Cyber war

Methods and Practice

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Summary

Computer and internet security is under discussion due to the increasing relevance of the Internet and of the information and communication technology (ICT). The cyberspace is meanwhile regarded as separate military dimension. This paper gives an overview on the methods and practice of cyber war and presents the cyber war activities since 1998 and the security architecture of the cyberspace. Finally, the cyber war strategies of the United States, China and Russia and the cyber policies of the European and African Union are discussed.

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1. Fundamentals

1.1 Introduction

Computer and internet security is under discussion due to the increasing relevance of the Internet and of the information and communication technology (ICT). The cyberspace is meanwhile regarded as separate military dimension[1]. This paper gives an overview on the methods and practice of cyber war and presents the cyber war activities since 1998 and the security architecture of the cyberspace. Finally, the cyber war strategies of the United States, China and Russia and the cyber policies of the European and African Union are discussed.

1.2 Background

The increasing dependence on computers and the increasing relevance of the Internet by the increasing number at users and available information are well-known. However, the intensive use of network-dependent technologies increased the susceptibility of states for attacks within the last years.

An increased risk for cyber attacks results in particular from:

- The Next or **New Generation Network NGN** where television, internet and phone submit their data packets via the internet protocol IP (**Triple-Play**).
- In the **Internet of Things IoT**, things (machines and goods) get IP-addresses to localize and track them, to receive status reports and so on. Also machines and devices with **Radiofrequency Identification (RFID)**-chips can communicate with computers and with each other[2]. The car-to-car-communication is another planned feature which may lead to a massive expansion of IoT applications[3].
- Remote control and maintenance of industry machines by Industrial Control Systems ICS or **Supervisory Control and Data Acquisition SCADA** allow the communication with machines via internet.
- The network based or **network centric warfare** is also a source of new problems such as security and stability of flying computer networks in the air force[4].
- Further planned extensions of the net are intelligent household appliances and electric meters (**smart grid**) [5] and the use of external computing centers via the Internet instead of using own capacities (**cloud computing**[6])

[1] USAF 2010a, DoD 2011
[2] The Machine-to-Machine (M2M) communication potentially concerns 50-70 billion 'machines', of which only 1 % are connected today EU 2009a, p.2
[3] Quirin 2010, p.2f.
[4] Grant 2010

- The introduction of mobile phones with internet access (**smartphones**[7]), which integrate the functions of navigation equipment (Global Positioning System GPS location data).
- The combination of machine-to-machine communication, Internet of Things and SCADA systems are key elements of **cyber-physical systems CPS**, where production processes are increasingly managed and modified by a network of machines, products and materials[8].

These developments and the dependence on information technology massively increase the vulnerability of critical infrastructures (CII)[9]. On the other hand, the execution of an attack is relatively simple[10].

- The attacks can be started from a long distance. A certain technical know-how is needed, but attacks can be conducted with less material and logistic efforts than conventional attacks
- This allows asymmetric attacks of small groups against large targets
- The notification of an attack and the identification of the attacking person/group is very difficult if the attack is well prepared (**attribution problem**), which makes deterrence and counterstrikes much more difficult.

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[5] In early 2013, the European energy supplier organization Entso-e presented plans for remote control of large household devices (like refrigerators) for all citizens of European Union so that energy companies can modify or switch off devices in case of energy shortages; this would also create a new large-scale vulnerability; Schelf 2013, p.1. The German government supports this plan, Neubacher 2013, p.82

[6] Postinett 2008, p.12, Knop 2010, p.14. Risks of cloud computing are e.g. the storage of data on foreign computers that are subject to foreign legislation. Also, this may lead to political influence; refer to FAZ 2010f, p.17. The cloud provider represents an additional entrance gate for attacks, with may be difficult to control by the outsourcing company, Menn 2010, p.H12-H13. In addition, cloud providers may look into the data of their users to scan and analyze them, also they can disconnect accounts under certain circumstances, Postinett 2013b, p.12

[7] For android smartphones, more than one million virus variants resulting from adaptive ('mutating') viruses are known, FAZ 2013b, p.21.

[8] Synonyms are Smart factory, Integrated Industry or Industry 4.0 (after mechanization, electricity and standardized mass production). However, as demonstrated recently by a Japanese software company Trend Micro, ICS and SCADA systems are meanwhile routinely checked for vulnerabilities by attackers. A simulated water supply system was set up as honeypot to attract hackers. Over 28 days, 39 cyber attacks with manipulations and malware injections were registered that came from 14 countries. The US ICS Emergency Response Team reported 172 security gaps in systems of 55 different providers; Betschon 2013a, p.38. SCADA systems often do not have automatic security updates or virus scans and firewalls can often not be implemented, because this interferes with the liability of the manufacturer of the SCADA-driven machine, Striebeck 2014

[9] Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term are facilities for: electricity generation, transmission and distribution; gas production, transport and distribution; oil and oil products production, transport and distribution; telecommunication; water supply (drinking water, waste water/sewage, stemming of surface water (e.g. dikes and sluices); agriculture, food production and distribution; heating (e.g. natural gas, fuel oil, district heating); public health (hospitals, ambulances); transportation systems (fuel supply, railway network, airports, harbors, inland shipping); financial services (banking, clearing); security services (police, military).

[10] Megill 2005, DoD 2011

In literature, there is no agreement when the first cyber war took place, but the first activities discussed in this context began already in the year 1998 with the operation **Moonlight Maze**.

1.3 Definition

The term **Cyber war** (also cyberwar, cyber warfare, computer warfare, computer network warfare) is a combination of the terms war and cyberspace and designates the military conflict with the means of the information technology. In practice, this is the attack on computers and their data, the computer network and the systems dependent on the computers[11].

War is the conflict between 2 states, so it is sometimes doubted whether there were any cyber wars at all and whether cyber war can be done as an independent conflict[12].
However, most authors believe that large-scale cyber attacks cannot be done without governmental support due to the required resources and the possible political consequences. Therefore, some large-scale cyber attacks are presented in literature as cyber war even when the aggressor could not be clearly identified.

Generally attacks on computers, information, networks and computer-dependent systems are called **cyber attacks**. Cyber attacks can also be of private, commercial or criminal nature, but in all types of attack the same technical methods are used, which makes the identification of the aggressor and the motives very difficult or even impossible.
If the attack has a terrorist background, the attack is called **cyber terrorism**, if the primary aim is illegitimate acquisition of information, it is called **cyber espionage**. Cyber terrorism and espionage are both illegal, however the term cyber crime is mostly used for 'normal' crimes like theft of money by abuse of online banking data[13].
In contrast to cyber war, cyber espionage tries to avoid damage of the attacked system to avoid detection and to ensure information flow after intrusion, i.e. it is a more ‚passive' form of an attack[14]. However, large-scale cyber espionage can lead to significant computer and network problems and is then often assigned to cyber war by literature, too.

In summary, there is an overlap between terms and definitions and the attribution of an incident to a certain kind of attack or aggressor may be very difficult. Without evidence, it should be avoided to accuse other states or governments.

[11] Wilson 2008, p.3ff.
[12] also CSS 2010, Libicki 2009, p. XIV
[13] also Mehan 2008, CSS 2010
[14] Libicki 2009, p.23

1.4 The general concept of cyber war

1.4.1 Basic principles

The networking of computers in a protected Internet environment with general improvements of encryption tools and pattern recognition as well as the Global Positioning system (GPS) are the technical basis for a multiplicity of technical and strategic innovations, which are summarized in the USA under the term **Revolution in Military Affairs (RMA)**[15].

Applications are in particular

- the **Airborne Early Warning and Control System (AWACS)**, which allows radar surveillance via airplanes,
- the **Network based warfare (NBW**) which focuses the **C4ISR** (Command, Control, Computers, Communications, Information for intelligence, surveillance, and reconnaissance)
- the use of **smart weapons** such as smart bombs
- the use of **drones** (Unmanned Aerial Vehicles UAV) or bomb defusors (PackBots[16])
- and the **integrated warfare**.

Drones are not only used for reconnaissance, but also for active fighting against terrorists as already done in Afghanistan and Pakistan[17]. Drones are used for all kinds of operations that are „dull, dirty, dangerous or difficult“[18]. The practical effect of the drones has led to an increased demand that cannot be covered by the current production capacities anymore[19][20].

In the **integrated warfare** civil issues and actors are already considered in the planning and execution of war and the war is accompanied by a systematic information policy. The systematic embedding of media in the political and military context of a conflict may help to influence the flow and content of information in a positive manner to achieve the goals of the conflict. This holistic approach is also known as **Effects based operations EBO** and aims to achieve **information dominance** at any time on all actors and stakeholders.

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[15] Neuneck/Alwardt 2008
[16] Hürther 2010, p.33-34
[17] Rüb 2010, p.5
[18] Jahn 2011, p.26
[19] FAZ 2010b, p.6
[20] The trend is to reduce size, as the drone type Rabe that looks like a toy, refer to Singer 2010; the research is also focusing on range, armament and noise, Jahn 2011, p.26. Meanwhile, private drones are available like the French AR-2.0, which can be controlled via smartphone and can fly 50 meters high, Fuest 2012, p.37.

The Department of Defense has described the objectives of **Information Operations IO** in detail.[21] Within IO, 5 core capabilities need to be achieved and maintained

- the **psychological operations PSYOP** to achieve information dominance. Further operation types are **counterintelligence (CI)** operations, counter propaganda and **public affairs (PA)** operations[22]
- to mislead the enemy by **military deception MILDEC**, e.g. as the Iraqi air defense systems in the Gulf war[23]
- protection of operations (**Operation Security OPSEC**), e.g. to prevent internet release of sensitive and military relevant information
- the cyber war as **computer network operations (CNO)**. **CNO** can be divided into three subsets: **computer network attacks (CNA)**[24], **computer network exploitation (CNE)** and the countermeasures as **computer network defense (CND)**[25]
- the conventional **electronic warfare (EW)** where the electronic signals of the enemy are e.g. disturbed by jamming.

1.4.2 Cyber war Definition

There are practical problems to answer the question „What is cyber war?“ In addition, there are political and legal concerns, because if an attack fulfills the criteria of a given definition, this may have massive political and military implications[26].

A comparison of cyber war concepts of various NATO states with Russia and China shows different perspectives. In particular, the question whether cyber war is limited to the military conflict dimension or may also include the civil and economic dimensions, is debated[27]. Nevertheless, the USA has worked on a more precise and pragmatic cyber war definition.

In 2007, the US Strategic Command USSTRATCOM defined *network warfare* as „*the employment of computer network operations with the intent of denying adversaries the effective use of their own computers, information systems and networks*“[28].

[21] Wilson 2007
[22] USAF 2010b, p.5
[23] USAF 2010b, p.32
[24] Wilson 2008
[25] CSS 2010
[26] Beidleman 2009, p.9ff. and p.24
[27] IT Law Wiki 2012a, p.1-4
[28] Alexander 2007, p.61

General Keith Alexander who was the previous commander of the US Cyber Command CYBERCOM, outlined his perspective on cyber war and emphasized the need to protect the own systems and to ensure the **freedom of action** for the own and allied forces[29]. Cyber war is an integral and *supportive* activity and not a stand-alone military concept. Also, the concept includes defensive and not only offensive components[30]. As a consequence, cyber war is done as common action of humans and computers (computers do not 'on their own') and is usually a group of activities and not only a single hit even if a surprising action may start the war.

This is reflected by the current definition of cyber war of the US Army[31] (note that CyberOps abbreviates the term 'Cyber Operations' and while Global Information Grid 'GIG' means military network):

„Cyber war is the component of CyberOps that extends cyber power beyond the defensive boundaries of the GIG to detect, deter, deny, and defeat adversaries. Cyber war capabilities target computer and telecommunication networks and embedded processors and controllers in equipment, systems and infrastructure."

The definition clarifies that cyber war is not limited to the internet, but includes all kinds of digital technologies[32]. Also, cyber war is only one part of military cyber activities.

In 2014, the NSA and Cybercom command was taken over by Vice Admiral **Michael Rogers**, who is a cryptology expert from them 10th fleet. Rogers emphasized the increasing role and frequency of cyber attacks and reported an intrusion into unsecured sections of the Navy network in 2013 by hackers for the purpose of cyber espionage[33].

1.4.3 Cyber warfare and International Law

The term 'adversary' in the above definition is used in literature both for state and non-state actors. A non-state actor or his cyber activities may require a military response, if this cannot be handled by police or intelligence alone. Even if war is legally the conflict between states, a cyber war concept has to consider attacks from non-state actors as well.

[29] Alexander 2007, p.61: "We are developing concepts to address war fighting in cyberspace in order to assure freedom of action in cyberspace for the United States and our allies while denying adversaries and providing cyberspace enabled effects to support operations in other domains."
[30] Alexander 2007, p.60
[31] IT Law Wiki 2012, p.2
[32] See also Beidleman 2009, p.10
[33] Winkler 2014b, p.3

This leads to the question when the stage of war is reached. As in conventional conflicts, the question whether an incident is a reason for war is a strategic and political decision that cannot be defined upfront in each case. This is also relevant for any counter-reaction, because an attack could also by answered by political sanctions or conventional measures, automatic reactions are problematic due to the escalation potential[34].

Also the **attribution problem**, i.e. to identify the correct source of an attack is legally important, because it is problematic to attack a certain opponent without clear evidence.

To overcome these uncertainties and to avoid uncontrolled escalation of cyber conflicts, the US government started in spring 2012 an initiative to set up **cyber hotlines** (in analogy to the 'red telephones' of the cold war era) with Russia[35] and China[36].

The United Nations Organization International Telecommunications Union (ITU) was mandated at the World Summits on the Information Society 2003 and 2005 to serve the member states as neutral cyber security organization. The ITU coordinated in 2012 the evaluation of the recently discovered spy software Flame[37].

A debate on global **cyber conventions** is ongoing since several years, but as the cyberspace is the only man-made domain, any convention would not only regulate actions *within* the naturally given domain, but could affect or even determine the *structure of the domain itself*[38]. Already for this reason, it is unlikely that a global legal framework for the cyberspace will be agreed in the next years.

The NATO Cyber Defense Centre of Excellence (CCD CoE) presented in 2013 the **Tallinn Manual** on the International Law applicable to Cyber Warfare. The Manual was compiled by an international group of legal experts and covers both the *jus ad bellum* (law related to use of force) and *ius in bello* (international law regulating the conduct of armed conflicts) [39].

Overall, the suggested rules for cyber war are consistent with the conventional international law and in principle, cyber warfare is handled in the same way as other military operations (use of force, rule 11). Per rule 41, "*means of cyber*

[34] Nevertheless, plans for fully computerized counterattacks are under discussion, Nakashima 2012b
[35] Nakashima 2012a
[36] Spiegel online 2012a
[37] ITU 2012
[38] See also Fayutkin 2012, p.2
[39] CCD CoE 2013, Schmitt 2013

warfare are cyber weapons and their associated cyber system, and methods of cyber warfare are the cyber tactic, techniques, and procedures by which hostilities are conducted". The key event is however the **cyber attack** that is defined as "*a cyber operation, whether offensive or defensive, that is reasonably expected to cause injury or death to persons or damage or destruction of objects*" (rule 30). Cyber warfare activities can be responded by other military activities (proportionate responses, rule 5.13). However, the proposed rules do not apply to cyber espionage per se (rule 6.4) and an act must be attributable to a state (rule 6.6). Non-state actors may fall under the rules, if the state has effective control over them, i.e. by giving instructions and directions (rules 6.10, 6.11) [40].

1.4.4 Cyber warfare and Drones

A special cyber war issue is the progress of the drone technology. Drones allow observation and/or targeted killing of adversaries[41]. However, the technical progress allows more and more **assistance functions**, i.e. the human decision making is increasingly supported and influenced by computers[42]. Meanwhile, the creation of a legal '**machine liability**' is now under discussion[43]. Any progress to fully automated drones would require enhanced cyber security efforts to avoid that machines are taken over by adversary hackers (Section 3.2.9) [44]. Autonomous drones can avoid detection by communication with control station, so this is part of stealth drone concepts such as the **Lijan** drone tested in 2013 by China[45].

The drone technology has various vulnerabilities resulting in losses of relevant number of drones. For US, the loss of 5 Global hawks, 73 Predators and 9 Reaper drones was reported, for Germany, the loss of 52 mostly small drones in the previous decade[46]. Mostly, these losses were caused by handling errors and conventional technical problems. Also, loss of communication can enforce the unplanned landing and require destruction, if there is a relevant danger of takeover by adversaries.

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[40] In the Manual, the usage of seemingly harmless, but damaging cyber traps (**cyber bobby**) is not acceptable. However, non-damaging defensive traps could be imagined, e.g. a harmless file, placed into sensitive folders with knowledge of the authorized users, indicates an intrusion to administrators if this file is used, e.g. opened, changed, copied or moved.

[41] Thiel 2012, p.Z2

[42] However, a possible future with fully automated killing decisions remains speculative. The research on **lethal autonomous robots (LARs)** is in progress, Klüver 2013, p.2

[43] In the civil sector, this is discussed in US for self-driving cars (i.e., cars with autopilot functions), California plans a respective regulation until 2015, Burianski 2012, p.21

[44] The largest drones are meanwhile able to replace conventional airplanes, i.e. an intrusion could create major security risks. The European drone project **Neuron** is an unmanned aerial combat vehicle (UACV) with stealth technology which may be able to execute larger air attacks than current drones (Bittner/Ladurner 2012, p.3; Hanke 2012, p.14).

[45] TAZ online 2013

[46] Gutscher 2013, p.4, Spiegel 2013a, p.11

Tests in New Mexico 2012 have shown that drones are vulnerable for **GPS spoofing**. The same could be shown for Automatic Dependent Surveillance Broadcast systems (ADS-B) that allow tracking of the flight route every second. Also, it was observed that drones can be inadvertently irritated by signals that are intended for other drones.[47]

However, there is also a risk for cyber attacks which may in the long run be the largest threat (Section 3.2.9).

The selling of a certain drone model to more than one state results in sharing knowledge of the capabilities and vulnerabilities[48]. To protect critical knowledge, the **black box-principle** is used by the US, i.e. technology modules e.g. for the EuroFighter, but also for the EuroHawk drones are provided as completed modules without access to foreigners[49].

The meanwhile suspended[50] EuroHawk drone combined drone technology derived from the Global Hawk drone provided by Northrop Grumann and a new advanced reconnaissance technology called **ISIS** from the EADS affiliate Cassidian. During a flight to Europe, this drone showed temporary losses of communication for a few minutes. As these times may also be potential windows of opportunity for (cyber) attacks from adversaries, cyber security is an essential issue for future drone technologies.

In the European Union, various research projects are evaluating the use of drones which are not steered by a human operator, but by a server for daily routine operations. Relevant projects are INDECT for the internal EU security since 2009[51] and certain others as part of the European Border Surveillance System (EUROSUR) which took place between 2008 and 2012.

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[47] Humphreys/Wesson 2014, p.82

[48] And conventional espionage is still an issue. In Northern Germany, a man was arrested in 2013 who tried to find out vulnerabilities of drones in a drone research unit and who was suspected to work for Pakistan, Focus 2013, p.16. The security company FireEye reported a large-scale espionage campaign against drone technology providers that was suspected to be linked to a Chinese hacker group, named **Operation Beebus**, Wong 2013, p1/4. Iran's new surveillance drone **Jassir** has similarities to the ScanEagle drone that was captured by Iran, Welt online 2013

[49] Löwenstein 2013, p.5, Hickmann 2013, p.6

[50] Buchter/Dausend 2013, p.4, Vitzum 2013, p.6. An issue was a missing sense-and-avoid system; details are disputed between involved parties. However, collision prevention and integration into airspace traffic are general challenges for drone technology.

[51] Welchering 2013a, p.T6. The research for automatic threat detection focuses on scenarios like the following one. If a camera observes abnormal behavior of an individual, the combination of automatically activated observation drones, microphones and automated face recognition may help to identify the individual and its intentions. If necessary, it is planned to utilize data from Facebook, Twitter, Google plus, credit card data etc. to identify and prevent dangerous activities.

The Eurosur projects were in particular[52]:

- OPARUS (Open Architecture for UAV-based Surveillance Systems) for border surveillance by drones that also intends to ensure integration into civil airspace
- TALOS (Transportable autonomous patrol for land border surveillance) with patrol machines
- WIMAAS (Wide Maritime area airborne surveillance) for use of UAVs for maritime control

The concept to conduct daily routine operations of these devices by a control server (**Unmanned Units Command Center UUCC**) was presented as part of these projects, but from a cyber war perspective this would be the key vulnerability and would need to be maximum secure and resilient. The European Union has enhanced their cyber security activities recently as shown in Section 4.5.
The above border concept is also known as **virtual border** or **virtual wall** and describes the combination of physical barriers with computed surveillance for long borders that are difficult to control. Similar approaches are currently developed in Saudi-Arabia (by EADS) [53] and in certain sectors of the US border[54].

The planned opening of US civil airspace for private drones may lead to a drone boom and will further increase the need for cyber secure drones[55].

[52] Oparus 2010, SEC 2011, p.7, Talos Cooperation 2012.
[53] Hildebrand 2010, p.6
[54] Miller 2013, p.12-13
[55] Wysling 2014, p.5

2. Methods

2.1 General issues

In general, there are three main types of attacks; these are the physical damage of computers and communication lines, the destruction of transistors by an electromagnetic pulse and the manipulation of computers and networks by malicious software (**malware**).[56]

2.1.1 Physical damage of computers and communication lines

This can be done by destruction and sabotage of hardware, cables, aerials and satellites. To prevent destruction of command and control structures by nuclear weapons, the decentralized computer network ARPANET was created by the USA, which was the very first step to the Internet. As communication lines can also be destroyed by disasters like fire or flooding, it is usual to protect mainframe computers and to have back-up systems, if possible.

2.1.2 Electromagnetic Pulse EMP

Modern electronic devices can be destroyed by electromagnetic waves as they occur during a so-called **electromagnetic pulse EMP**. An EMP can be caused by a nuclear explosion. The EMP protection is technically possible, but expensive and can only be done for selected systems.

2.1.3 The attack on and manipulation of computers and networks

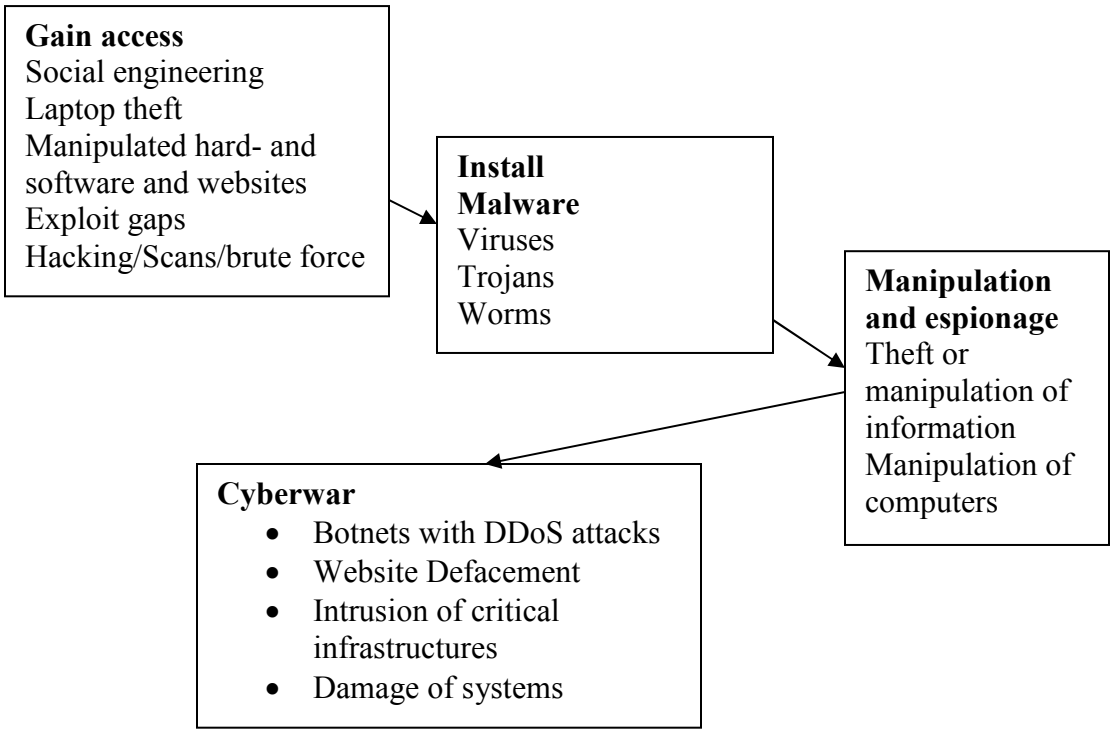
Computers and networks can be attached e.g. by placement of programs (i.e. a set of instructions) on the computer, but also by disturbing communication between computers. Cyber attacks typically use one of these methods or both methods in combination.

2.2 Attack on Computers

2.2.1 Strategy

There is a typical attack strategy: at the beginning, the attacking person or group tries to gain access to the computer and/or the network, then to install malware that can be used to manipulate the computer and/or the data on the computer and/or to steal data. This allows starting further actions which are presented below[57].

[56] Wilson 2008, p.11
[57] Northrop Grumman TASC 2004



2.2.2 Gain access

The following methods are common to gain access:

- the exploitation of security gaps in software programs and operation systems (e.g. Adobe and Windows) that is also known as **exploit problem.** The probing of computers can also be done by port scans[58]. Typically, IT architecture consists of multiple hardware and software components from multiple providers which makes it difficult to keep everything updated. Special programs can scan computers automatically for update status and apply known exploits for intrusion[59].
- **Hacking** of passwords which is increasingly done automatically (**brute force**)
- Intentional misleading of users by **social engineering**, where e.g. wrong 'administrators' ask users for passwords
- Also, manipulated emails with malicious attachments and links to malware-containing websites are increasingly used. **Phishing** is a method where users are misled to a malicious website by masquerading as a trustworthy entity to acquire sensitive information such as usernames, passwords and credit card details or to open attachments with malware (tailor-made emails

[58] A port scanner is a software application that checks a server or host for open ports, i.e. which services a system offers.
[59] Kurz 2013, p.31

for individual attack are known as **spear-phishing**). **Spoofing** is a situation where a person or program masquerades as another by falsifying data (in particular wrong Internet IP addresses) while **Cross-site-scripting** is a method where computers are infected while being on another website. **Drive-by download** is the unintended download of malware from the Internet during a website visit.

- **Infected data storage media** (such as floppy and hard discs, DVDs and now USB-Sticks) are more 'physical' ways to be infected
- Also there is a debate on '**backdoors**'[60], i.e. intentionally installed security gaps that allow access for secret services. Microsoft Germany confirmed in January 2007 an official cooperation with the American National Security Agency NSA with regard to the Windows Vista operating system, but denied the existence of backdoors[61]. Also, Microsoft has initiated the Government Security Program GSP where governments get insight into 90% of the source code. However, the USA is also afraid of backdoors, in particular in hardware, thus the use of Asian chips is avoided for security-relevant technologies. For the same reason, the US State Department avoids use of Chinese computers within their networks[62]. Nevertheless, military and government cannot produce all hard– and software alone, so the use of commercial off-the-shelf (COTS) technology cannot be avoided and will be a source of vulnerabilities[63]. The global supply chain of such products is also a potential source of vulnerabilities[64]: a study of the US senate from 2012 reported that up to one million falsified chips were installed in US weapons, 70% of these chips came from China, but a significant amount came from UK and Canada also[65].
- As encrypted communication could be used for terrorist activities also, it is essential for intelligence agencies to get access to keys or to the source code of encryption software to have the option to decode encrypted information based on the applicable legal provisions. In Germany, this access is guaranteed by the telecommunication surveillance regulation **Telekommunikations-Überwachungsverordnung (TKÜV)** since 2002. Similar regulations exist worldwide in almost all states, e.g. in the USA, where the **National Security Agency NSA** has access to the source codes

[60] A special variant are **bugdoors**, i.e. programming mistakes (bugs) that can be used as backdoors and which are sometimes intentionally implemented; Kurz 2012, p.33
[61] Die Welt 10 January 2007
[62] USA and India suspected in 2010 the Chinese provider Huawei and its competitor ZTE to have pre-installed espionage software (spyware) in their products. Huawei opened the source code and allowed inspections and this convinced Indian government that Huawei products are secure, Mayer-Kuckuck/Hauschild 2010, p.28. The US authorities instructed Huawei to sell their shares of the Cloud computing company 3Leaf for security reasons; Wanner 2011, p.8
[63] Security issues may exist here as well, e.g. the Software **Carrier IQ**, that was installed on estimated 130 million smartphones and that could track the location and work as keylogger; Postinett 2011, p.32
[64] USAF 2010a, p.5
[65] Fahrion 2012, p.1

of encryption software[66]. The access of national intelligence agencies means that a foreign or international IT platform can be technically accessed by foreign agencies[67].

- Meanwhile, it is known that many companies including IT security companies provide information on potential exploits to the intelligence *before* the exploits are published or closed by patches to support intelligence activities[68]. As a practical consequence, user of devices, software or IT security software have to consider the possibility that the intelligence of the manufacturer/provider country *may* have and use access, that by intelligence cooperation[69] an indirect access *may* also exist for further agencies from other countries and that a zero day-exploit *may* not be 'zero' at all. Together with the surveillance of information flow[70] and the above described intelligence access to encryption systems, cyber security *between* computers may also be a problem. Meanwhile, the US government officially confirmed to use exploits. The decision on keeping exploits secret is based on a thorough risk-benefit assessment, i.e. who else could use it, how large is the risk of disclosure and damage to own users and companies[71].
- Another issue is **pre-encryption access**, as providers often decrypt data for internal handling and re-crypt afterwards. By accessing node servers, intruders can bypass encryption. For this reason, some countries asked the Blackberry provider Research in Motion (RIM) in 2010 to put servers into their own countries[72].
- The outsourcing of sensitive IT projects to external providers brings additional risks by creating additional interfaces which may be used for attacks by adversaries[73]. Also, this can lead to loss of internal IT competence.

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[66] Scheidges 2010, p.12-13 Welchering 2013c, p.T2 reported a potential vulnerability of **quantum encryption**. Blinding of photon receivers by light pulses sent by a man in the middle-attack may allow to collect, decrypt and replace photons.

[67] Scheidges 2010, p.12-13

[68] FAZ 2013a, p.1

[69] There is for example the **five eyes-agreement** on intelligence cooperation of the USA, UK, Canada, Australia and New Zealand based on the **UKUSA agreement** from 1946 that was declassified in June 2010. Also, there is e.g. a cooperation between US and German intelligence for surveillance and prevention of terrorist activities, Gujer 2013, p.5. See also Section 2.2.9 for more details.

[70] This includes conventional surveillance of paper-based and analog communication as well as interception of information from optical fibers, Gutschker 2013b, p.7, Welchering 2013b, p.6. Also, in line with respective national law, e.g. the 1994 **Communications Assistance for Law Enforcement Act (CALEA)** and the **Foreign Intelligence Surveillance Act (FISA)** in US, providers may give technical access to data or systems.

[71] Daniel cited in Abendzeitung 2014

[72] Schlüter/Laube 2010, p.8

[73] Some outsourcing examples: Switzerland plans to outsource significant parts of the public IT infrastructure, the German army utilized encryption systems of US providers, Scheidges 2011, p.17,

- A new area of cyber war is **offline-attacks** on computers that are not connected with the internet. Of course, infected USB-sticks can affect every computer, but it was believed than physical distance (air gaps) would ensure a high level of security. A presumably Russian multi-functional malware named **Uroburos** is a rootkit that is able to connect computers within intranets as peer to peer-network. Within this network, Uroburos is then searching for a computer that has internet access to conduct data exchange. It is noteworthy that Uroburos remains inactive in computers that are already infected by the malware agent.btz indicating the same source[74].

  After reports about a malware called **BadBios** that was suspected to exchange information via the air in late 2013[75], the New York Times reported a radio pathway into computers and that is used by NSA as part of their active defense (Project **Quantum**). Here, a very small sender covertly placed on the computer or USB sticks is sufficient, the signals with the information can be sent over several miles/kilometers[76]. While the technical details remain unknown, researchers recently showed that a covert acoustical mesh network can be construed in computers via near-field audio communications. The system is based on high-frequency audio signals that can even be used for keylogging over multiple hops[77]. The vulnerabilities are increasing, because computers are increasingly communicating with smartphones, or are e.g. involved in smart home and smart entertainment environments. By this, even the car or the TV[78] can be an entry for an attacker. Also, routers[79] and printers can be infected.

2.2.3 Install malware and start manipulation

Cyber espionage may be done for private, commercial, criminal or political reasons and attempts to get sensitive information such as passwords, PIN numbers etc. while cyber war tries to manipulate computer systems actively.
In general, three types of **malware** are most relevant: **viruses** (programs that infect computers), **Trojans** or Trojan horses (programs that report information to other computers) and **worms** (programs that are able to spread actively to other systems). Typically, a malware program consists of two parts, an infection part, that installs the program on a computer and other parts that contain the instructions of the attacker. Meanwhile, it is practice to install a small initial **backdoor**

Baumgartner 2013, p.25. The US company CSC helped Germany to implement the public email system De-Mail and the new electronic passport, Fuchs et al. 2013a, p.1 and 2013b, p.8-9.
[74] Fuest 2014, p.1-3
[75] Betschon 2013b, p.34
[76] Winker 2014a, p.3
[77] Hanspach/Goertz 2013, p.758 ff.
[78] Via manipulated video files, Schmundt 2014, p.128
[79] Handelsblatt 2014 b, p. 23

program and to install further parts later that may also allow expanding administrator rights on the infected computer.
Examples for such programs are **keyloggers**, which report any pressed key to another computer which allows to overview all activities and also to register all passwords[80] and **rootkits**, which are tools that allow logins and manipulations by the attacker without knowledge of the legitimate user.

2.2.4 Cyber war

Distributed Denial of Service (DDoS)-attacks play a key role in cyber war. A DDoS attack is an attempt to make a computer resource unavailable to its intended users by concerted attacks of other computers[81]. The most important tool for a DDoS-attack is a **botnet**.

Computers can be controlled via a distributed software to cooperate with each other to conduct an action that requires large computing capacities[82] (**bot** is derived from robot = worker); the software can operate in the background while the normal programs are running. The coordinated network of bots is the botnet and allows to direct thousands of computers against another systems. Illegal botnets can be even leased today[83].

The dominance of botnets in cyber war is based on the following:

1. botnets are often not located in the country of the attacker which makes localization and attribution of an attack difficult and an immediate counterstrike almost impossible[84]
2. botnets provide large computer capacities needed for a successful attack
3. botnets allow targeted attacks while viruses and worms can spread without control and even affect the own systems/allies
4. the botnet software can theoretically be located in every computer, so it not possible to protect a system by excluding certain groups of computers

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[80] Stark 2009, Schmitt 2009, p.83

[81] A new form of cyber attack is the **distributed reflected denial of service attack (DRDoS)** where automated requests are sent to a very large number of computers that reply to the requests. Using Internet protocol spoofing, i.e. giving a wrong IP address as the source address all the replies will go to the victim computer (who normally has this address) and overload him. This kind of cyber attack makes attribution (identification of attacker) even more difficult than DDoS.

[82] The first large botnet was intentionally created by volunteers as part of the SETI (Search for Extraterrestrial Intelligence)-Project. The users downloaded a program that allowed to use their computers for analysis of data and to send back the analysis results to SETI.

[83] FAZ 225/2009, In East Asia one can ‚buy' packages of thousand infected computers, to resell them in the Western world for several hundreds of Dollars. It was estimated that the botnet based on Conficker infection consisted of 5 million computers in 122 countries, Wegner 2009.

[84] States may also use informal hacker groups, i.e. specialists who do not work in official positions. In case of a successful attribution, these groups could also serve as 'buffer', i.e. the state can reject the responsibility for an attack, if necessary. Hackers who use their know-how to protect their state, are sometimes called **white hat** or **ethical hackers** in contrast to destructively acting **black hat** hackers.

Summary: In line with the criteria of Clausewitz for a maneuver botnets can be used for a massive, surprising, efficient and easy manageable attack[85].

Other really used methods are:

- **Website Defacement**, where the look of a website is altered for propaganda reasons
- the infiltration and manipulation of **critical infrastructures** such as radar systems, power grids and power plant control systems
- and the **sabotage** of computer systems, which is often a side effect of massive espionage and subsequent system failures.

New technologies may change the scenario and strategies suddenly and completely so the history of cyber war may not allow to predict the future developments here[86]. However, it can be expected that botnets will be used in future as core tool for large-scale attacks.

A new variant of DDoS is **fake traffic**. In a test, fake traffic software could execute 100,000 clicks on a certain website from one computer, but simulate that each of these clicks came from single different computers, i.e. removing the need for a botnet. Also, it is possible to create large amounts of fake tweets and fake human communication (**socialbots, internet of thingies**)[87].

2.2.5 Attribution and cyber weapons

The attribution, i.e. the identification and localization of an attacker to start countermeasures is in important goal, but difficult to achieve.

However, the attribution research is in progress. Instead of immediate shut down of an infected computer, this could be used to find out which information is sent to whom, but often the information flow is going via interim servers („springboard computers“).

Also, hackers create **digital fingerprints**; these are typical program codes or certain access patterns which allow characterizing a certain group of attackers.[88] These patterns can include the use of **malware families** (related sets of malicious codes), use of specific tools or tool combinations, scope of stealing, characteristic encryption algorithms, use of covert communication to control servers (such as

[85] WhiteWolfSecurity 2007
[86] Gaycken 2009
[87] Graff 2014, p.13
[88] Mayer-Kuckuck/Koenen/Metzger 2012, p.20-21

mimicking legitimate communications) and language used (incl. typos, styles, preferred terms etc.) [89].

However, this does not allow clarifying whether an attacker worked on behalf of another state or authority.

Yomiuri Shimbun has reported that the Japanese Ministry of Defense awarded a three-year research project to the company Fujitsu Ltd. in 2008 for software that should detect attacks and also the source of the attack with all interim servers. This should work as cyber weapon and thus be able to deactivate the source of the attack including springboard computers. The budget was 178.5 million Yen. The tool was successfully tested in prepared networks[90].

Cyber weapons can be defined as software tools that can attack, intrude, doing espionage and manipulate computers and who can control self-replication and distribution. Ideally, this should include the option for self-deactivation (going silent). This type of software is more and more in use and the conventional differentiation between viruses, worms and Trojans is becoming less relevant. The term ‚cyberweapon' does not suggest that this is a military tool, as the technical principles are essentially the same as for software used for cyber crimes.

A subtype of cyber weapon is a **logic bomb**, i.e. a malware that executes actions at a predefined timepoint or after a predefined number of certain computer activities. A recent example of a logic bomb was the malware **DarkSeoul** that was activated in March 2013 in all infected computers at the same time[91]

The DoD agency **Defense Advanced Research Projects Agency DARPA** has initiated the project ‚**Plan X**' that also included a partially classified workshop on 27 Sep 2012. Due to the essential role of attribution in cyber warfare, a goal within this project is the mapping of the entire cyberspace (computer and other devices) for visualization and planning of cyber actions[92]. The research budget for Plan X is 110 million US-Dollars.

2.2.6 Professional cyber war

While cyber attacks historically started with spontaneous hacking, there is an ongoing trend to establish professional structures and processes.

[89] Mandiant 2013
[90] Daily Yomiuri online 03 Jan 2012
[91] Darnstaedt/Rosenbach/Schmitz 2013, p.76-80
[92] DARPA 2012, Nakashima 2012b

On the military level, this includes the systematic training. As an example, US Navy trains 24,000 people per year in their **Information Dominance Center** and the US Air Force has initiated a course (first completers in June 2012) at Nellis Air Force Base in Nevada to train how to detect electronic intruders, defend networks and launch cyber attacks[93].
However, the way is going forward to establish formal cyber officer careers as the US Air Force 17 deltas officer (**17D officer**) since April 2010 as a specialization pathway for communication officers[94]. An undergraduate cyber training (UCT) was also established to provide basic knowledge and how to defend the network, but continue to operate at the same time[95].
The US Department of Homeland Security DHS has meanwhile conducted its own young hacker contest to recruit skilled cyber personnel, the Virginia Governors Cup Cyber Challenge[96].

China reported in 2011 to have a group of 30 cyber experts called the **Blue Army** and to have a cyber training center in Guangdong[97].

The Russian Ministry of Defense started in 2012 an information research project including "methods and means of bypassing anti-virus software, firewalls, as well as in security tools of operating systems"[98]. In addition, an All-Russian hacker competition was initiated to recruit skilled young cyber professionals[99].

Media in Israel have reported the creation of a new military category, the 'attacker', who could affect the adversary remotely, e.g. via drones or via cyber operations (while the 'fighter' category includes soldiers who are physically present in a conflict). Also, the training of **cyber defenders** has started and the first course was completed in 2012. As preparation, an intensified cyber education is offered at schools, in addition 'cyber days' for education in ethical (white hat) hacking are conducted by the army and hacker contests[100].

Also, the United Kingdom plans to establish the **Joint Cyber Reserve** as a cyber army for defense and counterstrikes in cyber conflicts. The government plans to invest 600 million Euros[101].

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[93] Barnes 2012
[94] Schanz 2010, p.50ff., Franz 2011, p.87. Instead of the widely used term **cyber warrior**, the more formal term **cyber warfare operator** was introduced.
[95] Black cited by Schanz 2010, p.52
[96] Perlroth 2013, p.1. The news agency Reuters reported on 19 Apr 2013 that the NSA and the US Air Force Academy made an inter-agency hacker contest in a three-day cyber war exercise. The NSA has set up a comic series **CryptoKids** for children, Pofalla 2013, p.44.
[97] Kremp 2011
[98] Citation in Pravda 2012
[99] Pravda 2012
[100] Croitoru 2012, p.30
[101] Spiegel online 2013

The creation or modification of cyber warfare weapons, systems and tools as well as cyber defense require teams that include specialists for certain systems, software, hardware, SCADA applications etc.[102] Moreover, during the cyber operation offensive and defensive roles need to be clearly defined.

Finally, cyber attacks are increasingly based on systematic analysis, pre-tests in simulations and test environments before approaching the real target. This is done to reduce risk of discovery and attribution, to prolong the duration of successful attack and to expand the attack volume[103].

Also, the staff recruitment methods by intelligence and military have made significant progress. Studies have shown that the historical distance between hackers and state organizations has changed to a growing acceptance and interest to work for the state under certain circumstances[104].
As a consequence, recruitment methods for cyber security-related positions are now easier[105].

2.2.7 Is Cyber war overhyped?

Intense discussions are going on whether the cyber war debate is a kind of hype or myth which e.g. used by military institutions to justify their expansion in the cyber sector. A key argument presented is that a real cyber war probably did not happen in Estonia 2007, which is one of the most cited cyber war examples. For some authors, the attacks were too uncoordinated and unsophisticated to come from Russian state organizations; instead, they were assumed by these authors to be caused by patriotic **script kiddies**, i.e. attackers using simple standard tools that are available in internet[106].

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[102] Zepelin 2012, p.27, Chiesa 2012, slide 64, Franz 2011, p.88. Bencsath estimated e.g. that the development of the Flame spyware that was discovered in 2012 required up to 40 computer-, software- and network specialists, FAZ2012a, p.16

[103] Zepelin 2012, p.27. According to Chiesa 2012, publicly unknown security gaps (zero day-exploits) are also traded, refer to slides 77 to 79. Moreover, standardized malware creation tools are available on the market, refer to Isselhorst 2011, slide 9

[104] Zepelin 2012, p.27. Krasznay 2010 cited by Chiesa 2012, slide 69.

[105] Zepelin 2012, p.27. The following may illustrate the open approach: When searching in 2012 in US for cyber war issues (search words including the term cyber war) on *startpage.com*, a service allowing anonymous search on Google, it could happen that a sponsored link from the NSA appeared (also visible on *ixquick* or *metacrawler*). This offered cyber careers under the link www.nsa.gov/careers saying "National Security Agency has cyber jobs you won't find anywhere else!". The CIA also set up an own search engine ad "CIA Cyber careers – The work of a Nation – cia.gov The Center of Intelligence –Apply today" and opened in June 2014 an official Twitter account.

[106] Luschka 2007, p.1-3

Another argument presented is that most cases of cyber war as shown in the next section were only cases of cyber espionage, which as conventional espionage is usually not considered as an act of war.
However, there are some significant differences between conventional (physical) espionage and cyber espionage:
It takes a long track of training and covert actions until a conventional agent is placed in a position to gain sensitive information and he is permanently exposed to a high personal risk of discovery and punishment[107]. In cold war, it took years to export thousands of pages of sensitive information.
Cyber espionage can be done from home and even in case of discovery, the probability of punishment is low. It takes only seconds to export thousands of pages from an intruded system. As a result, cyber espionage is much more frequent and aggressive than conventional espionage.
But more importantly, the modern cyber weapons allow installing backdoors and to decide on attack escalation and manipulation later. If a critical system is successfully intruded for espionage, the intruder has the option to damage it, i.e. the border between passive espionage and active damage is now diminishing.

And finally, conventional weapons are increasingly based on computers, so cyber activities do affect conventional capabilities as well. As a result, the size of cyber staff in military is increasing, the Cyberspace Operations and Support Staff of the US Air Force included 63,828 persons, thereof 4,095 officers as of May 2012[108].

In summary, not any larger cyber attack may be an act of war and the terminology has to be used cautiously, but the cyber war problem should nevertheless be taken seriously[109].

2.2.8 Smartphone security

Eavesdropping of government smartphones[110] is only a part of security problems emerging from smartphones, personal digital assistants (PDAs) and tablet PCs. The smartphone is increasingly replacing the computer in daily routine such as web access and email-work, also the trend is going forward to use smartphones as **virtual master key** for online banking, control of smart homes[111], energy supply by smart grid and later on also for control of cars in the upcoming **e-mobility**

[107] A short and simple introduction into the topic is presented by Melton 2009, p.200ff.
[108] Matthews 2013, p.8
[109] The growing relevance of drones and cyber warfare is reflected by the US plan to create a new medal in 2013 for distinguished warfare for drone pilots and cyber warriors, the first one since 1944. This plan was cancelled after veterans and others said, that these fighters maybe under high stress, but are not directly exposed to hostile fire, NTV 2013.
[110] Graw 2013,p.4-5. Respective incidents were e.g. reported for Indonesia, Germany, Brazil.
[111] RWE 2013

projects[112][113]. The '**bring your own device (BYOD)' concept** describes the option for wireless coordination of multiple devices and machines by a key device. While currently coordination of entertainment devices is increasingly done by Triple play hard disk recorders or e.g. by the X-Box, the trend may also go forward to do this via smartphone or tablet. The BYOD philosophy creates a kind of **shadow IT** in companies which is quite difficult to control and to protect[114].

As a result, intruders will not only know all private data, control online banking and locate users by the mobile phone cell systems, but could control the household and the cars.
Relevant intrusion strategies (*in addition* to all standard threats resulting from email and internet access) [115] are simple collection of electromagnetic waves by radio masts (GSM standard is not secure[116]), mimicking radio masts by **IMSI-Catchers**, access to node servers or cables of node servers[117], implanting viruses and Trojans by infected Apps, unauthorized data use by hidden App properties[118], or sending invisible and silent SMS messages (**stealth SMS**) to transfer spyware such as *Flexispy* [119].
Crypto-mobile phones with end to end encryption are the suggested secure solution, but have some disadvantages, as they are cumbersome to handle and both sides need to use the same mobile phone, otherwise encryption is inactive[120].

2.2.9 Intelligence Cooperation

Media reports in 2013 gave the impression, that Intelligence cooperation is focused on computers and Signals Intelligence SigInt. However, intelligence cooperation was created during World War II, and was expanded during Cold War and in response to growing terrorist activities already in the decades before 9/11. As a result, the intelligence cooperation also includes the collection and analysis of information derived from human intelligence (HumInt), imaging intelligence (ImInt) and open source intelligence (OsInt)[121].

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[112] Heinemann 2013, p.3.
[113] There is also another trend to integrate IT structure with internet connection into cars, e.g. the plans to integrate Google Android into Audi cars. Researchers have found four classes of vulnerabilities, the **Car to X connection** to servers outside the car, the security of infotainment devices within the cars, the immobilizer functions and the internal interfaces of car components. Based on recent tests, it is apparently still (too) easy to intrude the IT infrastructure of cars; Karabasz 2014, p.14-15.
[114] Müller 2014, p.16
[115] Ruggiero/Foote 2011
[116] FAZ 2013c, p.14
[117] Wysling 2013, p.5
[118] Focus online 2013
[119] Welt 2013, p.3, Opfer 2010
[120] Drissner 2008, p.4, Opfer 2010
[121] Best 2009

The system of intelligence cooperation can be sorted into three levels, the intelligence cooperation within one country (**intelligence community**), the widespread bilateral intelligence cooperation and the multinational intelligence cooperation. Many countries have multiple intelligence organizations that cover inner and external security and civil and military issues. There is a never-ending discussion about the optimum size and number of organizations: a single organization may be too large to be controlled, also the potential damage in case of intrusion could be serious and internal communication maybe too cumbersome with the risk of information loss, late reactions and blind spots in analysis. Smaller organizations have specialization advantages and may be more focused on certain topics, but there is a risk of overlapping actions and responsibilities, internal competition and communication issues. The standard solution is to have multiple organizations with a coordinating level[122]. The largest Intelligence Community is in the US (formally established in 1981) where the **Director of National Intelligence DNI** (since 2004 in response to 9/11) coordinates all organizations, 8 of them are forming the military umbrella organization **Defense Intelligence Agency DIA**[123].

The second level is a network of **bilateral intelligence cooperation**, e.g. Germany has relations with more than 100 countries[124]. Depending on quality of political relationship, there may be formal official intelligence representatives and/or as (more or less) accepted alternative, intelligence staff as diplomatic (embassy and consulate) staff. This is necessary to detect, discuss and resolve bilateral intelligence-related incidents and topics.

The highest level is the **multi-lateral cooperation**, because even the largest intelligence organizations have limited human, technologic and budgetary capacities to achieve a global coverage. The information mode is typically as follows[125]:

- **Do ut des** – if you give something, the other one has to give something, too
- **Need to know** – only necessary information is provided, this is also important if the organization is infiltrated or agents are captured by adversaries

[122] Carmody 2005
[123] Air Force Intelligence, Surveillance and Reconnaissance Agency (ISR), United States Army Intelligence Corps (G2), Office of Naval Intelligence (ONI), Marine Corps Intelligence Activity (MCIA), National Geospatial-Intelligence Agency (NGA), National Reconnaissance Office (NRO) for satellites, National Security Agency (NSA) for SigInt. Non-military organizations are the Central Intelligence Agency (CIA), Office of Intelligence and Counterintelligence (Department of Energy), Bureau of Intelligence and Research (INR) (State Department), Office of Intelligence and Analysis (OIA) (Department of Finance), Office of National Security Intelligence (NN) (Drug Enforcement Administration DEA), Homeland Security DHS and Federal Bureau of Investigation (FBI). DNI Handbook 2006
[124] Daun 2009, p.72
[125] Jäger/Daun 2009, p.223

- **Third party rule** –an information received from second parties should not be given to third parties without approval
- **Assessed intelligence** – no raw data to protect knowledge on methods and sources[126].

Based on this exchange logic, smaller groups can easier have deep cooperation. US has established already after World War II the declassified **5-eyes** cooperation with UK, Canada, Australia and New Zealand and in response to 9/11 (officially not confirmed, reported in 2013 by *The Guardian* and others in November 2013) a wider cooperation the **9-eyes** cooperation including Denmark, France, Netherlands and Norway and the **14-eyes** cooperation additionally including Belgium, Italy, Spain, Sweden and Germany[127].

In the European Union, cooperation started with small counter-terrorist working groups in the 1970ies and was stepwise expanded. The Joint Situation Center **SitCen** (which since 2010 is subordinated to the **Standing Committee on operational cooperation on internal security COSI**)[128] is analyzing information provided by member state organizations, counter-terrorist working groups etc. [129] Africa has established the multinational cooperation **Committee of Intelligence and Security Services of Africa CISSA** a part of the African Union (see Section 4.7).

[126] vgl. Wetzling 2007
[127] See e.g. Shane 2013, p.4
[128] Note of 22 October 2009 which was followed by a Draft Council Decision: Council Decision on setting up the Standing Committee on operational cooperation on internal security (EU doc no: 16515-09 and EU doc no: 5949-10).
[129] Scheren 2009

3. The Practice of Cyber war

3.1 Introduction

In reality, cyber war is defined in literature as c*yber attack with damaging effects which was presumably conducted or supported by states due to their extent and/or complexit*y.

For analysis, please note a **very important abnormality**: in contrast to conventional conflicts, the information on the incident **is presented by one side only**, mostly by the victim, in exceptional cases by the attacker (Section 3.2.6). This unilateral information makes it extremely difficult to create objective evidence and analyses.

3.2 Cyber war from 1998-today

3.2.0 Cold war: Pipeline explosion in the Soviet Union

The Soviet Union tried to get high-tech control systems for their own pipelines which were not legally accessible due to the restrictions of the cold war. Nevertheless, the USA tolerated the theft, but managed to install a software bug that increased the internal pressure in the Chelyabinsk pipeline above maximum range in 1982[130]. A three kilotons explosion resulted which equaled 20% of the nuclear bomb of Hiroshima[131]. However, Russia contradicted to this presentation of events.

3.2.1 Moonlight Maze 1998-2000

Within nearly two years from 1998 on, **Moonlight Maze** was a series of attacks with probing of computer systems at the Pentagon, NASA, Energy Department and other private actors and tens of thousands of files were stolen. The US Defense Department assumed Russia as origin of attacks, but Russia denied any involvement[132].

3.2.2 Yugoslavian war 1999

Some authors believe that the first cyber war-like action was the blockade of Yugoslavian Telephone networks by the NATO during the Kosovo conflict in 1999[133]. Following the accidental bombing of the Chinese embassy in Belgrade, Chinese hackers attacked US government websites such as the website of the White House[134].

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[130] Kloiber/Welchering 2011, p.T6
[131] Falliere 2010, Herwig 2010
[132] Vistica 1999
[133] Hegmann 2010
[134] Hunker 2010, p.3. For the NATO, not only cyber war, but all forms of cyber attacks are relevant, Hunker uses the term **cyber power**.

3.2.3 The Hainan- or EP3-incident 2001

After a collision of a US reconnaissance plane of type EP-3 and a Chinese fighter jet, known as the Hainan or EP-3 incident, probably patriotic Chinese hackers released the worms *Code Red* und *Code Red II*, which resulted in nearly $2 billion in damages and infecting over 600,000 computers. This resulted in system downtimes and Website defacements, with the phrase „hacked by Chinese“[135].

3.2.4 Massive attacks on Western government and industry computers

Civil and military networks are main targets, but also arms manufacturers are of interest; US experts believe that a **cold cyber war** with China is already ongoing[136]. China was suspected to take away at least 10-20 terabytes of data from respective US computers in 2007; in the same year 117.000 internet-based attacks on Department of Homeland Security computers were reported. These activities followed a series of attacks which took some years and which was called **Titan Rain** by the US[137]. Also the German Federal Government reported attacks on their computer systems at a similar.

The analysis of Titan Rain revealed an attack pattern similar to the following: a team of 6-30 hackers takes control of computers, copies everything on the hard drive within 30 minutes, and then send that via a botnet to computers in the Chinese province of Guangdong, however, this could not be definitely proven[138].

Also, there are several media reports about Russian and Chinese attempts to intrude the systems of the Pentagon and the White House in the years 2007-2008. ArcSight reported 360 million attempts to break into the Pentagon in 2008[139]. Moreover, they reported that 1,500 pentagon systems were shut down after the U.S. Defense Secretary’s e-mail was breached. A successful intrusion in the Pentagon system resulted from an infected USB stick that was inserted into a computer linked to the Pentagon by a naive soldier in the Near East region[140]. The infection by a worm called **agent.btz** led to a set of security measures called **Operation Buckshot Yankee** which also included the creation of the US Cyber Command[141].

Other large-scale cyber attacks were **GhostNet** and **Operation Aurora** in 2009. According to BBC news, **GhostNet** was a large-scale computer virus attack on the embassies (amongst others) of India, South Korea, Indonesia, Thailand, Taiwan,

[135] Fritz 2008 and also Nazario 2009, who gives in his paper an overview on politically motivated relevant DoS attacks.
[136] Hegmann 2010, p.5. ‚Cold’, because it was espionage without the intention to damage the systems. This term shows how difficult an exact definition of cyber war is; see also Herwig 2010, p.61
[137] Fischermann/Hamann 2010
[138] Fritz 2008, p.55 and also Stokes 2005
[139] ArcSight 2008, p.2
[140] Glenny 2010, p.23
[141] Brown/Poellet 2012, p.131

Germany and Pakistan and the foreign ministries of Iran, Bangladesh, Indonesia, Brunei and Bhutan.
China was suspected to be the origin of the attack as the computer of the Dalai Lama was infected, too, but this could not be definitely proven. The virus was able to activate webcam and microphones to control the room where the infected computer was standing.
Within the **Operation Aurora** presumably Chinese intruders tried to gain access to computer programs and source codes of companies of the IT sector (such as Google and Adobe) and from high-tech companies of the security and defense sector in 2009[142]. Two further coordinated large-scale cyber attacks have been conducted against global oil, energy, and petrochemical companies (**Operation Night Dragon**) and against 72 global organizations over 5 years from July 2006 on (**Operation Shady RAT**), but China strongly denied involvement[143][144]. 2011 further attacks were reported, that affected in particular Google's mail service Gmail and the armament company Lockheed Martin[145].

Recently, two targeted high-level attacks were reported with a combination of spear-fishing, installed backdoors and covert communication to the intruding servers.

In Feb 2013, a new malware called **MiniDuke** was discovered by Kaspersky Lab. This consisted of 20 KB in the old computer language Assembler and was placed into PDF-files that sent with spear-fishing the emails. By this, 59 computers in 23 states were infected. The malware worked as beachhead to allow installation of further malware. MiniDuke was able to check whether it was in a **virtual machine** (simulated computers) and used Twitter for communication with attack servers. Also, information was hidden into small pictures, a method known as **steganography**. Such virtual machines can be part of cloud systems, but are also used as analysis tool for malware and in such machines, the program was inactive then to prevent analysis[146].

A similar high-level infection of diplomatic and government institutions from 2007 to 2013 was **Red October**. By spear-phishing, a Trojan was placed on the victim computers to extract files also from machines using the classified software *acid cryptofiler* [147].

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[142] Markoff/Barbosa, 18 Feb 2010
[143] Alperovitch 2011, McAfee 2011. RAT stands for remote administration tool.
[144] FAZ 2011b, p.7
[145] Koch 2011, p.20. There is a possible relationship between the attack on Lockheed Martin in May 2011 and on the IT security company RSA in March 2011, where information on the widespread security system **SecurID** was hacked, FAZ 2011a, p.11. RSA has developed the ‚Secure Cloud' concept for Lockheed Martin; Fuest 2011
[146] Raiu/Baumgartner/Kamluk 2013
[147] Kaspersky Labs 2013

In February 2014, another cyber attack was reported by Kaspersky Labs[148]. The malware **Careto (Mask)** was able -amongst other many functions- to record Skype VoIP talks. As in various other sophisticated cyber attacks, only a few computers were infected, but the profile of the targets is quite typical: research units, providers of critical infrastructures, diplomats, embassies and political activists.

3.2.5 The attack on Estonia in 2007

In 2007, the systems of Estonia were massively attacked by a distributed denial of service attack after moving a Russian memorial that represented for Russia the liberation of Estonia from Hitler, but was perceived by Estonia as symbol of repression[149]. Estonia's networks were flooded by data from Russia, however probably not by the state, but by patriotic organizations[150][151]. Some computers had an increase from 1,000 requests *per day* to 2,000 requests *per second* and the attack went on for weeks[152].

3.2.6 The attack on Syria 2007

On 06 September 2007, a suspected nuclear plant in Eastern Syria was destroyed by Israeli air attacks. Such an attack required a long route through the Syrian air space. Israel was technically able to simulate a free heaven to Syrian air defense systems and could thus conduct this attack without disturbance. This is a very good example how cyber war can be used as an additional tool within conventional attacks[153].

3.2.7 The attack on Georgia 2008

Already before the start of conventional war between Georgia and Russia in 2008 Georgia noted massive cyber attacks against its critical infrastructure systems e.g. in the media, banking and transportation sectors[154]. Some weeks before the website of the Georgian President was shut down by a distributed denial of service (DDoS)-attack on 20 July 2008. Also, web site defacement was executed and photos of Hitler were put next to photos of the Georgian president. One day before conventional attack, a massive DDoS attack seriously affected the Georgian IT systems.

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[148] Kaspersky 2014
[149] Busse 2007
[150] Later on the patriotic Youth Organization **Naschi** ('our people') said that they conducted the attack, Frankfurter Allgemeine Zeitung 11 Mar 2009
[151] Koenen/Hottelet 2007, p.2
[152] Wilson 2008, p.7ff.
[153] Herwig 2010, p.60
[154] refer to official statement of government of Georgia 2008

3.2.8 Intrusion into US electricity net 2003-2009

Also during the power failure of 2003 it was discussed whether this was caused by a computer virus[155]. In August 2003, the worm *Slammer* intruded the nuclear power plant in David-Besse in Ohio, but luckily this was turned off anyway at that time[156]. Since 2006 nuclear power plants were shut down two times after cyber attacks[157]. In April 2009, hackers successfully intruded the US electricity net control[158] and installed programs that allowed manipulation and turn-off. China was suspected, that denied and also Russia.

3.2.9 Intrusion of US drones 2009/2011

Iraqi insurgents were able to use commercially available software to intrude U.S. drones which allowed them to view the videos of these drones[159]. In 2011, the Creech Air Force Base in Nevada that serves as control unit for Predator- and Reaper- drones reported a computer virus infection; but the US Air Force denied any impact on the availability of the drones[160]. Also, Iran was able to capture a US drone (type RQ-170) in 2011[161].

The US Navy decided in 2012 to switch the drone control bases to Linux which will be done by the military company Raytheon, the estimated costs are 28 million dollars[162]. The vulnerability of drones depends also on the drone type with can have different control modes and grades of system autonomy[163].

3.2.10 Local cyber conflicts

An increasing number of local military and/or political conflicts are accompanied by more or less coordinated cyber attacks which may occur over a longer period of time. These attacks can also affect computers of the opponents' security structure, but activities may be accompanied by parallel media campaigns[164]. Important examples, out of many, are the conflicts of India and Israel with actors from neighbor states[165]. During the Crimea crisis in March 2014, cyber attacks were reported between Russia and Ukraine, also the Russian military firm **Rostec** claimed the capture of a US MQ-5B drone over the Crimea peninsula by electromagnetic jamming[166].

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[155] Gaycken 2009 with picture of power failure in Northeast USA 2003
[156] Wilson 2008, p.22
[157] ArcSight 2009
[158] Goetz/Rosenbach 2009, Fischermann 2010, p.26
[159] Ladurner/Pham 2010, p.12
[160] Los Angeles Times 13 October 2011
[161] Bittner/Ladurner 2012, p.3. As intrusion method, the use of a manipulated GPS signal (GPS spoofing) was discussed, but this could not be proven.
[162] Knoke 2012
[163] Heider 2006, p.9.
[164] Saad/Bazan/Varin 2010
[165] Saad/Bazan/Varin 2010, Valeriano/Maness 2011, Even/Siman-Tov 2012, p.37
[166] FAZ online 2014

3.2.11 The ‚digital first strike' by Stuxnet, DuQu and Flame 2005-2012

A series of sophisticated spyware programs and Trojans was deployed to computers mainly in Iran from end of 2006 on. A very large computer program called **Flame** served as technology platform for development and application of further programs such as **DuQu** and later on **Stuxnet** that affected uranium centrifuge control in Iranian nuclear facilities. In 2011 and 2012, US newspapers have reported that these activities were part of an US-Israeli plan called '**Olympic Games**' to stop Iran's nuclear plants, but this was officially not confirmed. The following section presents the events by order of discovery.

Industrial Control Systems ICS such as Supervisory Control and Data Acquisition SCADA[167]) allow remote control of and communication with machines.

Stuxnet is a malware that was used for the first large-scale attack on SCADA systems, here on Siemens systems in particular[168].

Stuxnet is a **worm,** i.e. a program that is able to spread actively to other systems[169]. The infection was started via an infected USB-stick and Stuxnet exploits security gaps in Windows LNK-files to intrude systems[170]. Falsified security certifications (digital signatures) of Realtek and Semiconductor, which were not aware of this, helped Stuxnet to install itself in the operating system Windows 7 Enterprise Edition[171].

The Simatic S7-system of Siemens is running under a Windows environment, also the WinCC software for parameter control and visualization[172]. Stuxnet executes a systematic search for WinCC and the Step 7-software in Simatic S7 to detect and to infect the versions S7-300 und S7-400, but only if a CP 342/5 network interface is used thus demonstrating a high selectivity of Stuxnet[173]. In case of success, Stuxnet starts to send information to external servers, thereof two servers in Malaysia and Denmark. Stuxnet also contains rootkits, i.e. tools for control of computers[174].

Stuxnet is also searching for other applicable systems by exploiting the *autorun*-function of Windows. After a certain number of successful infections, Stuxnet deactivates itself[175]. It was assumed that uranium gas centrifuges needed for construction of nuclear bombs were damaged in Iran, as the number of centrifuges

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[167] Shea 2003
[168] Welt online 2010b. Consequently, Siemens expands its cyber war research capacities, Werner 2010, p.7
[169] As Stuxnet has dozens of functions and tools, it sometimes also described as Trojan horse or virus, FAZ2010a.
[170] On 13 Oct 2010 Microsoft released 16 Updates to cover 49 security gaps, Handelsblatt 2010, p.27
[171] Rieger 2010, p.33, who invented the term ‚digitaler Erstschlag' (‚digital first strike').
[172] Krüger/Martin-Jung/Richter 2010, p.9
[173] Schultz 2010, p.2
[174] Kaspersky 2010
[175] Falliere 2010

declined in 2009 and the International Atomic Energy Agency (IAEA) reported downtime also in 2010[176], which was confirmed by Iran[177][178].
These issues, the use of several unknown security gaps (**zero-day-exploits**) and the estimated development costs of about 1 Million US-Dollars[179] resulted in the theory of a new weapon constructed by secret services to damage the Iranian nuclear program[180].

The above Stuxnet properties are applicable for Stuxnet Version 1.0 or higher. Symantec reported in 2013 that earlier versions existed that can be distinguished via different exploits used for intrusion. Stuxnet version 0.5 was developed from November 2005 on and used from November 2007 on. The infection was done via Step 7 Systems only and led to a random close of valves which could damage the uranium gas centrifuges. Infections with version 0.5 stopped in April 2009[181].

The New York Times reported on 15 Jan 2011 that the Department of Homeland Security and the Idaho national laboratories as part of the US Energy department checked Siemens systems for vulnerabilities in 2008[182]. In the same article, it was speculated that findings from these tests were then possibly used by an Israeli-US-intelligence cooperation to develop Stuxnet after they were able to build models of the uranium gas centrifuges for test purposes.

On 01 June 2012, the New York Times reported that Stuxnet was part of a cyber attack program called **Olympic Games** that was initiated in 2006 by the former US president George W. Bush[183]. The reports of the NY Times were *not* officially confirmed, but elements of the 2012 article were regarded by US Government officials and politicians as unauthorized disclosure of confidential information (but it was not said *which* elements) [184].

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[176] FAZ2010c, p.6
[177] refer to FAZ2010d, p.5, where it was also reported that on 29 Nov 2010 the leading cyber expert and coordinator of a Stuxnet task force, Madschid Schariari, was killed.
[178] The Institute for Science and International Security (ISIS) assumed due to respective findings in the Stuxnet code and the temporary reduction of available uranium gas centrifuges in Iran, that possibly 1000 Type IR-1 centrifuges were affected by Stuxnet. According to this analysis, Stuxnet could change the rotation frequency from the nominal value of 1064 Hertz to 1410 Hertz or to 2 Hertz leading to an unusual amount of centrifuge breakage (such breakage however also can occur during normal usage); ISIS 2010. Stuxnet also secretly recorded normal functions and simulated normal function to plant controllers during its actions, Broad/Markoff/Sanger 2011, p.3.
[179] Schultz 2010, p.2
[180] Ladurner/Pham 2010, p.12
[181] McDonald et al. 2013, p.1-2
[182] Broad/Markoff/Sanger 2011, p.4
[183] Sanger 2012, p.3
[184] NZZ 2012, p.1, FAZ 2012b, p.7

Erroneously, Stuxnet infected the computer of an engineer and then spread over the internet to other countries[185]. This would explain why other states were also affected, in particular Indonesia, India, Azerbaijan and Pakistan, and also many other states such as the USA and Great Britain[186]. Moreover, Stuxnet was not perfect even from the perspective of the attacker: Stuxnet was programmed to act within a certain time window, but as some internal computer clocks are altered to bypass license agreements, this did not work. Thus, Stuxnet was probably highly selective with regard to the system, but not with regard to time and location of attack[187].

Stuxnet may have unintended effects. The designers of Stuxnet have shown their sophisticated understanding of cyber war, but now this knowledge is disclosed to the public[188].
The German media reports on Stuxnet showed a strange ‚reporting gap' of 2 months. Newspapers started articles around mid of September 2010, while Stuxnet was already discovered in June 2010 by a Belorussian company. A commercially available protection software was already released since 22 July 2010, refer also to the report of *Bloomberg Businessweek* on 23 July 2010. The Iran confirmed the Stuxnet attack already on 26 July 2010 in *Iran Daily*[189]. Siemens confirmed that 15 clients were affected, thereof 60% in the Iran. Possible explanations for this gap may be the upcoming assumption of intelligence involvement, a presumed infection of the nuclear plant in Buschehr and the debate of the new NATO strategy[190].

The Stuxnet attack was accompanied by other activities. Significant portions of the source code of industry spyware **W32.DuQu** that was detected in September 2011 were identical to Stuxnet[191]. DuQu used a stolen security certificate from a Taiwanese company for intrusion and was e.g. able to make screenshots, keylogging and to extract information and like Stuxnet it had an expiry date with self-destruction[192]. It was speculated that DuQu may have been created to gain information from the target systems for creation of Stuxnet[193].
After Iranian oil terminals were affected by a data destruction virus called **Wiper** in April 2012, the security company Kaspersky Labs discovered another

[185] Sanger 2012, p.6
[186] Handelsblatt 2010, p.27, Symantec 2010, p.5-7
[187] Gaycken 2010, p.31 explained that the time window of Stuxnet was repeatedly changed by the attackers, acc. to Symantec (2010, p.14) to 24 Jun 2012
[188] Rosenbach/Schmitz/Schmundt 2010, p.163; Rieger 2011, p.27
[189] Iran Daily 26 July 2010
[190] Knop/Schmidt 2010, p.20
[191] Goebbels 2011, p.8. The name came from the DQ-prefix used in the program files.
[192] Goebbels 2011, p.8
[193] Welchering 2012, p.T1

multifunctional 'virus'[194] in May 2012 named **Flame** that gives very detailed system information about the infected systems and that again had some technical overlaps with Stuxnet[195]. Washington Post reported that Flame was already developed in 2007 and also part of the cyber activities against Iran[196]. The program part that allowed the distribution of Flame via USB-sticks was first used in Flame and then in Stuxnet[197].
Later in 2012, further malware technically related to Flame was reported: the Trojan **Gauss** collected information on financial transactions, e.g. from banks in Lebanon and a small Flame variant called **Mini-Flame**[198].

[194] Flame was much larger than normal viruses with 20 MB and functions included key logging, screenshots, control of audio functions, data flow and it had access to Bluetooth applications, Spiegel 2012, p.123. Like Stuxnet, it had also a self-destruction function. The name came from the word flame used in the program files. Flame is an example, why the conventional differentiation between viruses, worms and Trojans becomes less relevant.
[195] Welchering 2012, p.T1, Graf 2012, p.8, Gostev 2012, p.1
[196] Graf 2012, p.9
[197] Nakashima/Miller/Tate 2012, p.1-4
[198] Focus 2012, Symantec 2012, Mertins 2012, p.10

4 The security architecture of the cyberspace

4.1 Basic principles

In general, the security sector is divided into three sectors; the civil sector which is usually responsible for the protection of critical infrastructures, the Intelligence sector which is responsible for analysis of communication and data flow (**Signals Intelligence SigInt**) and the military sector. Often the offensive cyber war capacity is assigned to the military sector, at least the official and unclassified capacities.

4.2 The Federal Republic of Germany

In the civil sector, the key organizations are the **Federal Ministry of the Interior (Bundesministerium des Innern BMI)** and the subordinated **Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik BSI)**.

The **Federal Office for Information Security BSI** is the government agency in charge of managing computer and communication security for the German government since 1991. The predecessor of the BSI was the cryptographic department of Germany's foreign intelligence agency (BND). With the rise of the Internet and the end of cold war there was a need for an agency for the new technical challenges. Within Germany's foreign intelligence agency, the central service for information security was created in 1989 (Zentralstelle ZSI), and then the new BSI in 1991. The new amendment of the BSI-Act BSIG von 2009 has significantly strengthened the central role of the BSI for information security matters in Germany, in section 5 of the amendment also for the government communication[199].

Important responsibilities and projects are e.g.[200]:

- member of the German Critical Infrastructure working group (AK KRITIS)[201]
- communication security for the German government, e.g. by recommending encrypted mobile phones, but also by maintaining the **Berlin-Bonn Information Network (IVBB)** and the **Federal Administration Information Network (IVBV)** that is regularly scanned by the BSI for malware since 2009[202]
- document protection within **Government** procedures

[199] Act to Strengthen the Security of Federal Information Technology dated 14 August 2009
[200] Refer to Annual reports of the BSI 2005, 2006-2007 and 2008-2009 and 2010
[201] As part of the National Plan for Information Infrastructure Protection (NPSI) BMI and BSI were asked in 2005 to prepare an implementation plan for critical infrastructures (German Umsetzungsplan KRITIS)
[202] Steinmann 2010, p.10

- Protection of NATO communication via encryption technology, in particular **Elcrodat 6.2**
- BSI provides the Secure Inter-Network Architecture (SINA) to allow very secure communication via the ordinary internet
- BSI works on communication security (**Comsec**) projects such as shielding of buildings[203]
- Work on **computer resilience**[204] and on the **micro kernel's architecture** is based on firewalls within the computer sealing off the program segments from each other
- As part of the National Cyber Security Strategy (Nationale Cyber-Sicherheitsstrategie für Deutschland) published on 23 Feb 2011, a **National Cyber Defense Center** with a staff of 10 people became operational at the BSI[205]. The efficacy of the cyber defense center was so far affected by coordination issues between member authorities (Government, Intelligence, Police etc.)[206].
- Also, a **National Cyber Security Council** that consists of the State Secretaries of all large federal ministries was established[207].

Within the Intelligence Sector, the Federal Office for the Protection of the Constitution (German: **Bundesamt für Verfassungsschutz BfV** and **Landesämter für Verfassungsschutz LfV** on federal state-level) is the Federal Republic of Germany's domestic intelligence agency, while the Military Counterintelligence Agency **(Militärischer Abschirmdienst MAD)** is responsible for the protection of the German army including cyber security and cyber defense[208]. The Germany's foreign intelligence agency **Bundesnachrichtendienst BND** is responsible for all foreign issues. The BSI is allowed to support intelligence agencies technically under certain circumstances.

In the military sector, the **Zentrum für Nachrichtenwesen in der Bundeswehr ZnBW** served several years as Intelligence Center of the armed forces, but was then divided between the Germany's foreign intelligence agency BND and the new

[203] To control problems such as the computer radiation which allows to detect the information that is shown on the computer screen, Schröder 2008

[204] Resilience means permanent availability. Not only cyber attacks, but physical damages by an **electromagnetic pulse** are relevant issues here.

[205] FAZ 2010g, p.4, Tiesenhausen 2011, p.11, BMI 2011

[206] Goetz/Leyendecker 2014, p.5

[207] A cooperation in the economic sector, the **International Security Forum ISF** with currently 326 member companies was established. In 2012, the German IT association BITKOM and the BSI founded the **Allianz für Cybersicherheit** (Cyber Security Alliance) with 68 member companies and 22 member organizations who cooperate in cyber defense matters based on confidentiality agreements, Karabasz 2013, p.14-15

[208] Rühl 2012, p.10

German Army Secret Service for Exterior Affairs (**Kommando Strategische Aufklärung KSA**) that was founded in 2002[209] and which has key functions in military intelligence since 2008. In 2010 it had a workforce of 6,000 people[210] and is responsible for

- the electronic warfare (Elektronische Kampfführung EloKa),
- since 2007, the KSA has a **computer- and network operation (CNO) unit**[211] which is also responsible for cyber war issues[212] and since 2012 ready for operations[213]
- the new military satellites Synthetic Aperture Radar (SAR-Lupe)[214] and the communication satellites COMSATBW1 and 2.

In the IT sector the German Army is working on a modern and secure IT platform (**Herkules**), which is built by a joint venture of Siemens and IBM called **BWI IT**. The Herkules project led to simplification of IT infrastructure, the amount of used software programs was reduced from 6,000 to less than 300; however the structure is still complex with an estimate of 140,000 computers[215].

In Germany, the federal states conducted the common exercise **Lükex 2011** from 30 Nov to 01 Dec 3011 using an attack scenario on critical infrastructures developed by the Federal Office of Civil Protection and Disaster Assistance (BBK) and the BSI[216].

The BND plans to establish a defense unit against cyber espionage with 130 employees from 2013 on[217]. From BND perspective, important attack sources are China and also Russia where (in contrast to China) state hackers would be organized as private firms. The BND also plans to develop counter-strike capacities to switch off servers of cyber attackers. The BND has set up the **Strategische Initiative Technik** (Strategic Initiative Technology SIT) to enhance real-time surveillance capabilities of metadata and other measures[218]. Also, it is planned to give more support to cyber defense, i.e. the information gained should

[209] Eberbach 2002
[210] Bischoff 2012
[211] Bischoff 2012
[212] Goetz 2009, p.34f., von Kittlitz 2010, p.33. On 01 July 2010, the information operations unit (Gruppe Informationsoperationen InfoOp), was relocated from the KSA to the Centre for Operative Information which is also part of the Joint Support Service Branch of German Army (Streitkräftebasis SKB) (Uhlmann 2010). This allows providing a centrally coordinated information policy for media and citizens.
[213] Steinmann/Borowski 2012, p.1
[214] Bischoff 2012. Acc. to Bischoff, SAR Lupe is also part of the German-French cooperation in satellite reconnaissance. Together with the French satellite Helios II it forms the basis of the European satellite reconnaissance cooperation ESGA. For 2017, a successor system of SAR-Lupe is planned, SARah.
[215] Handelsblatt 2014, p.16
[216] Spiegel online 2011
[217] Spiegel 2013b, p. 22, also Spiegel 2013c, p.15
[218] SZ 2014, p.1

help to prepare for cyber-attacks. However, the necessary funding of 300 million Euros until 2020 was not yet approved[219].

4.3 The cyber war strategies of the USA and of China

Presumably more than 100 countries try to establish cyber war capacities and US experts say that approximately 140 foreign intelligence agencies try to get access computers of US government and companies[220].
The USA and China are the most discussed actors with regard to cyber war. However, it this is no new 'East-West-conflict', e.g. India is concerned about of the cyber war in general[221].

4.3.1 Strategic goals

The primary aim of actors is to achieve and maintain **electromagnetic dominance** and **cyberspace superiority**[222] in particular, that is to control the cyberspace during a conflict. As the system of the adversary can be restored after some time, the practical goal is to achieve the **freedom of action** for the own forces and to limit the others at the same time. The cyber activities are combined with conventional operations.

The Chinese cyber strategy is to hit the enemy network first and to check the resulting ‚operational blindness' with conventional weapons and to continue attack, if possible[223]. Of course, the enemy may be able to repair the network and the strategy may not be successful, thus it is necessary to get electromagnetic dominance as early as possible and to maintain this as long as possible. Also the enemy may not be hit as expected and is still able to react. US studies indicated that such a war can only be conducted for a limited time.[224]

4.3.2 Cyber war capacities

The USA emphasizes the defensive character of their cyber war strategy with the **cyber triad** *resilience*, *attribution* and *deterrence*. Meanwhile, the **Comprehensive National Cyber security Initiative (CNCI)** was started to strengthen cyber security by enhancing cooperation between all actors and by

[219] Spiegel 2014, p.18
[220] Wilson 2008, p.12
[221] Kanwal 2009. At the end of 2010, the French Department of Commerce experienced a massive cyber espionage that presumably aimed to gain information on the strategy for the G20 Economic Forum in 2011, Meier 2011, p.9
[222] USAF 2010a, p.2
[223] Krekel et al. 2009
[224] Tinner et al. 2002.

increasing awareness and education of citizens. The defensive elements are emphasized in the **National Strategy to Secure Cyberspace** while the **National Military Strategy for Cyberspace Operations (NMS-CO)** is more focused on operational issues to achieve cyberspace superiority.

The USA has systematically developed their cyber war capacities in the last 2 decades[225].
In 1988, the Department of Defence DoD established a Computer Emergency Response Team CERT at the Carnegie-Mellon University[226].
In 1992, the Defensive Information Warfare Program was established that was accompanied by a Management Plan in 1995.
According to Hiltbrand, the Air Force established the Air Force Information Warfare Center (I.W.C.) in 1996. That same year, the Navy established the Fleet Information Warfare Center (F.I.W.C.) and the Army established the Land Information Warfare Activity (L.I.W.A.). In 1998, the Pentagon established the Joint Task Force for Computer Network Defense.
Thereafter, Cyber Commands were established within the military branches[227] and consequently, a central **Cyber Command** (US CYBERCOM) was established in May 2010 with an estimated staff of 1,000 people and which is led by the director of the National Security Agency NSA, General Keith Alexander[228]. Also, it is co-located with the NSA[229]. US CYBERCOM is subordinated to the Strategic Command US STRATCOM that plans and executes Cyberspace Operations[230].
The CYBERCOM is responsible for the protection of the domain ‚.mil' that is exclusively used by the US military, while the Department of Homeland Security DHS is responsible for the civil US government domain 'gov'[231].

A first large cyber exercise was the so-called **electronic Pearl Harbour** of the US Navy in 2002, where a massive attack on critical infrastructures was simulated. Since that time, the term ‚electronic Pearl Harbour' is often used as figure of speech for the consequences of cyber attacks.
Regular exercises are the **Cyber Storm** exercises; Cyber Storm I-IV were organized in the years 2006, 2008, 2010 and 2012 by the Department of Homeland Security (DHS) and again, the capability to defend against massive attacks was tested. For the DHS exercise in 2010, a new defensive tool was developed, an internet shut down by codes that alter the Border Gateway Protocol BGP that is

[225] Hiltbrand 1999
[226] Porteuos 2010, p.3
[227] USAF: 24th Air Force, Army Forces Cyber Command (ARFORCYBER), Fleet Cyber Command (10th fleet/FLTCYBERCOM) and Marine Forces Cyber Command (MARFORCYBER), refer also to Dorsett 2010
[228] Hegmann 2010, p.5, The Economist 2010, p.9/22-24, Glenny 2010, p.23
[229] DoD 2011, p. 5
[230] USAF 2010, p.21-22
[231] Porteuos 2010, p.7

needed to transport information between two providers[232]. It was planned to test these codes in California, but not done to avoid unintended internet breakdowns[233]. Such internet shutdown tools also known as "**kill switches**"[234].
In March 2007, the Idaho National Laboratories (INL) conducted the **Aurora Generator test** that demonstrated that it is possible to damage a generator by manipulation of control programs.

The question of whether a more offensive alignment is necessary, was discussed in the context of the strategy papers published in 2011, which were more defensively oriented.
The White House emphasized in its *International Cyberspace Strategy* from May 2011 that it will promote compliance with international norms and standards on the Internet to ensure the functionality and freedom of information[235].
The DoD released a Defense Strategy for Operating in Cyberspace in July 2011 which emphasizes the need for interagency cooperation as well as for an intensified public-private partnership to protect the Defense Industrial Base DIB.[236]
To strengthen cyber security considering the growing problems, e.g. by increasing intrusions of critical infrastructure, President Obama released an Executive Order on 12 Feb 2013 to establish a Cyber-security framework that involves the agencies involved in protection of critical infrastructures and is intended to identify, control, communicate and mitigate cyber risks for critical infrastructures[237].

An analysis of the DoD agency **Defense Advanced Research Projects Agency DARPA** has shown that information security software needs up to 10 million lines of program code while malware only needs an average of 125 lines of code[238]. From this perspective, it is necessary to rethink the research focus on defensive tools[239]. The NSA plans to handle Chinese cyber war issues in a more offensive

[232] Welchering 2011, p.T2
[233] Welchering 2011, p.T2 who also reported, that Egypt used these codes for an internet shut down on 27 Jan 2011 to restrict protests against government. The same method was reported for an internet breakdown in Syria end of November 2012, Spiegel online 2012b.
[234] von Tiesenhausen 2011, p.11
[235] White House 2011, in particular p.5 and 9
[236] DoD 2011, p.8-9
[237] White House 2013
[238] Dugan 2011, p.16/17: "Over the last 20 years, using lines of code as a proxy and relative measure, the effort and cost of information security software has grown exponentially—from software packages with thousands of lines of code to packages with nearly 10 million lines of code. By contrast, over that same period, and across roughly 9,000 examples of malware—viruses, worms, exploits and bots—our analysis revealed a nearly constant, average 125 lines of code for malware. This is a striking illustration of why it is easier to play offense than defense in cyber, but importantly, it also causes us to rethink our approach."
[239] As part of DARPA's Plan X research, one research area "focuses on building hardened "battle units" that can perform cyber warfare functions such as battle damage monitoring, communication relay, weapon deployment, and adaptive defense." DARPA 2012, p.2

way[240]. It was reported that the Presidential Policy Directive PPD 20 from October 2012 now defines the conditions under which cyber-attacks against foreign servers are allowed[241]. However, the activities for cyber defense are still going on[242].

Also the Chinese government is working on cyber war issues and is building cyber war capacities like many other states, too.
Compared to conventional war, cyber war is relatively cheap and allows to get to close the gap to other states much quicker than with massive expenses for conventional weapons („leapfrog strategy"). Cyber war cannot replace conventional capabilities, but helps to expand the own options quickly and also fits well with the concept of ‚**active defense**', where the early and quick elimination of possible retaliation of the enemy is an essential aim[243].
Also China is surrounded by states which have critical relations with China or are even allies of the USA[244], such as Japan, Taiwan and South Korea, so that China may currently not be able to apply major physical damage to the USA in case of serious conflict (e.g. in an escalating Taiwan conflict scenario). The cyber war can be done without distance problems, it allows making an asymmetric war and the cyber war training brings a lot of useful information, because intrusion can be used for cyber espionage also.

Analysis of Chinese cyber war-strategy by Northrop Grumman showed the critical points. There are three security levels, the normal civil net, the secured **Secret Internet Protocol Router Network SIPRNET** for critical infrastructure and government and close-to-military institutions and the third maximum security level for military operations[245]. The cyber war would be mainly directed against level 2 and would affect networked based warfare operations significantly[246][247].
However, other issues may be even more relevant for the future of computer and internet industry. China has 97% market share[248] for rare industry metals which cannot yet be recycled in an efficient manner and China is reducing the export

[240] Barnford 2010
[241] Biermann 2012, p.1. However, in other countries a legal framework for activities against foreign computers is discussed as well, e.g. in Switzerland, Häfliger 2012b, p.23
[242] According to Clauss 2012, the NSA is building the Utah Data Center which is planned to be able to store and analyze digital communication permanently from 2013 on, computerized analysis should be ready in 2018; Clauss 2012, p.60. However, defensive decryption and re-encryption of encrypted messages e.g. by secure socket layer (SSL)-interception is already now commercially available, Creditreform 2012, p.48.
[243] Kanwal 2009, p.14
[244] Rogers 2009
[245] In the USA, these are the Non-classified Internet Protocol Router Network NIPRNET, the Secret Internet Protocol Router Network SIPRNET and the Joint Worldwide Intelligence Communication System JWICS; in Germany the Herkules platform is similar to SIPRNET and the JASMIN database to JWICS.
[246] Krekel et al. 2009
[247] The Internet worm **Conficker** damaged in 2008 German army and French Marine, also military jets could not start for 2 days, Leppegrad 2009.
[248] Büschemann/Uhlmann 2010, p.19

volume to satisfy the needs of their domestic industry[249]. The extremely high market share resulted from low prices of Chinese metals which led to resignation of most competitors; however the search for and exploitation of such metals was restarted resulting in decreased prices[250].

Chinas People Liberation Army PLA is suspected to have specialized cyber units in approximately 6 main locations[251]. In 2013, the Cyber security company **Mandiant** presented an in-depth analysis of Chinese cyber activities[252]. The cyber war unit 61398 in the Datong Road in Pudong near Shanghai conducted 141 major cyber attacks on government institutions, companies and energy suppliers in the previous years and Mandiant stated that the hacker group APT1 may be identical with a state-backed cyber unit 61398 which was strongly denied by China. The standard cyber tactic was to send spear-phishing mails containing malware that installed small backdoor programs to allow further actions.

4.3.3 Centralized or decentralized architecture?

For security architecture, there is a trend towards centralization to improve the coordination, but also to reduce options for attacks and interface issues caused by too many and too small small-scale or too complex network architectures.

A simplified network structure and centralization would be possible through the use of **cloud computing**, where data and programs are no longer on the hard drives of their computers, but the work is done after log in by computers of large server farms[253].
This would reduce the complexity of the networks and the number of possible attack points considerably. However, these centralized data centers can also be targets of cyber attacks[254], of classic espionage and of conventional physical attacks[255].
There seems to be a change in security architecture, because the Internet and its predecessor ARPANET were installed to reduce the probability of success of a physical attack by decentralization. Thus, there is a strategic optimization problem

[249] Mayer–Kuckuck 2010, p.34-35, refer also to Mildner/Perthes 2010, p.12-13, Bardt 2010, p.12 and Schäder/Fend 2010, p.3
[250] FAZ 2010d, p.12, Bierach 2010, p.11, FAZ 2013d, p.24
[251] Finsterbusch 2013, p.15
[252] Mandiant 2013
[253] ENISA 2009, p.2; See also Dugan 2011, p.8
[254]Cloud computing can also be vulnerable. The attacks on several US banks in late 2012 have shown novel features such as conscripting computers in cloud computing centers to use them for data traffic, The Economist 2013, p.59. The cloud computing service Evernote was affected by stealing all passwords, FAZ 2013b, p.21.
[255] Also, electricity issues can damage large computers seriously as reported in Oct 2013 for the Utah Data Center, Spiegel online 2013b

where the benefits of decentralization (protection against physical attacks) must be compared with the benefits of centralization (protection against virtual attacks).

However, while technical centralization may be an optimization problem, it is widely agreed that countries have a need for administrative centralization and coordination of the cyber activities. A recent example is the establishment of a **High Council of Cyberspace** (Shoray-e Aali-e Fazaye Majazi) in Iran which now gives directions to all other authorities involved in cyberspace[256]. Before that, already a Cyber Defense Command was established in 2010 for protection of critical infrastructures after the Stuxnet events.

Large server farms can also be used for analysis of large data volumes, also known as **big data**. As shown in Section 2.2.2, the main problem is not to gain information, but to store[257] and analyze them in a useful manner.
The storage of metadata (e.g. who spoke when and how long to whom) is also done to identify contact networks of individuals under suspicion. As an example, the terrorist network involved in the Madrid 2004 attack could be represented by analysis of connection data[258].
To reduce the data volume, e.g. the British GCHQ (Government Communication Headquarters) does a **massive volume reduction (MVR)** procedure by removing large files such as music files[259].
Then, search terms (selectors) help to identify relevant data. As an example, the German Intelligence Service BND has analyzed e-mail traffic, SMS and connections by more than 15,000 search words, but only 290 of 2.9 million initial checks in 2011 led to relevant findings[260]. More than 90% of the BND search terms are formal terms such as telephone numbers, email- or IP-addresses of users or companies under suspicion[261].

A more targeted approach is the collection and analysis of **user profiles**. In March 2012, Google announced that profiles of users can be compiled by combining data from search engine usage, YouTube, Google plus and gmail[262]. Similar procedures are also known from social network companies, but Google and other companies were affected in 2013 by a presumably Chinese hacking by which profiles of Chinese users were checked and exported[263].

[256] Nligf 2012, where also the existence of an informal 'cyber army' was noted.
[257] The storage volume discussed for the NSA data center in media is in Yottabytes, this is 10^{24} bytes, Juengling 2013, p.52.
[258] Hayes 2007. The network identification is also known as **community detection.**
[259] Tomik 2013a, p.6.
[260] Amann 2013, p.17
[261] Schulz 2013, p.6.
[262] Spiegel 2013d, p.111
[263] Süddeutsche Online 2013

4.3.4 Analysis of Leakages

Meanwhile, the WikiLeaks disclosure of confidential SIPRNET data from 28 Nov 2010 showed that too many people also of low ranks had access to SIPRNET[264], as discussed in the debates after the incident[265].
Possible countermeasures against massive data theft as in the Wikileaks incident or by cyber attacks from outside could be **vertical segmentation** based on ranks and **horizontal segmentation** of access depending on project-related or topic-related involvement, blockade of printing and downloads by **document management** systems and the **tracking** of document usage and changes. Also the transmission of confidential data via secured or physically **separated communication** lines in line with the **need to know-principle** may help to prevent further security incidents[266]. As a first step, the number of people with SIPRNET access was reduced[267].

In 2012, an IT administrator within the secret service of Switzerland, the **Nachrichtendienst des Bundes NDB**, started an unauthorized data collection which was discovered early enough. Security countermeasures here were separation of and restricted access to sensitive data bases and the **four eye-principle** for IT administrators[268].

The public disclosure of the surveillance programs PRISM (NSA) and Tempora (GCHQ) with the involvement of large internet companies as well as of telecommunication providers[269] by Edward Snowden who worked for the security firm Booz Allen Hamilton (and the subsequent reporting in the newspaper *The Guardian*) led to a broad debate on security matters[270].
In fact, 1.5 million people in US have a cyber-relevant security clearance level, thereof 480.000 from private companies[271]. Moreover, the ODNI (office of the Director of National Intelligence who coordinates the US Intelligence Community) was cited that 70% of the intelligence budget is assigned to private

[264] About 2.5 million persons had basic access and 280.000 persons access to higher classified documents; Schneider 2011, p.9
[265] Schaaf 2010, p.9
[266] Sattar et al. 2010, p.3
[267] Schneider 2011, p.9
[268] Gujer 2012a, p.30, Gujer 2012b, p.24, Häfliger 2012a, p.29. The key cyber security structure of Switzerland is the **Melde- und Analysestelle Informationssicherung Melani** (reporting and analysis office for information security), where the Departments of Defense and Finance and the NDB are involved, Gujer 2012a, p.30
[269] Tomik 2013b, p.2.
[270] However, some aspects were already discussed during the European "Echelon debate" in the 1990ies, such as an assumed global surveillance of telecommunication, internet and emails by the NSA. The debate resulted in a preparation of a summary report by the EU 2001, refer to Ulfkotte 1998, p.8, FAZ 2000, p.1, Schröm 1999a/b, Schmid 2001, Schöne 1999, p.32, Schöne 2000, p.39.
[271] Gartmann/Jahn 2013, p.24

firms[272]. On the other hand, it was argued that the cooperation with private firms is already long-standing[273] and would be necessary to utilize expert knowledge in the rapidly growing cyber sector.

4.4 The cyber war concept of Russia

4.4.1 Definitions and background

Definitions

In 2012, an article presenting the official Russian position was released based on a preceding presentation at a security conference in Berlin in Nov 2011[274].

The definition of cyber war is based on the agreements of the **Shanghai Cooperation Organization (SCO)** from 2008 which provides a wide definition as follows: "*Cyberspace warfare is a contest involving two or more countries in information and other environments to disrupt the opponent's political, economic, and social systems, mass-scale psychological efforts to influence the population in a way to destabilize society and the state, and to force the opposing state to make decisions favoring the other opponent*." [275] This definition is consistent with the information security doctrine given by President Putin in the year 2000[276] and integrates aspects of cyber warfare in a strict sense, information warfare and psychological warfare. Thus, this definition is much broader than e.g. the US definition which is focused on the military aspects. Consequently, the Russian definition of cyber weapons is also a broad one: "*Cyber weapons are information technologies, capabilities, and methods used in cyberspace warfare operations*." [277]

Russia emphasizes the defensive attempt of this doctrine and the need for a cyber convention of the United Nations and suggests an international cooperation to stop proliferation of cyber weapons[278].

Background

The definition is influenced both by theoretical considerations and historical experience.

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[272] Huber 2013, p.18-19

[273] BAH cracked German submarine codes in WWII, Gartmann/Jahn 2013, p.24. Other security firms are e.g. Xe and USIS.

[274] Bazylev et al. 2012, p.10.

[275] Annex I to the Agreement between the Governments of the Member Countries of the Shanghai Cooperation Organization on Cooperation in International Information Security in Yekaterinburg in 2008, cited by Bazylev et al. 2012, p.11.

[276] Annex I to the Agreement between the Governments of the Member Countries of the Shanghai Cooperation Organization on Cooperation in International Information Security in Yekaterinburg in 2008, cited by Bazylev et al. 2012, p.11.

[277] Annex I, cited by Bazylev et al. 2012, p.11.

[278] Bazylev et al. 2012, p.11-15

Cyberspace warfare in the above defined way is a tool of modern geopolitical strategies[279]. The control of the information flow and the influence on the content to support the own position are now relevant tools of soft power in international relations[280]. Also, lack of control may lead to de-stabilization and destruction[281]. Moreover, this perspective could also be influenced by historical experience. Various authors argue that the collapse of the Soviet Union and the socialist state system was also influenced by information influx from the Western alliance[282].

Strategic implications

Based on the above concept, it is essential to control the information flow within the own territory. This requires a legal framework with the nation state as key actor and technical measures[283] to control the information flow.

Consistent with the above concepts and definitions, the SCO members Russia, China, Tajikistan and Uzbekistan submitted a letter to the United Nations on 12 Sep 2011 with a suggestion for an international code of conduct for information security which emphasizes the rights and the role of the sovereign Nation State (Preamble/Section d) with the right to control information by law (Section f) [284]. Technically, it is possible to block certain websites and/or to redirect users to national substitutes for search engines, Twitter and other services. For larger countries, such an 'island solution' may be challenging and difficult to control[285].

[279] Maliukevicius 2006, p.121

[280] Maliukevicius 2006, p.125ff.

[281] Bazylev et al. 2012, p.12

[282] As an example, leading intelligence officers from the former Communist German Democratic Republic analyzed the collapse and concluded that the measures of part III in the Organization for Security and Co-operation in Europe OSCE treaty of 1975 such as travel, personal contacts, information and opinion exchange contributed to the erosion (German: Aushöhlung) of the socialist Warsaw Treaty states (Grimmer et al. 2003, I/101, also I/189-I/190).

[283] Russia uses the surveillance system SORM for supervision of data traffic, FAZ 2010h

[284] UN letter 2011, p.1-5. The role of the nation state is emphasized. The preamble states that "policy authority for Internet-related public issues is the sovereign right of States, which have rights and responsibilities for international Internet-related public policy issues." and in Section (d) "that the code of conduct should prevent other States from using their resources, critical infrastructures, core technologies to undermine the right of the countries that have accepted the code of conduct to gain independent control of information and communications technologies or to threaten the political, economic and social security of other countries". Section (f) states "To fully respect rights and freedom information space, including rights and freedom to search for, acquire and disseminate information on the premise of complying with relevant national laws and regulation".

[285] In 2012, another technology was under discussion. At the World Telecommunication Standardization Assembly (WTSA-12) in Dubai from 20 to 29 Nov 2012 a technical recommendation defining the requirements for **Deep Packet Inspection (DPI)** in next generation networks was submitted by a Chinese expert (Y.2770 2012). This recommendation Y.2770 describes the use of DPI e.g. for the detection of encrypted data and classification of data types such as VoIP, video streams, MP3 music files, BitTorrent traffic, Business cards (vCards) etc. The approval by ITU members on 20 Nov 2012 via Traditional Approval Procedure TAP, i.e. unopposed agreement of Member States present at the respective meeting of this draft may be a step forward to a standardized targeted content analysis; but, the ITU emphasized that this recommendation does not open the door to private user information.

4.4.2 The WCIT 2012

In 1988, International Telecommunication Regulations (ITR) of the International Telecommunication Union (ITU) were agreed which replaced separate regulations for telegraph, telephone and radio[286]. Based on the rapid technological changes since 1988, the World Conference on International Telecommunications (WCIT) was held in Dubai from 03 to 14 Dec 2012 to discuss new ITRs.

Based on the telecommunication definition in the ITU Constitution *("any transmission, emission or reception of signs, signals, writing, images or sound or intelligence of any nature by wire, radio, optical or other electromagnetic systems"*)[287], the opinion that the various technologies cannot be separated in practice[288] and some involvement in cyber issues (such as Flame), the ITU hold the opinion that this organization could be the responsible body for regulation of Internet *and* Information and Communication Technology (ICT), i.e. for all digital technology[289].

A group of states led by Russia, China, some Arabian and other states called to discuss whether the ITU should be the responsible body for the Internet Regulation[290]. While media reports focused much on the internet issue, the draft document suggested by these states also used the term ICT[291]. Also it was argued that the Internet affects all people on the globe and should thus be regulated by a UN body, the ITU.

The United States, the European Union, Australia and other states argued that the current multi-stakeholder model of Internet Governance with organizations like the Internet Corporation for Assigned Names and Numbers (ICANN), the Internet Society (ISOC), the Internet Engineering Task Force (IETF) and others should be kept, because it has proven to be fair, flexible and innovative. This model was able to manage the rapid expansion of the Internet around the globe[292]. Also, it was emphasized that except the ICANN that is linked via a Memorandum of Understanding to the US Department of Commerce, the US government does not control these organizations. Also, these states expressed concerns that a control by states may affect freedom of information[293] and could hamper innovation and for

[286] WCIT2012 presentation, introductory section
[287] WCIT2012 presentation, section myths and misinformation
[288] Touré 2012. Touré, the Secretary General of the ITU said *"The word Internet was repeated throughout the conference and I believe this is simply a recognition of the current reality the telecommunications and internet are inextricably linked*"
[289] ICT is mentioned in the WCIT2012 presentation, section myths and misinformation
[290] Touré 2012
[291] WCITleaks 2012. Please note that this was a 'leaked' draft only and not an official presentation
[292] EU 2012b (Position Paper of the EU)
[293] Kleinwächter 2012, p.31, Lakshmi 2012, p.1

these reasons this group of states resisted against any formulation that could open the door for ITU influence on the Internet[294].
Finally, a legally non-binding annex was adopted by a disputed voting procedure stating that the "*Secretary General [of the ITU] is instructed to continue the necessary steps for ITU to play an active and constructive role in the development of broadband and the multi-stakeholder model of the Internet as expressed in paragraph 35 of the Tunis Agenda*"[295]. Also, new ITRs were adopted, but a consensus could not be reached[296]. As a consequence, the United States, the states of the European Union, Australia and many other states did not sign the new ITRs[297]. The hard dispute between two large groups of states gave to some observers the impression of a **digital cold war**.

In addition to the issues discussed above, the Internet Governance also influences the cyber capabilities. Recently, the US Air Force analyzed this as follows:[298]: "*Failure to pay attention to our vulnerabilities from Internet governance and friendly contest may provide our adversaries with a strategic advantage in cyber conflict. Our own cyber-attacks will also become complicated as networks that are not based on protocols and standards developed by US-entities are deployed by our competitors. […] The United States currently enjoys technological dominance through its position of developer and core provider of Internet Services made possible by the ICANN and the top-level Domain Name System.*"

4.5 The cyber policy of the European Union

In contrast to USA and China the European Union consists of 28 nation states. Security gaps (exploits) in national networks are highly sensitive information. Disclosure of such information may lead to intrusion by other states. In real life, distrust is still dominating between nation states.
This is caused by a security paradox: IT and cyber attacks are global matters, but IT security structure paradoxically promotes national solutions.

In most states so-called **Computer Emergency Response Teams (CERTs)** or Computer Security Incident Response Teams (CSIRTs) are established for detection and reporting of security incidents and for countermeasures. However, the **European Government CERT Group EGC** still has only 12 member states (Finland, France, Germany[299], Netherlands, Norway, Hungary, Spain, Sweden, United Kingdom with 2 CERTs, Switzerland, Austria and Denmark)[300] [301].

[294] Touré 2012
[295] WCIT 2012 Resolution Plen/3
[296] WCIT 2012 Final Acts
[297] Betschon 2012, p.4, Lakshmi 2012 estimated that 113 of 193 member states will sign, 80 not.
[298] Yannakogeorgos 2012, p.119-120
[299] The German group CERT-Bund is presented on the BSI Website
[300] IT Law Wiki 2012b, p.1.

Meanwhile, a CERT-EU team for the security of EU IT infrastructure was permanently established in 2012 [302]

Cyber attacks are a global problem and nation states would profit from an information exchange, the EU summarized the central problem of European cyber policy as follows (in German, English translation follows): „Die Wirkung einer besseren Zusammenarbeit wäre sofort spürbar, doch sind zunächst kontinuierliche Bewusstseinsbildung *und Vertrauensaufbau* erforderlich (the effects of an improved cooperation could be seen immediately, but as a first step we need to enhance awareness *and to build trust*.)"[303]

The focus is now on the **ENISA (European Network and Information Security Agency**), that was founded in 2004 with regulation 460/2004 with a budget of 33 Mio. Euros and 50 employees. ENISA became operational in 2005 and is located in Heraklion/Iraklion, the capital of Crete, at the Southern EU border, which is perceived as a suboptimal solution[304].
The ENISA works on network security studies, encryption tools, etc. Cryptography is also part of the current EU research program[305]. In 2008, the mandate of the ENISA was prolonged until 2012, already in 2011 then until 2013 and 2013 the mandate is planned to be prolonged until 2020 with expanded responsibilities.
The director of the ENISA, Dr. Udo Helmbrecht, was the former president of the German BSI and was appointed in 2009. Since that year, the following actions were started to strengthen the key role of ENISA in European cyber policy:

- the ENISA should strengthen the cooperation between National/Governmental CERTs, also by leveraging and expanding existing cooperation mechanisms like the EGC[306],
- the ENISA has released a comparative study in 2009 of the states of the European Economic Area EEA that showed major differences between member states with regard to regulatory settings, the insufficient capacity building of CERT groups, a lack of cooperation and poor procedures for *incident reporting*. Consequently, the ENISA gave recommendations how

[301] ECG 2008, Website der ECG Nov 2010. Weitere CERT-Foren, an denen die deutsche CERT-Bund beteiligt ist, sind FIRST (Forum of Incident Response and Security Teams) und TI (Trusted Introducer).
[302] EU2013b, p.5
[303] EU 2010b. The European Council released already in 2006 a cooperation plan for Critical Information Infrastructure Protection, it took some time after attack on Estonia 2007 before further steps were implemented. Taking these facts into consideration, the discussed development of an international **cyber war convention** seems to be unlikely, Dunlap 2011, p.83
[304] EU-ISS 2007
[305] ENISA 2007
[306] EU 2007, EU 2009b

processes and cooperation could be improved under the leadership of ENISA[307].

- In line with the European Commission Communication on Critical Information Infrastructure Protection 2009,[308] the ENISA conducted the first Pan-European Exercise **Cyber Europe 2010** with 70 organizations from 22 countries (and 8 observer countries) with a total of 320 stress tests[309]. However, the exercise showed the uneven and uncoordinated national approaches and insufficient preparedness of smaller member states[310]. After analysis and lessons learned sessions, the next exercise will also include private actors.
- Meanwhile, a common exercise of the EU and the USA took place, **Cyber Atlantic 2011**.

The European Commission plans to establish a **European Public Private Partnership for Resilience (EP3R)** and a European Information Sharing and Alert System (EISAS), which is also accessible for citizens and small and medium-size enterprises (SMEs). Moreover, it is planned to develop in cooperation with Member States and all relevant stakeholders the criteria for identifying European critical infrastructures for the information and communication technology (ICT) sector[311].

A legal framework to enhance network and information security (NIS) was proposed in early 2013. It was stated that there still is no effective mechanism at EU level for effective cooperation and collaboration for trusted information sharing on NIS incidents and risks among the member states. Therefore, each member state should establish a competent authority (CA) for NIS and establish a communication network with the other CAs, and provide early warnings and relevant information. Also, the cooperation with private stakeholders should be enhanced[312].

In 2013, an evaluation of CSIRTs within the EU is planned and an anti-botnet initiative.[313] The recently launched **European Cybercrime Centre E3C** will cooperate with ENISA and the **European Defense Agency EDA** to enhance cooperation for NIS matters[314]. For 2014, ENISA and EU Commission will organize a cyber security championship for students.

[307] ENISA 2009a
[308] EU 2009b
[309] ENISA 2010a, ENISA2010b
[310] Mertins 2010, ENISA 2010a: „There is a lack of pan-European preparedness measures to test. This reflects the fact that many Member States are still refining their national approaches."
[311] EU2009b, also EU 2010b
[312] EU2013a
[313] EU2013b
[314] EU2013b, p.18

The United Kingdom and France agreed upon a general military cooperation in November 2010, which also should include cyber war issues[315].

A new area of concern is the rapid growth of cloud computing where data may be stored on external computers under a foreign jurisdiction. In addition to the various security issues[316] uncertainties about rights and responsibilities on cross-border situations[317] are relevant so an update of the European legal framework for to address cloud computing is under discussion.
In the new **Cloud Computing Strategy** the EU has identified three primary problems, the fragmented market, problems of contracts and the "jungle of standards"[318].

4.6 The cyber capabilities of the NATO

While the focus of the CCD CoE is on research, the **NATO Communication and Information Systems Services Agency** in Mons near Brussels is responsible for operative issues[319].

The primary purpose of the NCSA is to install, operate, maintain and support the communication and information systems of the NATO. In line with the NATO Cyber Defense Program of 2002, the NCSA is the first line of defense for the NATO IT-infrastructure[320].
The NATO Information Security Technical Centre (NITC) is NCSA's authority for operational information security and operates both the NATO Information Security Operations Centre and the NATO Computer Incident Response Capability Technical Centre (NCIRC).
The Information Security Operations Centre provides centralized management of integrated communication and cyber defense capabilities while the NCIRC is responsible for incident detection, response and recovery.

The attack against Estonia in 2007 alerted the NATO that now works on protection of member states against cyber attacks. In May 2008, the **Cooperative Cyber Defense Centre of Excellence (CCD CoE)** was initiated in Tallinn[321], Estonia with a staff of 30 people, which is supported by Estonia, Lithuania, Latvia,

[315] Thibaut/Alich 2010, p.15
[316] ENISA 2009b
[317] EU2011
[318] EU 2012a, p.5
[319] Schuller 2010, p.6
[320] NCSA 2009a-c
[321] In reality, the CCD CoE became operational already in 2006 after an Estonian initiative in 2004; CCDCoE 2010a

Italy, Spain, Slovakia and Germany, i.e. it is supported by a few member states only[322], Poland plans to join in 2011.
NATO Cyber Defense exercises were **Digital Storm** and **Cyber Coalition** 2008, 2009 and 2010 and were managed by the CCD CoE together with the NCIRC and other NATO bodies[323]. Together with Sweden, the CCDCoE conducted the **Baltic Cyber Shield** exercise in May 2010.
At the Lisbon summit in November 2010 the NATO presented a new strategy with the aim to intensify and coordinate cyber war defense *(„bringing all NATO bodies under centralized cyber protection"*)[324]. The exercise Cyber Coalition (CC) is now done annually, last time in November 2012.

4.7 The cyber policy of the African Union

In May 1996, the United Nations Economic Commission for Africa (ECA) started the African Information Society Initiative (AISI) which included an initiative to develop and implement National Information Communication (NICI) policies and plans[325].
Since that time, the IT infrastructure of Africa was massively expanded, e.g. by new broadband deep sea cables as well as by intense competition between European and Chinese telecommunication providers (in particular Huawei and ZTE)[326].
In 2009 the African Union (AU) agreed to develop a convention for cyber legislation within the AISI framework which was released as draft version in 2011[327]. The convention is dealing with electronic commerce, data protection and processing and cyber crime in general, but does not contain specific provisions on cyber war[328].

In addition, cooperation on cyber legislation is discussed within the African Regional Economic Communities (RECs) such as the East African Community EAC, the South African Development Community SADC and the Economic Community of West African States ECOWAS[329].
A main topic in many documents is the need for intensified Inter-African Cooperation and to enhance cyber security awareness[330].

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[322] The NATO plans to rely on consultations after a cyber attack; von Kittlitz 2010, p.33
[323] Wildstacke 2009, p.28/29, CCDCoE 2010b
[324] NATO 2010. For the NATO, not only cyber war, but all kinds of cyber attacks are relevant, Hunker used 2010 the term **cyber power**.
[325] ECA 2012, p.1
[326] Martin-Jung 2008, EMB 2010, Schönbohm 2012 who stated that 8.400 kilometers deep sea cable were provided 2010 at the East African coast to enhance high-speed internet. Also, on the West Coast new cables were provided at the same year which allowed e.g. expansion of Nigeria's internet, Adelaja 2011, p.7
[327] ECA 2012, p.3, AU 2011
[328] AU 2011
[329] ECA 2012, p.4
[330] For general intelligence and security cooperation in Africa, the **Committee of Intelligence and Security Services of Africa CISSA** was founded in 2004 in Nigeria which organizes regular meetings of

South Africa already started the development of a National Cyber security Policy Framework in 2010 which was approved by the cabinet in March 2012[331]. One of the primary aims of this policy was the coordination of various national authorities dealing with cyber security[332].

In Africa, the role of smartphones is rapidly growing, as this helps to abridge digital infrastructure gaps, but this exposes Africa more than other regions to the vulnerabilities shown in Section 2.2.8[333].

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the member institutions, Africa 2010, p.72f.. Meanwhile, 50 Intelligence and Security Services have signed the CISSA Constitutive Memorandum of Understanding, CISSA 2012.

[331] South Africa 2012

[332] South Africa 2010, p.6

[333] Puhl 2013, p.118f.

5 Cyber war and biologic systems

5.1 Implantable devices

There are a growing number of wireless **implantable medical devices (IMDs) s**uch as cardiac pacemakers/defibrillators, deep brain neurostimulators, implants for ear and eye (cochlear and ocular) and others. It was shown that insulin pumps can be hacked and modified remotely[334]. As physicians need to have easy access in case of emergencies, protection is difficult and communication may be affected by adversaries. For this reason, the research for signal jamming and other strategies is in progress[335].

In response to the threats for the digital health sector, the US Food and Drug Administration FDA released a safety communication on health-related cyber security[336]. This includes recommendations to protect hospital networks to prevent identification of potential targets, i.e. patients with devices and the respective device specifications. As hospitals may have data exchange with devices to supervise patients remotely, hospitals are a potential entry for cyber attackers to certain patients. In addition, draft guidance was released to ensure cyber security of medical devices by requiring manufacturers to develop a set of security controls to assure medical device cyber security to maintain information confidentiality, integrity, and availability[337]. The challenge is to balance security/privacy with medical safety/usability[338].

The three key principles of both FDA documents are to limit access to trusted users only, to ensure trusted content use and to provide fail safe and recovery features. The security recommendations included a large variety of measures such as authentication of users, a layered authorization model, avoiding "hardcoded" passwords (which are the same for each device, difficult to change, and vulnerable to public disclosure), appropriate controls before permitting software or firmware updates, including those affecting the operating system, applications and anti-malware and to ensure secure data transfer to and from the device, and when appropriate, use accepted methods for encryption[339].

Meanwhile, deep brain neurostimulators were developed that can measure the brain activity, emit signals out of the brain ('brain radio') and influence the brain

[334] Gupta 2012, p.13
[335] Xu et al 2011, Gollakota et al 2011.
[336] FDA 2013a
[337] FDA 2013b, p.2
[338] Gupta 2012, p.26
[339] FDA 2013b

by giving electric stimulation[340]. The evaluation of the emitted signals allows to modify the stimulation pattern by sending wireless instructions into the stimulation device, which could help e.g. to influence neuromuscular disorders or severe cases of depression. The brain radio analyses so-called **latent field potentials** (LFPs), which can be displayed as complex curves which reflect a specific activity pattern of the brain[341]. The collection and analysis of LFP (as a kind of brain signal decryption) is expected to be complex and the first analysis is expected to take some years and the study to take almost a decade until late 2023[342].

The recent progress motivated the DARPA on 12 Nov 2013 to suggest new devices that help to analyze and treat severe brain injuries.
A current limitation is the need for battery exchange or reload, for this reason, the research is targeting on using the human body as energy source by glucose (blood sugar) utilization[343]. Recently, cardiac pacemakers were developed that could utilize organ movements to win energy[344]
Retinal implants are already in use as sub retinal implants, i.e. chips that are positioned behind the retina (the natural optical detection layer of the eye) and contains 1500 pixels (independent micro-photodiode-amplifier-electrode elements) on a 3 mm*3 mm; an amplified electrical signal is sent by the electrode to the bipolar cells, i.e. the cells that process the optical input further[345]. The chips however still need an external energy supply.
Hacking of implantable devices does not only include the risk of manipulation, but also of serious injuries[346], so legislators need to ensure that device hacking is not only judged as virtual crime.

Another topic are **wearable technologies** such as *Google Glass*, i.e. glasses with integrated computing and competitor products which are expected to be marketed during 2014[347]. Intruders could not only track the individual user, but also use the glasses to observe others[348]. Other concepts are **smart wigs** or **smart helmets** that may support paralyzed or blind people, and device patches that monitor the health status of the user[349].

[340] Young 2013, p.1, Medtronic 2013
[341] LFP signals were found to encode dynamic aspects of behaviour, unrelated background dynamics with distinct state fluctuations, and possibly other aspects, refer to Stamoulis/Richardson 2010, p.8
[342] ClinicalTrials.gov 2013
[343] Jürisch 2013, p.10
[344] Welt online 20 Jan 2014
[345] Stingl et al 2013
[346] Such as delivery of electric shocks, see Gollakota et al 2011, p.1
[347] Postinett 2013a, p.30
[348] Also, RFID chips are meanwhile implanted e.g. in expensive horses to prevent stealing and in some children to prevent kidnapping.
[349] The analysis of user condition could also be done by cameras, such as in the new Microsoft X-Box, Mähler 2013, p.38.

From a cyber war perspective, wireless wearable technologies that can be attributed to individuals as well as the possibility to give IPv6 addresses to weapons as part of the Internet of Things may allow tailor-made attacks on certain groups of individuals and/or objects. While the cyber war was initially believed to be a large-scale conflict between computers and is meanwhile seen as embedded part of military operations, the trend may go forward to highly selective attacks.

5.2 Relations between cyber and biological systems

5.2.1 Viruses

Nucleic acids are the code within cells, genes are sequences of nucleic acids. Each gene is used for production of a specific protein, which can be used for formation of structures (like muscles) or that conduct metabolism as enzymes. So genes are the biologic equivalents to computer programs.
Historically, the term computer virus was derived from it biological counterpart. Biological viruses are small coated particles that contain a defined set of genes, i.e. are the biologic counterpart of malware. They use cells of an infected organism to copy (replicate) themselves and the copies leave the cells to infect other cells.

In former times, it was believed that the damage resulting from viral infections in humans was only caused by using infected cells and their subsequent destruction. However, meanwhile it is clear that many viruses also have 'Trojan-like' properties and can disturb the network of immune cells, where different types of immune cell communicate via release and receipt of molecules called **cytokines**.
Many viruses find ways to reduce Interferon gamma levels which is the key cytokine for anti-virus actions[350]. Some viruses, e.g. from the group of influenza ('flu') viruses, can even confuse the immune system communication, resulting in imbalanced and/or excessive release of cytokines and/or enhance secondary infection with bacteria[351]. The excessive release of cytokines, known as **cytokine release syndrome** or 'cytokine storm' can result in potential fatal shock-like conditions (circulation failure, organ failure, blood clotting etc.)[352].

An unconventional matter is viruses against viruses, so called **virophages**. From a cyber-perspective, it could be interesting to develop codes that could be inserted into existing malware to modify or re-direct it (malware infecting other malware), however this remains hypothetical.

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[350] Haller 2009, p.57
[351] Kash et al 2011, Stegemann-Koniczewski 2012
[352] For such viruses, corrective actions on immune system communication (such as cut-off of cytokine excess) by cortisone and other substances could be a new option to mitigate infections in addition to the established approaches of prevention by vaccines and antiviral medications. See also Li et al. 2012/ Li, C., Yang P., Zhang Y., Sun Y., Wang W. et al 2012

From a biological perspective, nine virophages were found until 2012, all of them directed against a special subclass of viruses, the giant double-stranded DNA viruses[353]. The Sputnik virophage is directed against the Mimivirus that can cause human pneumonia[354]. Interestingly, the pox virus (variola) is also a large double-stranded DNA virus, so maybe modified virophages can open new treatment options. There are increasing reports of pox-like infections with monkey pox[355], in Germany some fatal pox infections were reported already in 1990 mainly in immunosuppressed patients where the cow pox virus was able to pass species barrier to cats[356].

5.2.2 Bacteria

Bacteria are single-cell microorganisms that can infect other organisms such as humans[357]. Some of those who cause relevant infections in humans can form liquid platforms called **biofilms**[358] where they can exchange information via pheromones and can share materials for nutrition, this mode of action is also known as **quorum sensing** (meaning that this platform is established when a critical mass of bacteria is reached). New research is targeted on disrupting these platforms and shutdown of bacterial communication which would make it much easier for immune cells to attack and destroy the bacteria[359].

Biotechnology allows to change genes or to introduce new genes into organisms, which raised concerns that new dangerous organisms maybe created intentionally[360] or inadvertently. In the last decade, a new phenomenon called **bio-hacking** was observed[361]. The typical biohacker works outside established research units or companies and tries as a kind of ethical hacking to modify genes to invent something useful, but due to biosecurity reasons the biohacking scene is closely observed by government authorities[362]. However, there are high structural, functional and energetic hurdles for achieving stable modifications of genes or

[353] Zhou et al. 2012
[354] Zhanga et al. 2012
[355] Shah 2014, p.27
[356] Scheubeck 2014, p.7
[357] Just for matter of completeness, biological worms are multi-cell organisms that can actively move and infect other organisms, while viruses are passively spread (e.g. by cough, diarrhea, rhinitis, blood etc.).
[358] Bakaletz 2012, p.2
[359] Gebhardt 2013, p.38.
[360] This is not only intended by bio-terrorists, but sometimes also in research. Recently, the virus researcher Fouchier enhanced infectious properties of avian flu ('bird flu') virus to get a better understanding of the virus, Guterl 2013, p46f. Both US and China expressed serious concerns, see Guterl 2013, Zeng Guang 2013. Practical recommendations for defense against biological weapons were released by the European Medicines Agency EMA, refer to EMEA 2002 (updated 2007).
[361] Kunze 2013, p.19-20
[362] In US, the responsible authority for biosecurity is the **National Science Advisory Board for Biosecurity** NSABB, but the biohacker scene is also observed by the FBI, the CIA is also interested in this matter, Hofmann 2012, p.14.

organisms. Genetic modifications of bacteria typically result in microscopic variations of surface glycoproteins which could be used for production plant attribution like a fingerprint[363].

A special topic is **bacteriophages**; these are viruses against bacteria which use bacteria for their replication. From a cyber-perspective, tailor-made genetically engineered bacteriophages can specifically bind a large variety of ions and be used for formation of highly effective electrodes in lithium-ion batteries, photovoltaic cells and nanomaterials by self-assembly[364]. However, as phages are dependent from a bacterial carrier system, there is no risk that bacteriophages could damage digital devices by ion-binding, i.e. they are no anti-material weapons.

From the biologic perspective, there is growing bacterial resistance against existing antibiotics which is typically caused by inappropriate use. Bacteriophages were already used as anti-bacteria viruses in the Soviet Union and today Russia and Georgia for severe infections[365]. Despite concerns of a coming post-antibiotic era, the research activity is still low and a legal framework is still missing in the Western states[366]. Bacteriophage enzymes may have also military relevance, as one bacteriophage product was effective against the standard bioweapon *Bacillus anthracis*, more commonly known as Anthrax[367].

5.2.3 Control by cyber implants

Based on progress of device and biologic research, discussions are ongoing whether cyber implants (biochips) could be used to control human behaviour and decision making[368]. However, there are some limitations of potential cyborg[369] scenarios:

[363] In the past, there were some discussions whether there is a risk that genetically modified bacteria could infect machines with degradation and depolymerization. However, no such infection was ever reported in practice, so this remains theoretical.
[364] Yang et al. 2013, p.46ff
[365] Mandal 2014
[366] WHO 2014, Verbeken et al. 2014
[367] Zucca/Savoia 2010, p.83
[368] Jüngling 2014, p.63
[369] There is some confusion about the definition of cyborgs. A wider definition interprets this as any man-machine system; this could also include wearable technologies. A stricter approach defines cyborgs as physically integrated man-machine systems. Retinal and cochlear implants as well as pacemakers fulfill this definition already. From a cyber war perspective, it is noteworthy that based on analysis of brain implants besides the sensitivity for interfering electromagnetic signals the need for external programming and modification is the key vulnerability of any potential cyborg system, e.g. the handhelds devices needed to modify brain implant settings or the smartphones needed to control biobots.

Certain insects that serve as hosts can e.g. be forced by parasites to execute specific actions that protect the parasites (bodyguard manipulation) and promote their replication by avoiding predators[370]. On the other hand, the endoparasites of insects typically cause only certain actions but do not urge the infected insect to "do whatever they want". However, parasites can modify levels of neuronal transmitters dopamine and serotonin (5-HT) levels which are involved e.g. in the emotional (limbic) system, i.e. a similar way of action as many modern psychiatric medications[371].

In humans, the parasite *Toxoplasma gondii* has been shown to influence human behaviour (such as affects, novelty seeking, schizophrenia risk, dominant attitude of infected males etc.) significantly by infecting the brain[372] as evaluated by several standard psychological questionnaires. The behavioural influence is based on changing dopamine and testosterone levels[373], but does not mean mind control or specific changes of decision making. Human beings are no target host for *Toxoplasma gondii*, they are inadvertently infected and a kind of dead end-host. In the natural rodent intermediate host, the parasite-induced behavioural changes facilitate enhance transmission to the feline definitive host[374]. Also, it is not yet clear which effects in humans are really targeted manipulations or just side effects of the chronic infection[375].

Implantable brain devices (deep brain stimulation DBS and Vagus nerve stimulation VNS) are already tested or used to treat a larger variety of neuropsychiatric disorders, such as depression, anxiety, schizophrenia, obsessive-compulsive disorder, Tourette syndrome, tics, epilepsy, Parkinson disease and so on[376]. The DBS works by sending electric signals to groups of specialised nerve cells, so-called nuclei, which are located deeply in the brain and where the probe is located[377]. The implant electrodes not reach in the grey substance of the neocortex (the functional layer on the brain surface that is responsible for the intellectual functions), so implants do not control the intellect; instead they have an indirect influence by as the nuclei below the cortex are involved in the emotional and hormonal system[378] and also in some motoric coordination.

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[370] For example, the spider host *Plesiometa argyt* builds under influence of the parasite wasp *Hymenoepimecis sp.* a unique cocoon web as a durable support for the wasp larva's cocoon to protect this. Manipulated caterpillar *Thyrinteina leucocerae* hosts stay close to parasitoid pupae of parasitic wasp *Glyptapanteles sp* and knock off predators with violent head thrashing leading to higher survival rates or parasite pupae. Eberhard 2000/2001 and Grosman et al., 2008 cited by Maure et al. 2013, p.38

[371] Perrot-Minnot and Cézilly 2013, p136-137

[372] Adamo and Webster 2013, p.1, Flegr 2013, p.127f.

[373] Increased synthesis of dopamine takes place in infected host brains in tissue cysts of Toxoplasma. Disturbed dopamine levels are involved in various severe psychiatric disorders such as schizophrenia.

[374] Adamo and Webster 2013, p.2, Flegr 2013, p.128

[375] Flegr 2013, p.127

[376] Refer to ClinicalTrials.gov - A service of the U.S. National Institutes of Health Search of: deep brain stimulation - List Results Retrieved in June 2014

[377] VNS stimulates the tenth brain nerve, the vagus nerve, the stimulation is done beyond the brain.

[378] Target areas for deep brain stimulation in severe neuropsychiatric diseases amongst others are: Thalamus; subthalamic nucleus; nucleus accumbens; Cg25, subgenual area of cingulum, Kuhn et al. 2010,

The DARPA initiated in 2006 HI-Mems projects (hybrid insect micro electromechanical systems) to develop biological robots (biorobots, biobots), i.e. cyber-biological systems of insects with integrated electronics. One of the aims was to develop insect drones for espionage and other military duties[379]. Recently, a chip became commercially available which after connection allows control cockroach movements by smartphones, here as **RoboRoach** from the firm Backyard Brains. The cockroach species is *Blaberus Discoidalis*[380]. The cockroach chip is *not* implanted into the head or brain of the cockroach, but only put on the back and then connected with small cables to the antennae[381]. Electric signals to the antennae induce a movement change of the cockroach by remote control via smartphone and Bluetooth[382]. Typically, the control is diminishing after some days, but it is disputed whether this is an adaptation or simply a damage of the chip-antenna connection.

5.3 Conclusions and implications for cyber war

Overall, while there are networks and communication also within biological systems, there is only a limited comparability and any reference to biological systems should be made very cautiously.

But the above sections have shown the crucial role of communication. The practical focus of cyber security is currently on prevention of infections, i.e. on *incoming* communication. Much less attention is paid to the *outgoing* communication (which is also needed to expand infections by beachhead Trojans). The average private or business user has neither control nor any overview which data are leaving the computer (or the smartphone) in the background, also not why, to whom and to which extent[383]. The reports from Kaspersky, Symantec, McAfee, Mandiant and others typically show that even massive illegal data export is realized *after* the infection was detected, i.e. by far too late. One reason for this is the widespread "what is not forbidden, is allowed"-approach, i.e. except a list of unsafe or forbidden websites, standard computers settings factually allow sending data to almost everywhere. It may make sense to think about more rigid approaches for sensitive environments (e.g. reverse protocols where only

p.106. In the military sector, a study to treat post-traumatic stress disorder in soldiers was planned in 2012, but was not conducted, Department of Veterans Affairs 2013

[379] Hummel 2014b,

[380] Hummel 2014a, p.1

[381] Hummel 2014a, p.2

[382] The chip is needed to transfer smartphone command into electric signals; the control of the cockroach is limited to give electric stimulation to its antennae. These signals do not contain any specifically coded information; they only irritate the insect to change the direction. For technical details, refer to Latif/Bozkurt 2012. This does not match the common understanding of robots, so it is still a long way to animal-robot hybrids, see Hummel 2014, p.42

[383] Even the television may record and export all user data without knowledge if designed as Internet-TV (IPTV), SZ online 2013

explicitly allowed servers/IP addresses can be approached) and improved tools that facilitate overview about data export and authorization.

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