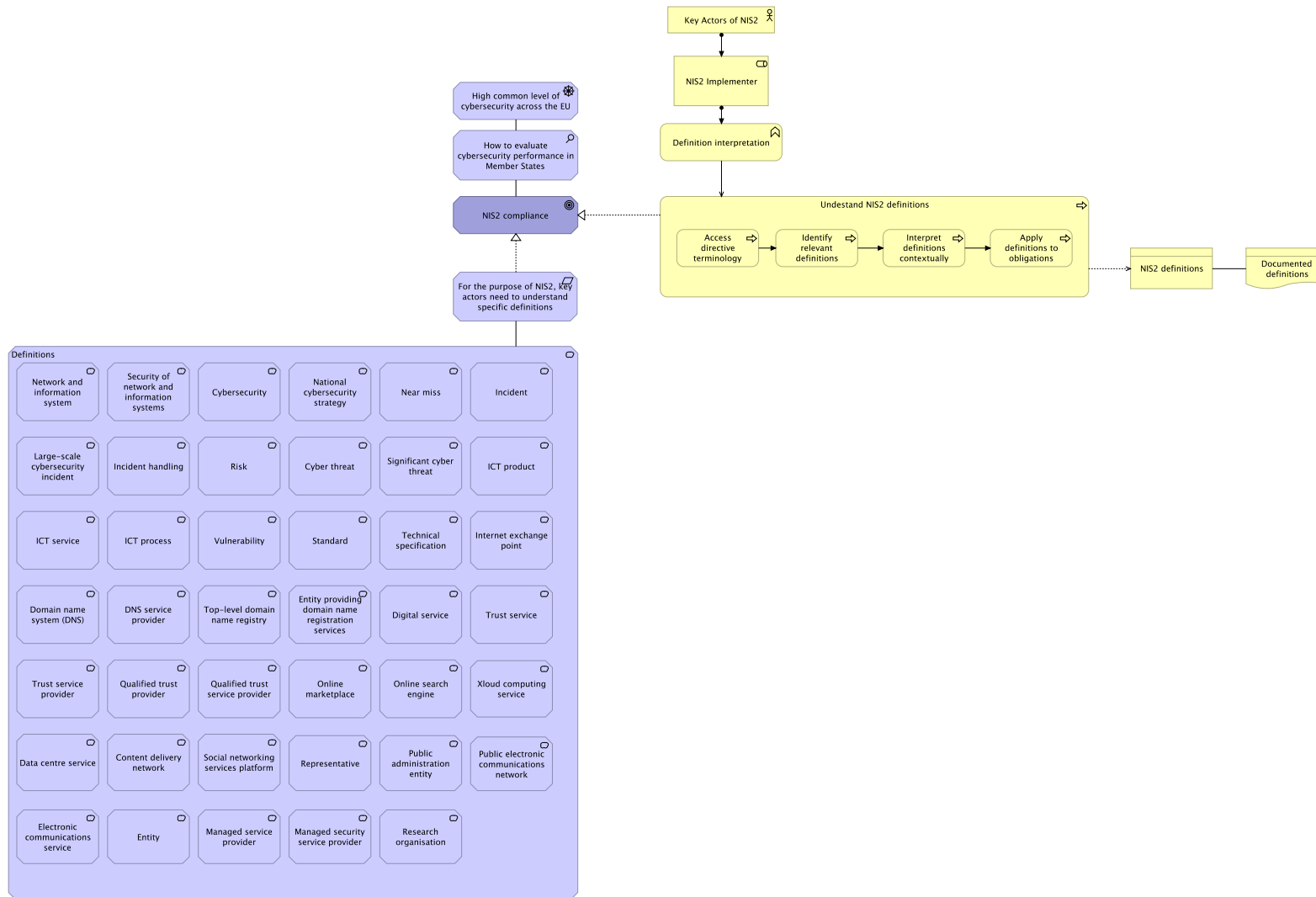
Appendix 12.4. NIS2 Article 4



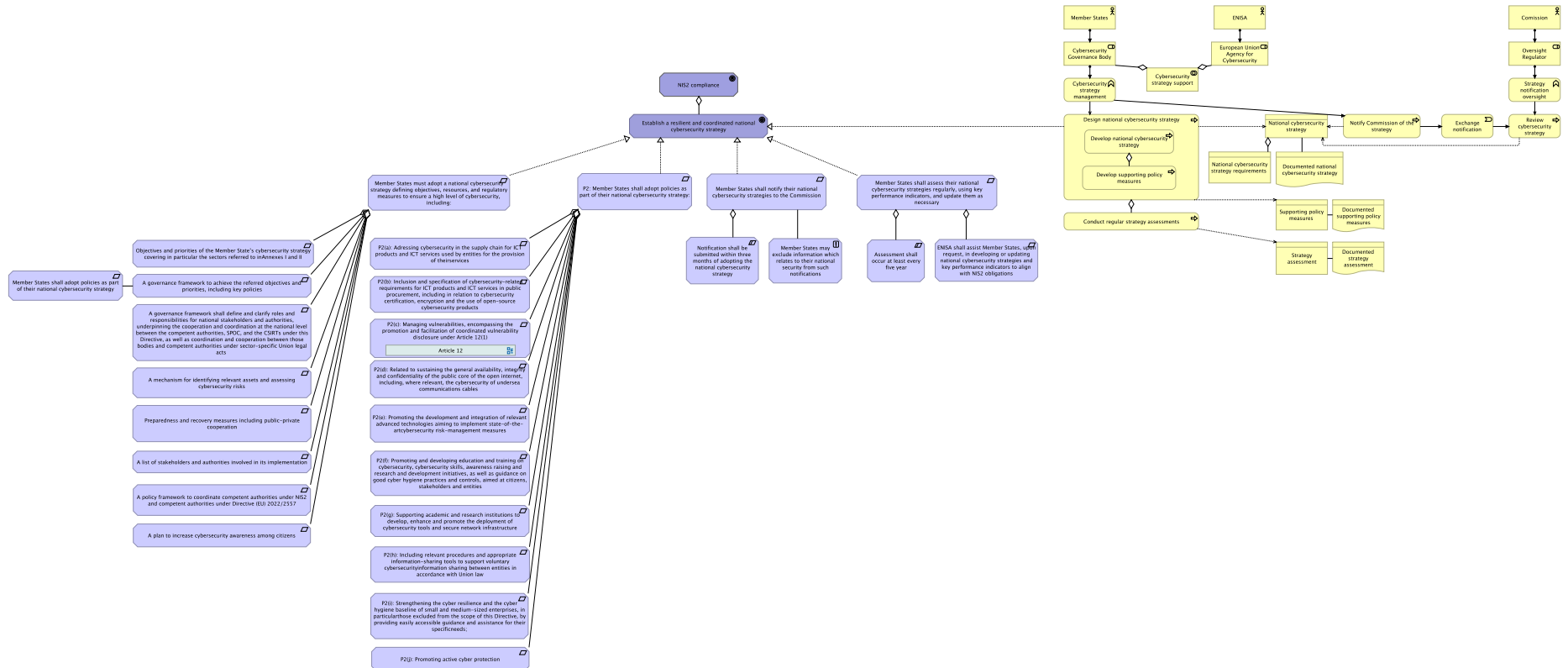
Appendix 12.5. NIS2 Article 5



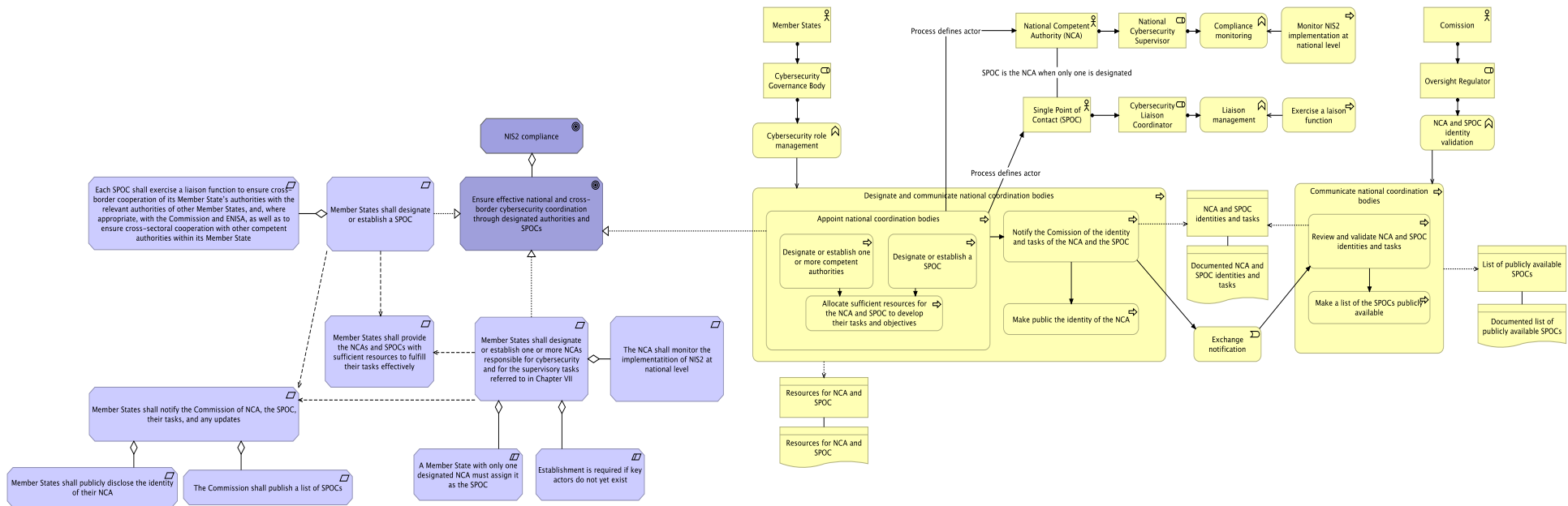
Appendix 12.6. NIS2 Article 6



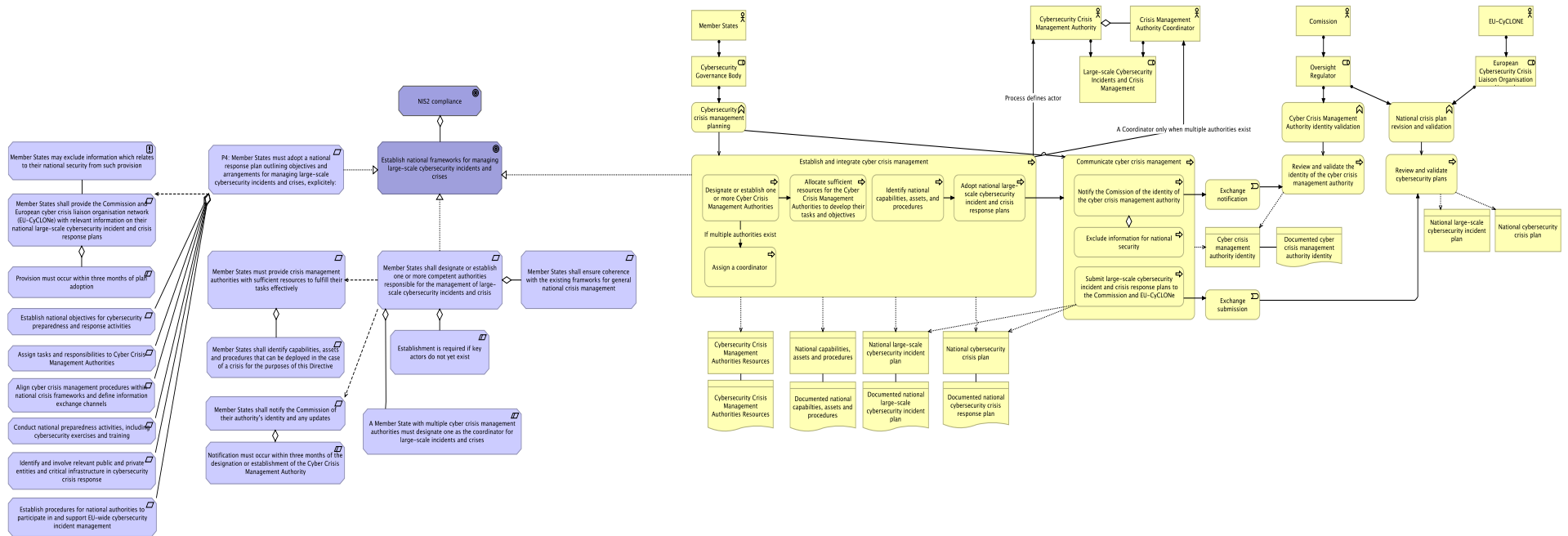
Appendix 12.7. NIS2 Article 7



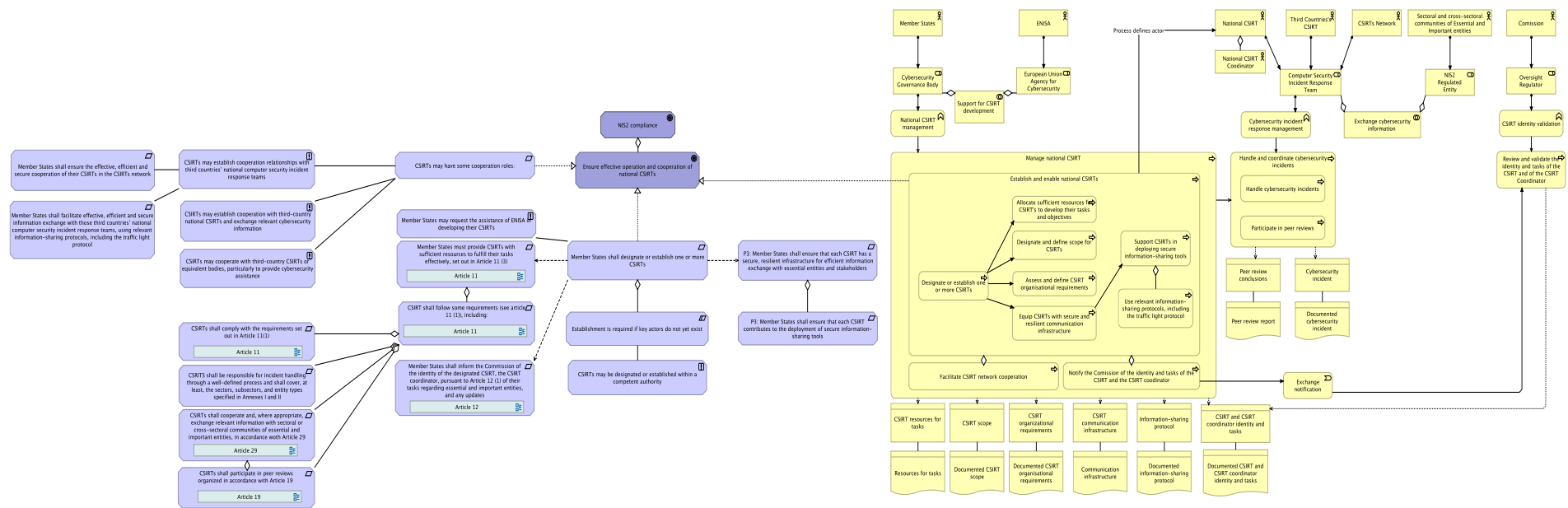
Appendix 12.8. NIS2 Article 8



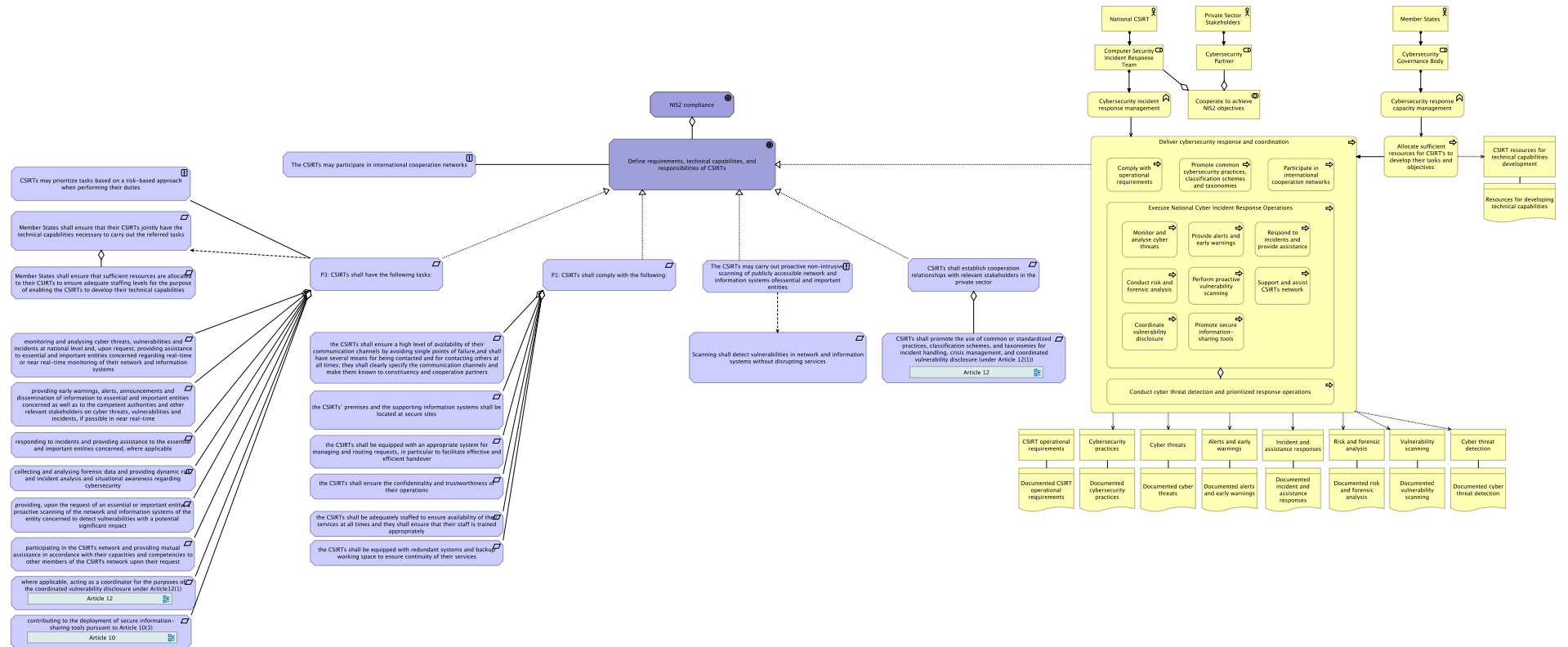
Appendix 12.9. NIS2 Article 9



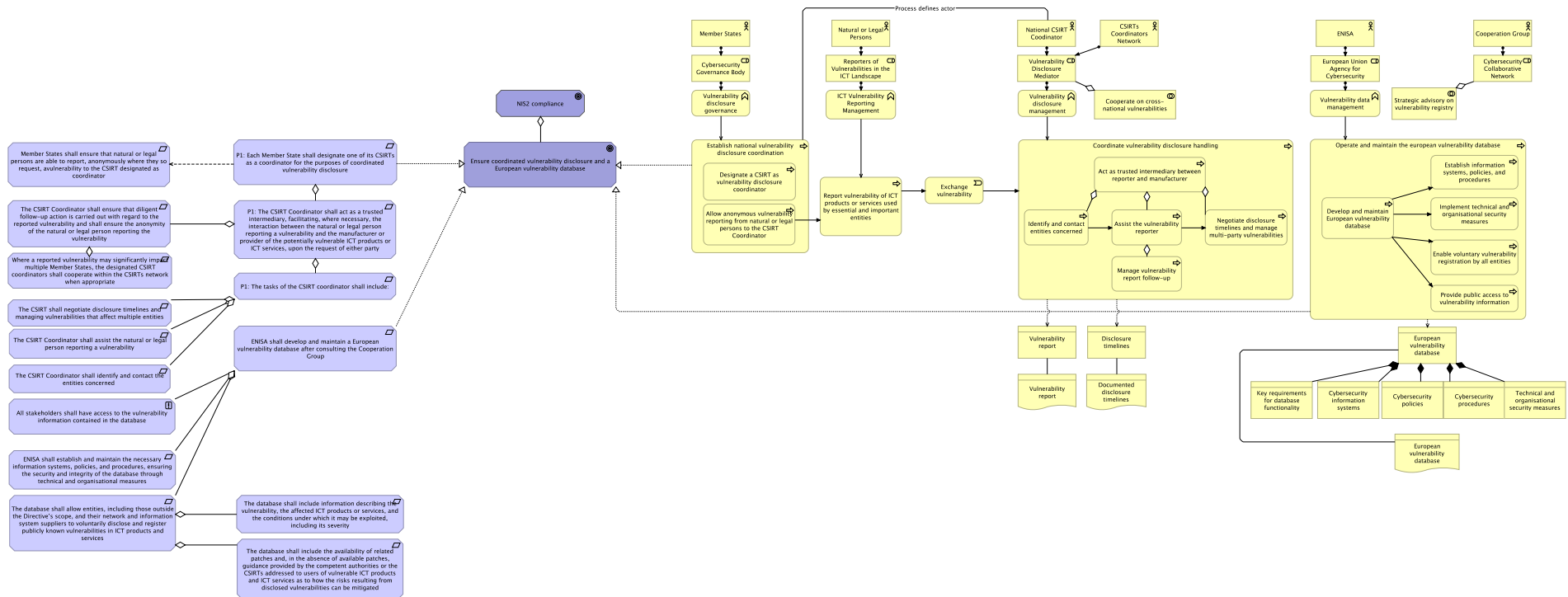
Appendix 12.10. NIS2 Article 10



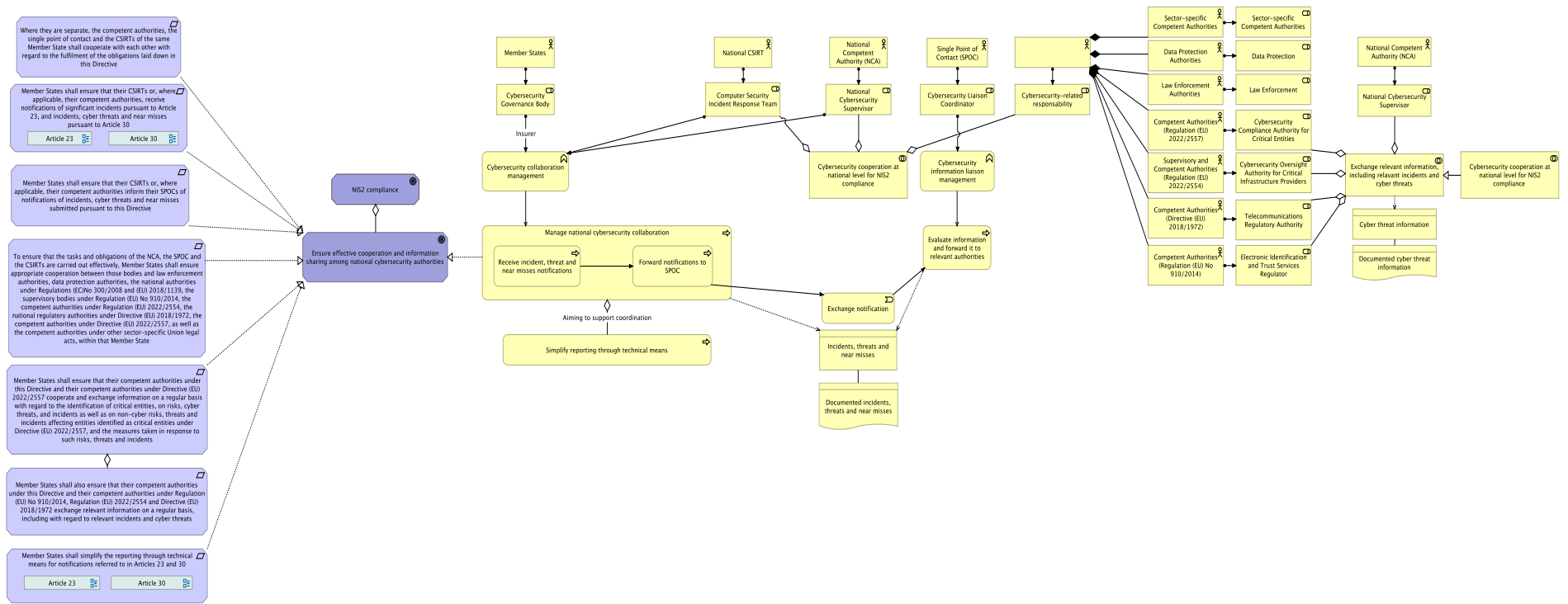
Appendix 12.11. NIS2 Article 11



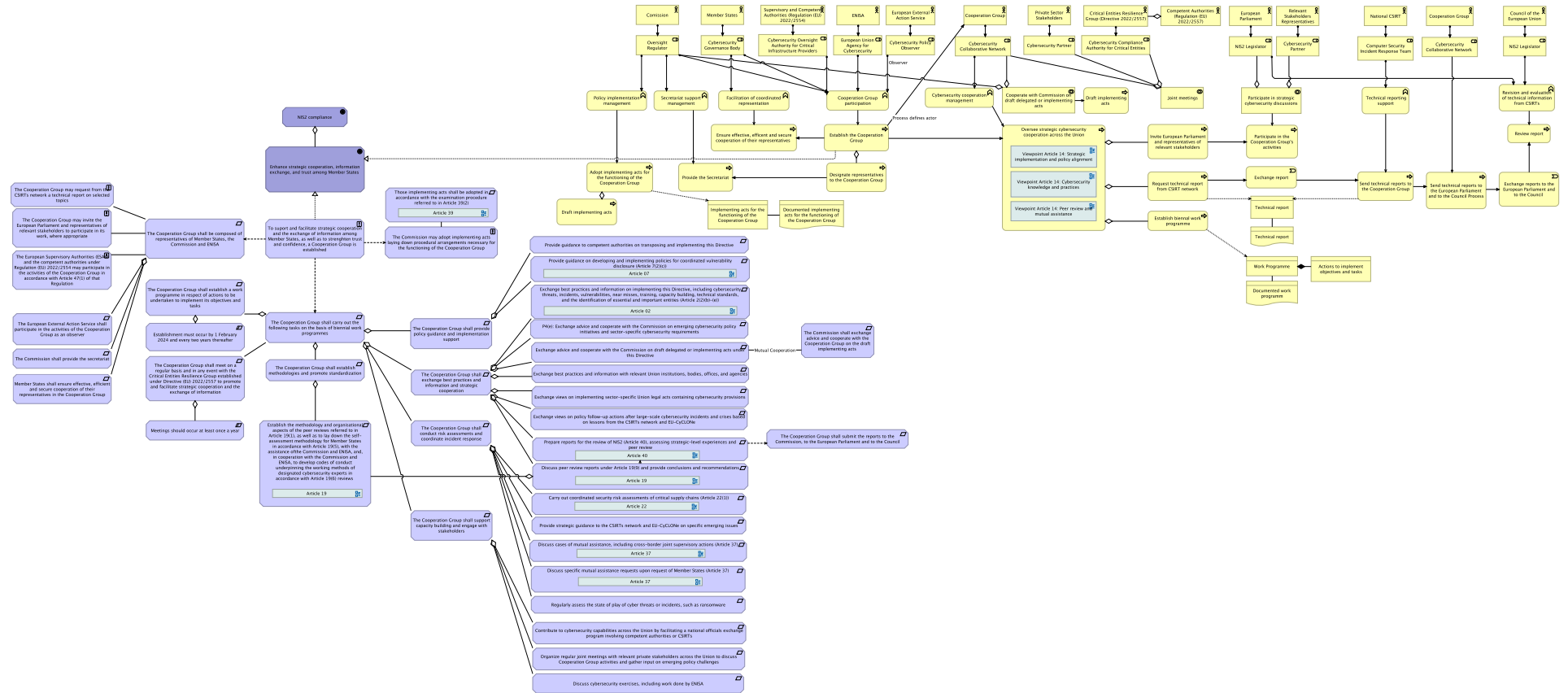
Appendix 12.12. NIS2 Article 12



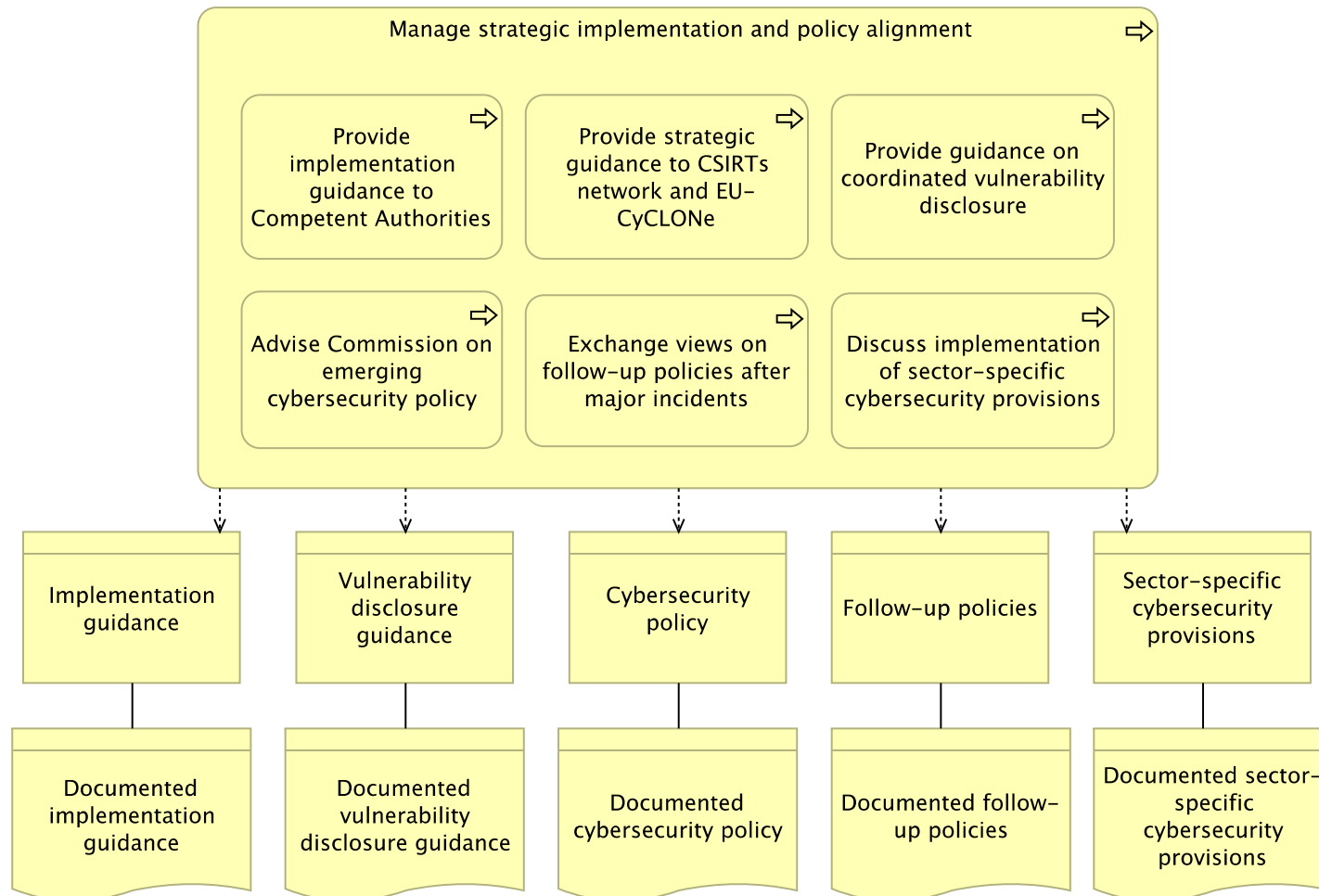
Appendix 12.13. NIS2 Article 13



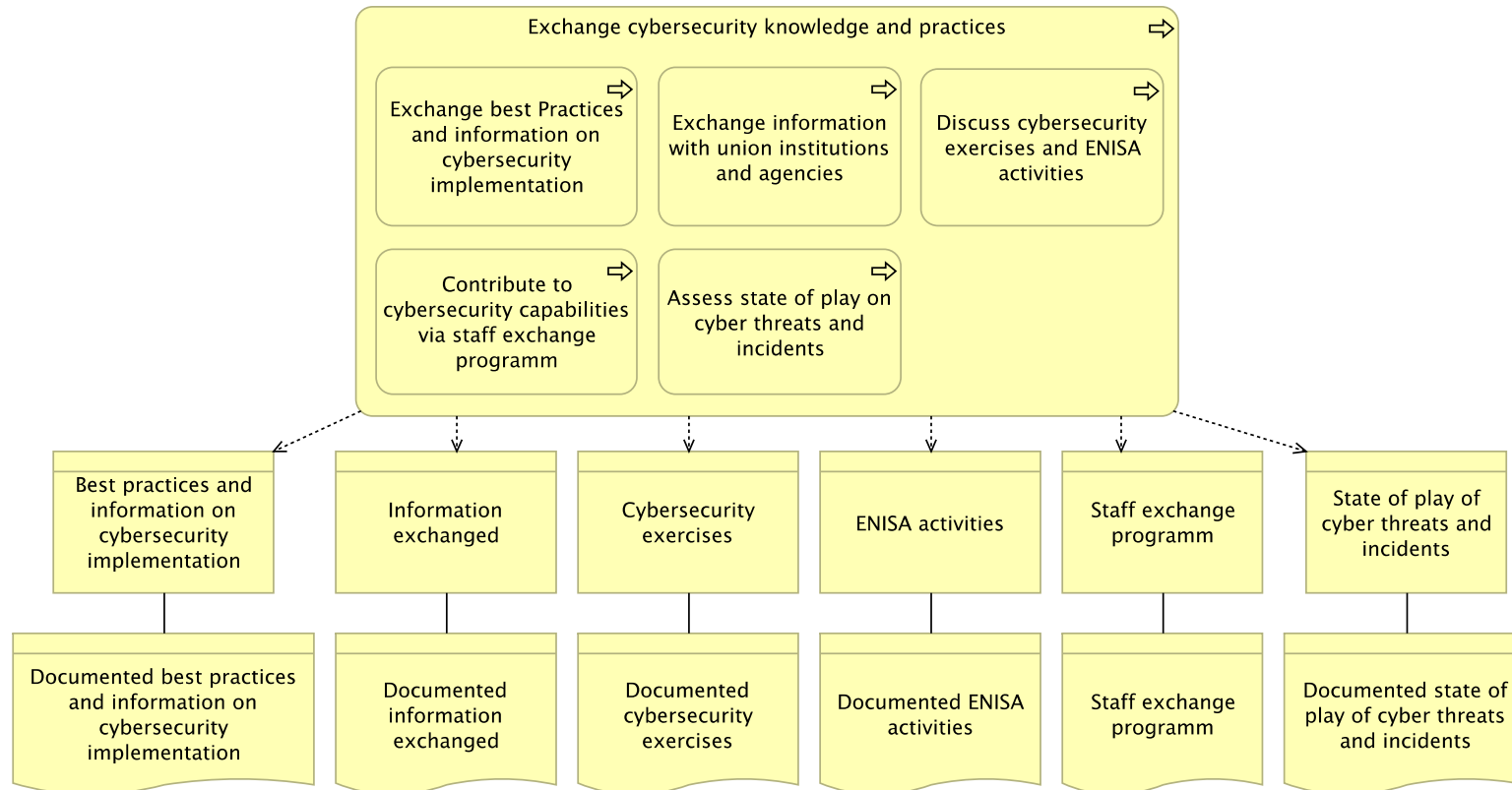
Appendix 12.14. NIS2 Article 14



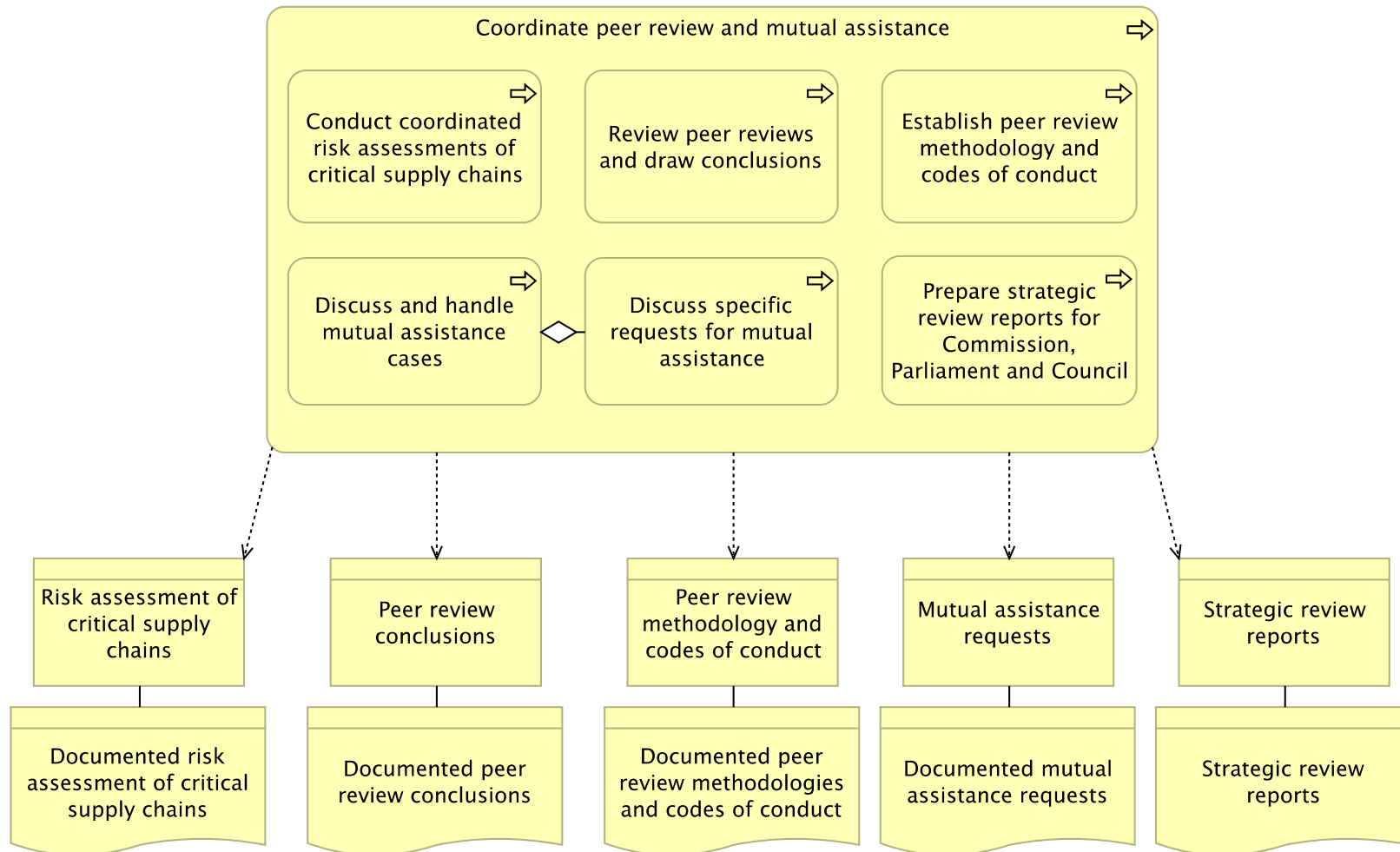
Appendix 12.14.1 NIS2 Viewpoint Article 14: Strategic implementation and policy alignment



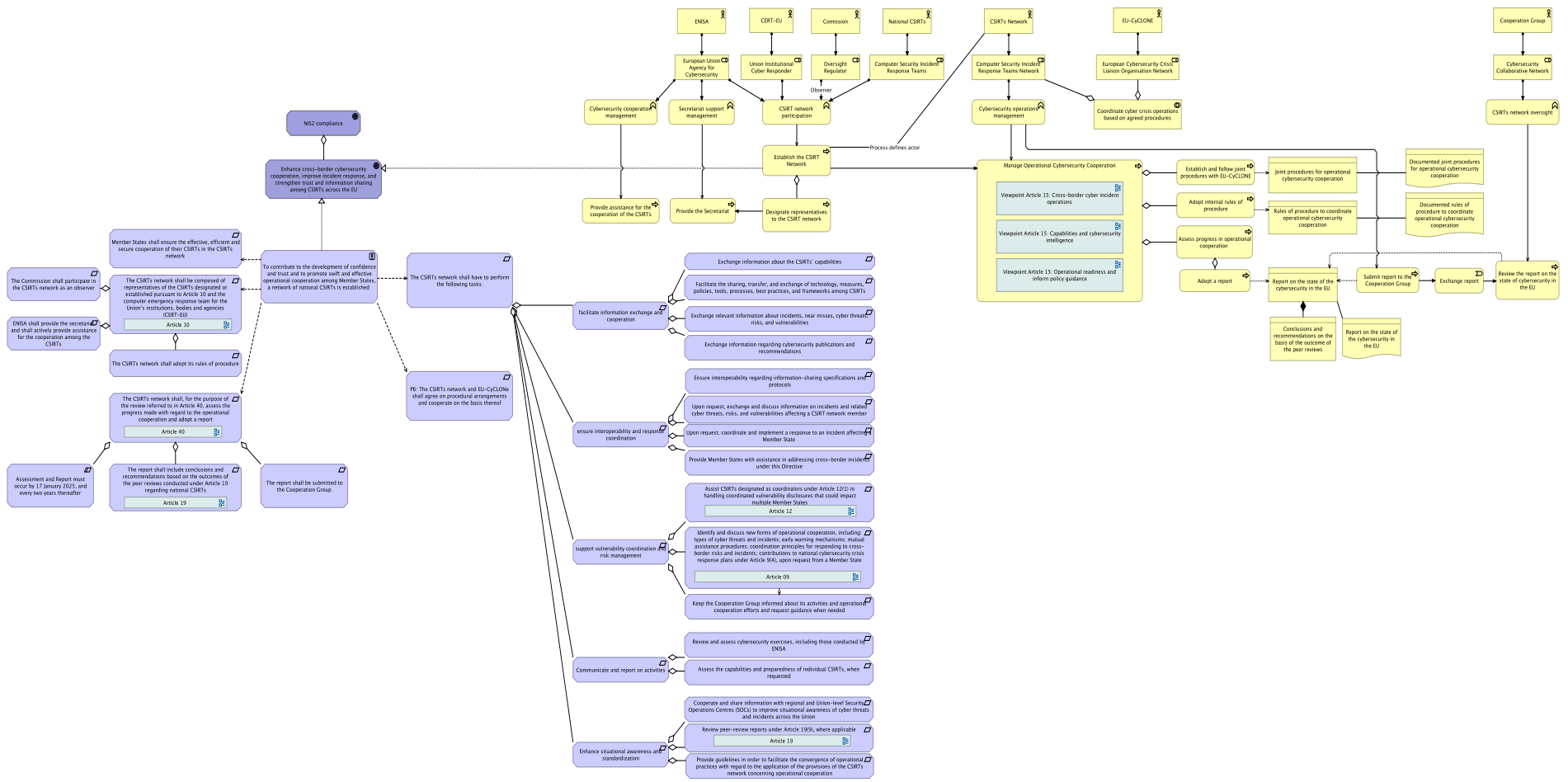
Appendix 12.14.2. NIS2 Viewpoint Article 14: Cybersecurity knowledge and practices



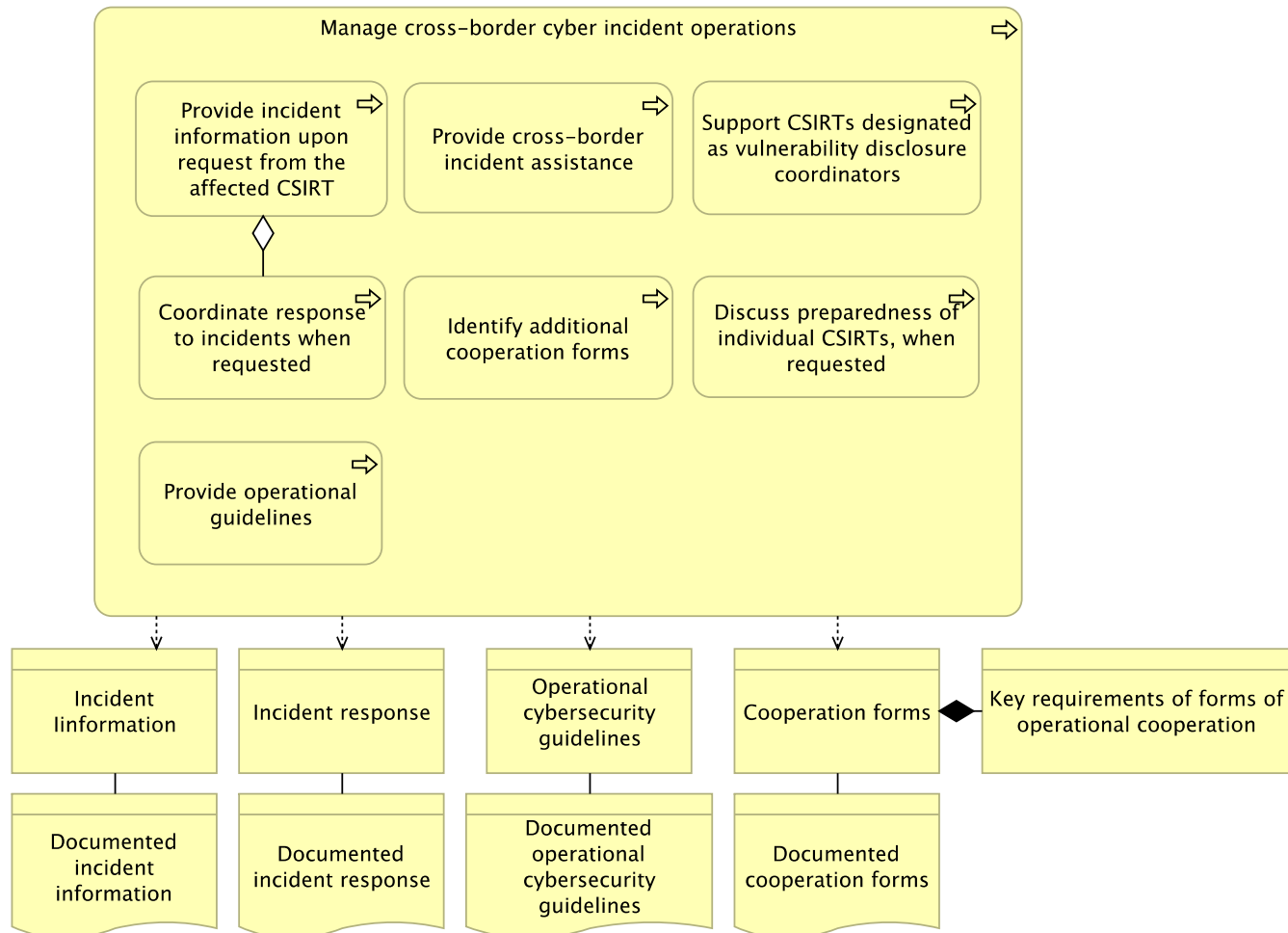
Appendix 12.14.3. NIS2 Viewpoint Article 14: Peer review and mutual assistance



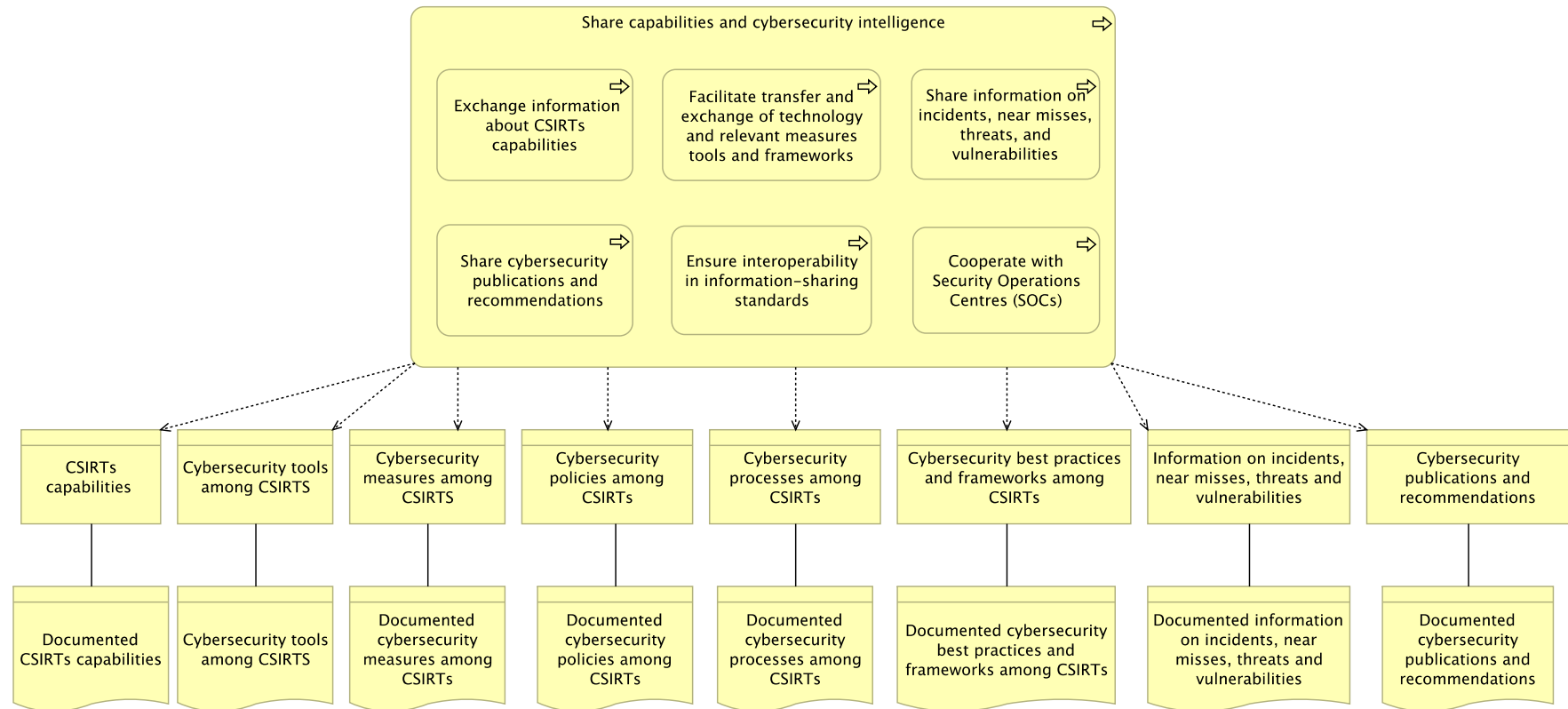
Appendix 12.15. NIS2 Article 15



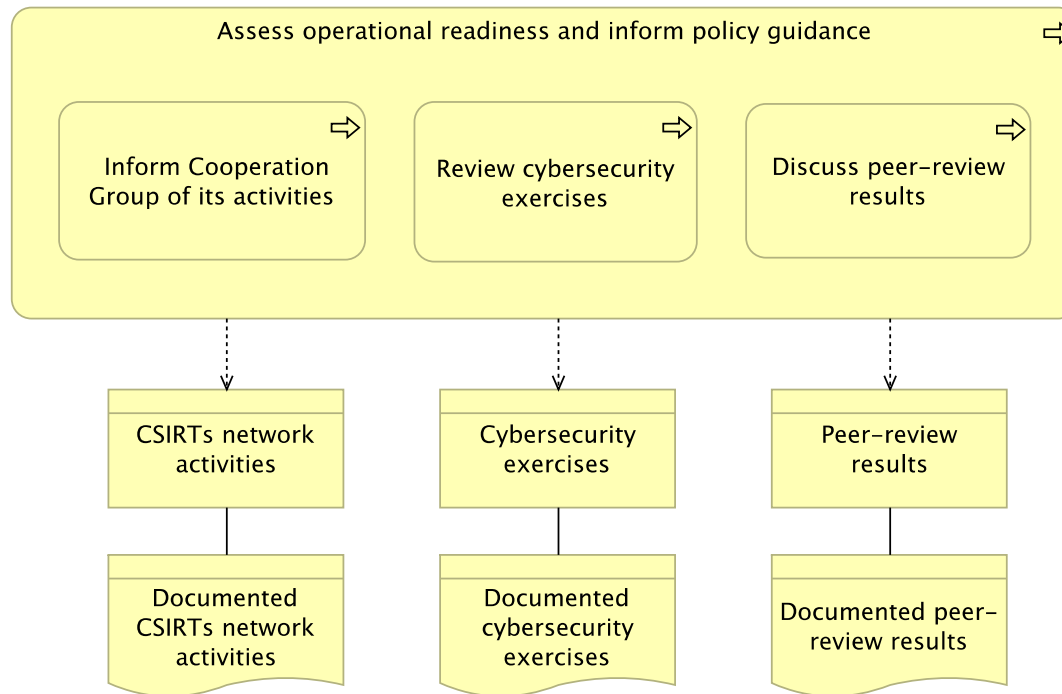
Appendix 12.15.1 NIS2 Viewpoint Article 15: Cross-border cyber incident operations



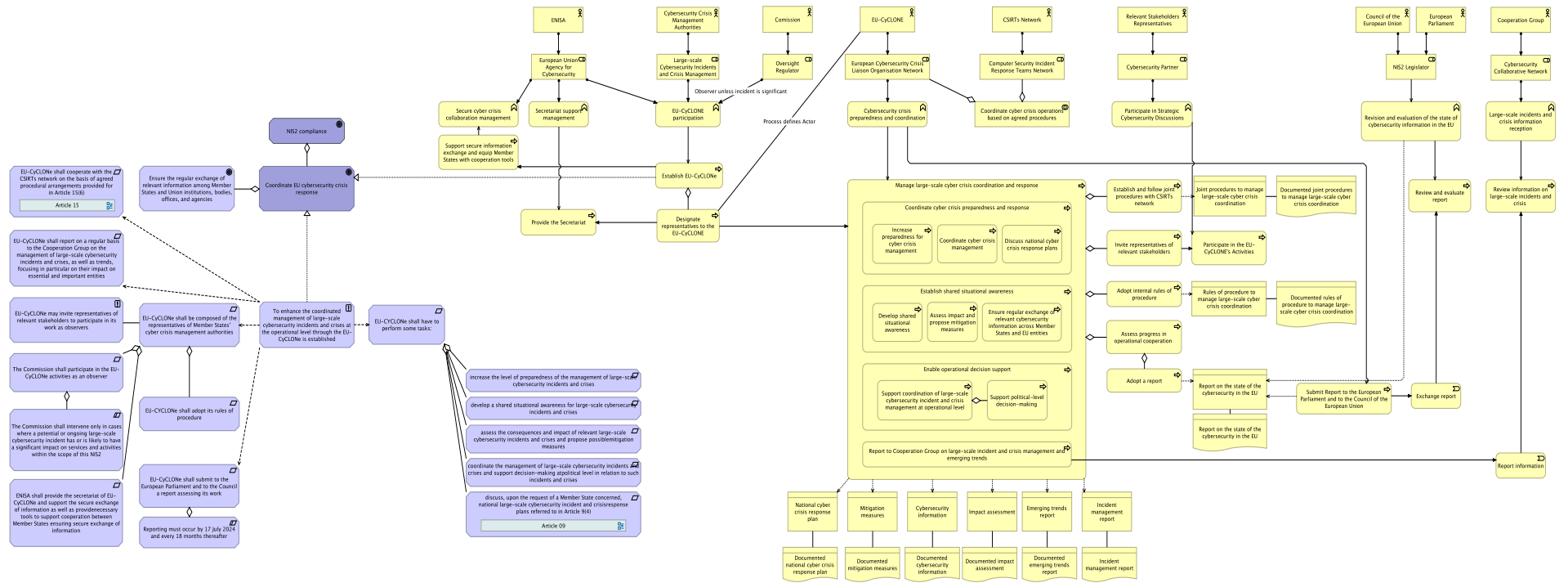
Appendix 12.15.2. NIS2 Viewpoint Article 15: Capabilities and cybersecurity intelligence



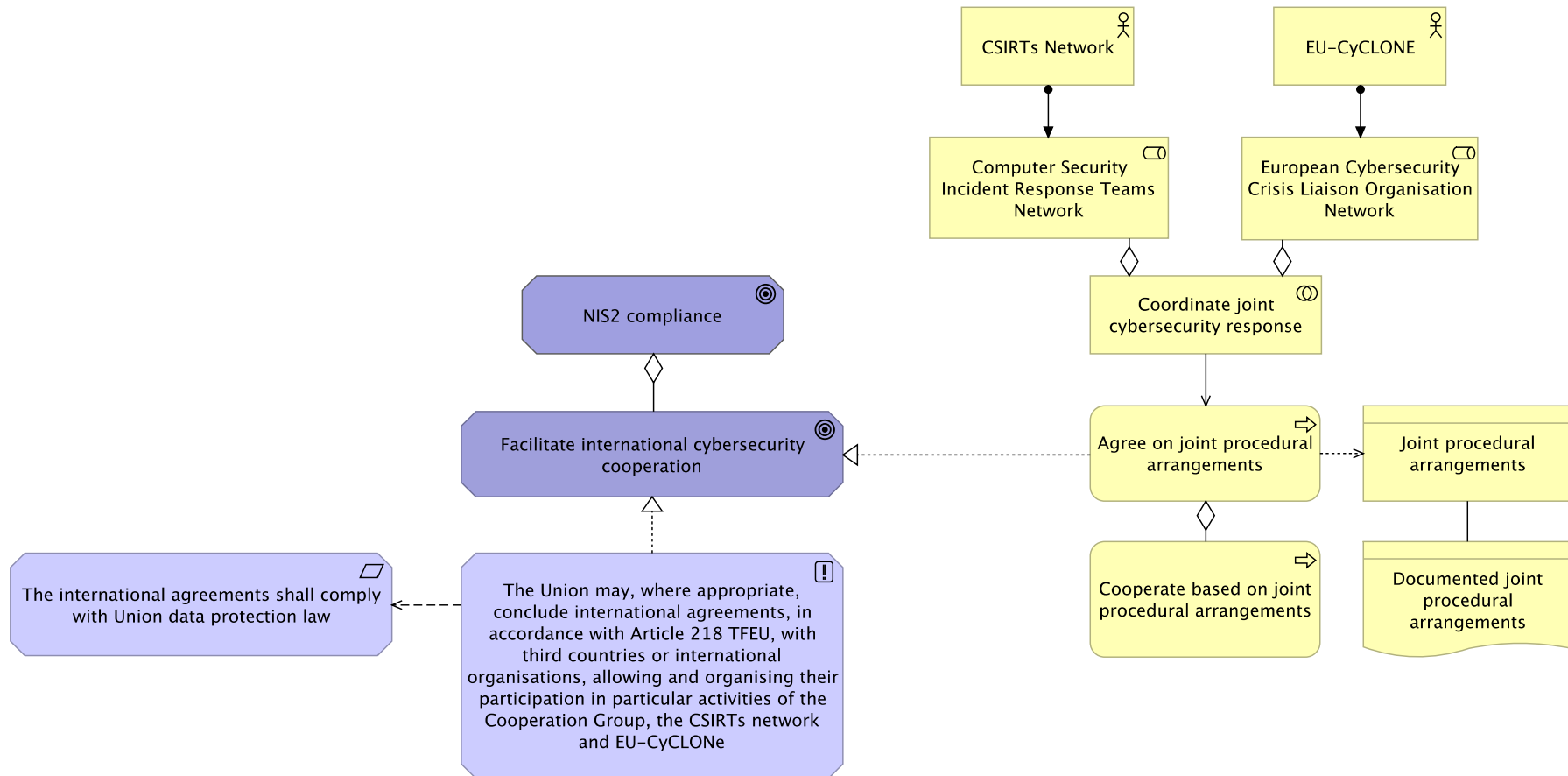
Appendix 12.15.3. NIS2 Viewpoint Article 15: Operational readiness and policy guidance



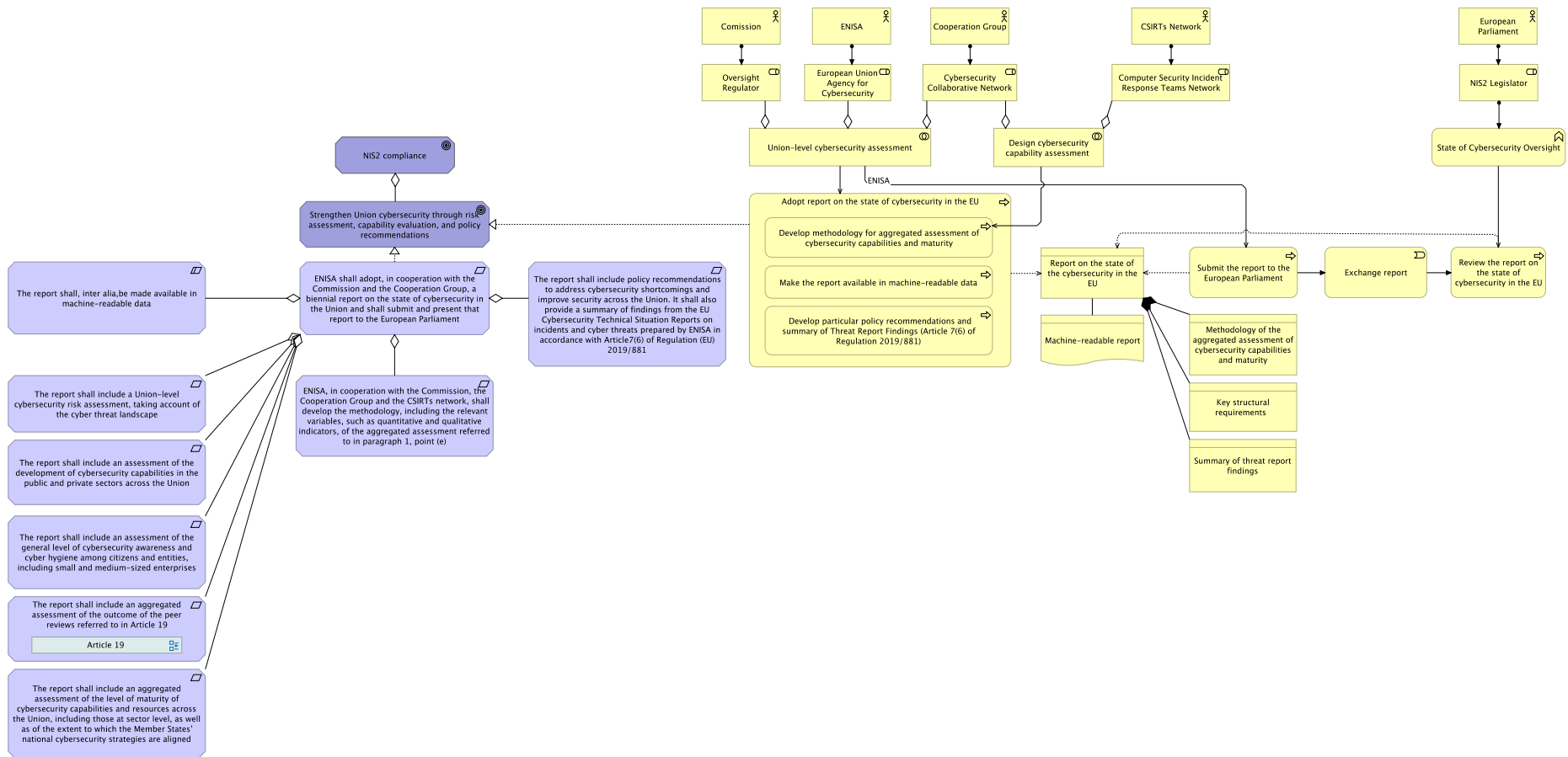
Appendix 12.16. NIS2 Article 16



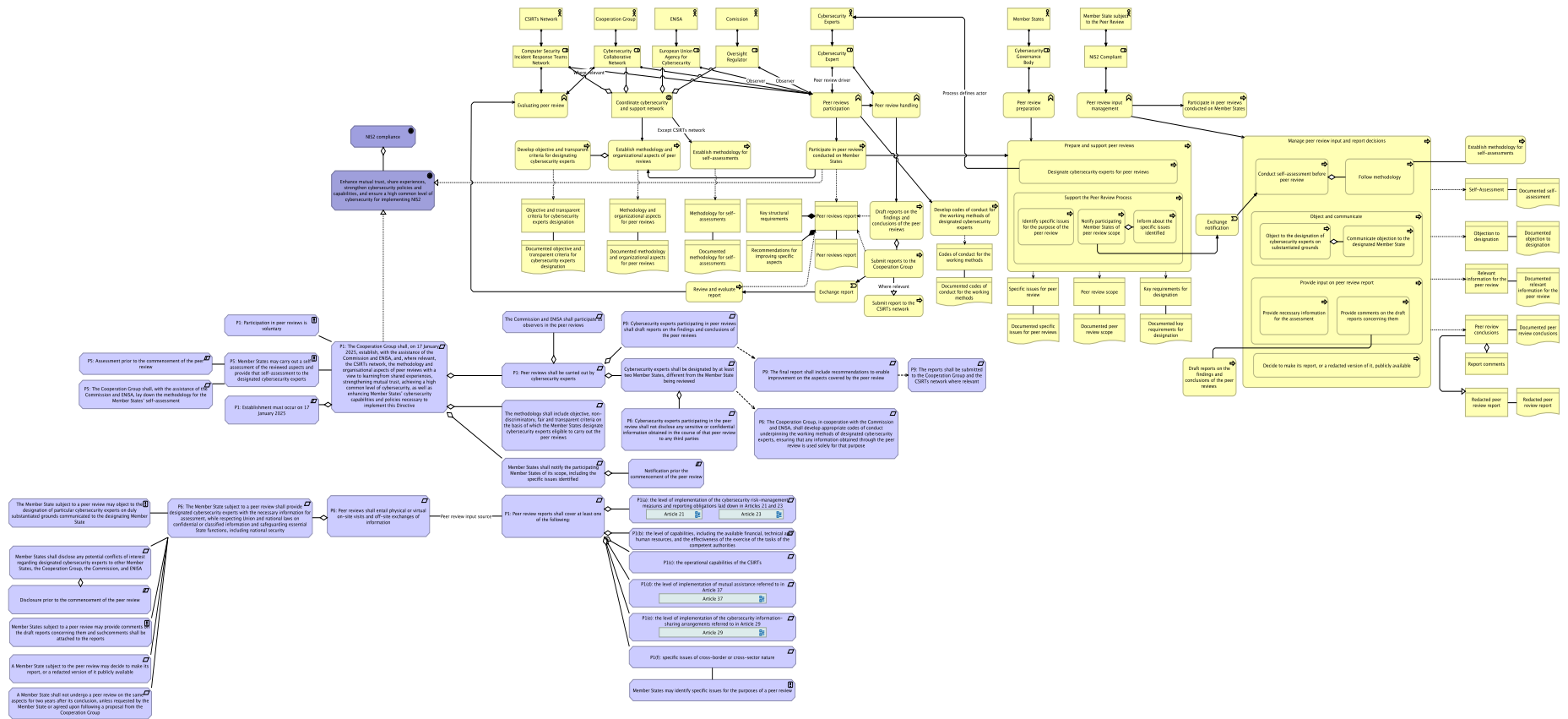
Appendix 12.17. NIS2 Article 17



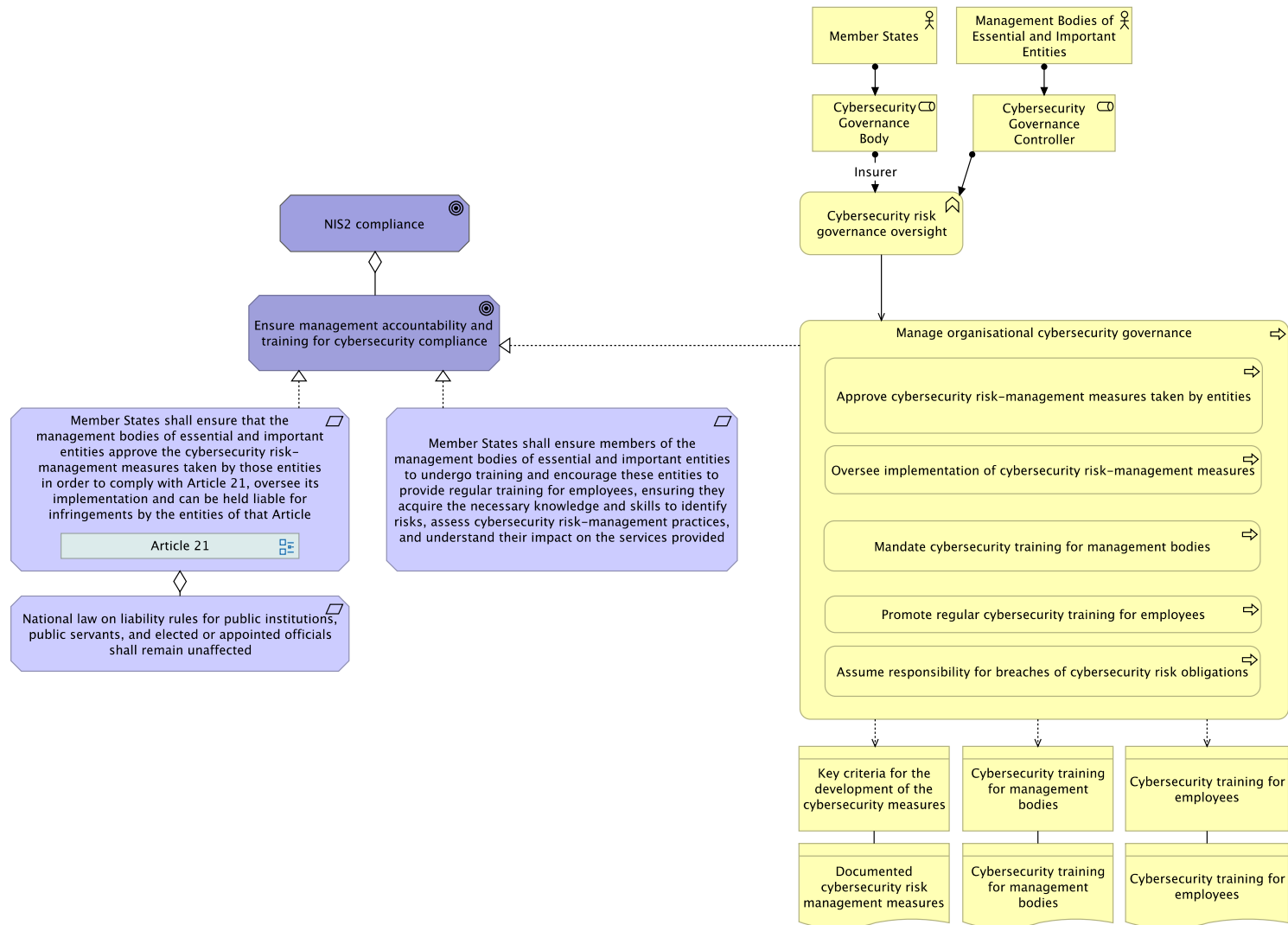
Appendix 12.18. NIS2 Article 18



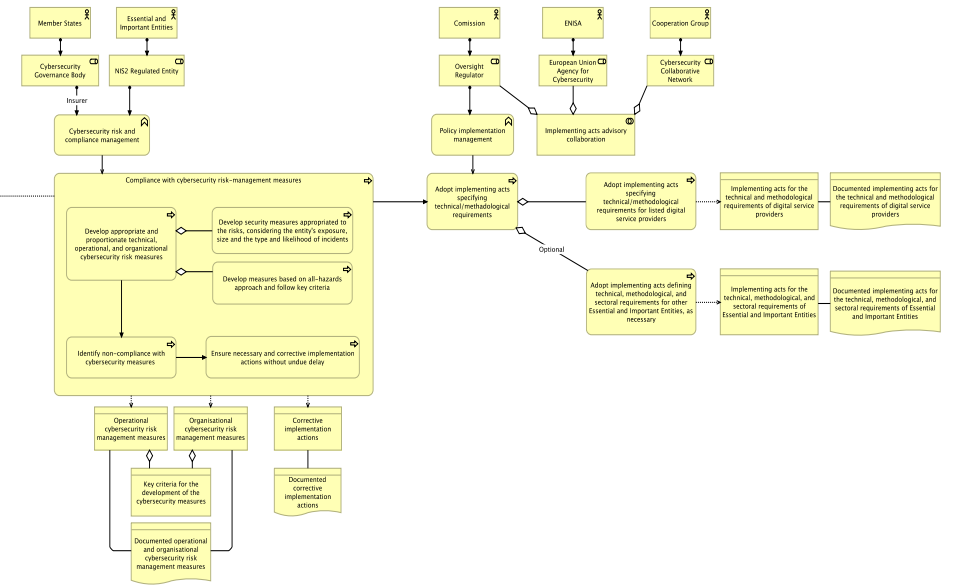
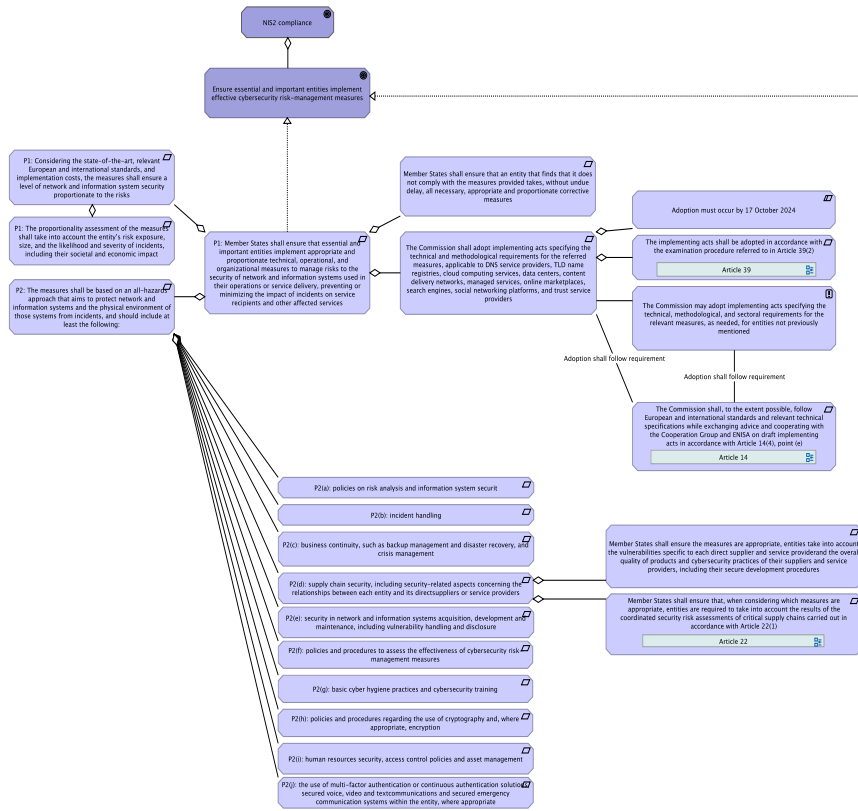
Appendix 12.19. NIS2 Article 19



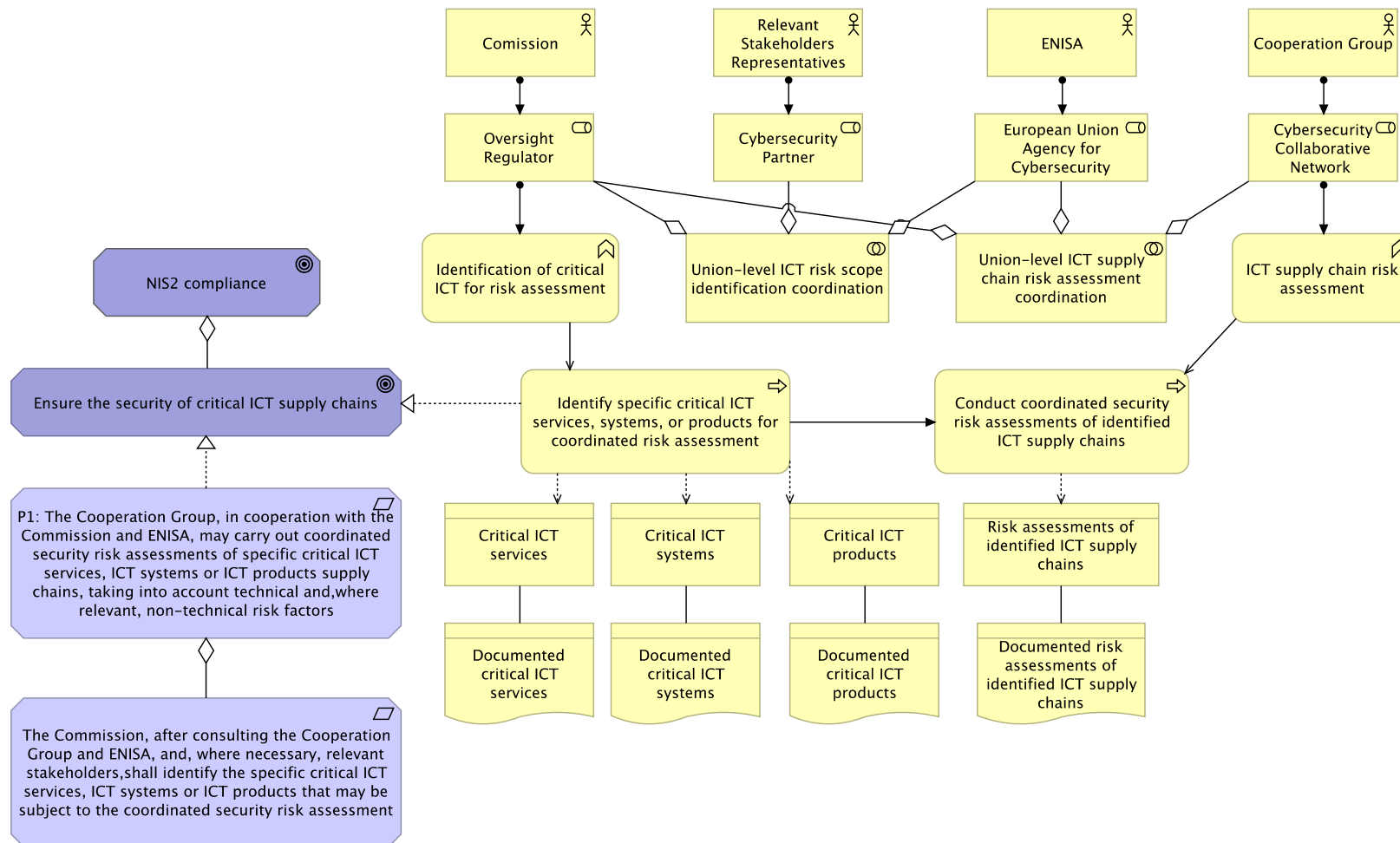
Appendix 12.20. NIS2 Article 20



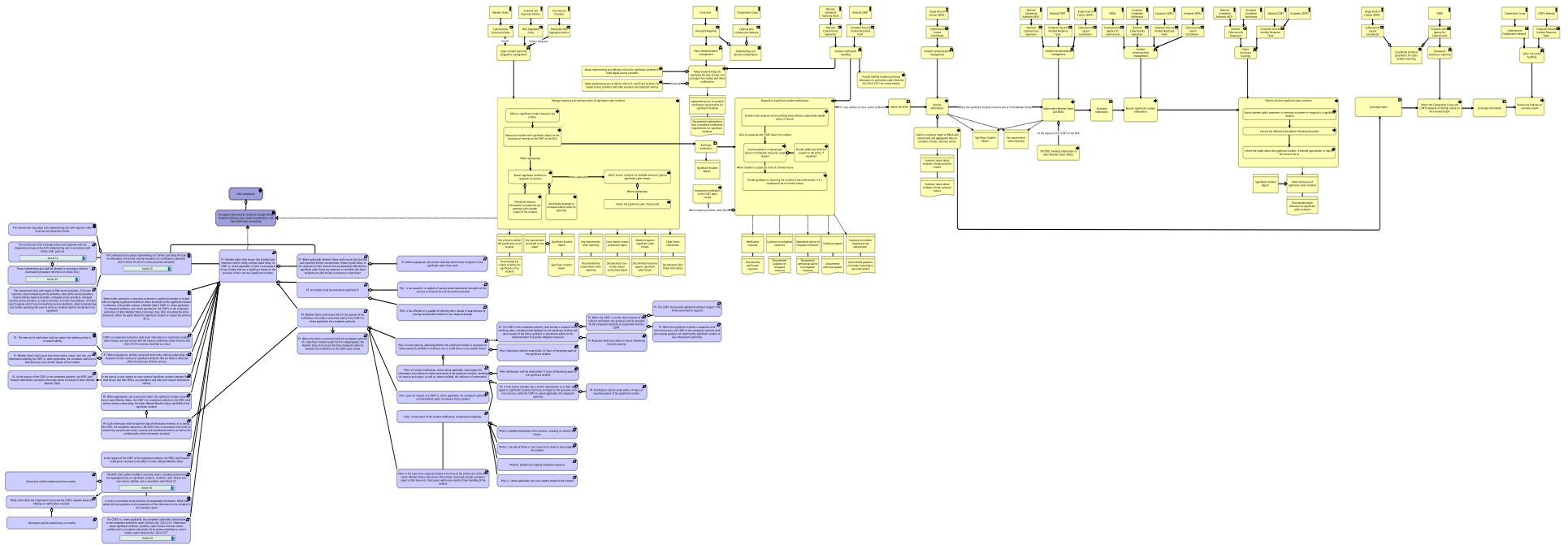
Appendix 12.21. NIS2 Article 21



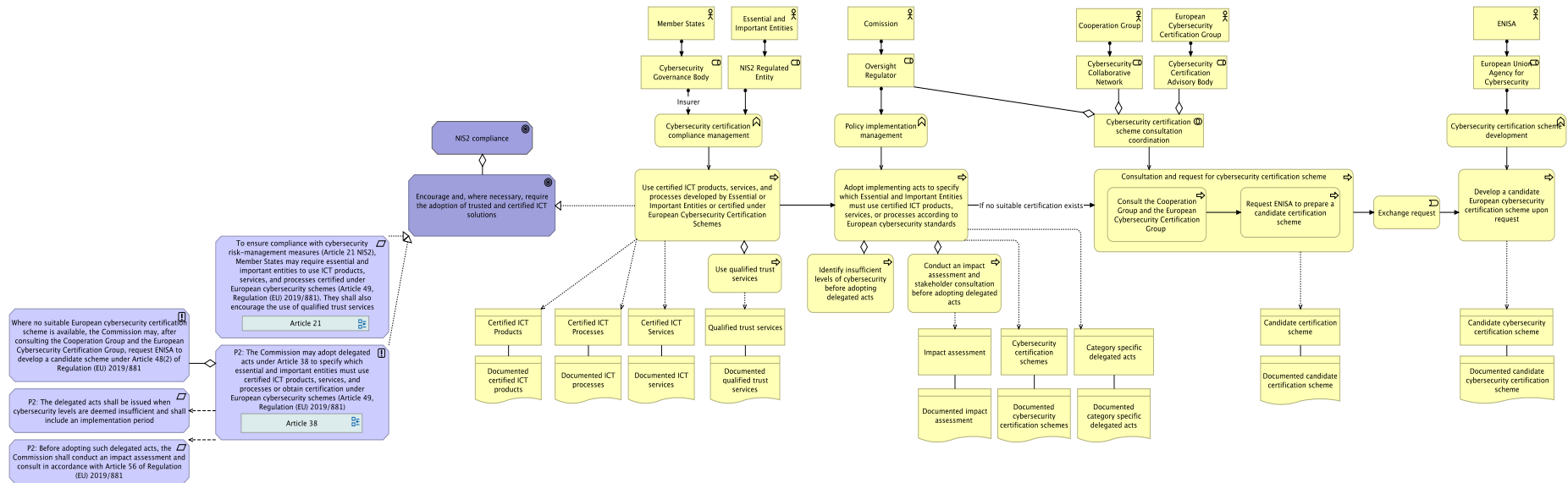
Appendix 12.22. NIS2 Article 22



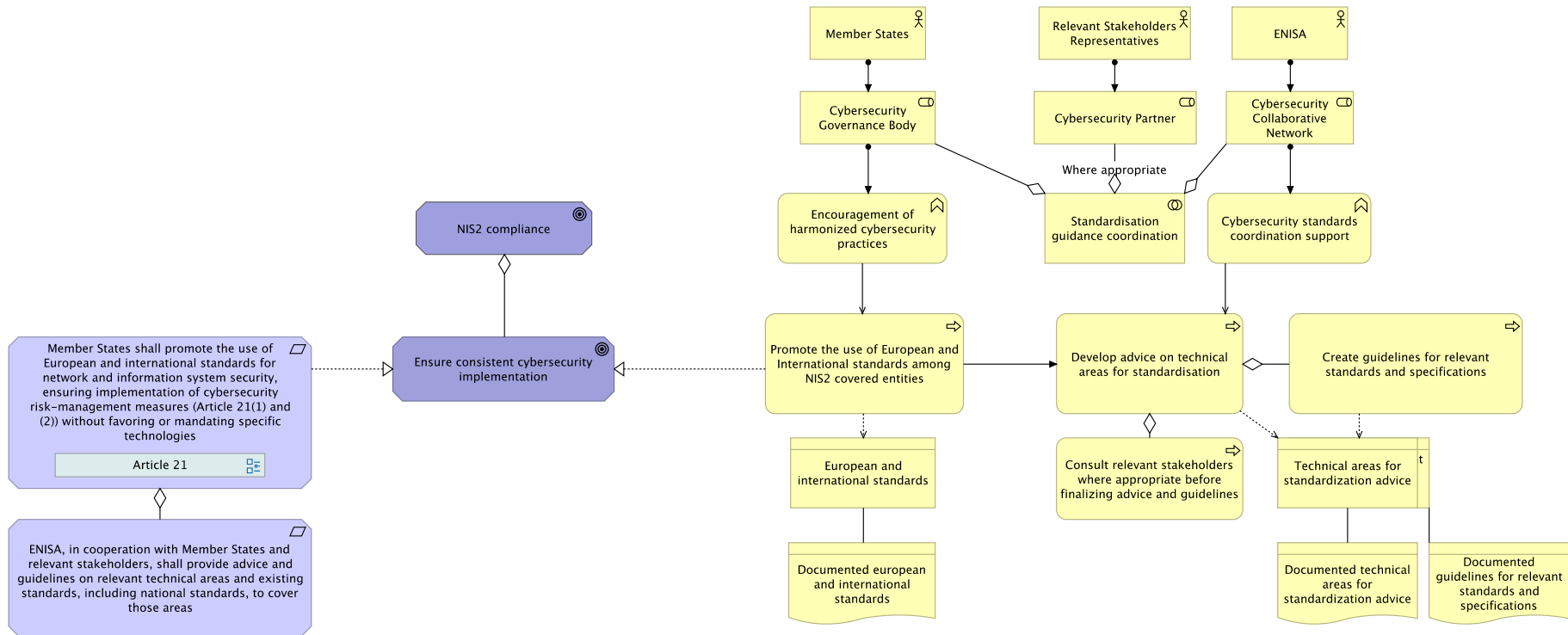
Appendix 12.23. NIS2 Article 23



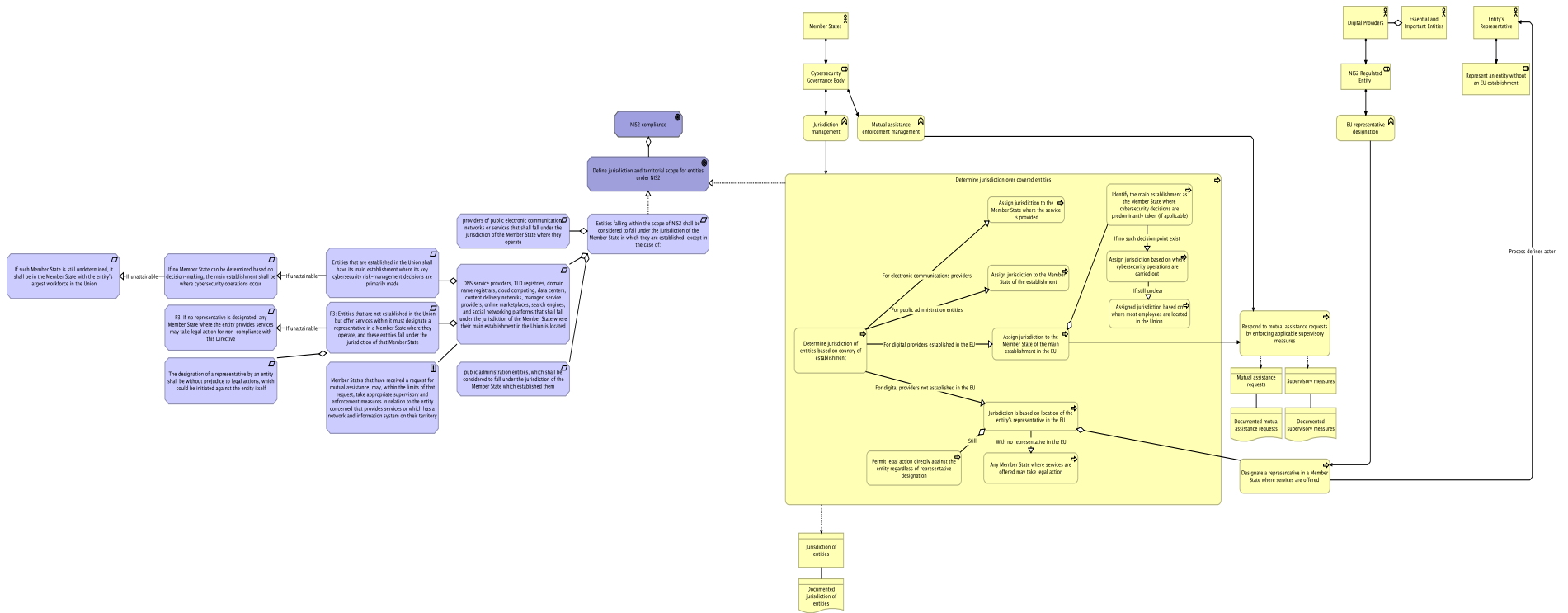
Appendix 12.24. NIS2 Article 24



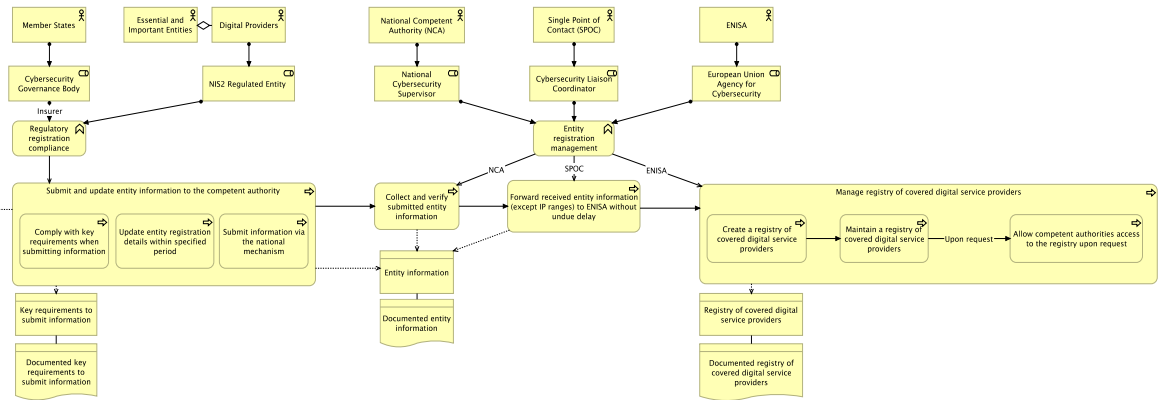
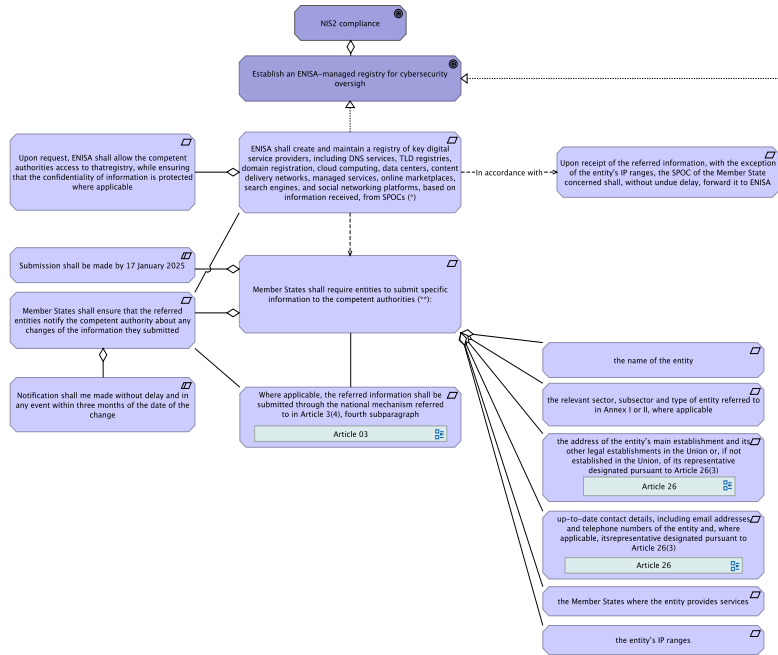
Appendix 12.25. NIS2 Article 25



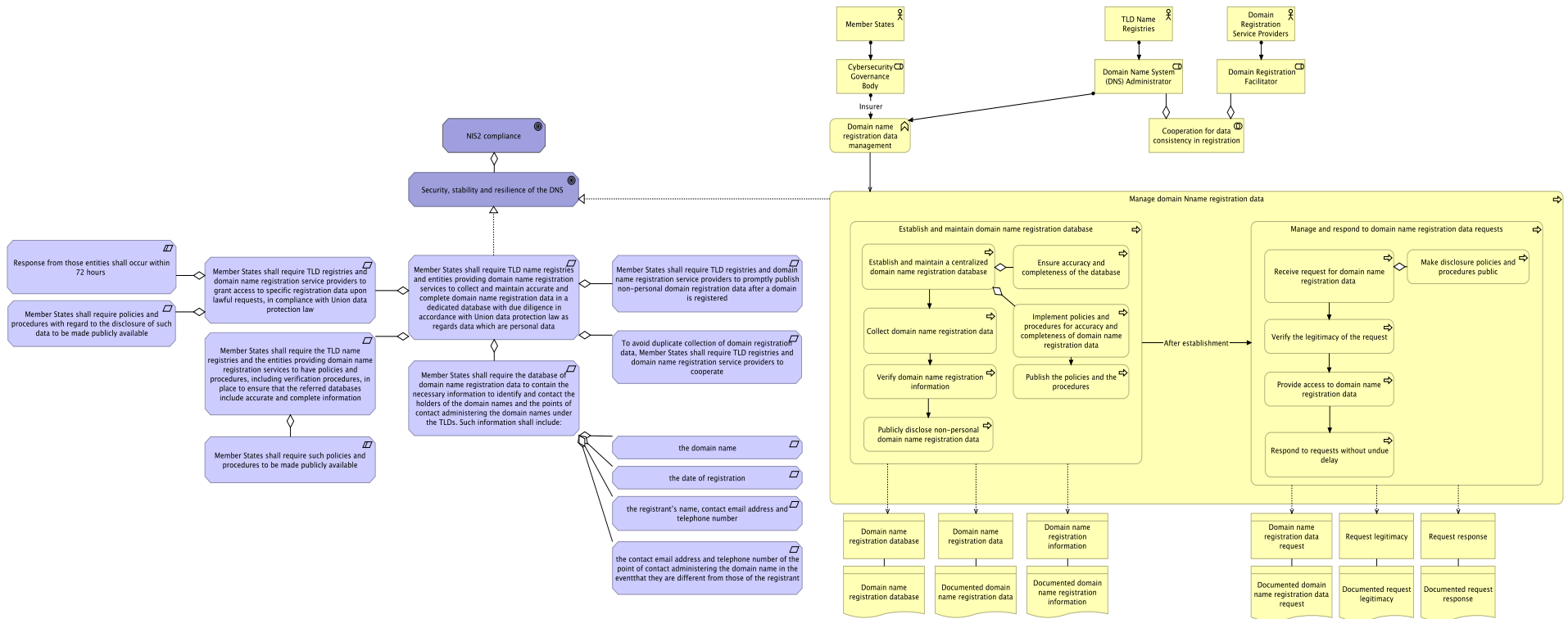
Appendix 12.26. NIS2 Article 26



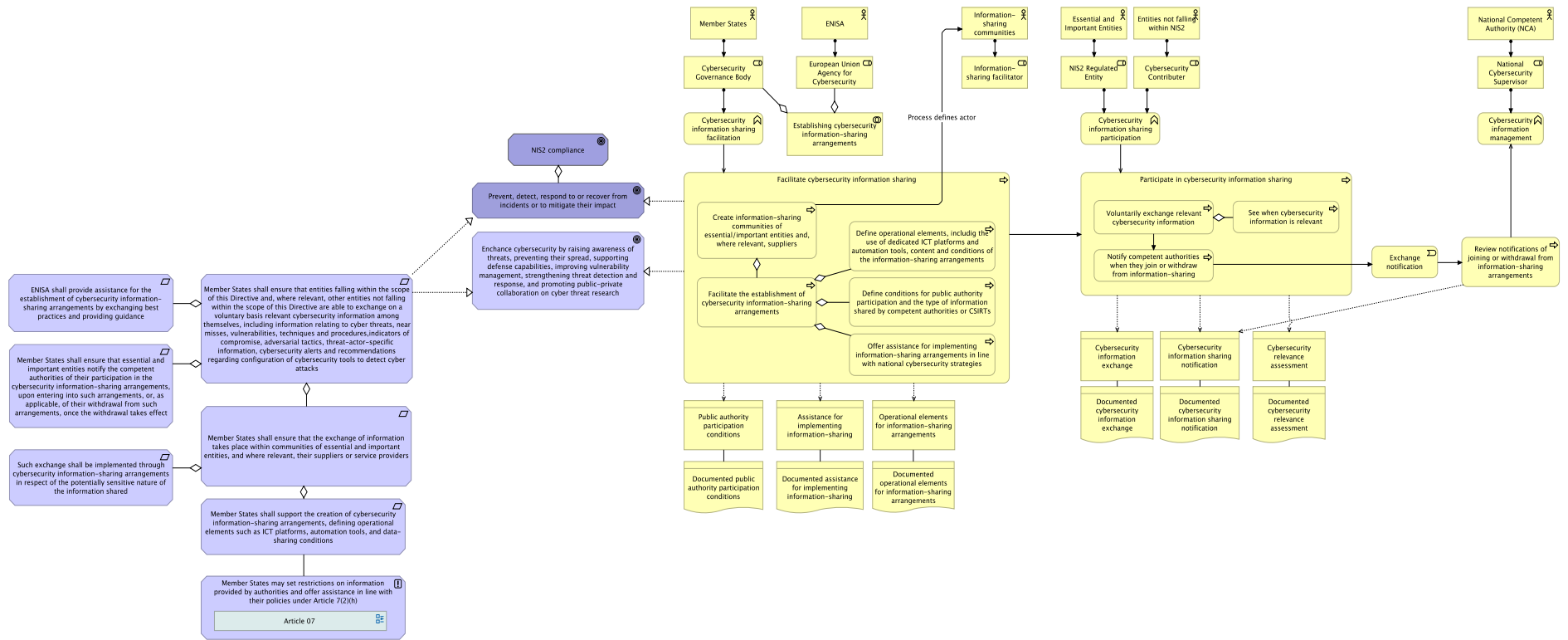
Appendix 12.27. NIS2 Article 27



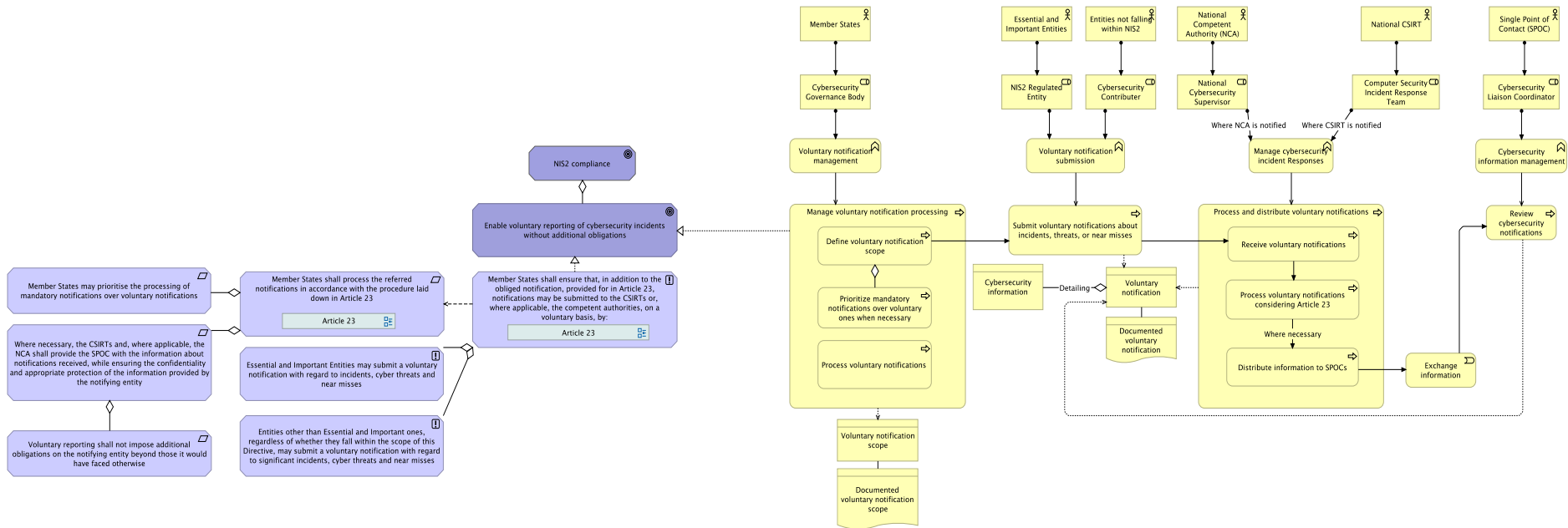
Appendix 12.28. NIS2 Article 28



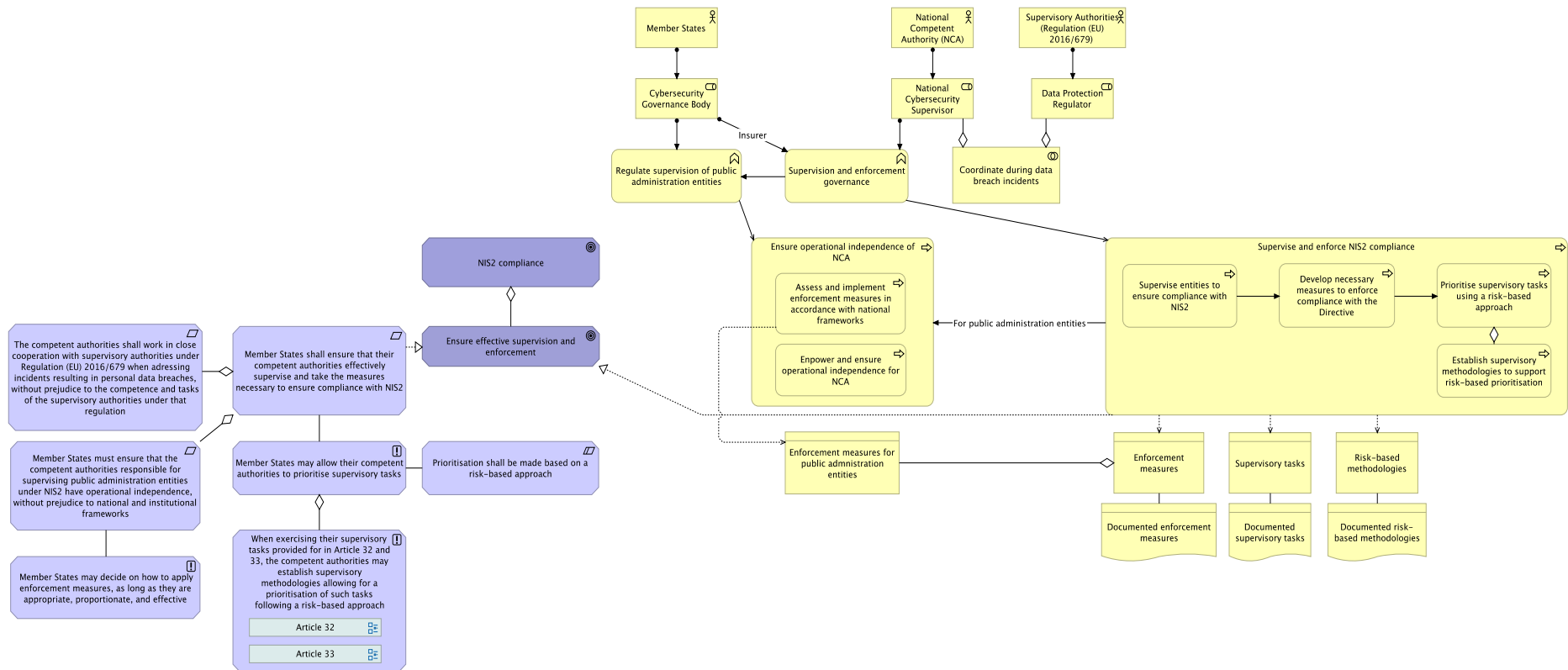
Appendix 12.29. NIS2 Article 29



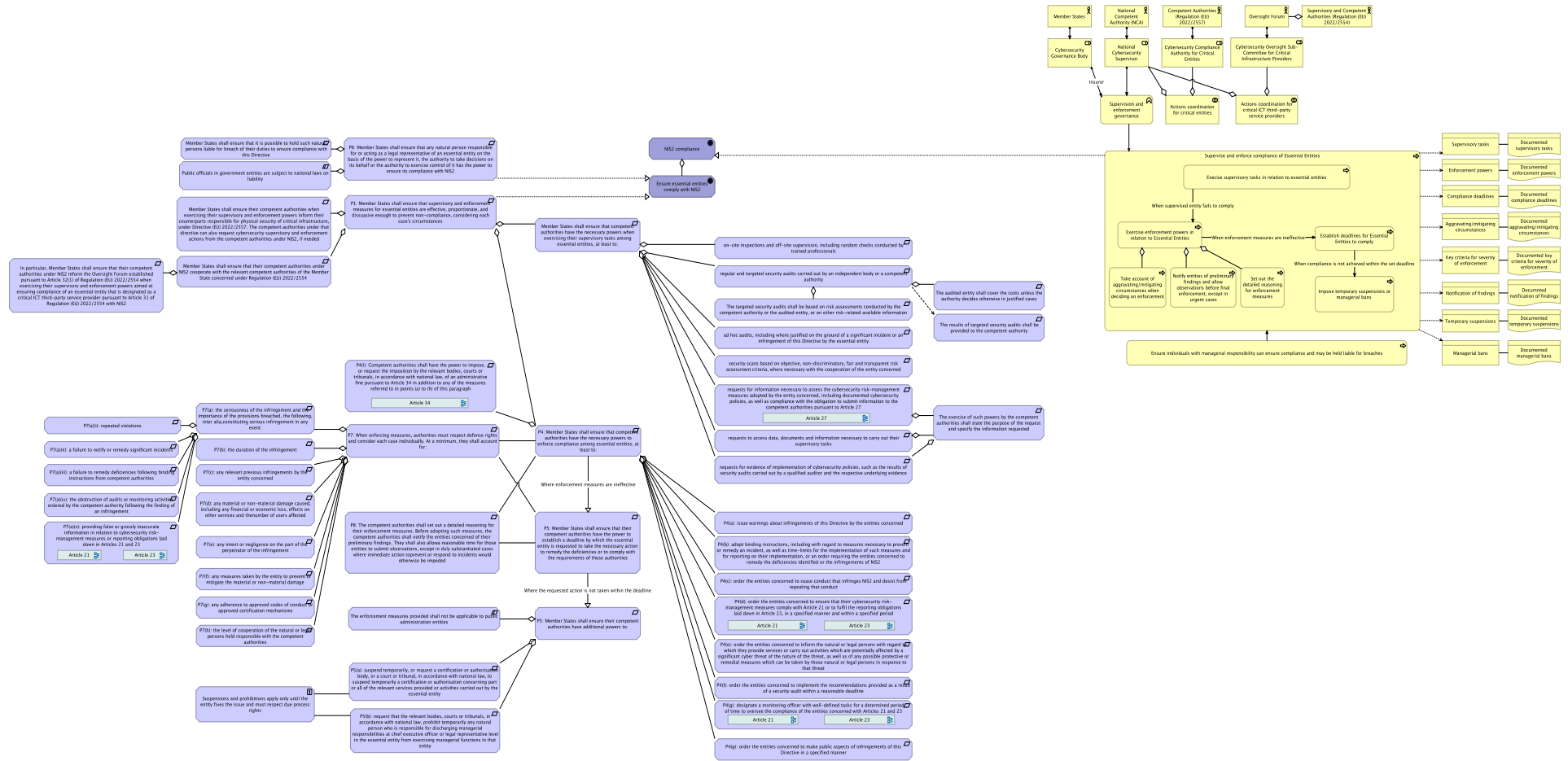
Appendix 12.30. NIS2 Article 30



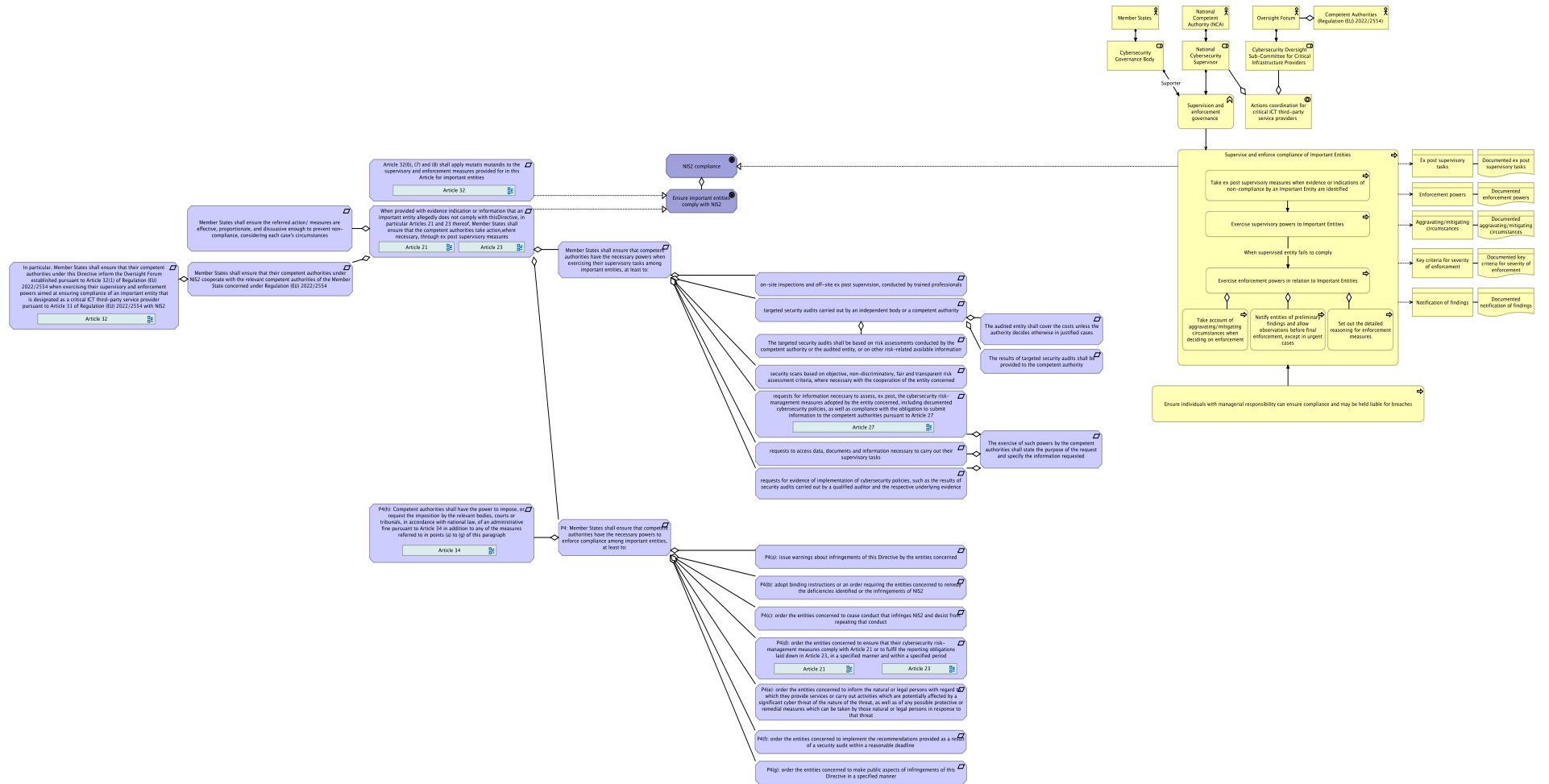
Appendix 12.31. NIS2 Article 31



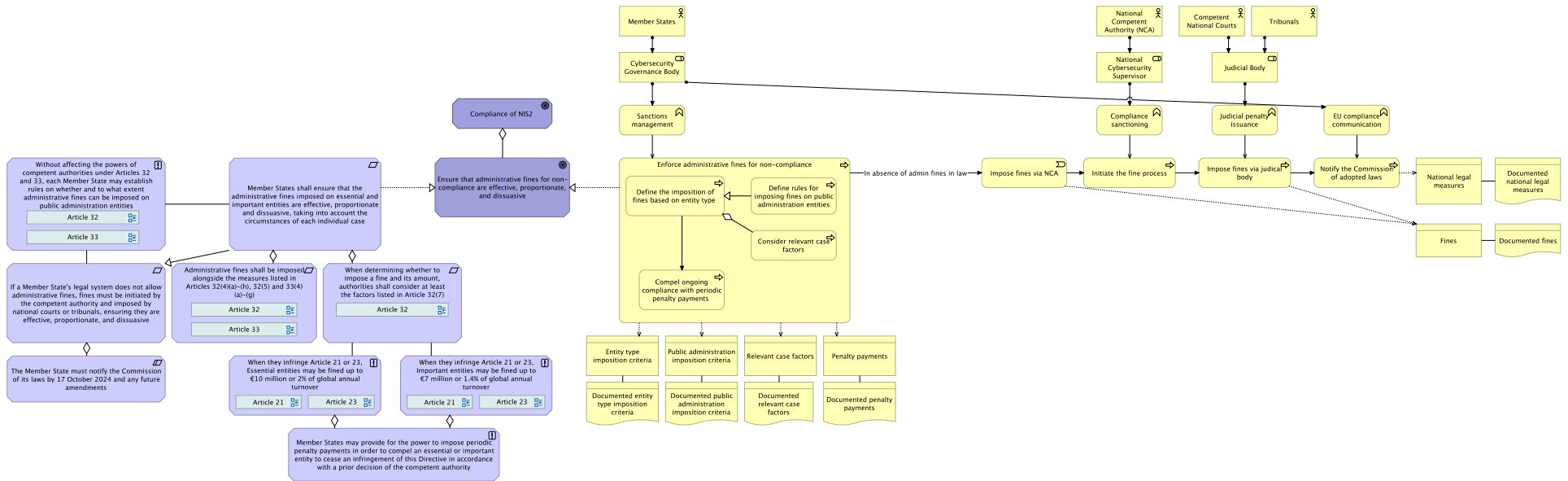
Appendix 12.32. NIS2 Article 32



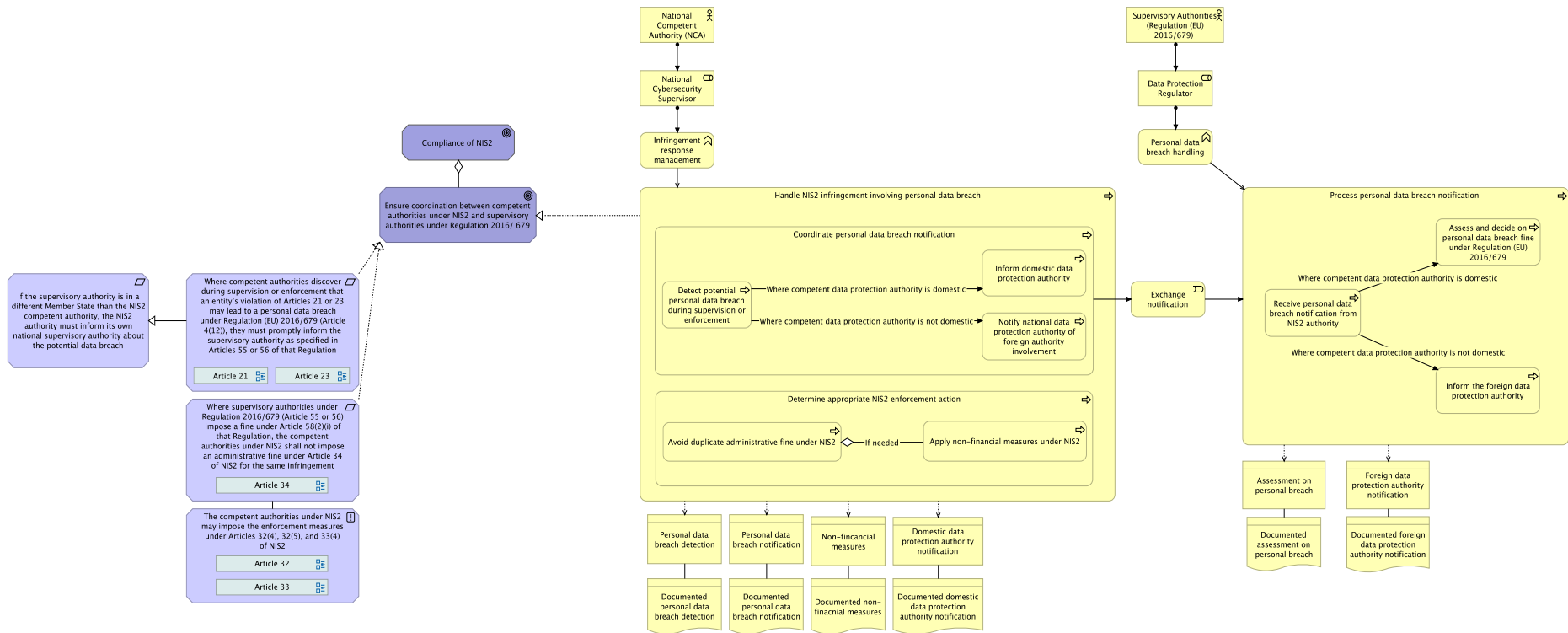
Appendix 12.33. NIS2 Article 33



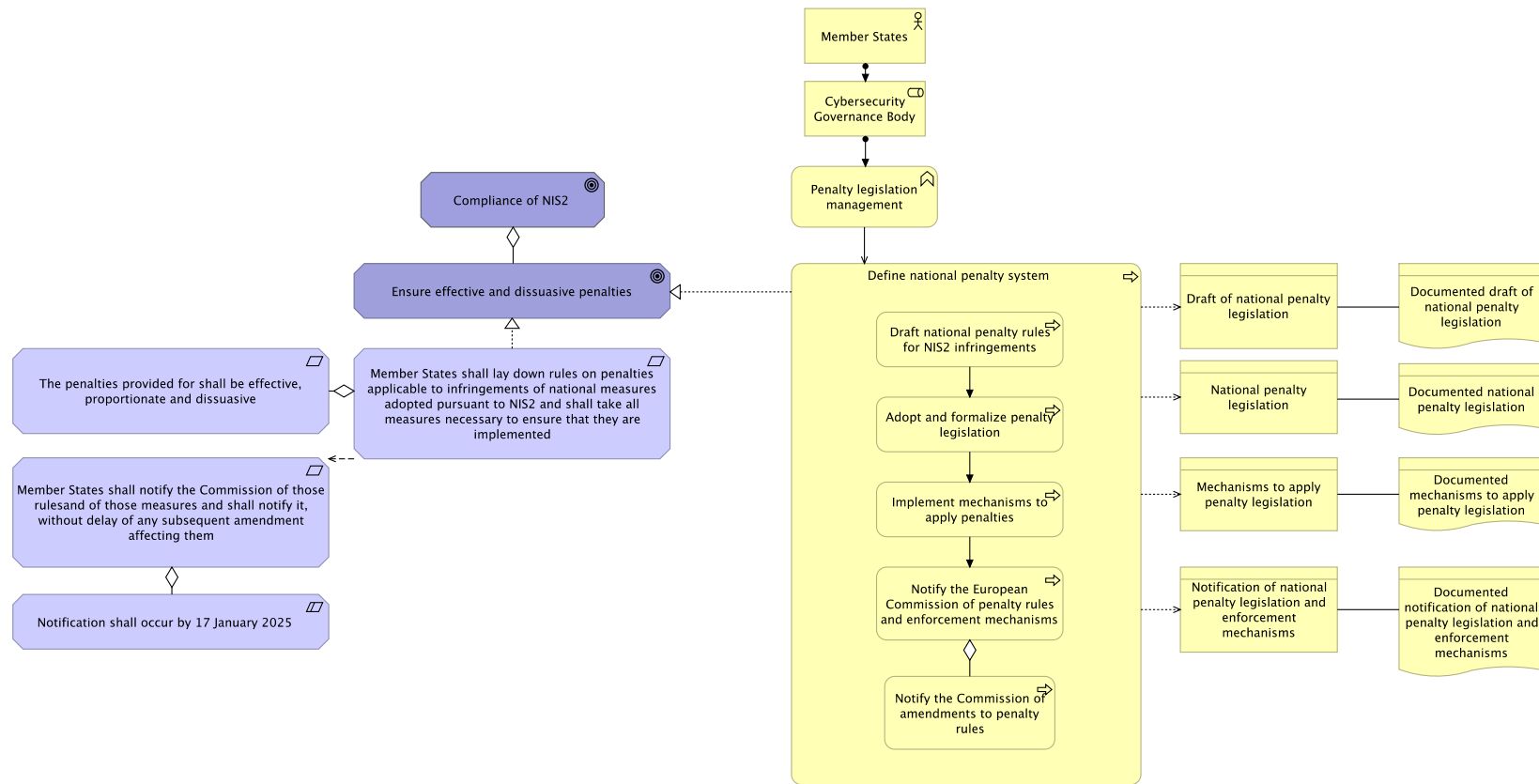
Appendix 12.34. NIS2 Article 34



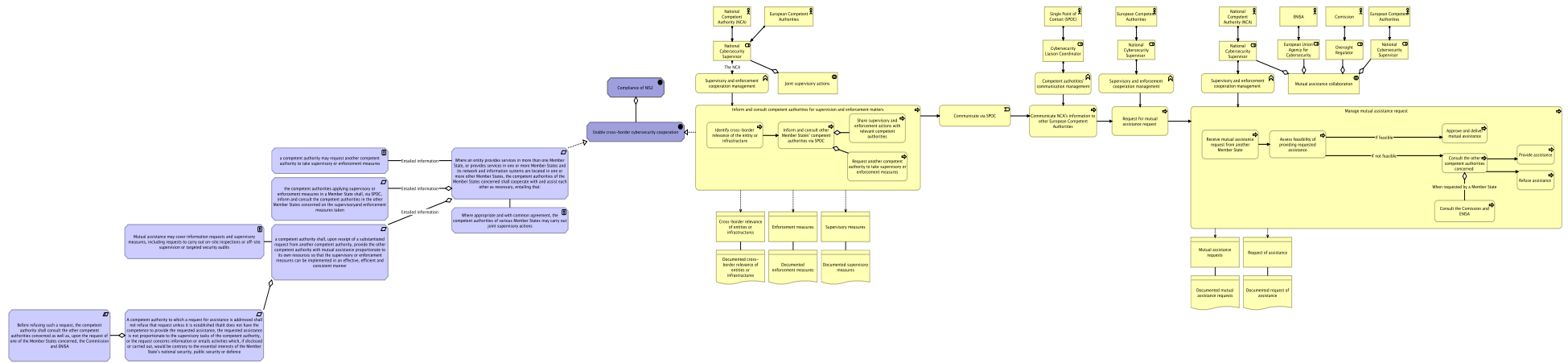
Appendix 12.35. NIS2 Article 35



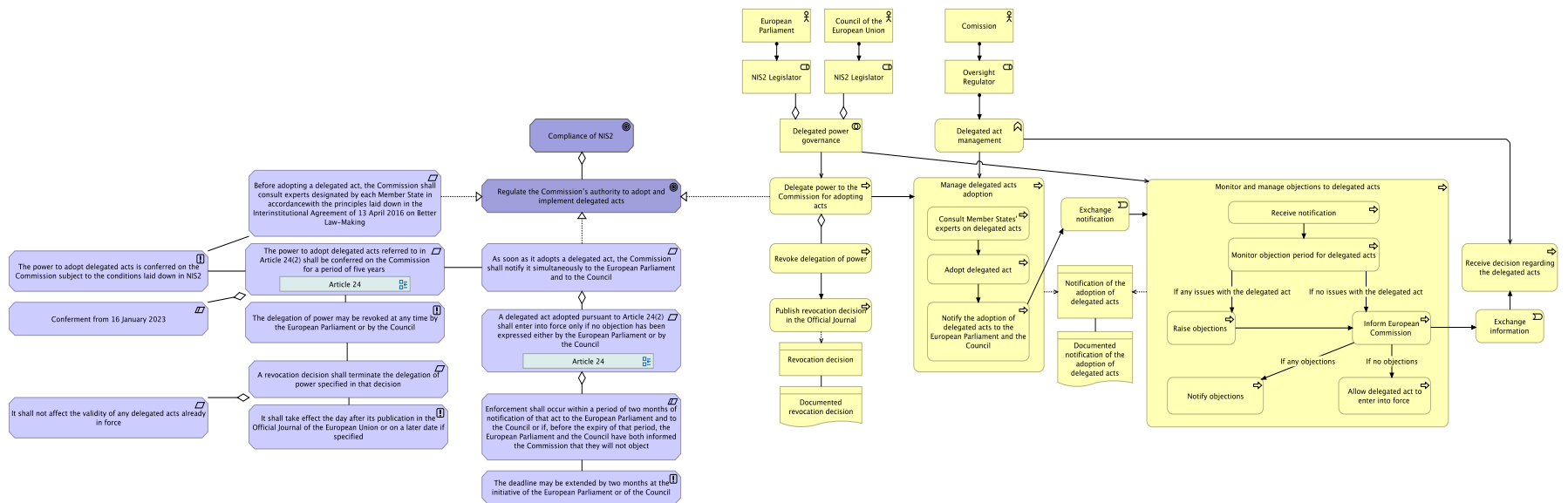
Appendix 12.36. NIS2 Article 36



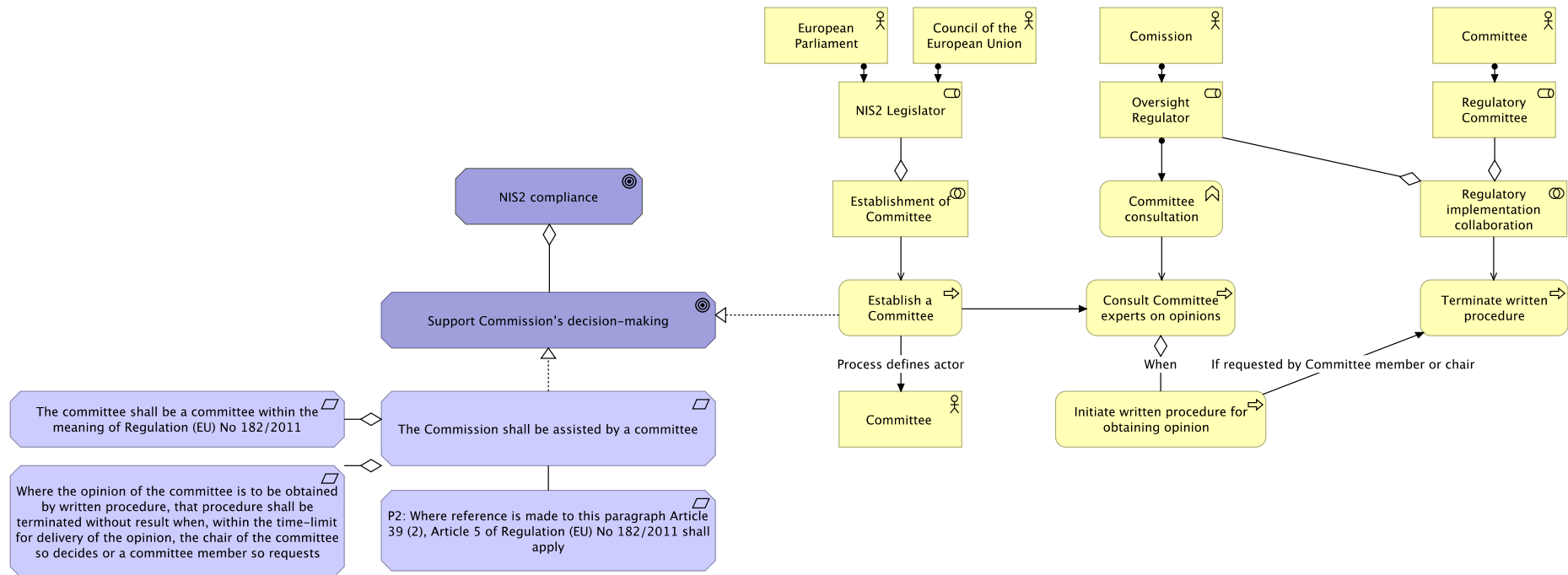
Appendix 12.37. NIS2 Article 37



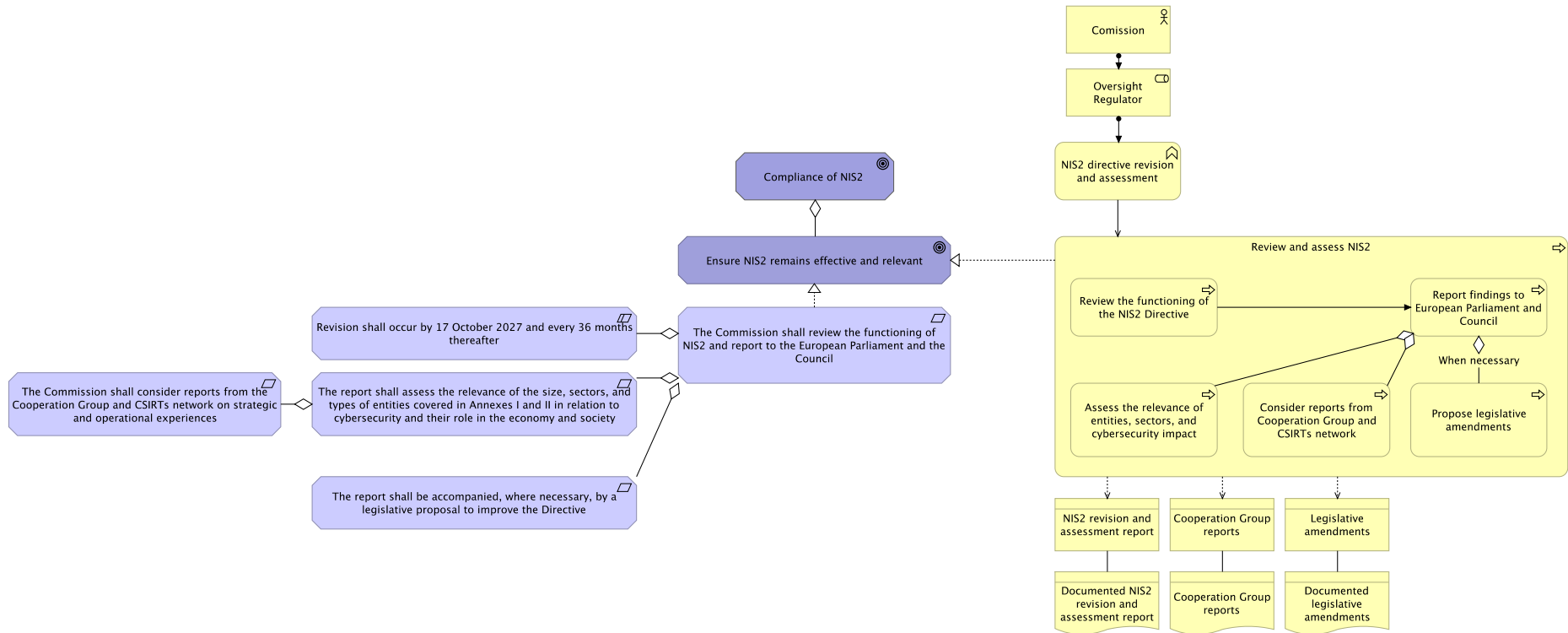
Appendix 12.38. NIS2 Article 38



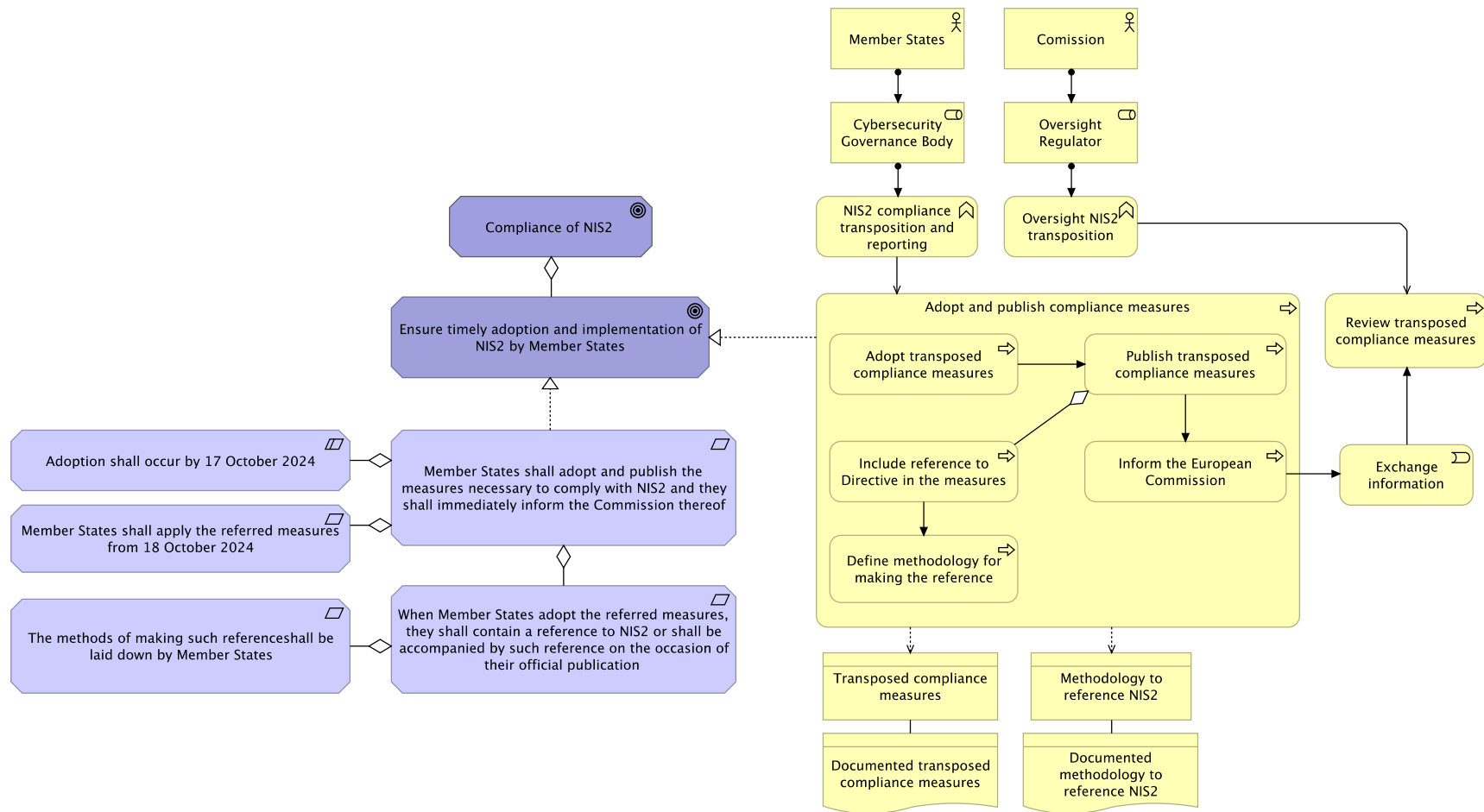
Appendix 12.39. NIS2 Article 39



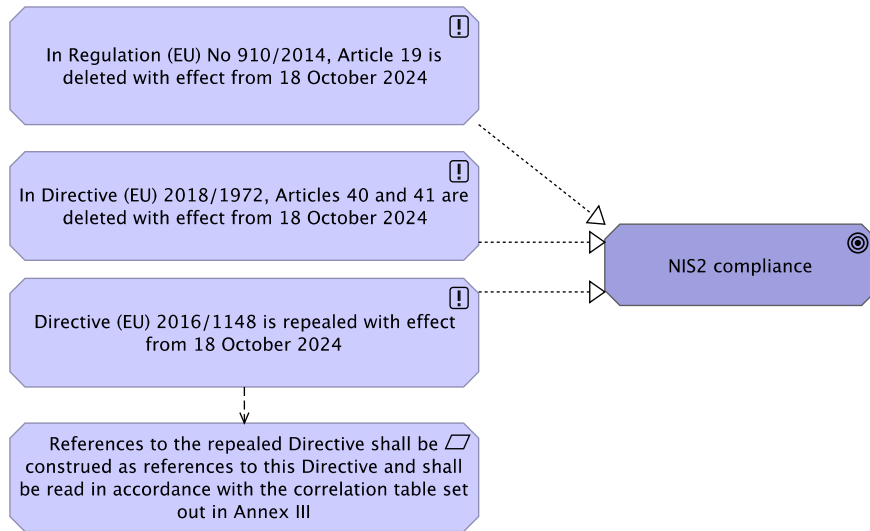
Appendix 12.40. NIS2 Article 40



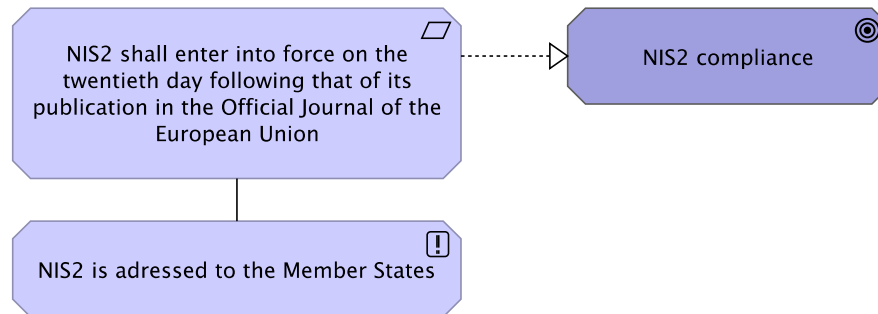
Appendix 12.41. NIS2 Article 41



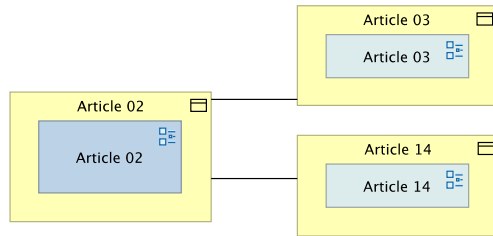
Appendix 12.42. NIS2 Article 42/43/44



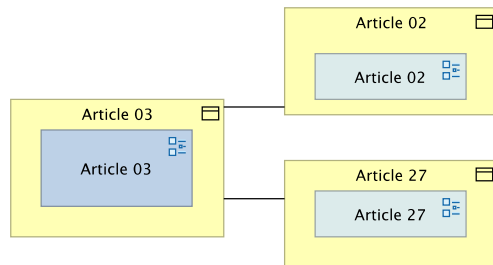
Appendix 12.43. NIS2 Article 45/46



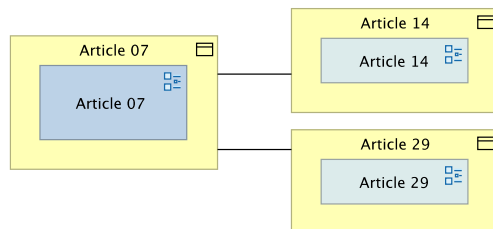
Appendix 12.44. Viewpoint Connections to Article 2



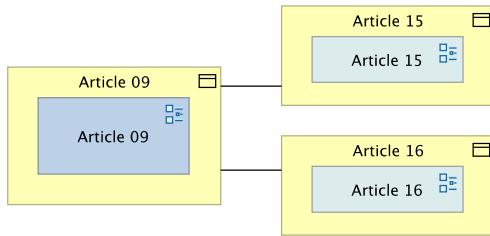
Appendix 12.45. Viewpoint Connections to Article 3



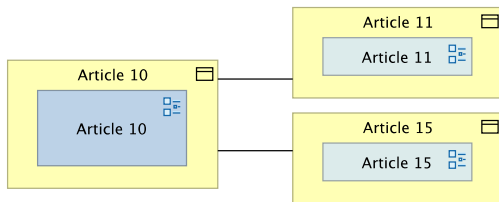
Appendix 12.46. Viewpoint Connections to Article 7



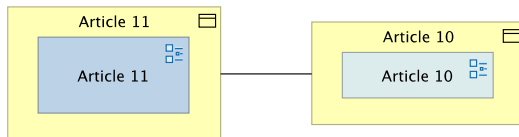
Appendix 12.47. Viewpoint Connections to Article 9



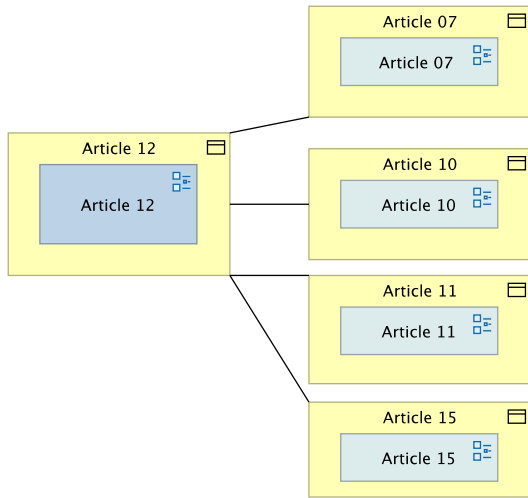
Appendix 12.48. Viewpoint Connections to Article 10



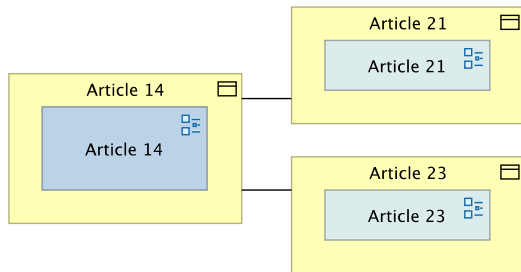
Appendix 12.49. Viewpoint Connections to Article 11



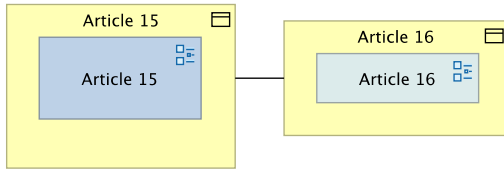
Appendix 12.50. Viewpoint Connections to Article 12



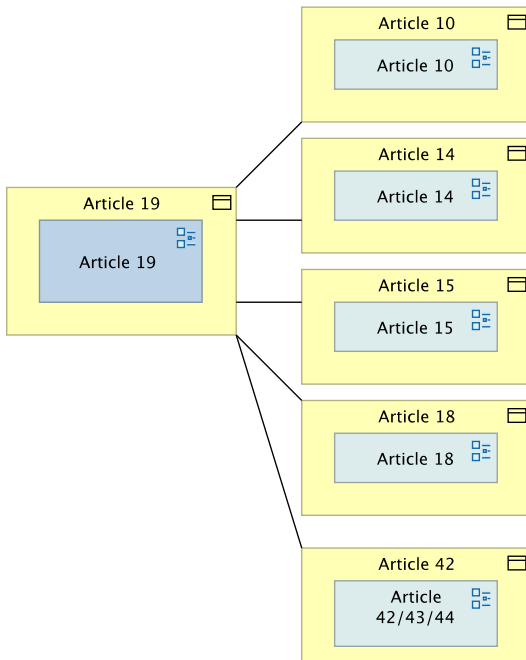
Appendix 12.51. Viewpoint Connections to Article 14



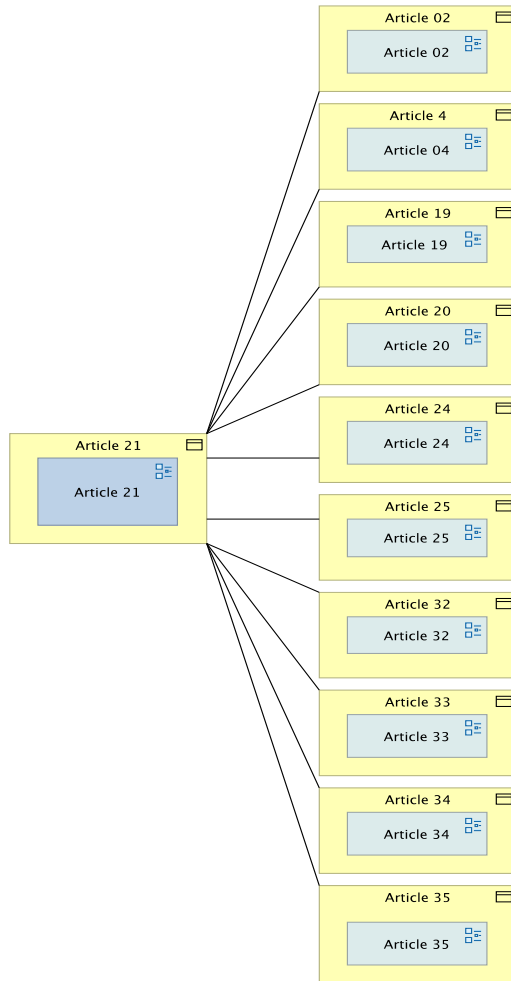
Appendix 12.52. Viewpoint Connections to Article 15



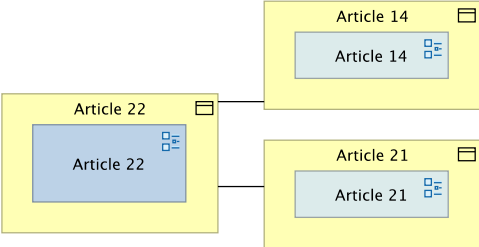
Appendix 12.53. Viewpoint Connections to Article 19



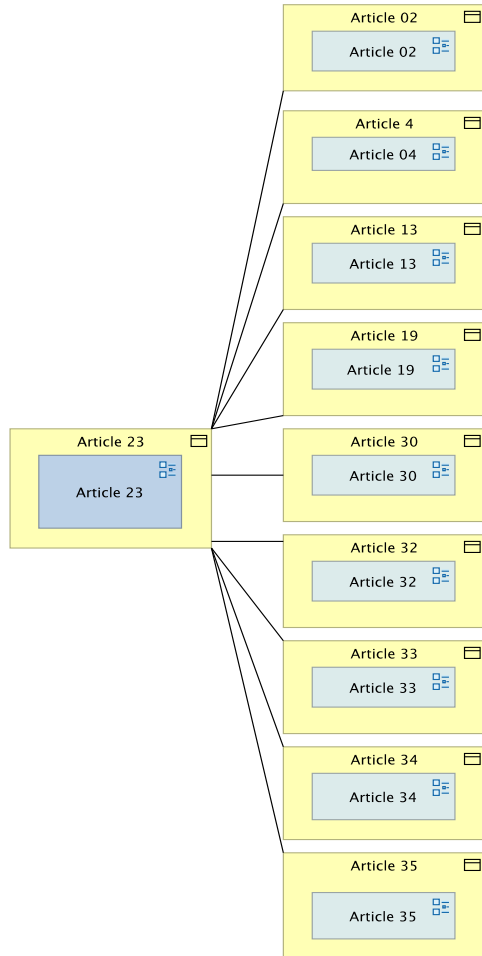
Appendix 12.54. Viewpoint Connections to Article 21



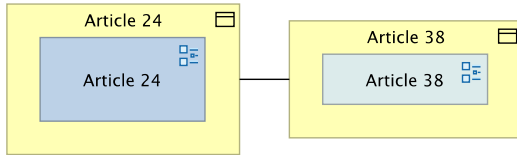
Appendix 12.55. Viewpoint Connections to Article 22



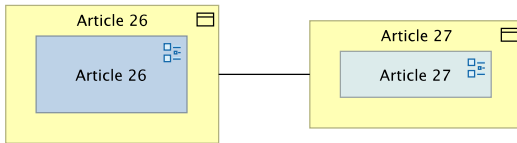
Appendix 12.56. Viewpoint Connections to Article 23



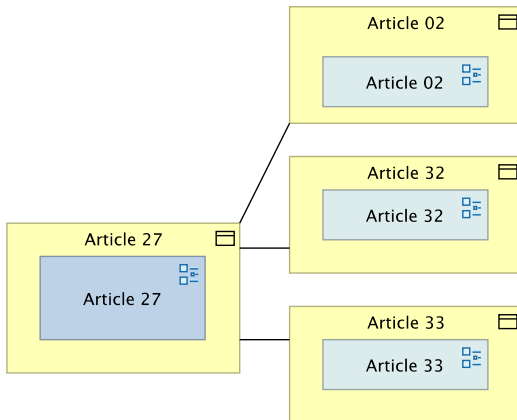
Appendix 12.57. Viewpoint Connections to Article 24



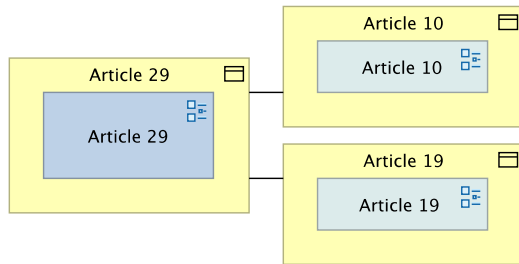
Appendix 12.58. Viewpoint Connections to Article 26



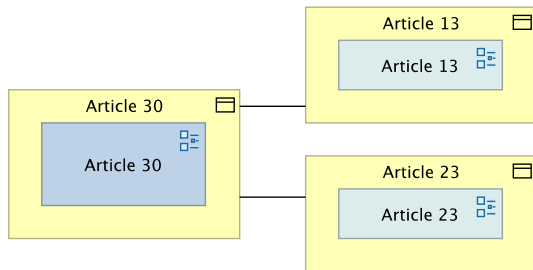
Appendix 12.59. Viewpoint Connections to Article 27



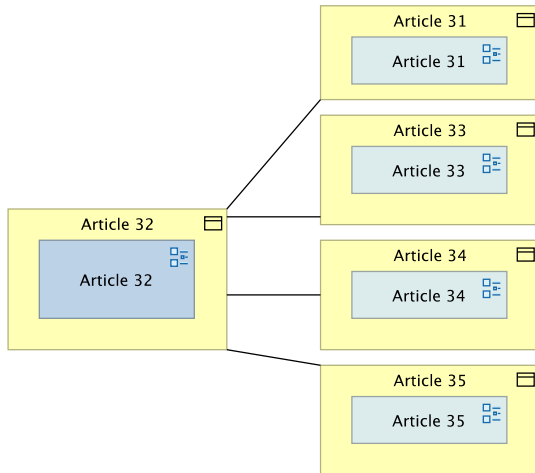
Appendix 12.60. Viewpoint Connections to Article 29



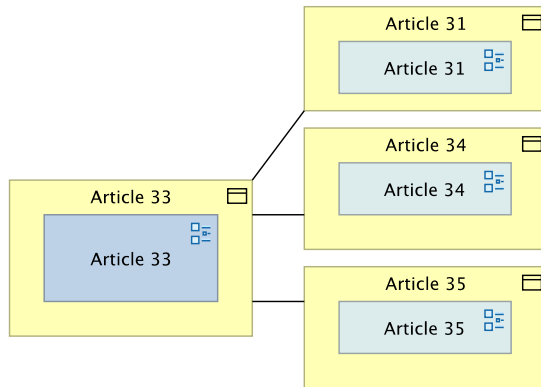
Appendix 12.61. Viewpoint Connections to Article 30



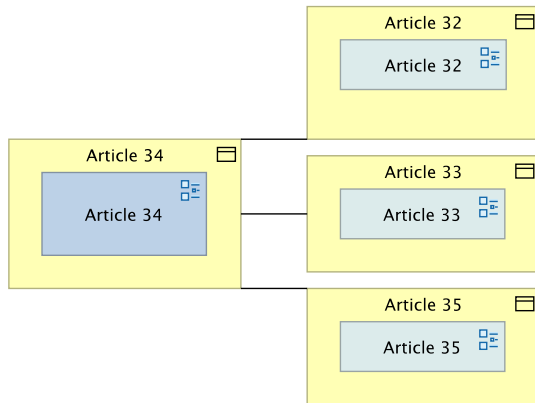
Appendix 12.62. Viewpoint Connections to Article 32



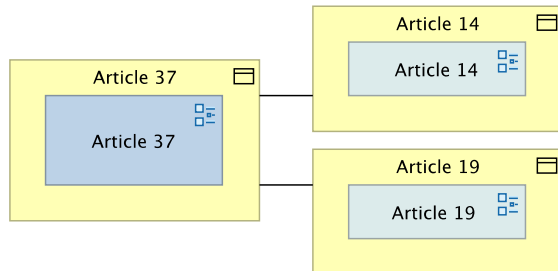
Appendix 12.63. Viewpoint Connections to Article 33



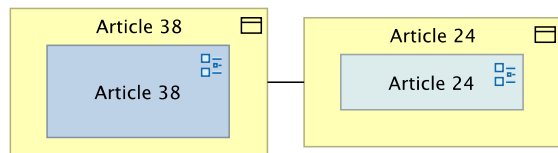
Appendix 12.64. Viewpoint Connections to Article 34



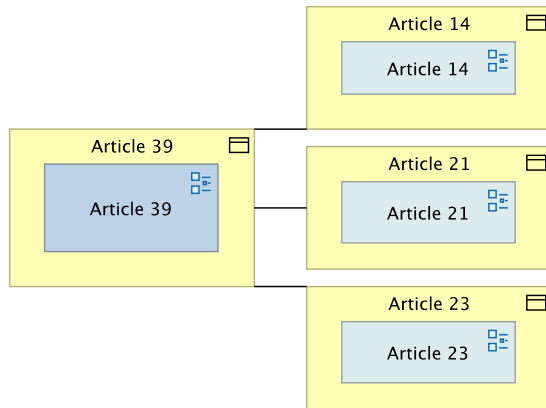
Appendix 12.65. Viewpoint Connections to Article 37



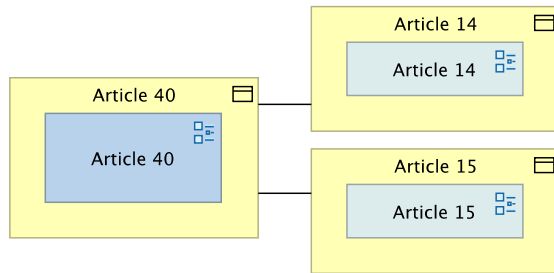
Appendix 12.66. Viewpoint Connections to Article 38



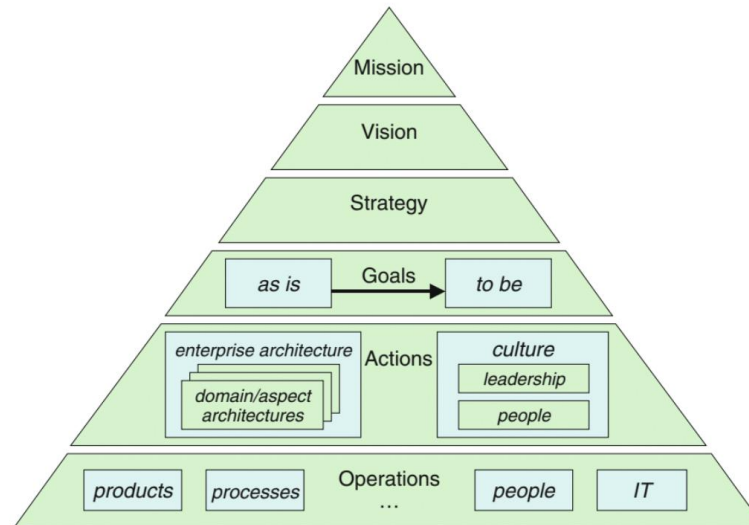
Appendix 12.67. Viewpoint Connections to Article 39



Appendix 12.68. Viewpoint Connections to Article 40



Appendix 13. Enterprise Architecture as a Management Instrument



(Source: Lankhorst, Marc, Jan Dietz, Erik Proper, José Tribolet, Terry Halpin, Jan Hoogervorst, Martin Op 't Land, Ronald G Ross, and Robert Winter. 2013. "Enterprise Architecture at Work- Modelling, Communication and Analysis".)