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EUROPEAN UNION AGENCY
FOR CYBERSECURITY

BE PRA E FOR BER R MA A EME

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ABO E A

he European nion Agency for ybersecurity, E A, is the E agency dedicated to achieving a high common level of cybersecurity across Europe. Established in 2004 and strengthened by the E ybersecurity Act, E A contributes to E cyber policy, enhances the trustworthiness of products, services and processes with cybersecurity certification schemes, cooperates with Member tates and E bodies and helps Europe prepare for the cyber challenges of tomorrow. hrough knowledge sharing, capacity building and awareness raising, the agency works together with its key stakeholders to strengthen trust in the connected economy, to boost resilience of the E 's infrastructure and, ultimately, to keep Europe's society and citizens digitally secure. More information about E A and its work can be found here: www.enisa.europa.eu.

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his study highlights the **complexities behind the notion of cyber crisis** and the degree of **subjectivity** it involves. **The elevation of a large-scale cyber incident into a cyber crisis relies predominantly on a political decision**, and depends largely on the level of risk that E Member tates (M) are prepared to tolerate (i.e. 'risk appetite').

Differences in interpretation of what constitutes a cyber crisis between M pose challenges at the E level. he definition of cyber crisis is important as it directly influences the way the crisis is managed. n the meantime, identifying the **causes, nature and impact** of a cyber crisis can facilitate the assessment of the crisis and its severity, and influence the selection and adoption of appropriate measures for cyber crisis management.

he management of a cyber crisis involves a variety of actors at the **organisational** or **corporate, sectoral, regional, national** and **EU levels.** A cyber crisis is managed at the **strategic, operational** and **technical levels,** with the operational level playing a key role in bridging the gap between the other two, ensuring that information is shared at all levels and enhancing cooperation and coordination between all relevant stakeholders. n addition, cyber crisis management frameworks are **part and parcel of general crisis management frameworks.** As a result, the **EU has a complex ecosystem of cyber security actors, structures** and **mechanisms,** with a 'highly complex and interwoven system of actors, structures and processes operating in the cyber domain', mainly because cyber crises are often transboundary by nature.

hile the E has developed a **crisis management framework specifically dedicated to the management of cyber crises** – including through the Blueprint for coordinated response to large-scale cross-border cybersecurity incidents and crises (2017) (Blueprint) ([1]), the ybersecurity Act (2019) ([2]) or the network and information security ( ) directive (2016) ([3]) – **the NIS 2 directive (NIS2)** ([4]) **has the strongest impact on cyber crisis management at the strategic, operational and technical levels in the EU.** At the operational level, it will consolidate E A's support to M ([5]) in cyber crisis management, introduce new obligations for M and assert the E - yber rises Liaison Organisation etwork (E - y LO e) as the key player in cyber crisis management. **NIS2 enables a more coordinated approach through greater cooperation between MS and relevant EU institutions, bodies and agencies (EUIBAs).**

n this study, cyber crisis management at the operational level in the E is analysed around the four phases of the cyber crisis management cycle, namely **prevention, preparedness,**

([1]) European ommission (2017), ommission Recommendation (E) 2017/1584 of 13 eptember 2017 on coordinated response to large-scale cybersecurity incidents and crises (O L 239, 19.9.2017, pp. 36–58), https://eur-lex.europa.eu/legal-content/E / /?uri= ELE %3A32017 1584&qid=1702033489333.

([2]) European Parliament and ouncil of the European nion (2019), Regulation (E) 2019/881 of the European Parliament and of the ouncil of 17 April 2019 on E A (the European nion Agency for ybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (E) o 526/2013 (ybersecurity Act) (O L 151, 7.6.2019, pp. 15–69), https://eur-lex.europa.eu/eli/reg/2019/881/oj.

([3]) European Parliament and ouncil of the European nion (2016), Directive (E) 2016/1148 of the European Parliament and of the ouncil of 6 uly 2016 concerning measures for a high common level of security of network and information systems across the nion (O L 194, 19.7.2016, pp.1–30), https://eur-lex.europa.eu/legal-content/E / / ML/?uri= ELE :32016L1148.

([4]) European Parliament and ouncil of E , Directive (E) 2022/2555 of the European Parliament and of the ouncil of 14 December 2022 on measures for a high common level of cybersecurity across the nion, amending Regulation (E) o 910/2014 and Directive (E) 2018/1972, and repealing Directive (E) 2016/1148 (2 Directive) (O L 333, 27.12.2020, pp. 80–152), https://eur-lex.europa.eu/eli/dir/2022/2555/oj.

([5]) ee hapter 3.4 'Role and obligations of E A in cyber crisis management at the operational level in the E '.

response and recovery, which should be framed by **an all-hazards approach**, given that threats can have many different origins.

he best practices identified show that M have already introduced some effective cyber crisis management measures at the operational level. hese are likely to continue to grow and evolve, as M implement 2 and develop their own responses to the challenges of cyber crisis management.

he identified best practices are shown below.

The prevention phase aims to better prevent and reduce the risk of cyber crises and to minimise their effects should they arise.

- **BP #1.** Adoption of a national definition of 'cyber crisis', taking into account its transboundary dimension.
- **BP #2.** Development of information security standards specific to the national public sector, to be reviewed and updated regularly.
- **BP #3.** Foster national initiatives which promote the creation of prevention programmes such as centralised distributed denial-of-service attack (DDo) mitigation programmes.

The preparedness phase aims to develop plans to support response operations.

- **BP #4.** Definition of a governance structure, provision of specific capabilities and appointment of a crisis coordinator, whose nomination is mandatory under 2, ensuring their department has the necessary operational and technical cyber skills to directly coordinate stakeholders during a cyber crisis.
- **BP #5.** Mapping and gathering information on critical entities and their most critical assets to enable rapid action.
- **BP #6.** Establishing instantaneous, secured communication channels during a crisis.
- **BP #7.** Formalisation of a clear allocation of roles between the parties involved in responding to a cyber crisis in an overall plan.
- **BP #8.** Development of escalation criteria for activating the cyber crisis plan and deploying the relevant cooperation units/groups, taking into account factors such as time, priority, players involved, severity of the attack, etc.
- **BP #9.** Development of a methodology and risk assessment tools to optimise coordination and interoperability in the event of a crisis.
- **BP #10.** esting of the overall plan for operations in response to cyber crises through a multiannual programme of cyber crisis management exercises and training sessions.
- **BP #11.** etting up training sessions for current and future staff responsible for cyber crisis management at the operational level.
- **BP #12.** Development of a communication strategy including a clear format for messaging, stakeholders to involve, priority levels and time factor and communication channels to be used.

The response phase aims to stem the cyber crisis and prevent further damage.

- **BP #13.** Encourage the mobilisation of private-sector certified 'trusted providers' to provide technical assistance to victims.
- **BP #14.** upporting victims' crisis communication, for instance with a unified and transparent message.

The recovery phase aims to enable quick recovery through tailored measures and return to a level of security that is normal or even higher than before the crisis.

- **BP #15.** Develop and implement business resumption plans (BRP) defined in reference frameworks, with regular reviewing and updates, in consultation with relevant stakeholders.
- **BP #16.** Establishment of a unit tasked with gathering feedback, drawing lessons learnt and producing recommendations for reviewing, updating and modifying procedures and infrastructure, and refining the action plan for cyber crisis management.

Based on the analysis and the way forward of the best practices ([6]), E - y LO e could consider the following recommendations.

Recommendation #1. oordinate working sessions involving all M to define a list of E -wide cyber crisis mechanisms to enable a common assessment of incidents and identify the players to be involved depending on the severity of the incident, leading to a model cyber crisis response plan. hese cyber crisis management mechanisms could be regularly updated in line with progress made by the M , particularly in terms of human and technical resources, situational awareness and impact assessment. hey should always be part of overarching national crisis management frameworks, considering the transboundary nature of most crises and the potential for spill-over effects impacting many sectors at the same time.

Recommendation #2. Develop simulation exercises at the E level which test the operational level players and procedures in particular. hese exercises, which should involve all three levels (strategic, operational and technical), aim to practice the allocation of tasks, cooperation and fluidity of action of the M during a cyber crisis. Actors in charge of cyber crisis management must know each other well to trust one another. o ensure continuity, coherence and overall consistency, each exercise could be organised on the basis of the results of the previous one. he exercises would thus test the operational level's ability to coordinate and exchange information, assess the situation, act as the computer security incident response team's (R s) interpreter with political decision-makers, and manage crisis communication with stakeholders. E - y LO e can play a key role not only in strengthening capacity-building but also developing long-lasting trust among M .

Recommendation #3. upport M in the set-up of secure communication platform(s) to exchange with essential entities, including for informal communication, during a cyber crisis. hile the platforms selected by M should obviously be the result of national choices, E - y LO e could help said choices by publishing guidelines, and even comparative analyses, about the messaging systems best suited to cooperate and exchange information in complete confidentiality.

Recommendation #4. Ensure that M national cyber crisis management authorities, in coordination with the ooperation roup ([7]), regularly update critical information system ( ) maps of essential entities in their country. o do so, they could encourage essential entities to send regular updates, in particular during change or update of projects. Precise maps are essential for cyber crisis management, enabling more effective operational coordination in the event of an incident. hey contribute to a rapid reaction in the event of an incident, to qualify the impact, or to prevent the consequences of the defensive actions carried out.

Recommendation #5. upport the organisation of media training sessions for executives of M national cyber crisis management authorities, so that they can give coherent and clear updates on the progress of the crisis, in any type of media (press, radio, , social networks). As each

([6]) ee hapter 4 ' yber crisis management best practices in the E '.
([7]) According to 2 (Article 14.4), the ooperation roup is responsible for providing strategic guidance to E - y LO e and for exchanging information relating to the identification of essential and important entities.

M has its own capacity needs, these communication sessions could be organised at national level, with content adapted to the context of the M concerned. E crisis communicators could regularly follow awareness-raising sessions on cyber issues, as well as refresher courses.

1. ROD O

1.1 EU POLICY CONTEXT

E policy and legislation framing cyber crisis management have evolved significantly in response to a fast-evolving threat landscape, with the E actively engaged in shaping a comprehensive cyber crisis management framework. he E has adopted a proactive stance, acknowledging the potential impact of cyber incidents on the internal market, public security, and society across M . trengthening European crisis management governance involves fostering effective cooperation amongst operational actors within the E , including the creation of synergies between national authorities, M and E institutions, bodies, agencies. A key policy measure was enacted in 2016 with the directive. aking account of the many different crisis response mechanisms across E institutions, the Blueprint attempted to present, for the first time, a possible E -wide concept to responding to cybersecurity incidents too large for one or two M or E institutions to handle. he E framework further progressed with key legislative texts including the ybersecurity Act and the 2 directive (2022), which supersedes the Blueprint and underlines the critical need for cybersecurity preparedness and effectiveness in addressing the escalating 'number, magnitude, sophistication, frequency, and impact of incidents'. Most recently, the E established E - y LO e, tasked with enhancing cooperation and coordination between relevant actors, overcoming the gap between the strategic and technical levels, preparing decision-making at the political level and coordinating cyber crisis management, situational assessment and mitigation action measures in case of massive cyber incidents.

1.2 STUDY CONTEXT

n the wake of the adoption of 2 in 2022, this study aims to identify tried and tested practices (best practices) in cybersecurity crisis (cyber crisis) management at the operational level in the E . t provides an understanding of the specifics of cyber crises, a concept which is understood differently in M , and of the management thereof at the operational level. t provides insights into key actors, capabilities and procedures to prevent, detect, respond to and recover from this type of event.

he E is in 'an era of permacrisis and polycrisis' ([8]). t has experienced numerous crises over a short amount of time, including the O D-19 pandemic, the growing impact of climate change and Russia's war of aggression against kraine. he unprecedented scale of these crises threatens the functioning of society and requires a 'rapid response despite the great uncertainty regarding their potential evolution and the effectiveness of available countermeasures' ([9]). he E 's role in crisis management has expanded, from facilitating coordination and solidarity between M to providing rapid, flexible and cross-sectoral responses ([10]). he E 's added value is 'higher in transboundary crises and incidents that can overwhelm the response capabilities of individual M ' ([11]). As recently mentioned by the

([8]) European ommission (2023), ommission communication – 2023 trategic Foresight Report: ustainability and people's wellbeing at the heart of Europe's Open trategic Autonomy, OM(2023) 376, 6 uly, https://eur-lex.europa.eu/legal-content/E / /PDF/?uri= ELE :52023D 0376.

([9]) European ommission (2022), *Strategic crisis management in the EU*, ndependent expert report, cientific Advice Mechanism, cientific Opinion o 13, 22 ovember 2022, p. 6, https://allea.org/wp-content/uploads/2022/11/ec rtd sam-

ommission's cientific Advice Mechanism, European crisis management governance still needs strengthening by fostering synergies between E BAs and with M ([12]).

ybersecurity has become an integral part of European security ([13]). he increasing dependence on information technology and the societies' growing interconnection has increased vulnerability surfaces, in particular to cyber threats. he orld Economic Forum considers cross-border cyberattacks as an area where risk mitigation is still in the early stages of development ([14]). E A's *Threat Landscape 2022* report shows that cybersecurity attacks have continued to increase, in terms of vectors, number and impact ([15]). ncidents due to human errors should not be underestimated, as they too can lead to major disruption.

yber crises can affect the proper functioning of the internal market and public security in several M or the E as a whole ([16]). he E has worked to develop a dedicated crisis management framework, first with the Blueprint ([17]) and with key texts such as , the ybersecurity Act and 2. he objectives of the latter on cyber crisis management include:

- increasing the capabilities and preparedness of M to respond to cyber crises;
- improving cooperation, including information sharing and coordination between M and E BAs to deal with cyber crises;
- strengthening the E 's capacity to complement M action in managing cyber crises.

2 requires M to develop the structures, entities and procedures needed specifically for cyber crisis management. t formalises E - y LO e, launched informally in 2020, to improve cooperation among M at the operational level, which is understood as the intermediary between the technical level and the strategic level.

E A's strengthened role in cyber crisis management in the E includes the provision of the secretariat for E - y LO e, and support the secure exchange of information as well as provide necessary tools to support cooperation between M .

1.3 OBJECTIVES OF THE STUDY

his study aims to:

- update E A's cyber crisis management knowledge base ([18]);
- clarify the complexities and nuances of the notion of cyber crisis;
- provide an overview of the framework for cyber crisis management at the operational level in the E , including the identification of key actors, highlighting their role and obligations;
- identify best practices for cyber crisis management at operational level in the E .

he study is aimed at all cybersecurity stakeholders keen to improve both their understanding of and capabilities and procedures to manage cyber crises at the operational level.

([12]) bid.
([13]) European ommission (2020), oint communication to the European Parliament and the ouncil – he E 's ybersecurity trategy for the Digital Decade, O (2020) 18, 16 December, https://digital-strategy.ec.europa.eu/en/library/eus-cybersecurity-strategy-digital-decade-0.
([14]) orld Economic Forum (2022), *The Global Risks Report 2022 (17th Edition)*, p. 7, https://www.weforum.org/publications/global-risks-report-2022/.
([15]) E A (2022), *ENISA Threat Landscape 2022*, October 2022, https://www.enisa.europa.eu/publications/enisa-threat-landscape-2022/@@download/fullReport.
([16]) European Parliament and ouncil of the European nion (2022), Directive (E) 2022/2555 of the European Parliament and of the ouncil of 14 December 2022 on measures for a high common level of cybersecurity across the nion, amending Regulation (E) o 910/2014 and Directive (E) 2018/1972, and repealing Directive (E) 2016/1148 (2 Directive) (O L 333, 27.12.2020, recital 69), https://eur-lex.europa.eu/eli/dir/2022/2555/oj.
([17]) ee footnote (1).
([18]) ee 'Annex: E A's knowledge base'.

1.4 SCOPE OF THE STUDY

his study covers recent evolutions in cyber crisis management at the operational level in the E . t focuses on the following elements.

- he transposition of 2 into national legislation, especially Article 9, which is dedicated to national cyber crisis management frameworks.
- he operational level, the meaning of which may vary among M . n this study, the operational level is understood as the cornerstone for facilitating coordination and understanding between the strategic and technical levels.
- Best practices and lessons learned from M , along with key challenges, to adequately prevent, detect, respond to or recover from cyber crises at the operational level. **'Best practices'** will be defined as 'activities that have been shown through research and evaluation to be effective, efficient, sustainable and/or transferable, and to reliably lead to a desired result' ([19]). hese best practices have been proven at the national level or within the national cyber crisis management authority.

1.5 METHODOLOGY

his following methodology was used to identify best practices in cyber crisis management at the operational level in the E .

Task 1: Data collection

- A research plan was elaborated to identify relevant open sources for data collection.
- Deep-dive desk research was conducted to collect data on cyber crisis management in the E . ources are available in ection 7 ' ources'.

Task 2: Expert consultation

- An expert consultation was designed to complement open-source information on best practices in cyber crisis management, to gather feedback from E - y LO e members.
- A workshop, including a presentation and discussion of identified best practices for cyber crisis management, and complementary interviews were conducted to enrich the study's conclusions.
- ndividual interviews were conducted with a select number of E - y LO e members.

Task 3: Drafting of deliverables

- Data was analysed, conclusions were drawn and drafts of the study were submitted to and reviewed by E A in an iterative fashion.
- he final report was submitted to E - y LO e members for review.

([19]) European ommission (n.d.), " hat are 'good practices?'", https://ec.europa.eu/migrant-integration/page/what-are-good-practices_en.

2. DEF O FOR BER R MA A EME A E OPERA O AL LE EL E E

his section sets out to define the term 'cyber crisis'. t provides a brief definition of the notion of crisis in general, and the factors that shape a crisis. t examines the difference between a cybersecurity incident, a large-scale incident and a cyber crisis. t then turns to the management of cyber crises, beginning with a brief definition of crisis management, exploring the different levels at which a cyber crisis can be managed. t describes the capabilities and measures needed to manage cyber crises at the operational level in the E , looking at the all-hazards approach and the four stages of the cyber crisis management cycle.

2.1 DEFINING A CYBER CRISIS

here are several definitions of a **crisis.** According to O 22361, a crisis is an 'abnormal or extraordinary event or situation which threatens an organisation or community and requires a strategic, adaptive and timely response in order to preserve its viability and integrity' ([20]). t can also broadly be defined as 'an extraordinary event that differs from the normal and involves serious disturbance or risk for disturbance of vital societal functions' ([21]). A more granular definition of a crisis is 'a serious threat to the basic structures or the fundamental values and norms of a system, which, under time pressure and highly uncertain circumstances, necessitate making vital decisions' ([22]). Defined more comprehensively, a crisis is 'an event that affects many people and large parts of society and threatens fundamental values and functions. risis is a condition that cannot be handled with ordinary resources and organisation. A crisis is unexpected, far removed from the ordinary and mundane. Resolving the crisis requires coordinated action from several players/actors' ([23]). **Factors of uncertainty, risk and potential for severe consequences** are essential in qualifying and measuring the severity of a crisis, in addition to time sensitivity and the transboundary element of crises.

he **time sensitivity factor** is important to understand the nature of a crisis. hree types of crisis can be distinguished:

- a **creeping crisis**, or hidden latent crisis, which simmers under the radar of the authorities, before suddenly and unexpectedly erupting;
- an **acute crisis**, which is sudden, unforeseen and can have a massive impact in a very short amount of time;
- a **recurring crisis**, which occurs on a regular basis as part of a cycle.

([20]) Estall, . (2023), ' O 22361:2022 – risis Management uidelines: a closer look', ontinuity entral, https://www.continuitycentral.com/index.php/news/business-continuity-news/8182-iso-22361-2022-crisis-management-guidelines-a-closer-look.
([21]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember, p. 26.
([22]) bid.
([23]) bid.

he time factor is essential for responding to crises appropriately, effectively and quickly. For example, because a creeping crisis occurs over a longer period of time, there is in theory more room for crisis prevention measures. An acute crisis, on the other hand, occurs over a very short period of time, meaning priority should be given to crisis mitigation measures.

Another factor that helps better define a crisis is its transboundary and cross-sectoral impact. A transboundary crisis can be understood as crossing geographical, organisational and/or political borders. E A's work for E - y LO e found that a transboundary crisis could simply be characterised by its tendency to escalate rapidly, transform, proliferate across multiple jurisdictions and (national) borders, affecting various sectors, policy areas and critical infrastructures, straining and even exceeding the capacity of national crisis management systems.

ransborder crises can have different scopes and simultaneously affect several territories, jurisdictions and/or sectors, and pose major challenges for decision-makers, who must cooperate beyond their national structures to respond effectively ([24]). Because **factors of scope and time sensitivity are not mutually exclusive,** a crisis can be both transboundary and acute, transboundary and creeping, or transboundary and recurrent.

As such, the **notion of a cyber crisis can be complex to define.** his is largely due to the differences among M in definitions of the thresholds which make a cybersecurity incident a crisis.

A **cybersecurity incident** refers to 'an event compromising the availability, authenticity, integrity or confidentiality of stored, transmitted or processed data or of the services offered by, or accessible via, network and information systems' ([25]). o complement this definition, 2 specifies that an incident is considered significant when it has 'caused or is capable of causing severe operational disruption of services or financial loss for the entity concerned' and 'has affected or is capable of affecting other natural or legal persons by causing considerable material or non-material damage' ([26]).

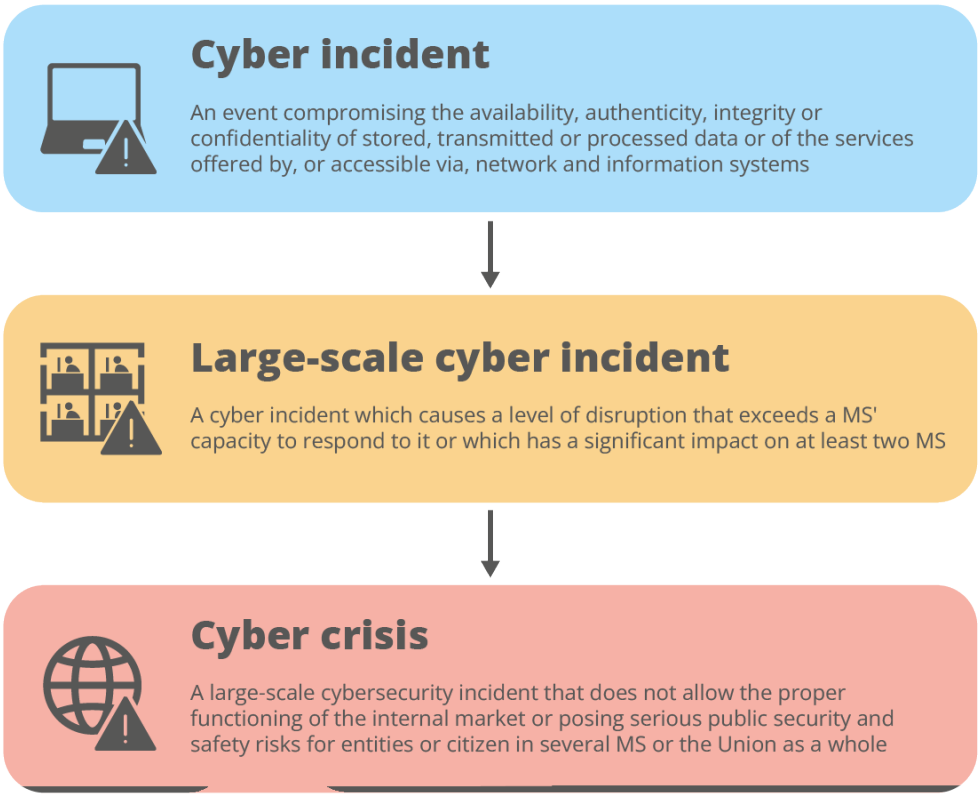
A cyber incident becomes a **large-scale cybersecurity incident** when it 'causes a level of disruption that exceeds a M capacity to respond to it or which has a significant impact on at least two M ' ([27]). A cyber incident therefore moves to 'large-scale' status if a M is unable to take mitigating action on its own, or if more than two M are affected.

A large-scale cybersecurity incident can further escalate into a **cyber crisis.** As explained, the term is subject to varying definitions in M , depending largely on the severity of the incident according to the M and the risk appetite. At the E level, the notion of cyber crisis has often been defined with direct reference to the notion of (large-scale) cyber incident since such a crisis is directly caused by a cybersecurity incident. he **scope, impact** and **frequency** of the cyber event enables the evaluation of its severity, which is essential to escalate to the level of crisis. ltimately, the transition to crisis status depends largely on a political decision to treat a large-scale cyber security incident as a crisis or not. his contributes to the complexity of defining a cyber crisis.

([24]) Ansell, , Boin, A. and Keller, A. (2010), 'Managing transboundary crises: dentifying the building blocks of an effective response system', *Journal of Contingencies and Crisis Management*, ol. 18, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1468-5973.2010.00620.x.
([25]) European Parliament and ouncil of E , Directive (E) 2022/2555 of the European Parliament and of the ouncil of 14 December 2022 on measures for a high common level of cybersecurity across the nion, amending Regulation (E) o 910/2014 and Directive (E) 2018/1972, and repealing Directive (E) 2016/1148 (2 Directive) (O L 333, 27.12.2020, Article 6(6)), https://eur-lex.europa.eu/eli/dir/2022/2555/oj.
([26]) ee footnote (25), Article 23.
([27]) ee footnote (25).

he notion of cyber crisis is based on a number of E cyber regulations and policies. 2 indicates that depending on their cause and impact, a large-scale cybersecurity incident 'may escalate and turn into **fully-fledged crisis** not allowing the proper functioning of the internal market or posing serious public security and safety risks for entities or citizens in several M or the E as a whole' ([28]). Previously, the Blueprint (2017) had attempted to give a definition of 'cyber crisis' by differentiating it from a cybersecurity incident, stating that 'a cybersecurity incident could be considered a crisis at nion level when the disruption caused by the incident was too extensive for a concerned M to handle on its own or when it affected two or more M with such a wide-ranging impact of technical or political significance that it required timely coordination and response at nion political level' ([29]). n addition to this transboundary dimension, a cyber crisis can be characterised by an abnormal and unstable situation that threatens an entity's strategic objectives, its reputation or its viability. he E A *Report on Cyber Crisis Cooperation and Management* (2014) further indicates that a cyber crisis is an event that strikes at the heart of an entity and that can have an impact beyond the entity itself ([30]).

Figure 1: Distinguishing between cyber incident, large-scale cyber incident and cyber crisis ([31]) ([32])



t is thus difficult to find a common definition of the concept of cyber crisis shared by all M and the E . ithin M , the escalation from cyber incident to large-scale cyber incident and finally to fully-fledged crisis depends largely on the risk appetite of each M . Rather than relying on facts alone, declaring a cyber crisis as such at the M level is above all a political decision linked to

([28]) ee footnote (13).
([29]) ee footnote (14).
([30]) bid.
([31]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember, p. 27.
([32]) ee footnote (17).

the risk appetite of the M . he *Report on Cyber Crisis Cooperation and Management* shows that escalation to the status of crisis is largely subjective, with political and organisational perceptions and constraints 'creating' the crisis. ere, crisis exists as an interpretation of the situation rather than as an absolute truth. As a result, what one actor perceives as a crisis may be perceived as daily routine by another, giving a degree of subjectivity to the escalation to crisis status ([33]). he escalation to crisis status depends on a M ' risk appetite; beyond a certain threshold of tolerance, the incident can no longer be managed with the usual means: **it is then declared, and thus becomes, a crisis.** Meanwhile, at the E level, all M must agree to move to crisis level based on agreed standard operating procedures (OPs).

A cyber crisis and its severity can be assessed by looking at different factors which include the **causes, nature** and **impact.** uch an assessment is essential, as it should lead to the adoption of appropriate cyber crisis management measures.

he **causes of a cyber crisis** can be multiple and both physical and non-physical. on-physical causes include targeted action by malicious actors, such as a cyberattack, which may escalate into a crisis. uman errors, malfunctions and malicious actions can also disrupt the functioning of networks and and result in a cyber crisis. auses can also be found in the physical environment ([34]). As highlighted by 2, theft, fire, flood, telecommunications or power failure, unauthorised physical access or damage can all compromise the availability, authenticity, integrity or confidentiality of data stored, transmitted or processed or services offered by or accessible through networks and ([35]). onsequently, the **hybrid nature** of the cyber domain poses particular challenges to determining the origins of a cyber crisis, as it combines a 'mixture of conventional and unconventional, military and non-military, overt and covert actions that can be used in a coordinated manner by state or non-state actors to achieve specific objectives while remaining below the threshold of formally declared warfare' ([36]). his hybrid nature can act as a brake to the escalation of a cyber incident into a crisis, due to the potentially political connotations of the term and the difficulty of assessing both the physical and non-physical origins of the crisis.

A **cyber crisis can be considered as transborder.** yberspace is made up of physical assets scattered across different countries, but which remain (inter)dependent ([37]). t knows no geographical boundaries, meaning that a cyber crisis has a serious potential to spread across several entities, jurisdictions or territories. n addition, every sector now has a cyber element, which can lead to a cyber crisis spreading beyond a specific sector. For example, a cyber crisis originating in the energy sector could very well affect the transport sector via its . E A's work for E - y LO e found that **EU cyber crises could be considered as potentially transborder by definition, as they transcend traditional political, functional and sectoral boundaries within and between MS** ([38]) ([39]).

he **impact** of a cyber incident is a determining factor in the escalation to a large-scale cybersecurity incident or a crisis. mpact can be defined by the number of entities affected, whether a number of individuals, companies/organisations, sectors or M . he type of

WannaCry, the first ever case of cyber cooperation at the EU level, a creeping crisis?

n May 2017, the anna ry ransomware rapidly spread to more than 230 000 computers in 150 countries, encrypting files on the hard drives of indows systems, preventing users from accessing them and demanding a ransom to decrypt the files. t was a cross-sector propagation that affected several users in several countries, impacting thousands of operating systems ([35]).

anna ry was considered a large-scale cyber security incident and was not elevated to the status of a crisis. At the time, only the technical level of cyber crisis management was in place.

anna ry could be considered a large-scale **creeping cybersecurity incident** because the cyberthreat was hidden in plain sight, evolving gradually over time on computers around the world in a non-linear pattern ([39]).

([33]) E A(2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([34]) Physical damage can have repercussions in the virtual world: for example, a flood or fire can disrupt servers, causing a cyber incident that can turn into a crisis. One such example of a cyber incident caused by physical damage occurred in France in March 2021, when a fire broke out in a data centre, causing major disruptions on the servers.
([35]) ee footnote 13, recital 79.
([36]) European ommission (2016), 'FAQ: oint Framework on countering hybrid threats', April 2016, https://ec.europa.eu/commission/presscorner/detail/en/MEMO_16_1250.
([37]) E A (2018), *Good practices on interdependencies between OES and DSPs (November 2018)*, p. 8, https://www.enisa.europa.eu/publications/good-practices-on-interdependencies-between-oes-and-dsps.
([38]) ee footnote (37).
([39]) Prevezianou, M.F. (2021), ' anna ry as a reeping risis', in Boin, A., Ekengren, M. and Rhinard, M. (eds), *Understanding the Creeping Crisis*, Palgrave Macmillan, ham, pp. 37–50, https://doi.org/10.1007/978-3-030-70692-0_3.

entities affected and whether they operate services considered vital to the functioning of the nation is crucial. Particular attention is therefore paid to services and activities defined by 2 as **essential** (energy, transport, banking, financial market infrastructure, health, drinking water, waste water, digital infrastructure, service management, public administration and space) and **important** (postal and courier services, waste management, manufacturing, chemicals, production, food, manufacturing, digital suppliers and research) ([40]). f these services are affected, the incident is likely to reach crisis level, given the potential to disrupt vital services.

here are therefore different types of cyber crisis, with different degrees of complexity. his diversity, together with the varying capabilities of each M to combat cyber crises, influences their classification of a cyber incident as a crisis. he lack of common indicators for defining a 'cyber crisis' at the E level makes it both complex and sensitive to escalate a large-scale cybersecurity incident into a full-fledged crisis.

2.2 DEFINING CYBER CRISIS MANAGEMENT

his study builds on previous work by E A, which defines crisis management as 'an institutional and organisational design process' ([41]), a ' broad structure that encompasses decision-makers with specific roles and actions ' ([42]). n general terms, crisis management is understood as 'making and effecting difficult decisions under difficult circumstances' ([43]).

The EU's crisis management competences have grown significantly in sectors such as civil protection, terrorism, health, the environment, critical infrastructures and cybercrime ([44]). hile **national security remains the prerogative of MS, the EU plays a growing role** in coordinating and improving cooperation between M in the event of a crisis. he E has developed the capacity to support M overwhelmed by a disaster or crisis, to manage transboundary crises and to provide assistance in the event of a crisis outside the E ([45]). **Crisis management at the EU level involves a highly complex and interwoven system of actors, structures and processes operating at many levels.**

Cyber crisis management is part of a wider crisis management framework. hile some consider that every type of existing crisis has a cyber element, others argue that cyber crisis management should be seen as a stand-alone practice. **These approaches are not mutually exclusive and could even be more effective when combined.** yber crisis management can be understood as the management of a crisis which has a cyber origin or a significant cyber component.

At the EU level, both approaches exist for cyber crisis management. yber crisis management in the E is handled by different E institutions and agencies, depending on the type of crisis encountered. he E 's high-level (or generic) crisis management mechanisms can be used and applied in the context of cyber crises specifically, but are not limited to them. his is the case, for example, of the ouncil's ntegrated Policy Response apability (P R) Mechanism, the European ommission's AR system or the European External Action ervice's (EEA) risis Response Mechanism (RM) ([46]) ([47]). **Overall, the cross-sectoral nature of crises means that multiple actors from different sectors must cooperate and**

([40]) ee footnote (13), Article 16.
([41]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([42]) bid.
([43]) bid.
([44]) APEA (2022), *Strategic crisis management in the European Union*, Evidence Review Report o11, https://allea.org/wp-content/uploads/2022/11/crisis-management-report.pdf.
([45]) bid.
([46]) bid.
([47]) ee hapter 3.1 'Overview of the structure of cyber security crisis management at the operational level in the E '.

share information, and the transboundary nature of cyber crises is a perfect illustration ([48]).

he E has long been working on a **specific legislative framework for cyber crisis management.** he aim is for M to comply with minimum requirements for cybersecurity resilience, which includes improving cyber crisis management capabilities. hree major pieces of legislation have structured the development of cybersecurity crisis management, namely , the ybersecurity Act and, most recently, 2 ([49]). n particular, 2 introduces new rules to improve the way the E prevents, manages and responds to large-scale cyber security incidents and crises by establishing clear responsibilities, proper planning and better cooperation within the E ([50]). **However, even with the development of measures specifically designed for cyber crisis management, the latter remains embedded in the policies and plans of broader crisis management structures, both at the national and EU levels.**

he management of a cyber crisis involves **public and private stakeholders** from the **civilian**, **law enforcement** and **defence sectors, depending on the nature and impact of the cyber crisis.** hese actors operate at different levels.

- **Organisational and corporate level.** ritical entities affected by a cyber crisis are key players in managing cyber crises. heir cooperation and information are essential to ensure that situational awareness is shared in a timely manner and that mitigation measures are properly implemented. hey also play a crucial role in crisis prevention, for example by communicating the mapping of their s to the national authorities responsible for crisis management, and must be supported to increase their resilience to cyber crises.
- **Sectoral level.** risis management can also follow a sectoral approach, incorporating a cyber element for each sector considered critical. his can be envisaged for better coordination and cooperation between actors, providing a cyber crisis management plan tailored to each sector. n this case, 2 can serve as a basis since it defines the entities in the sectors considered 'essential' and 'important' ([51]) because they provide vital services to the nation.
- **Regional level.** ithin M , regional authorities can be involved in managing cyber crises, among others, because of their proximity to the entities affected in the event of a crisis.
- **National level.** M have primary responsibility for cybersecurity, for crisis management, and for the management of cyber crises. onsequently, M must take the necessary measures to ensure the protection of essential national security interests and to safeguard public order and public security ([52]). hile cyber crisis management can be a politically sensitive issue and remains a national competence, M often choose to work together through coordination mechanisms and networks, with varying degrees of formalisation ([53]). 2 now requires M to draw up a cyber crisis management plan and set up national crisis management authorities.
- **EU level.** 2's definition of a cyber crisis implies that the affected M is either unable to respond to the situation alone, or that the crisis affects at least one other M . he E plays an essential role in preventing and mitigating cyber crises, in particular by establishing common benchmarks which contribute to raising the European level of resilience to cyber crises and by strengthening M crisis management capabilities and improving collective situational awareness ([54]).

([48]) E A(2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([49]) he Blueprint (2017) was also a key policy initiative that helped refine the definition of a cyber crisis, although it is now outdated.
([50]) European ommission (n.d.), 'Directive on measures for a high common level of cybersecurity across the nion (2 directive) – FAQs', https://digital-strategy.ec.europa.eu/en/faqs/directive-measures-high-common-level-cybersecurity-across-union-nis2-directive-faqs.
([51]) Essential entities include the energy, transport, finance, banking, health, drinking water, waste water, digital infrastructure, service management, public administration and space sectors. mportant entities include postal and courier services, waste management, manufacturing, chemicals, production, food, manufacturing, digital suppliers and research. (2 directive).
([52]) ee footnote (13), recital 9.
([53]) bid.
([54]) European ommission, 'FAQ: oint Framework on countering hybrid threats', April 2016.

- **International level.** yber crises can go beyond the borders of M and involve non-E countries, requiring international intervention to resolve the situation. Bilateral agreements can be concluded between M and non-E countries directly, or between the E and non-E countries or other regional organisations worldwide. he cyber diplomacy toolbox, for example, was created to provide 'an appropriate framework for a common E diplomatic response to malicious cyber activities in order to mitigate and/or deter potential cyber attackers from harming the political, security and economic interests of the European nion' ([55]), beyond the E 's borders.

Different actors from different sectors and levels can be involved in the management of cyber crises. **This study focuses specifically on the EU level.**

n the event of a cyber crisis, M and the relevant E BAs must cooperate 'to properly coordinate the response across the E ' ([56]) at three different levels: the strategic, operational and technical levels ([57]).

- he **strategic level** is responsible for the strategic and political management of both the cyber and non-cyber aspects of a crisis. Actors include M ministers responsible for cybersecurity, the European ouncil and its President, the Presidency of the ouncil of the European nion and the ouncil of the European nion, the European ommission, including the President or the delegated ice-President/ ommissioner and the EEA , including the igh Representative of the nion for Foreign Affairs and ecurity Policy ([58]).
- **The operational level focuses on preparing decision-making at the strategic level, coordinating cyber crisis management, and situational awareness, impact assessment and mitigation measures.** t should be noted that the definition of the 'operational' level may vary from one M to another, in some cases corresponding to the technical level. n this publication, the operational level is defined as the **cornerstone for strengthening cooperation between the various MS and EU institutions,** and for **facilitating coordination between the strategic and technical levels. EU-CyCLONe** was established precisely to fill this gap ([59]).
- he **technical level** involves incident handling during a cyber crisis and incident monitoring and surveillance, including continuous analysis of threats and risks. Actors include the R s etwork, national R s, the European ommission, EEA , the omputer Emergency Response eam for the E institutions, bodies and agencies, E A and the European ybercrime entre of the European nion Agency for Law Enforcement ooperation ([60]).

([55]) De homas olatin, . (2020), ' i vis cyber pacem, para sanctiones: the E yber Diplomacy oolbox in action', D OE, https://ccdcoe.org/library/publications/si-vis-cyber-pacem-para-sanctiones-the-eu-cyber-diplomacy-toolbox-in-action/.
([56]) ee footnote (13), recital 69.
([57]) E A (2016), *Strategies for incident response and cyber crisis cooperation*, 25 August.
([58]) ee footnote (1).
([59]) ee footnote 13, Articles 9 and 16.
([60]) bid.

Table 1: Strategic, operational and technical levels of cyber crisis management ([61]) ([62])

	Actors	Responsibilities
Strategic level	• M ministers responsible for cybersecurity • President of the European ouncil • Presidency of the ouncil • President or the delegated ice-President/ ommissioner of the European ommission • igh Representative of the nion for Foreign Affairs and ecurity Policy	• trategic and political management of both the cyber and non-cyber aspects of the crisis
Operational level	• E - y LO e	• Ensure enhanced cooperation and coordination • Bridge the gap between the strategic and technical levels • Prepare decision-making at the political level • oordinate cyber crisis management, situational assessment and mitigation action measures
Technical level	• R s etwork ([63])	• ncident handling during the cyber crisis • ncident monitoring and surveillance, including continuous analysis of threats and risks

Managing a cyber crisis involves a significant number of actors. As E A's 2016 *Strategies for incident response and cyber crisis cooperation* report points out, **'the key in effective cyber crisis coordination is the shared responsibility and comprehensive approach among the stakeholders'** ([64]). n the E , the question of who is responsible largely depends on the level(s) at which the cyber crisis occurs. his study however focuses on the **operational level,** as do the best practices identified in the next chapter.

A variety of capabilities and measures can be put in place to manage cyber crises. hese **need to be organised in a comprehensive way** to ensure successful cyber crisis management. ndeed, in the cyber domain, crisis management involves 'capabilities to adequately prevent,

([61]) ee footnote (13).
([62]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([63]) R s etwork (n.d.), official website, https://csirtsnetwork.eu/.
([64]) E A (2016), *Strategies for incident response and cyber crisis cooperation*, 25 August.

detect, respond to, recover from or mitigate the impact of incidents' ([65]). ince threats can have different origins, management measures should be based on an **all-hazards approach.** his approach aims 'to protect networks, s and the physical environment of those systems from events such as theft, fire, flood, telecommunication or power failures, or unauthorised physical access and damage which could compromise the availability, authenticity, integrity or confidentiality of stored, transmitted or processed data or of the services offered by, or accessible via, network and information systems' ([66]). he all-hazards approach offers a comprehensive approach to cyber crisis management, taking into account the multiple potential causes of cyber crises, which can originate in both the physical and non-physical worlds.

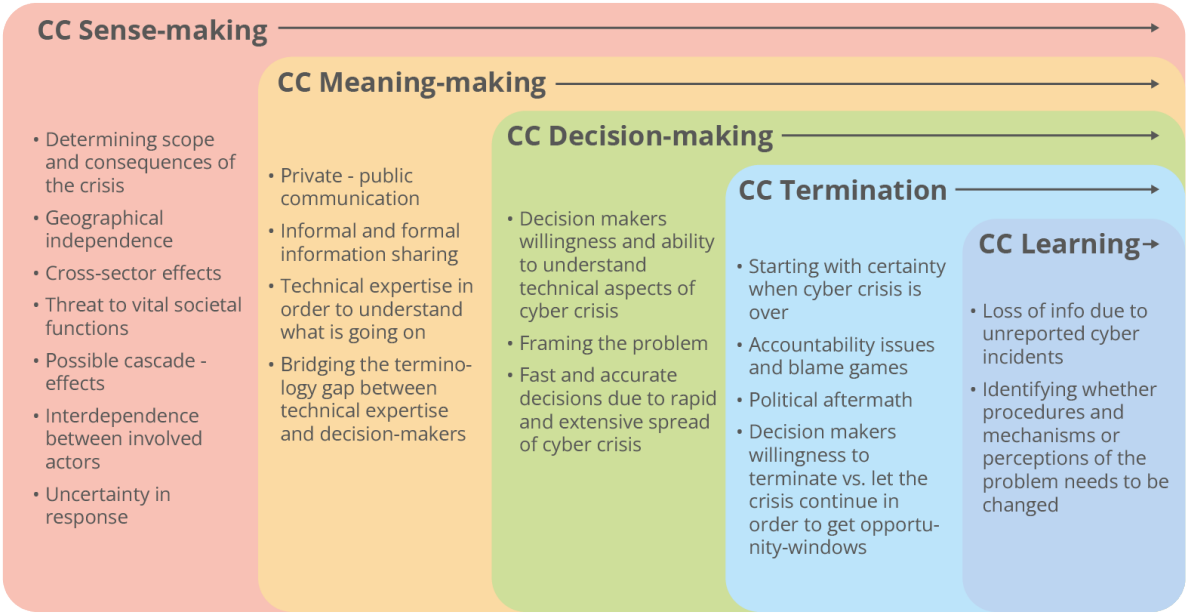
aking into account the origins of cyber crises is important to shaping the adequate response, but it is equally important to integrate certain key steps in the development of an effective and coherent cyber crisis management strategy. he E A *Report on Cyber Crisis Management and Cooperation* (2014) highlights five key tasks to conduct crisis management in order to resolve any kind of crisis situation. hese tasks overlap and flow into each other and include:

- **sense-making,** which involves finding out what is happening and why;
- **meaning-making,** which involves conveying an understanding of the situation to others so that they understand why it is a crisis and why certain actions must be taken;
- **decision-making,** which involves taking action to resolve the situation using available resources, taking into account logistical, time, legal and democratic constraints, ensuring that the objectives of resolving the crisis are achieved at all levels, from strategic to operational and technical;
- **termination,** with decision-makers deciding that the crisis is over and that the crisis management organisation can be dissolved; the situation at this point may not have completely returned to normal, but what remains can be managed using non-crisis measures;
- **learning and reform,** with investigations and potential changes in policies and practices, a crucial step which offers an opportunity to improve and correct the flaws in the system revealed by the crisis.

hese **five tasks form the basis for the management of any type of crisis,** as they enable crucial questions to be tackled by authorities responsible for crisis management. Each task brings its own challenges for the organisation of crisis management and can be used to guide the design of crisis management operations ([67]). ith regards to cyber crisis management specifically, the E A *Report on Cyber Crisis Management and Cooperation* (2014) proposes using the challenges associated with the five tasks as an analytical roadmap to guide the development of cyber crisis management operations ([68]). hese challenges are summarised in Figure 2.

([65]) ee footnote (13), recital 120.
([66]) bid, recital 79.
([67]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([68]) bid.

Figure 2: Cyber crisis management challenges ([69])



These challenges should be taken into consideration when designing comprehensive cyber crisis management measures. he tasks and challenges can then be used to develop and improve best practices at each phase of the cyber crisis management cycle, namely **prevention, preparedness, response and recovery** ([70]). All these phases can include several of the tasks depicted in Figure 2 (sense-making, meaning-making, decision-making, termination, learning).

he four phases are detailed below ([71]).

- **Phase 1 – Prevention.** his aims to better prevent and reduce the risk of cyber crises occurring and to anticipate and minimise their potential effects should they arise. Preventive measures are taken before a crisis occurs, but also afterwards as they allow lessons to be learned for the management of future crises.
- **Phase 2 – Preparedness.** his aims to improve the management of crises by developing plans to support response operations. his includes activities such as setting up a resilient crisis organisation, maintaining the confidence of the ecosystem, prioritising the critical activities affected or ensuring that responders know how to act by undergoing training and exercises. Preparedness measures are taken before a crisis occurs.
- **Phase 3 – Response.** his aims to stem the cyber crisis and prevent further damage. At the E level, response is based on effective technical, operational and strategic cooperation between M and E BAs. An effective and safe response involves activating predetermined measures. hese measures are taken during crises.
- **Phase 4 – Recovery.** his aims to enable quick recovery by taking measures when a crisis is over or its end is in sight to return to a level of security and activity that is normal or even higher than before the crisis. his phase covers restoration of affected systems and arrangements or organising lessons learned to better prevent, respond to and mitigate future crises. uch measures are taken after crises occur.

([69]) E A (2014), *Report on Cyber Crisis Cooperation and Management*, 6 ovember.
([70]) ee hapter 4 ' yber crisis management best practices at operational level in the E ' for more information.
([71]) bid.

These four phases should always be taken into account for effective management of cyber crises, along with the all-hazard approach, to provide a comprehensive approach to cyber crisis management.

Key takeaways

- he **notion of a cyber crisis is complex**, not least because it leaves room for a degree of subjectivity: a cyber incident may be considered as a crisis in one M but not necessarily in another. hile a given M may be unable to respond to the situation and therefore require the activation of exceptional measures, another may well have the capacity to manage the incident without having to elevate it to crisis status. Risk assessment is therefore inextricably linked to the notion of cyber crisis and depends largely on the level of risk that each M is prepared to tolerate.
- At the E level, this brings about numerous challenges. he **development of clear indicators or decision mechanisms** for escalation to crisis status at the E level, taking into consideration both national capabilities and priorities, could help alleviate some of those challenges.
- he **causes**, **nature** and **impact** of a cyber crisis can support the assessment of the crisis and its severity and influence the selection and adoption of appropriate measures for cyber crisis management.
- ith 2, M have to develop **a specific framework for cyber crisis management.** owever, because cyber crises tend to have a transboundary nature, any cyber crisis management framework must remain part of overarching crisis management for overall coherence.
- he management of a cyber crisis involves a variety of actors at the **organisation/company, sectoral, regional, national** and **EU levels.** t is managed at the **strategic, operational** and **technical levels,** with the **operational level playing a key role** in bridging the gap between the other two levels, ensuring information is shared across all levels, greater cooperation and coordination between all relevant stakeholders.
- yber crisis management should take into account the **four phases of the cyber crisis management cycle**, i.e. **prevention, preparedness, response and recovery.** hese four phases should be framed by an **all-hazard approach,** since threats can have many different origins.

3. R RE A D A OR OF BER R MA A EME A E OPERA O AL LE EL E E

his section gives an overview of the E 's complex cybersecurity ecosystem of actors, structures and mechanisms. t first outlines the structure of cyber crisis management at the operational level in the E , then describes the roles and obligations of the main E actors in cyber crisis management at the operational level, namely E A, M and E - y LO e.

3.1 OVERVIEW OF THE STRUCTURE OF CYBER CRISIS MANAGEMENT AT THE OPERATIONAL LEVEL IN THE EU

Due to the transboundary nature of cyber crises, a vast network of public actors participates in their management across the E , leading to a highly complex and overlapping system of actors, structures and processes operating within the cyber domain. n this context, 2 aims to bring about a more coordinated approach through greater cooperation between M and relevant E BAs at the technical, operational and strategic levels ([72]).

Several EUIBAs are involved in cyber crisis management at all levels. hese include the European ommission and the EEA , whose work is mainly at the strategic level. he omputer Emergency Response eam for the E institutions (ER -E), bodies and agencies is a R s etwork member and is responsible for E BAs. he European nion Agency for Law Enforcement ooperation is responsible for the fight against cybercrime through its European ybercrime entre, through the Law Enforcement Emergency Response Protocol and within the oint yberspace Action ask Force.

E organisations responsible specifically for cyber crisis management at the strategic, operational, technical levels include, for instance:

- at the strategic level, the orizontal orking Party on yber ssues or the ommittee of Permanent Representatives;
- at the operational level, E - y LO e ([73]);
- at the technical level, the R s etwork.

A lot has changed for cyber crisis management in the E since E A's report on E common crisis management practices and their applicability to cyber crises (2015). At the time, the E did not yet have its own legislative and operational framework dedicated to cyber crisis management. nstead, it relied on **several crisis management mechanisms,** which follow the guiding principle of complementarity and continue to apply today to cyber crises.

([72]) ee footnote (13), recital 69.
([73]) ee hapter 3.4 'Role and obligations of the European yber risis Liaison Organisation etwork (E - y LO e) in cyber crisis management at the operational level in the E '.

- he **Council's IPCR,** to coordinate the policy response to cross-sectoral crises and cyber crises. t can be activated by institutional cybersecurity actors in the event of an E -wide crisis with a cybersecurity dimension.
- he **European Commission's ARGUS system,** an internal early warning communication system which provides a specific coordination process that can be activated in the event of a multi-sector crisis.
- he **EEAS CRM,** to provide a coordinated and synergistic response to crises and emergencies of an external nature or with an external dimension. t can be activated if a cyber crisis has a ommon Foreign and ecurity Policy or ommon Defence Policy dimension, for example impacting E or M national security interests.

he E has since worked to develop an appropriate crisis management framework specifically for cybersecurity. hile continuing to build on broader existing crisis management frameworks and integrate new initiatives, the E now has **specific cybersecurity legislation.** his includes the **Cybersecurity Act** and the **NIS directives,** which shaped European cybersecurity by introducing obligations and relevant sanctions, introducing mechanisms to better manage cyber crises in the E and strengthening E A's role and capabilities in this field.

3.2 ROLE AND OBLIGATIONS OF ENISA IN CYBER CRISIS MANAGEMENT AT THE OPERATIONAL LEVEL IN THE EU

he ybersecurity Act and 2 have significantly strengthened E A's mandate. One of the agency's strategic objectives, reaffirmed by the Agency ingle Programming Document 2023–2025, is to enable effective cooperation amongst operational actors within the E in case of large-scale cyber incidents, in particular **by developing tools and methodologies for effective cyber crisis management** ([74]). Among other things, E A serves as an information hub, enabling all actors involved at the E level to collaborate and respond to large-scale cyber incidents and crises by ([75]):

- enhancing and improving incident response capabilities and readiness across the E through the R etwork;
- enabling effective European cybersecurity crisis management at the operational level via E - y LO e ([76]);
- ensuring coordination in cybersecurity crisis management among relevant E BAs;
- improving the maturity and capabilities of operational communities (R etwork, E - y LO e and E BAs) including cooperation with law enforcement authorities;
- contributing to preparedness, sharing situational awareness, coordinating response and recovery from large-scale cyber incidents and crises in different communities;
- supporting the evolution of an E joint response by enabling the deployment of E -level proposals.

NIS2 provides ENISA with new tasks, including ([77]):

- developing and maintaining a European vulnerability registry;
- providing the ecretariat of E - y LO E;
- publishing an annual report on the state of cybersecurity in the E ;
- supporting the organisation of peer reviews between M ;

([74]) E A (2023), *ENISA Single Programming Document 2023–2025,* p. 22, https://www.enisa.europa.eu/publications/corporate-documents/enisa-single-programming-report-2023-2025.
([75]) E A (n.d.), ' yber risis Management', https://www.enisa.europa.eu/publications/corporate-documents/enisa-single-programming-report-2023-2025.
([76]) ee hapter 3.4 'Role and obligations of the European yber risis Liaison Organisation etwork (E - y LO e) in cyber crisis management at the operational level in the E '.
([77]) E A (2016), ' directive', https://www.enisa.europa.eu/topics/cybersecurity-policy/nis-directive-new.

- creating and maintaining a registry for entities providing cross-border services (D service providers, LD name registries, entities providing domain name registration services, cloud computing service providers and data centre providers).

2 makes E A responsible for supporting the coordination of cyber crises in the E by advising and assisting E - y LO e, which supports the coordinated management of large-scale cybersecurity incidents and crises at the operational level ([78]). he agency provides E - y LO e with a secretariat, but also with the infrastructure and tools necessary to ensure effective cooperation among M ([79]). E A therefore contributes to improved sharing of situational awareness at the operational level across the E , thereby enhancing the management of large-scale cyber incidents and crises in the E .

Finally, **ENISA plays a key role in implementing the NIS directives** by providing assistance to the M on its transposition, for instance with Article 9 of 2 on national cyber crisis management frameworks, and by organising exercises.

3.3 ROLE AND OBLIGATIONS OF MS AND COOPERATION MECHANISMS FOR CYBER CRISIS MANAGEMENT AT THE OPERATIONAL LEVEL IN THE EU

M cyber crisis management procedures are integrated into their own general national crisis management frameworks ([80]). **A variety of actors are therefore in charge of cyber crisis management at the operational level within MS.** hey are responsible for liaising between the strategic level, often represented by the national crisis management structure, and the technical level, embodied by the appointed R s etwork member ([81]).

hese actors include **'National cybersecurity authorities'** (the exact terminology varies from one M to another), which tend to be the government agency responsible for cybersecurity, and to be in the lead for national cybersecurity efforts at the technical, operational and sometimes strategic levels. hese authorities are represented in E - y LO e in cyber crisis management at the operational level in the E by **EU-CyCLONe Executives,** i.e. heads of national cybersecurity authorities and **EU-CyCLONe Officers,** i.e. experts in crisis management and/or international relations supporting the decision-makers, prior to and during large-scale incident or crisis situations ([82]).

he majority of M rely on a comprehensive national crisis management structure which can be deployed regardless of the origin or nature of the crisis, including cyber. A few M have developed specific frameworks and structures for cyber crisis management. A high degree of centralisation of cyber crisis management is beneficial in terms of speed and efficiency of decision-making and access to information, but can exclude important stakeholders and overburden certain institutions. onversely, a decentralised approach is likely to offer flexibility and the ability to adapt to changing needs, but has the disadvantage of hampering government-wide coordination efforts ([83]).

Much of the current work to improve the management of cyber crises at the E level has focused on helping M to **build up their capabilities** in this area, preventing crises and preparing M to deal with them should they arise. **NIS2 impacts the organisation of cyber**

([78]) ee hapter 3.4 'Role and obligations of the European yber risis Liaison Organisation etwork (E - y LO e) in cyber crisis management at the operational level in the E '.
([79]) ee footnote (77).
([80]) ee footnote (77).
([81]) R s etwork (n.d.), official website, https://csirtsnetwork.eu/.
([82]) E A (2021), 'E Member tates test rapid yber risis Management', press release, 19 May, https://www.enisa.europa.eu/news/enisa-news/eu-member-states-test-rapid-cyber-crisis-management.
([83]) bid.

crisis management within MS, as it dictates the development of National cyber crisis management frameworks.

n this respect, **Article 9 of NIS2** extends the obligations of M in the management of cyber crises. By 2024, M will have to ([84]):

- designate or establish one or more cyber crisis management authorities competent for the management of large-scale cybersecurity and crises;
- equip such cyber crisis management authorities with the appropriate resources to carry out their mission in line with general national framework for crisis management;
- identify capabilities, assets and procedures to be deployed in case of a crisis;
- adopt a national large-scale cybersecurity incident and crisis response plan highlighting objectives and arrangements for the management of large-scale cybersecurity incidents and crises, including:
    - objectives of national preparedness measures and activities,
    - tasks and responsibilities of cyber crisis management authorities,
    - cyber crisis management procedures, how they integrate into general national crisis management frameworks and channels for information exchange,
    - national preparedness measures (including exercises and training programmes),
    - national procedures and agreements between the competent national authorities and bodies to ensure the effective participation and support of M in the coordinated management of large-scale cybersecurity incidents and crises at the E level.

For cyber crisis management at the operational level, M have benefited from **EU-CyCLONe** since 2020; this was formalised by 2 in anuary 2023.

3.4 ROLE AND OBLIGATIONS OF THE EUROPEAN CYBER CRISIS LIAISON ORGANISATION NETWORK IN CYBER CRISIS MANAGEMENT AT THE OPERATIONAL LEVEL IN THE EU

E - y LO e acts as the key intermediary between the technical and strategic levels during large-scale cybersecurity incidents and crises. Launched in 2020 and formalised in 2023, it supports decision-making at the strategic level while **improving cooperation** at the operational level through the **regular exchange of information between MS** ([85]).

E - y LO e plays a **central role in the European cyber crisis management landscape,** encompassing **representations from both the MS and EUIBAs.** t is composed of representatives of the cyber crisis management authorities of the M and the European ommission, and its secretariat is provided by E A ([86]). t is chaired by the M holding the Presidency of the European nion ([87]).

Article 16 of NIS2 defines the tasks of E - y LO E:

- to increase the level of preparedness of the management of large-scale cybersecurity incidents and crises;
- to develop a shared situational awareness for large-scale cybersecurity incidents and crises;
- to assess the consequences and impact of relevant large-scale cybersecurity incidents and crises and propose possible mitigation measures;

([84]) ee footnote (13).
([85]) E A (n.d.), 'E - y LO e', https://www.enisa.europa.eu/topics/incident-response/cyclone.
([86]) bid.
([87]) bid.

- to coordinate the management of large-scale cybersecurity incidents and crises and support decision-making at political level in relation to such incidents and crises;
- to discuss, upon the request of a M , national large-scale cybersecurity incident and crisis response plans referred to in Article 9(4) of 2.

n short, E - y LO e enables rapid cyber crisis management coordination in case of a large-scale cross-border cybersecurity incidents or crises in the E by providing timely information sharing and situational awareness among competent authorities. he group supports the cooperation among M , in particular through the regular exchange of information between and among M and E BAs ([88]).

Key takeaways

- At the E level, **several EU institutions and EUIBAs** are involved in crisis management **at the strategic, operational and technical levels,** and various **crisis management mechanisms** are available (P R, AR , RM). hese actors and mechanisms can be used for the management of cyber crises.
- he E has a **complex cybersecurity ecosystem of actors, structures and mechanisms.** he transboundary nature of cyber crises means a vast network of public actors participate in crisis management across the E , leading to a 'highly

([88]) bid.

4. BER R MA A EME BE PRA E A E OPERA O AL LE EL E E

his section presents 15 best practices in cyber crisis management at the operational level in the E . Each of these best practices is in line with the provisions of 2, particularly Article 9 ‘ ational cyber crisis management frameworks’ and Article 16 ‘European cyber crisis liaison organisation network (E - y LO e)’. hese best practices are all established, tested and approved in at least one M or at the E level, and have been the subject of public communication. Each best practice contains a concrete example of application by a M , an analysis of its contribution to cyber crisis management at the operational level in the E and of the way forward, and is linked to 2 objectives. his structure provides food for thought to entities seeking to improve their cyber crisis management practices, including in the framework of the implementation of 2.

The management of cyber crises can be broken down into different phases. he Blueprint (2017) breaks down the crisis management lifecycle into four phases: prevention, preparedness, response and recovery ([89]).

Figure 3: Cyber crisis management lifecycle

([89]) ee footnote (1).

The operational level of cyber crisis management is central to the first two phases of the cycle, i.e. prevention and preparedness, as it is particularly concerned with threat analysis, situation assessment and mitigation measures. It is directly relevant for the other two phases as the crucial interface between the strategic and technical levels.

For the purposes of this study, **'best practices'** are understood as 'activities that have been shown through research and evaluation to be effective, efficient, sustainable and/or transferable, and to reliably lead to a desired result' ([90]).

4.1 PHASE 1 – PREVENTION

he prevention phase aims to support the E and its M to improve the prevention and reduce the risk of cyber crises occurring and anticipate ways to minimise their effects. Preventive measures include reinforcing protection and erecting barriers to prevent malicious actors from attacking an system, thereby avoiding a crisis. Preventive measures are taken before a crisis occurs, but also afterwards as a result of lessons learned from past crises.

Table 2: Summary of best practices for Phase 1 – Prevention

Phase 1 – Prevention
BP #1. Adoption of a national definition of 'cyber crisis', taking into account its transboundary dimension
BP #2. Development of information security standards specific to the national public sector, to be reviewed and updated regularly
BP #3. Foster national initiatives which promote the creation of prevention programmes such as centralised DDo mitigation programmes

Best practice #1: Adoption of a national definition of 'cyber crisis', taking into account its transboundary dimension.

- **Example.** everal M define a 'cyber crisis' by the major impact on the operations of the organisations affected, the need for prompt decision-making and the ineffectiveness of usual incident handling procedures. he Dutch definition focuses more closely on the geographical dimension. he etherlands identifies eight basic elements which characterise a cyber crisis in its ational risis Plan Digital (2022) ([91]). Most of these criteria refer to the transboundary nature of such a crisis: a 'technical failure inside or outside the etherlands', an 'involvement of a statewide or other actor', 'cross-regional effects' (including physical ones), and 'effect of the crisis abroad'. All these elements suggest an international coordination effort to respond to the cyber crisis.
- **Analysis and way forward.** he definition of 'cyber crisis' varies among M . Most only consider the consequences on their territory, to the detriment of the cross-border effects. A joint understanding of the transboundary nature of this type of event could contribute to a clearer perception of the issues at stake and the resources to be put in place for more efficient management at the E level. On the basis of 2, which points out that a cyber crisis could pose 'serious public security and safety risks for entities or citizens in several M ', the homogenisation of national definitions highlighting the potentially foreign origin and/or consequences would facilitate better European coordination and cooperation. uch

([90]) European ommission (n.d.), ' hat are good practices?', https://ec.europa.eu/migrant-integration/page/what-are-good-practices_en.

([91]) ational oordinator for ounterterrorism and ecurity (2022), *Landelijk Crisisplan Digitaal* (ational risis Plan Digital), Ministry of ustice and ecurity, 23 December, pp. 10–11, https://www.nctv.nl/documenten/publicaties/2022/12/23/landelijk-crisisplan-digitaal.

a definition could also include a list of detailed indicators or decision-making mechanisms that would serve as a roadmap on how to operate in a state of crisis. n this respect, E - y LO e could be used to gather input from M to formulate such a list. owever, such a definition should avoid imposing a one-size-fits-all solution and instead take into account the varying capabilities and priorities of M . E - y LO e could work on developing a sort of 'cybersecurity dictionary', gathering M ' definitions and their equivalents in each jurisdiction, to facilitate mutual understanding ([92]).

- **Matching NIS2 objective**
  - **Article 9.1.** Each Member tate shall designate or establish one or more competent authorities responsible for the management of large-scale cybersecurity incidents and crises (cyber crisis management authorities). Member tates shall ensure that those authorities have adequate resources to carry out, in an effective and efficient manner, the tasks assigned to them. Member tates shall ensure coherence with the existing frameworks for general national crisis management.

Best practice #2: Development of information security standards specific to the national public sector, to be reviewed and updated regularly.

- **Examples**
  - ince 2004, Estonia has required its public administrations to adopt and comply with the KE (Baseline ecurity ystem) standard ([93]). KE is an information security standard developed specifically for the Estonian public sector, guaranteeing a sufficient level of security for data processed in systems. t is regularly updated and, from 31 December 2023, will be replaced by a new standard, the Estonian nformation ecurity tandard (E-). E- will improve the information security of Estonian public authorities and private companies, and will be updated every autumn ([94]).
  - France's ational Agency for the ecurity of nformation ystems (A) developed a self-assessment tool for cyber crisis preparedness which enables entities to assess their level of preparedness for cyber crises ([95]). he tool allows users to share their anonymised data with A , enabling the agency to consolidate its understanding of the maturity levels of each sector in France, highlighting those which may require closer attention. uch a tool could be used to support national cyber crisis management authorities in the development of advanced mappings.
- **Analysis and way forward.** he national cyber crisis authority is responsible for developing and implementing information security standards specifically designed for the national public sector. Organisations must comply with these standards, thus increasing their ability to prevent crises, improving their resilience. his facilitates cyber crisis management by lowering the risk of crises. hey should be regularly reviewed and updated to account for evolving cyber threats and opportunities to strengthen national . his update could include, for instance, risk and compliance assessments to ensure that the standards remain relevant. he standards should guarantee a minimum level of cybersecurity and standardised system protection for public administrations, strengthening the barriers against malicious actors. his practice could be generalised at the E level for all M , to guarantee a commh5.1 (he) 0 (ous)een (he) 0 -1.724.853 -1.373
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- **Matching NIS2 objectives**
  - **Article 9.4.b.** Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular: the tasks and responsibilities of the cyber crisis management authorities.
  - **Recital 57.** As part of their national cybersecurity strategies, M should adopt policies on the promotion of active cyber protection as part of a wider defensive strategy. Rather than responding reactively, active cyber protection is the prevention … of network security breaches in an active manner, combined with the use of capabilities deployed within and outside the victim network.

Best practice #3: Foster national initiatives which promote the creation of prevention programmes, such as centralised DDoS mitigation programmes.

- **Example.** n several M , national actors have come together to launch nationwide threat and incident mitigation programmes. For example, the Artemis ([96]) (Poland) and D Belgium ([97]) (Belgium) initiatives were respectively designed to research the vulnerability of websites and domain names, alert others to these vulnerabilities and warn of potential consequences. For more large-scale incidents, such as DDo attacks, the etherlands has promoted the creation of the Dutch Anti-DDo oalition (AD), of which the ational yber ecurity entre is a member ([98]). he 16 members of this national consortium are Dutch organisations from different sectors, including essential and important ones (government agencies, law enforcement, Ps, banks, etc.). hey work together to improve the resilience of Dutch critical service providers by fighting against DDo attacks ([99]). his joint initiative aims to share expertise and experience between its members, organise drills, communicate information to the public and promote security standards to help protect against DDo attacks. As part of the orizon 2020 project O ORD A, AD is developing the 'DDo learing ouse', a technical system allowing the continuous and automatic sharing of the metadata of DDo attacks that have been processed by its members (duration of the attack, addresses, source P, etc.). his tool consists of an extra layer of security in addition to DDo mitigation facilities that users must have in place. t aims to broaden users' view of the DDo attack landscape, while enabling them to proactively prepare their networks for an ongoing DDo attack, thereby reducing the likelihood of disruption to critical and associated consequences ([100]).
- **Analysis and way forward.** AD 's collective management and mitigation model could inspire other types of coalitions. he principle could be the same, i.e. bringing together cooperating organisations to improve the resilience of their digital services by fighting against a type of large-scale attack which has the potential to lead to a cyber crisis, such as supply chain attack and ransomware attack. hese new coalitions would conduct three types of activities similar to AD 's, i.e. sharing metadata about attacks through a 'clearing house' (cf. *supra*), organising exercises to test the resilience of participants and sharing information. ts members can be public and/or private actors (government agencies, Ps, banks, etc.). hile the composition of a coalition can be cross-sectoral, it could also focus on a single specific essential or important sector (energy, health, financial market infrastructures, etc.), at the national or E levels ([101]).

([96]) ER .PL (2023), 'Artemis – ER Polska verifies the cybersecurity of Polish organizations', 25 anuary, https://cert.pl/en/posts/2023/01/artemis-scanning/.
([97]) D Belgium (n.d.), 'Partners for a safe Belgian internet', https://www.dnsbelgium.be/en/smart-online/partners.
([98]) Anti-DDo - oalitie (n.d.), 'About the coalition', https://www.nomoreddos.org/en/about-the-coalition/.
([99]) According to *ENISA Threat Landscape 2022*, DDo attacks are significantly on the rise, and are larger and more complex.
([100]) Anti-DDo - oalitie (2020), ' ncreasing the etherlands' DDo resilience together', https://www.nomoreddos.org/en/increasing-the-netherlands-ddos-resilience-together/.
([101]) yber ecurity ompetence for Research and nnovation (O ORD A) (2022), *DDoS Clearing House Cookbook*, orizon 2020 Programme (2014–2020), Deliverable D3.6: DDo learing ouse Platform, https://www.concordia-h2020.eu/wp-content/uploads/2023/03/PREPR -D3-6_DDo learing ouse ookbook.pdf.

- **Matching NIS2 objective**
  - **Article 16.3.c.** E - y LO e shall … assess the consequences and impact of relevant large-scale cybersecurity incidents and crises and propose possible mitigation measure.

4.2 PHASE 2 – PREPAREDNESS

he preparedness phase aims to prepare M and the E to manage crises by developing plans to support response operations. his includes activities such as setting up a resilient crisis organisation, maintaining confidence within the ecosystem, prioritising the critical activities affected or ensuring that responders will know how to act by organising training sessions and exercises. Preparedness measures are taken before crises occur.

Table 3: Summary of best practices for Phase 2 – Preparedness

Phase 2 – Preparedness
BP #4. Definition of a governance structure, provision of specific capabilities and appointment of a crisis coordinator, whose nomination is mandatory under 2, and ensuring their department has the necessary operational and technical cyber skills to directly coordinate stakeholders during a cyber crisis
BP #5. Mapping and gathering information on critical entities and their most critical assets to enable rapid action
BP #6. Establishing instantaneous, secured communication channels during a crisis
BP #7. Formalisation of a clear allocation of roles between the stakeholders involved in responding to a cyber crisis in an overall plan
BP #8. Development of escalation criteria for activating the cyber crisis plan and deploying the relevant cooperation units/groups, taking into account factors such as time, priority, players involved, severity of the attack, etc.
BP #9. Development of a methodology and risk assessment tools to optimise coordination and interoperability in the event of a crisis
BP #10. est the overall plan for operations in response to cyber crises through a multiannual programme of cyber crisis management exercises and training sessions
BP #11. etting up training sessions for current and future staff responsible for cyber crisis management at the operational level
BP #12. Development of a communication strategy including a clear format for messaging, stakeholders to involve, priority levels and time factor and communication channels to be used

Best practice #4: Definition of a governance structure, provision of specific capabilities and appointment of a crisis coordinator, whose nomination is mandatory under NIS2, and ensuring their department has the necessary operational and technical cyber skills to directly coordinate stakeholders during a cyber crisis.

- **Example.** n taly, the Director eneral of the ational ybersecurity Agency (A) was appointed as the national cyber crisis coordinator. hile A covers the technical and operational levels in cybersecurity, integrating the national R , the point of contact and the ybersecurity eam, it is also a member of the R s etwork and E - y LO e at the E level, enabling it to benefit from shared situational awareness and information from other M . As a result, its director general has direct access to all the relevant information needed to efficiently support and advise the strategic level in the event of a

cyber crisis ([102]). ith its central position, the A bridges the gap between the strategic and technical levels and enables better coordination, fulfilling its mission as a key operational player.

- **Analysis and way forward**
  - Designating an authority with operational and technical skills as cyber crisis coordinator speeds up decision-making, which is decisive for any crisis management. n the majority of M , the national cybersecurity authority has the necessary resources to ensure the national response to cyber incidents ([103]). t often encompasses all the entities at the technical and operational levels, which greatly facilitates their mutual coordination and cooperation. As a member of the R s etwork and E - y LO e, it also has experience of cooperating with other M , which is crucial when managing a cyber crisis at the E level. his synergetic architecture is ideal for rapidly consolidating and correlating all the information, alerts and notifications of interest, from the detection of a cyber event to its potential escalation to the state of a cyber crisis, while ensuring that they are shared with other relevant government authorities. his type of entity therefore appears as the ideal player to act as a link between the different levels and ensure an intelligent distribution of tasks, in order to prioritise and facilitate the work of all actors involved. t is also in a privileged position to gather feedback and lessons learnt to improve processes after the crisis has ended, contributing to improved prevention and mitigation of future crises. he entity would play a key role in managing the cyber crisis management plan and should be at the forefront of continuous process improvement ([104]).
  - For effective management and a 360° view of the crisis, the entity should comprise staff from diverse backgrounds and mindsets, ranging from political scientists to engineers. he entity could also include experts in several key areas (judicial, sectoral issues, international relations, etc.) whose specific expertise could be leveraged depending on the type of crisis, allowing to better understand and interact with all affected stakeholders in times of crisis ([105]).
- **Matching NIS2 objective**
  - **Article 9.1.** Each Member tate shall designate or establish one or more competent authorities responsible for the management of large-scale cybersecurity incidents and crises (cyber crisis management authorities). Member tates shall ensure that those authorities have adequate resources to carry out, in an effective and efficient manner, the tasks assigned to them. Member tates shall ensure coherence with the existing frameworks for general national crisis management.

Best practice #5: Mapping and gathering information on critical entities and their most critical assets to enable rapid action.

- **Example.** n France, ‘operators of vital importance’ who have activities considered essential to the survival of the country must communicate a mapping of their to A (

makes it possible to better understand the connections with customers and partners, and therefore to better communicate in the event of a crisis ([108]). n this regard, as not all actors use the same security standards, E A has developed the ' nterdependencies' web tool ([109]), which can be used to find the corresponding information security standards and frameworks of one standard to another.

- **Analysis and way forward.** he precise mapping of of essential entities enables more effective operational coordination in the event of an incident. 2 deems that these systems are the most critical for M , and also the most vulnerable given their exposure. he mapping of is essential for cyber crisis management. t relates directly to the defence of the by allowing for a rapid reaction in the event of an incident, to qualify the impact thereof, or to prevent the consequences of the defensive actions carried out. Mapping also contributes to the resilience of the , since it is used to define, for example, the business continuity plan. hese mappings, with regard to the critical nature of the activities of an essential entity, could be affixed with a mention of protection or even classification, according to the relevant rules of the M . he competent authority could ensure that the mappings communicated by the essential entities have been developed, in addition to an approach focused on cybersecurity, to the highest level of granularity, by offering a complete view of the and all of its 'visions' (i.e. business, application, infrastructure) and its connections with the outside. he competent authority could encourage essential entities to send regular updates, in particular during change or update of projects ([110]). M could also consider retaining a degree of flexibility when drawing up these mappings, with the possibility of including entities of interest, even if not in the scope of 2, in their early warning systems, in order to improve responsiveness and cooperation with all parties concerned in the event of a crisis ([111]).
- **Matching NIS2 objective**
  - **Article 3.3.** By 17 April 2025, Member tates shall establish a list of essential and important entities as well as entities providing domain name registration services. Member tates shall review and, where appropriate, update that list on a regular basis and at least every 2 years thereafter.

Best practice #6: Establishing instantaneous, secured communication channels during a crisis.

- **Example.** n ermany, the Federal Office for nformation ecurity (B) is evaluating the ' ire' instant messaging system for the exchange of 'restricted' classified information. ts use is currently limited to the authorities connected to the federal government network. More than 30 ministries and authorities use it to exchange information at the restricted level ([112]). owever, an extension to users of the 'open network' is planned for a later phase of the project. his would give B a secure communication channel for collecting and exchanging sensitive information with private-sector stakeholders, which could be useful in responding to a cyber crisis, particularly when pooling information with affected critical infrastructures operators, or external security service providers ([113]). n terms of performance, ire messaging enables end-to-end encrypted messages, including attachments, to be sent between two users and in secure group discussions. t is

([108]) bid.
([109]) E A (n.d.), ' nterdependencies', https://www.enisa.europa.eu/topics/cybersecurity-policy/nis-directive-new/ nterdependencies_OE and_D_Ps.
([110]) ational Agency for the ecurity of nformation ystems (2018), *Mapping the information system*, https://www.ssi.gouv.fr/guide/mapping-the-information-system/.
([111]) nterview with a member of E - y LO e.
([112]) Federal Office for nformation ecurity (B) (2023a), *Sichere, zeitgemäße Kommunikation innerhalb der Netze des Bundes mit Wire* (ecure, up-to-date communication within the federal networks with ire), pp. 10–12, https://www.bsi.bund.de/ haredDocs/Downloads/DE/B /Publikationen/Magazin/B -Magazin_2020_02.pdf? blob=publicationFile&v=4.
([113]) ee BP #12: Encourage the mobilisation of qualified security service providers to provide technical assistance to victims.

compatible with the main operating systems, and can be used on smartphones, tablets and computers ([114]).

- **Analysis and way forward.** n uly 2019, an E A report highlighted that stakeholders engaged in incident response need secure and reliable communication channels to cooperate and share information ([115]). nsofar as the essential entities of a cyber crisis are involved in its management, it is important that knowledge be shared with the M national cyber crisis management authorities, within the framework of a secure communications group. hile several types of solutions can be used to create a group discussion, central messaging systems, such as lack and Mattermost, stand out because they are easy to use, either as software as a service or via a website. iven the sensitivity of the information exchanged, the M national cyber crisis management authority could ensure that the choice of messaging system takes into account as many requirements as possible. hile end-to-end encryption of discussions is the basic criterion, E A defines the following seven other features ([116]):
  - authentication of members using identity-based cryptography,
  - archiving so that all members – even new ones – can access and learn from past discussions,
  - exchange of attachments in all formats,
  - an open specification to enable security audits,
  - a source code under an open source license,
  - availability on all major desktop and mobile operating systems,
  - a 'future-proof' maturity through the development of a stable business model.

  Once the messaging system has been selected, the M national cyber crisis management authority could define it as the default communication platform, even for the most informal exchanges, to make it easier for stakeholders to adapt to its use. he national cyber crisis management authority could, for instance, open channels including representatives from all relevant entities, to ensure smooth cooperation and rapid exchange of information, which would promote rapid action and greater flexibility. uch channels could be opened to critical operators, allowing information on vulnerabilities to be gathered and shared faster and in a more targeted manner, encouraging a faster reaction. Participants could exchange information on a more regular and informal basis, which would foster trust, a key factor in cyber crisis management. n the event of a crisis, more formal rules could be established on the platform, such as the use of specific templates to promote clear messaging, as well as specific channels for questions. Finally, any mapping of participants to be included in such channels ahead of the crisis should be regularly updated ([117]).
- **Matching NIS2 objectives**
  - **Article 21.1.** Member tates shall ensure that essential and important entities take appropriate and proportionate technical, operational and organisational measures to manage the risks posed to the security of network and which those entities use for their operations or for the provision of their services, and to prevent or minimise the impact of incidents on recipients of their services and on other services.

  aking into account the state-of-the-art and, where applicable, relevant European and international standards, as well as the cost of implementation, the measures referred to in the first subparagraph shall ensure a level of security of network and appropriate to the risks posed …
  - **Article 21.2.a and Article 21.2.f.** he measures referred to in paragraph 1 shall be based on an all-hazards approach that aims to protect network and information systems and the physical environment of those systems from incidents, and shall include at least …: policies on risk analysis and information system security; the use

([114]) bid.
([115])E A (2019), *Secure Group Communications for incident response and operational communities*, pp. 6–7, https://www.enisa.europa.eu/publications/secure-group-communications.
([116]) ee footnote (115).
([117]) nterview with a member of E - y LO e.

of multi-factor authentication or continuous authentication solutions, secured voice, video and text communications and secured emergency communication systems within the entity, where appropriate.

Best practice #7: Formalisation of a clear allocation of roles among the stakeholders involved in responding to a cyber crisis in an overall plan.

- **Example.** n 2017, Belgium adopted a ational yber Emergency Plan which is subject to annual evaluation and, if necessary, development ([118]). he entre for ybersecurity Belgium (B) and the ational risis entre are responsible for implementing this confidential document, which was designed as a basis for the operational aspects of cyber crisis management at national level. Depending on the intensity of the incident, the plan describes the procedures and security measures to be followed. t formalises the framework for collaboration between the various competent services, and their tasks within the limits of their legal and regulatory powers, to regain control of the situation as quickly as possible (B and its ER .be service, the ational risis entre, the Public Prosecutor, Police services, etc.). he plan also promotes the rapid and correct exchange of information between services ([119]).
- **Analysis and way forward.** he key to an effective coordinated response to a cyber crisis is a strict division of roles between the relevant authorities. Drawing up an overall plan detailing the framework for action by the players to be involved, as well as their missions and obligations, helps to prevent overlap throughout the crisis. his document could take into account the nuances and complexities of the cyber crisis and propose, according to several scenarios, the operations and successive measures to be put in place at the national level, but also in cooperation with E partners. t should be regularly updated, based on experience, feedback and technical progress, in order to develop a M national cyber crisis management framework. hile the overall plan for operations must be confidential for security reasons, the development of a common base for all the M could encourage and promote a common culture of response to cyber crises across the E . E - y LO e could be tasked with contributing to this coordination between M .
- **Matching NIS2 objectives**
  -

- **Example.** n 2018, the members of the ooperation roup published a cybersecurity incident taxonomy ([120]). his taxonomy provides a common, simple and high-level classification for cybersecurity incidents at the strategic and policy levels, and was designed to facilitate the exchange of information across borders and international collaboration. he taxonomy assesses the cyber incident according to its nature (the underlying cause that triggered the incident) and its impact on services and specific sectors of the economy/society, as follows:
  - **nature,**
  - **root cause category:** system failures, natural phenomena, human error, malicious actions, third-party failures,
  - **severity of the threat:** high, medium, low,
  - **impact,**
  - **sectors impacted:** energy, transport, banking, finance, health, drinking water, digital infrastructure, communications, trust and identification services, digital services, government services,
  - **scale of the national impact for the economy and society:** red – very large impact, yellow – marginal impact, green – minor impact, white – no impact,
  - **outlook, i.e. the prognosis for the impact for the economy and society:** improving, stable, worsening.

his taxonomy is only for 'naming' cyber incidents and does not include processes to, for example, notify or escalate incidents.

- **Analysis and way forward.** hile the above was developed for the strategic level, it could serve as a basis for operational players to assess and qualify a cyber incident as a crisis using clear escalation criteria. hese could lead to the activation of the cyber crisis plan required by 2, in order to deploy appropriate measures proportionate to the scale of the crisis. n the future, such a measure could build on the work of the ooperation roup, bringing an operational perspective that not only qualifies cybersecurity incidents, but also addresses processes to be implemented depending on the level of the crisis. he establishment of escalation criteria would provide a coherent mechanism for objectively assessing cyber incidents, determining the actors to be involved according to the seriousness of the incident and informing decision-makers at all levels of the nature and speed of the response and the procedures to be adopted. hese escalation criteria could be developed at the national or the E level, for instance through a working group coordinated by E - y LO e and involving actors from both the strategic and technical levels, and could be integrated in national crisis plans. hile common criteria may be difficult to agree upon, M should endeavour to reach a mutual understanding, either by adopting a common approach or by developing a tool for rapid understanding, using E - y LO e. Rather than proposing common definitions, this tool would provide an equivalence scale matching varying concepts in the different M .
- **Matching NIS2 objectives**
  - **Article 9.4.b.** Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular: the tasks and responsibilities of the cyber crisis management authorities.
  - **Article 16.3.c.** E - y LO e shall assess the consequences and impact of relevant large-scale cybersecurity incidents and crises and propose possible mitigation measures.

([120]) ooperation roup (2018), *Cybersecurity Incident Taxonomy (04/2018)*, https://ec.europa.eu/information_society/newsroom/image/document/2018-30/cybersecurity_incident_taxonomy_00_D828_-F851-AF_4-0B1B416696B5F710_53646.pdf.

Best practice #9: Development of a methodology and risk assessment tools to optimise coordination and interoperability in the event of a crisis.

- **Example.** he Polish ybersecurity trategy (2018) for 2019–2024 sets as an objective the development and implementation of a risk-assessment approach, a Polish government priority for the establishment of a national cybersecurity system. he strategy proposes a 'joint static and dynamic risk-assessment methodology which takes into account the specificity of individual sectors, critical-infrastructure operators, operators of essential services, and digital service providers, shall be introduced for the purpose of cybersecurity management at the national level' ([121]). n this way, the government intends to facilitate the comparison of assessments and risk levels, particularly for reporting on national security risks, in line with crisis management regulations ([122]). As a result, risk assessment becomes a continuous process which allows the level of risk to be identified in near real time ([123]). he Polish government developed a risk assessment method and tools through the ational ybersecurity Platform, a project aimed at creating a prototype for 'a comprehensive, integrated system for monitoring, imaging and warning of threats to the state's cyberspace '. his platform is intended to help prevent, detect and minimise the effects of cyber incidents on the information and communication systems that are important to the functioning of the state, while also promoting information sharing on cyber threats ([124]).
- E A has published several reports on risk assessment and interoperability, including *Interoperable EU Risk Assessment Toolbox* (2023) ([125]) and *Interoperable EU Risk Assessment Framework* (2023) ([126]). he former ([127]) aims to address interoperability issues related to the use of risk management methods to facilitate the seamless integration of risk management methods within and between organisations, bridging gaps between different approaches. t thus promotes a common understanding of the risks of interoperable risk assessment results. he latter ([128]) proposes a methodology to evaluate the potential interoperability of risk management frameworks and methods, proposing, for example, a four-level scale to assess the degree of interoperability of each method and set of characteristics combined.
- **Analysis and way forward.** he development of a risk assessment methodology and tools is essential to enable a progressive approach to the management of large-scale cyber incidents and crises. t not only improves coordination and cooperation between the various levels – strategic, operational and technical – through improved mutual understanding, but also between M . t is a key measure for promoting information sharing, while at the same time proposing ways of interconnecting and harmonising national approaches. n particular, the operational level would play a key role in bridging the gaps between all the stakeholders involved. his approach could also solve some of the problems associated with the difficulty of defining the notion of a cybersecurity crisis and the subjectivity of what is considered a cyber crisis across M . t could also easily be integrated into national and European general crisis management frameworks. E - y LO e could elaborate such a methodology, bringing together the perspectives of the M .
- **Matching NIS2 objectives**

([121]) Ministry of Digital Affairs (2019), *Cybersecurity Strategy of the Republic of Poland for 2019–2024*, https://www.gov.pl/attachment/6a4aafc6-e339-4cd5-a8e6-cd47257f02d8.
([122]) bid.
([123]) bid.
([124]) A K (n.d.), ' ational ybersecurity Platform', https://en.nask.pl/eng/activities/science-and-business/research-projects/2088, ational- ybersecurity-Platform.html.
([125]) E A (2023), *Interoperable EU Risk Management Toolbox*, https://www.enisa.europa.eu/publications/interoperable-eu-risk-management-toolbox.
([126]) E A (2023), *Interoperable EU Risk Management Framework*, https://www.enisa.europa.eu/publications/interoperable-eu-risk-management-framework.
([127]) E A (2023), *Interoperable EU Risk Management Toolbox*, https://www.enisa.europa.eu/publications/interoperable-eu-risk-management-toolbox.
([128]) E A (2023), *Interoperable EU Risk Management Framework*, https://www.enisa.europa.eu/publications/interoperable-eu-risk-management-framework.

- **Article 9.3.** Each Member tate shall identify capabilities, assets and procedures that can be deployed in the case of a crisis …
- **Article 9.4.c and Article 9.4.f.** Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular:
  - the cyber crisis management procedures, including their integration into the general national crisis management framework and information exchange channels,
  - national procedures and arrangements between relevant national authorities and bodies to ensure the Member tate's effective participation in and support of the coordinated management of large-scale cybersecurity incidents and crises at the E level.

Best practice #10: Test the overall plan for operations in response to cyber crises through a multi-annual programme of cyber crisis management exercises and trainings.

- **Examples**
  - Finland has been organising major joint cybersecurity exercises for several years. For the Finnish ransport and ommunication Agency's ational yber ecurity entre, these exercises aim to create common situational awareness and coordinating activities between participants and their partners, rather than improving its own internal processes ([129]).
  - At the E level, E A has been organising local, international and E -wide exercises for the past 15 years, developing cyber exercise platforms available to stakeholders so they may host their own exercises. he agency organises the following specific exercises to test cyber crisis management:
    - **Cyber Europe,** the biannual exercise simulating large-scale cybersecurity incidents which escalate into cyber crises, for both the public and private sectors from the E and European Free rade Association M ([130]),
    - **CyberSOPex,** the biannual exercise to test the R s etwork OPs,
    - **CySOPex,** the biannual exercise to test the Eu- y LO e Officers' OPs for rapid E cyber crisis management when faced with large-scale cross-border cyber incidents and crises ([131]),
    - **BlueOLEx,** the annual exercise to test the Eu- y LO e Executives' OPs for rapid E cyber crisis management when faced with large-scale cross-border cyber incidents and crises.
- **Analysis and way forward.** he programming of cyber exercises over several years could help to develop and strengthen M ' national cyber crisis management frameworks. hese exercises should not be considered as isolated events, but rather as a series forming a coherent whole enabling the continuous improvement of all stakeholders, as well as the evolution of capabilities requirements ([132]). hey could involve all three levels (strategic, operational, technical), around operational level actors as the federating level, to bridge the gap between the strategic and technical levels. n order to identify training needs, a survey could be conducted at the E level. hen, in order to match the needs identified, the following phases should be followed: selecting the type of exercise, setting up a planning team, preparing the exercise, supporting observers, carrying out the exercise, providing feedback and drawing lessons learned. Rather than repeating similar exercises every few

([129]) ational yber ecurity entre (2020), *Instructions for organising cyber exercises: A manual for cyber exercise organisers*, https://www.kyberturvallisuuskeskus.fi/sites/default/files/media/file/ nstructions for organising cyber exercises.pdf.
([130])E A (2022), *Cyber Europe 2022: After action report*, https://www.enisa.europa.eu/publications/cyber-europe-2022-after-action-report.
([131])E A (n.d.), ' yber risis Management', https://www.enisa.europa.eu/topics/cyber-crisis-management.
([132]) ational yber ecurity entre (2020), *Instructions for organising cyber exercises: A manual for cyber exercise organisers*, p. 29, https://www.kyberturvallisuuskeskus.fi/sites/default/files/media/file/ nstructions for organising cyber exercises.pdf.

months, different types of exercises could be programmed (tabletop exercise, functional exercise, major joint exercise), just as scenarios could be expanded to involve a growing number of players and critical sectors. Examples of programmes could include, but are not limited to:

- a series of smaller exercises, workshops, and training session, which could be organised more frequently throughout the year, and on specific topics: this would allow participants to benefit from regular reminders about new things they have learned, promote a common vocabulary and knowledge base and build trust between participants ([133]),
- exercises taking into account a sectoral approach, mobilising representatives from critical sectors (banking, energy, transport, etc.) to facilitate discussions between the sector and regulators, promote mutual understanding and improve trust and information sharing ([134]),
- exercises including anticipation scenarios, to prepare and improve response in the event that stakeholders are faced with new situations for which there are not yet clear operational procedures ([135]).

By practising the management of a series of large-scale incidents under realistic conditions, the M cyber crisis management authorities, the operators of critical and important entities and partners develop methods and reflexes for dealing with real crises ([136]). hese exercises could also be used to test internal procedures (such as business continuity plans) and external procedures (such as the quality of information sharing) ([137]). he transposition of 2 into national legislation will require M to adopt response plans for large-scale cyber security incidents and crises, making the organisation of exercises to test national cyber crisis plans particularly relevant.

- **Matching NIS2 objective**

  - Article 9.4.d. Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular: national preparedness measures, including exercises and training activities.

Best practice #11: Setting up training sessions for current and future staff responsible for cyber crisis management at the operational level.

- **Example.** n Portugal, the ational Defence nstitute has set up a short-term programme called ' yber ecurity and risis Management in yberspace ourse'. he course, which is open by selection, is aimed at senior and middle-level government managers, armed forces and security officers, diplomats, civil society organisations, academics and executives. t prepares them to intervene in the event of a cyber crisis, in particular by promoting the sharing of knowledge, while disseminating a strategic culture of cybersecurity. Among the five teaching modules, which aim to raise awareness and provide training in the various issues at stake in the digital space (security, technology, economy, etc.), the ' trategic Decision Exercise' module endeavours 'to encourage and raise relevant issues related to crisis management situations in cyberspace' among the attendees, in order 'to improve processes and provide methodologies to be used in decision-making' ([138]).

([133]) nterview with a member of E - y LO e.
([134]) nterview with a member of E - y LO e.
([135]) nterview with a member of E - y LO e.
([136]) ational Agency for the ecurity of nformation ystems (2021), *Crisis of cyber origin: the keys to operational and strategic management*, https://www.ssi.gouv.fr/uploads/2022/05/20220516_np_anssi_guide_gestion_crise_cyber_en.pdf.
([137])E A (2022), *Cyber Europe 2022: After Action Report*, https://www.enisa.europa.eu/publications/cyber-europe-2022-after-action-report
([138]) nstituto da Defesa acional (Portugal) (2023), ' yber ecurity and risis Management in yberspace ourse'.

- **Analysis and way forward.** Regular training cycles help to train and improve the skills of personnel responsible for managing cyber crises. n particular, modules specifically dedicated to the operational level could help to bring together the public and private managers (representatives of the national cyber crisis management authority of the M , key and important entities, etc.) who will be required to work together during a cyber crisis, in order to clearly determine the division of tasks and individual roles. As well as exchanging best practice in cyber crisis management, such training would enable the operational level to be better integrated at the technical and strategic levels. For example, participants could develop and test their knowledge of threat analysis, situation assessment and mitigation measures through feedback, lessons learned and cyber crisis exercises. his type of training could be delivered via an e-learning platform to allow regular updating of knowledge. he educational content of this platform could be populated by the M ' national cyber crisis management authority, in coordination with E - y LO e.
- **Matching NIS2 objective**
  - **Article 9.4.d.** Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular: national preparedness measures, including exercises and training activities.

Best practice #12: Development of a communication strategy, including a clear format for messaging, stakeholders to involve, priority levels and time factor and communication channels to be used.

- **Example.** he etherlands has developed its communication strategy around the ad hoc establishment of a ational entral risis ommunication eam. his is made up of communication professionals from the ational risis entre and relevant ministries. he team coordinates the central government's communication with Dutch society and the press, as well as with the other M , on the crisis and its visible consequences. As part of a unified approach, it coordinates the timetable and content of messages from all the public and private actors involved, who must express themselves on their own responsibility on their own subjects. For example, local authorities only comment on the implementation of security measures at their level, private companies on the consequences of the crisis on their employees, customers and suppliers, and ministries on the prospects for action at the national level in their areas. n the run-up to a crisis, the centre's ommunications Department coordinates communications between central government and public and private partners, providing them with advice, resources and a network of crisis communication experts as required ([139]).
- **Analysis and way forward.** A crisis communication strategy defines the rules for delivering a clear message at the right time. n the cyber domain, the challenge is to communicate proactively to prevent doubt in public opinion, even though identifying the causes and consequences of an incident is always uncertain. hatever the organisation of crisis management, a competent unit or department should be designated to coordinate the timing and content of messages, in the interest of a unified and coherent discourse. hese communications experts should be included in all meetings, at all stages and at all levels, to contribute to managing the crisis. t is therefore crucial that roles are allocated upstream to clarify the communication tasks of each government actor. iven the complexity of cyber issues, it seems important that the designated communicators master the technical vocabulary, the challenge being to make the general public understand the complexities of a cyber crisis. hey must be able to respond effectively to requests for information, both internal (government departments, public partners, etc.) and external (press, citizens, foreign partners, etc.). n terms of deadlines and content, the aim is to inform the public as

([139]) ational oordinator for ounterterrorism and ecurity (2022), Landelijk risisplan Digitaal, (ational crisis plan digital), Ministry of ustice and ecurity, 23 December, pp. 31–33, https://www.nctv.nl/documenten/publicaties/2022/12/23/landelijk-crisisplan-digitaal.

quickly as possible about what is known, what is not yet known and what measures have been taken. ntil it is certain that a cyber crisis is the result of deliberate action, reference to possible causes, duration and scale should be avoided as far as possible.

- **Matching NIS2 objective**
  - **Article 9.3.** Each Member tate shall identify capabilities, assets and procedures that can be deployed in the case of a crisis …

4.3 PHASE 3 – RESPONSE

he response phase aims to stem the cyber crisis and prevent further damage. At the E level, response is based on effective technical, operational and strategic cooperation between M . An effective and safe response involves activating predetermined measures. hese measures are taken during crises.

Table 4: Summary of best practices for Phase 3 – Response

Phase 3 – Response
BP #13. Encourage the mobilisation of private-sector certified 'trusted providers' to provide technical assistance to victims
BP #14. upporting victims' crisis communication, for instance with a unified and transparent message

Best practice #13: Encourage the mobilisation of private-sector certified 'trusted providers' to provide technical assistance to victims.

- **Examples**
  - n May 2023, B published its list of qualified service providers for responding to advanced persistent threat (AP) attacks ([140]). Following a particularly powerful and sophisticated attack (but also beforehand as a preventive measure), erman essential entities can consult this list to quickly request assistance from one of these approved actors. Qualified service providers are private companies selected in two stages: applicants must first provide B with full documentation for assessment (description of products and services, compliance with defined criteria, existing certifications, etc.), then conduct a technical interview at B , during which they must prove their ability to manage an incident in a professional manner, in the framework of a fictitious scenario. Qualified security service providers are presented on the B 's list according to a number of performance characteristics, including 24x7 availability, O 27001 certification, head office location, internal resources for AP incident response, ability to provide other services (legal, crisis communication, etc.), and technical equipment.
  - A has drawn up a set of requirements for security incident response providers, a set of rules for providers to obtain qualification for their services in this area. t covers requirements relating to the incident response provider, its staff and the way in which incident response services are provided. he following activities are eligible for qualification: system, network and malicious code analysis, and technical monitoring.

([140]) Federal Office for nformation ecurity (B) (2023), *Qualifizierte APT-Response Dienstleister* (Qualified AP response service providers), https://www.bsi.bund.de/ haredDocs/Downloads/DE/B / yber- icherheit/ hemen/Dienstleister_AP -Response-Liste.pdf? blob=publicationFile&v=17.

his standard was drawn up in consultation with market players and is regularly updated ([141]).

- **Analysis and way forward.** he certification of trusted private-sector security service providers could be encouraged to assist targeted critical infrastructure operators. iven the potentially large number of organisations affected during a cyber crisis, the mobilisation of these partners would relieve national cyber crisis management authorities which, if they lack the resources to act on all fronts, could concentrate on other tasks with higher added value. ertified trusted security incident response service providers, approved in advance and compliant with high-level requirements, could be called on directly by an essential entity. o provide an overview of the market for these approved providers, the M competent authority could publish a directory, enabling the appropriate partner to be found quickly in case of emergency. his list could briefly present certified trusted security service providers, their contact details and their performance characteristics, allowing for a kind of pre-approved, trusted pool of experts. n order to avoid time-consuming research when responding to a cyber crisis, the M national cyber crisis management authority could ensure that all essential entities have contracted a partnership with a certified trusted security service provider. owever, authorities should establish clear procedures for certifying these suppliers, in order to avoid distorting the market and to leave little room for subjectivity and interpretation, in order to maintain a high level of transparency and accountability ([142]).
- **Matching NIS2 objective**
  - **Article 9.4.e.** Each Member tate shall adopt a national large-scale cybersecurity incident and crisis response plan where the objectives of and arrangements for the management of large-scale cybersecurity incidents and crises are set out. hat plan shall lay down, in particular: the relevant public and private stakeholders and infrastructure involved.

Best practice #14: Supporting victims' crisis communication, for instance with a unified and transparent message.

- **Example.** n 2017, a car manufacturer was forced to halt production at several of its plants as a result of the anna ry attack. t was the first company to acknowledge being a victim of this large-scale attack, which disrupted the systems of several organisations across the E . he company explained it was doing **'everything necessary to counter this attack'**, stating that the first step of the management procedure was to set up measures to stop the spread of the virus ([143]). wo days later, the Director eneral of A spoke to the main French media outlets to say that his teams were working with those of this company, and those of companies that chose to remain anonymous, which he refused to name. e added that A was 'really trying to restore as quickly as possible in the most problematic cases' ([144]). is message was quickly picked up by the regional daily press and the specialist press, contributing to the company's transparency and therefore to the protection of its reputation.
- **Analysis and way forward.** he main source of information in managing a cyber crisis should ideally be the organisation that is the victim of the crisis. t is essential for it to be proactive and take the initiative, but not in a hurry. Lies, silence or passivity should be avoided at all costs. o protect the organisation's reputation, the cyber crisis management authority can support the victim organisation's communication to avoid uncertainty. he communications team of the national cyber crisis management authority should be involved at all times, to

([141]) ational Agency for the ecurity of nformation ystems (n.d.), *Référentiels d'exigence: PRIS*, https://www.ssi.gouv.fr/administration/qualifications/prestataires-de-services-de-confiance-qualifies/referentiels-exigences/#referentiel-pris.
([142]) nterview with a member of E - y LO e.
([143]) France24 (2017), "France's Renault hit in worldwide 'ransomware' cyber attack", 14 May, https://www.france24.com/en/20170512-cyberattack-ransomware-renault-worldwide-british-hospitals.
([144]) RF (2017), 'Renault not only ransomware victim in France', 15 May, https://www.rfi.fr/en/economy/20170515-renault-not-only-ransomware-victim-france.

help in managing the crisis ([145]). his approach does not mean that everything should be said. As a general rule, it is important to gain time until the extent of the situation is better understood. As the panish ational ryptologic entre states in its report dedicated to good practices in the management of cyber crisis, 'any communication shall avoid mentioning the causes of the incident, the person responsible for it, information that the investigation may reveal or the possible consequences for the organisation or another stakeholder' ([146]).

- **Matching NIS2 objective**
  - **Article 9.3.** Each Member tate shall identify capabilities, assets and procedures that can be deployed in the case of a crisis …

4.4 PHASE 4 – RECOVERY

he recovery phase aims to enable the M and the E to recover quickly by taking measures, as soon as the crisis is over, to return to a level of security that is normal or even higher than before the crisis. Activities include restoring and reintegrating affected systems and arrangements or organising lessons learned to better prevent, respond to and mitigate future crises. uch measures are taken after crises occur.

Table 5: Summary of best practices for Phase 4 – Recovery

Phase 4 – Recovery
BP #15. Develop and implement BRP defined in reference frameworks, with regular reviewing and updates, in consultation with relevant stakeholders
BP #16. Establish a unit tasked with gathering feedback, drawing lessons learnt and producing recommendations for reviewing, updating and modifying procedures and refining the action plan for cyber crisis management

Best practice #15: Develop and implement BRP defined in reference frameworks, with regular reviewing and updates, in consultation with relevant stakeholders.

- **Example.** Predefined frameworks such as 800-34, B 25999-1, AP 232, FPA 1600, OB , B 292-2006 or PA 77 can be used as part of a BRP ([147]). ational cybersecurity agencies provide guides to help impacted entities recover from a cyber crisis, which could be used to develop robust BRP at a national level. For example, France's A has developed a guide proposing a gradual approach, describing the different phases that impacted entities should follow to recover their assets and gradually resume their activities ([148]).
- **Analysis and way forward.** ational cyber crisis management authorities must support the victims of a cyber crisis until its end, i.e. when the essential activities concerned can resume as usual. he measures to be taken in this respect must be formulated in advance to enable smooth activation at the end of a crisis, as part of a BRP and should be regularly updated with lessons learned. he BRP is the final component of a business continuity plan that groups together all the measures that an organisation (public institution, private company, etc.) must take as soon as a crisis occurs in order to continue operating. t also

([145]) nterview with a member of E - y LO e.
([146]) ational ntelligence entre (2020), *Gestión de Cibercrisis. Buenas prácticas en la gestión de crisis de ciberseguridad* (yber crisis management. Best practices in cybersecurity crisis management), - ER , p. 23, https://www.ccn-cert.cni.es/informes/informes-de-buenas-practicas-bp/5425-ccn-cert-bp-20-buenas-pra-cticas-en-la-gestio-n-de-cibercrisis/file.html.
([147])E A (n.d.), 'Business Resumption Plan', https://www.enisa.europa.eu/topics/risk-management/current-risk/bcm-resilience/bc-plan/business-resumption-plan.
([148]) ational Agency for the ecurity of nformation ystems (2021), *Crisis of cyber origin: the keys to operational and strategic management*, https://www.ssi.gouv.fr/uploads/2022/05/20220516_np_anssi_guide_gestion_crise_cyber_en.pdf.

includes a business recovery plan, which precedes the BRP and is used to re-establish the processes of the or teams following an incident. ndeed, the notions of 'recovery' and 'resumption' should be distinguished: recovery refers to the return of operations back to normal, while resumption refers to the return to business with less capacity and in a different environment ([149]), gradually bringing back into service the digital tools and infrastructure affected. hese plans should be developed in consultation with the different stakeholders involved in cyber crisis management, in order to promote a holistic approach. ational cyber crisis authorities could also develop guides for different kinds of stakeholders such as essential and important entities, but also smaller structures which may not have the internal resources to develop such plans.

- **Matching NIS2 objective**
  - **Article 21.1.** Member tates shall ensure that essential and important entities take appropriate and proportionate technical, operational and organisational measures to minimise the impact of incidents on recipients of their services and on other services.

Best practice #16: Establishment of a unit tasked with gathering feedback, drawing lessons learnt and producing recommendations for reviewing, updating and modifying procedures and infrastructure, and refining the action plan for cyber crisis management.

- **Example.** n February 2021, a hospital in France was the target of a ransomware attack, forcing it to reschedule surgical operations. A was called in to conduct technical investigations. After the crisis, all the teams involved were mobilised in two stages, firstly in a 'hotwash' session and then at a later date. he aim of these feedback sessions was to 'question and improve the practices and procedures of the business lines', with a view to being even 'more resilient in the event of a long-lasting crisis' ([150]).
- **Analysis and way forward**
  - n order to develop the cyber crisis management framework, both for the M and for the organisation affected, each crisis could be immediately followed by the organisation of a feedback session, which would later be evaluated within 30 days ([151]).
  - As soon as the crisis is over, a team could be identified to interview the relevant actors, according to a defined timetable and interview methods. everal themes could be addressed, including governance and the crisis management process, crisis communication, the decision-making and action-monitoring process, technical and operational capabilities and interactions with external stakeholders. he interviews could lead to the drafting of a summary document, which could be supplemented by a digital investigation commissioned from service providers.
  - Based on the data collected, the team would then draft an action plan aimed at improving the national crisis management framework. Feedback could be organised at the level of the M cyber crisis management authority, which would receive a summary report for its management, along with a more comprehensive document for the technical teams.
- **Matching NIS2 objective**
  - **Article 9.3.** Each Member tate shall identify capabilities, assets and procedures that can be deployed in the case of a crisis …

([149]) Leal, R. (2021), 'Explanation of the most common business continuity terms', Advisera, https://advisera.com/27001academy/blog/2021/01/18/explanation-of-most-common-business-continuity-terms/.
([150]) ational Agency for the ecurity of nformation ystems (2021), *Crisis of cyber origin: the keys to operational and strategic management*, p. 65, https://www.ssi.gouv.fr/uploads/2022/05/20220516_np_anssi_guide_gestion_crise_cyber_en.pdf.
([151]) bid.

hey contribute to a rapid reaction in the event of an incident, to qualify the impact or to prevent the consequences of the defensive actions carried out.

Recommendation #5. upport the organisation of media training sessions for executives of M national cyber crisis management authorities, so that they can give coherent and clear updates on the progress of the crisis, in any type of media (press, radio, , social networks). As each M has its own capacity needs, these communication sessions could be organised at the national level, with content adapted to the context of the M . E crisis communicators could regularly follow awareness-raising sessions on cyber issues, as well as refresher courses.

ational and E cyber crisis management procedures will doubtless continue to evolve. Based on the experience of M (and beyond), E A should continue to identify best practices on a regular basis, beginning once 2 has been implemented in all M .

6. B BL O RAP

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his table summarises E A’s knowledge base per phase.

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ABOUT ENISA

he European nion Agency for ybersecurity, E A, is the E agency dedicated to achieving a high common level of cybersecurity across Europe. Established in 2004 and strengthened by the E ybersecurity Act, E A contributes to E cyber policy, enhances the trustworthiness of products, services and processes with cybersecurity certification schemes, cooperates with Member tates and E bodies and helps Europe prepare for the cyber challenges of tomorrow. hrough knowledge sharing, capacity building and awareness raising, the agency works together with its key stakeholders to strengthen trust in the connected economy, to boost resilience of the E 's infrastructure and, ultimately, to keep Europe's society and citizens digitally secure. More information about E A and its work can be found here: www.enisa.europa.eu.

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