

# > Resilien-Tech

## Resilience-by-Design: a strategy for the technology issues of the future

acatech POSITION PAPER – Executive Summary and Recommendations



The severe flooding that devastated parts of Central Europe in May 2013 provided a dramatic reminder of the vulnerability of our critical infrastructure and brought home just how important it is for business and society to be able to adapt in the face of major adverse events. In order to guarantee the effective protection of both people and infrastructure against future extreme events, our society will need to ensure that the relevant prevention, planning and protective measures are firmly established, together with adequate crisis response measures and a strategy for making sure that the right lessons are learned from past events.

The combination of a world characterised by digital networks, demographic change in Germany, the threat of global overpopulation and the growing frequency of extreme weather events is giving rise to new, hitherto undetectable risks that are making our modern industrialised society increasingly vulnerable. The growing interconnectedness of critical infrastructures means that even minor and superficially harmless disruptions can trigger chain reactions capable of causing severe damage to the entire system.

In Germany, the security of our critical infrastructure is key to our way of life and economic prosperity. Security research aims to identify and analyse vulnerabilities of all types and develop recommendations and technologies geared towards mitigating or preventing the associated risks. It also investigates strategies and procedures for rapidly returning the system or infrastructure to normal functioning in the event of a failure. The overall long-term goal is to build an infrastructure that is resilient, fault-tolerant and robust. Today, security research even includes low-probability disasters in its planning. Rather than adopting a purely technological perspective, it also considers society and its ability to adapt.

In security research, the concept of resilience provides a holistic approach that takes both technology and society into account. Resilient societies are able to minimise the human, economic and environmental costs arising from adverse events by drawing

on every conceivable solution that can realistically be implemented. Put simply, resilience describes a system's ability to continue functioning reliably in the event of unexpected disruption, or the ability to restore it to normal functioning as quickly as possible.

Resilience is the ability to defend oneself against actual or potential adverse events, prepare and plan for them, cope with and recover from them and continuously improve one's ability to adapt to them. Adverse events are disasters or change processes with devastating consequences that are the result of man-made, technological or natural causes.

Countries such as the US, the UK and Switzerland have stolen something of a march on Germany by replacing inflexible security strategies with concrete, practical implementations of the resilience concept. Germany, too, will need to incorporate resilience strategies into future government programmes. In order to effectively protect the future security of both its people and its critical infrastructure, Germany must make resilience a fundamental requirement of all its social and technological security solutions.

### Recommendations

#### 1. Resilience should be employed as a holistic strategy for minimising the harmful impacts of adverse events on our society.

This will facilitate a sustainable increase in the ability to keep functioning, adaptability, robustness and ability to learn of complex systems in the face of external or internal disruption. In order for this to be possible, it will be necessary to research, develop and implement appropriate and relevant technological, social and economic measures and to ensure that they are combined in an integrated manner.

## 2. Metrics and indicators should be developed for evaluating vulnerability and resilience.

Well-designed and practical quantitative tools are essential for assessing the vulnerability and resilience of societies and their subsystems. These tools will improve our ability to systematically identify weaknesses, establish the effectiveness of investments and determine how specific measures impact on resilience. The German research community should therefore take up the challenge of developing practical methods for measuring resilience.

## 3. Methods should be developed for modelling and simulating complex socio-technical systems that are critical to our society.

Security research should place greater emphasis on research initiatives that develop existing modelling approaches and help to simulate the impacts of adverse events, particularly in terms of cascade effects. It will be especially important to guarantee reliable identification of system-critical nodes and interfaces that could trigger cascade effects if damaged, as well as to predict the system's ability to self-organise.

## 4. Resilience engineering should be established as an independent discipline. The research, development and implementation of resilient designs and construction methods for critical infrastructure should be accelerated.

Innovative technology should be employed to ensure that infrastructure is capable of meeting the needs of the 21<sup>st</sup> century. Resilience engineering involves the development of customised technological and interdisciplinary methods and solutions for building resilience into systems that are critical to our society.

## 5. Strategies should be developed and implemented for sustainably strengthening people's self-reliance in the face of adverse events.

In order to ensure that they are actively involved in shaping resilient societies, the public should be engaged in a dialogue as equal partners and provided with wide-ranging opportunities to participate at a variety of different, decentralised levels. Government can encourage people to take precautions against risks and promote their acceptance, for example through school curriculum content, by supporting volunteering with the fire service, Red Cross, humanitarian aid organisations such as Germany's THW and other emergency services, or through other concrete measures.

### At a glance

- Our dependence on critical infrastructure coupled with the growing frequency of extreme events means that our society is becoming increasingly vulnerable.
- The growing interconnectedness of critical infrastructures means that even minor disruptions can have a severe impact on the entire system.
- The concept of resilience provides a holistic approach that enables the human, environmental and economic costs arising from adverse events to be minimised.
- Resilience helps to keep systems up and running for as long as possible in the event of disruption, or enables them to be rapidly returned to normal functioning.
- In order to guarantee the future security of its critical infrastructure, Germany must make resilience a fundamental requirement of its social and technological security solutions.

## 6. The case should be made for the long-term value-added that resilience can bring to our society.

We need to adopt a wider perspective, abandoning short-termist and short-sighted cost-benefit optimisation in favour of strategic, long-term thinking and actions. Future research initiatives should therefore incorporate the economic aspects right from the outset, demonstrating why it is worth investing in resilience and making the business case for why resilience should not simply be regarded as a cost.

## 7. Incentives should be created for businesses to increase their resilience.

Consideration should be given to the introduction of a standardised resilience monitoring system that would be supported and, if necessary, coordinated by the State. The system would provide appropriate incentives to socially critical businesses that were able to demonstrate an increase in their resilience. It would also seek to influence the behaviour of those socially critical businesses that failed to take measures to improve their resilience by penalising them with higher insurance premiums, additional levies, etc.

## 8. An early warning system should be established, featuring compulsory reporting of adverse events.

While the probability of major adverse events may be low, they do nonetheless occur from time to time. A national early

warning system should therefore be established, together with industry-specific compulsory reporting arrangements (i.e. the criteria for reporting events would vary from industry to industry). Businesses would thus be under an obligation to report security-critical events.

#### 9. A national resilience strategy should be developed.

In the broader context of sustainable development, it will be necessary to develop an overarching vision of resilient societies. The holistic concept of resilience is not something that can simply be ordained by law. A national resilience strategy, on the other hand, can provide a consistent and comprehensive basis for addressing the numerous challenges associated with an increasingly complex, high-tech world,

serving as a platform for the subsequent development of targeted solutions for specific problems.

#### 10. Resilience should be established as a key component of sustainable development.

Sustainability means finding a way of living together that meets the needs of the people alive today without jeopardising future generations' ability to in turn meet their own needs. For this to be possible, societies must be capable of surviving major challenges. The fundamental characteristics of resilient systems are the ability to keep functioning, adaptability, robustness and the ability to learn. These are all key to a society's ability to survive. The concept of resilience thus bridges the gap between security and sustainability research.

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