COURSE DESCRIPTION CARD - SYLLABUS

Course name
Synchronization [S1Cybez1>SYNCH]

Course

Field of study
Cybersecurity

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
24

Laboratory classes
16

Other
0

Tutorials
0

Projects/seminars
16

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

A student starting this subject should have basic knowledge of computer network security, network architecture and protocols, network devices and ICT infrastructure protection mechanisms. They should have the ability to analyze threats in teleinformatic networks, configure network devices and monitor network traffic to detect anomalies. In terms of social competences, the student should present such attitudes as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture and awareness of ethical aspects of cybersecurity and data protection.

Course objective

1. Providing students with knowledge about sources of timing signals, methods of synchronizing ICT networks and threats related to manipulation of time and frequency signals. 2. Developing skills in designing secure synchronization systems and detecting and responding to disruptions, attacks and failures in synchronization networks. 3. Shaping skills in acquiring knowledge about current solutions in the field of secure synchronization in teleinformatic systems.

Course-related learning outcomes

Knowledge:
Has structured, detailed knowledge of telecommunications theory, necessary to understand, analyze and evaluate the operation of synchronization methods in the context of the security of modern ICT networks. Knows the principles of operation of time synchronization protocols and their impact on data integrity and protection against time manipulation attacks in networks. K1_W05, K1_W15.
Knows the basic principles of operation of synchronization systems at the link and network level, with particular emphasis on aspects related to ensuring service continuity, detecting and counteracting attacks aimed at disrupting synchronization. K1_W09, K1_W10.
Has basic knowledge of timing signals and the operation of time and frequency signal distribution systems in telecommunications networks. K1_W07.

Skills:
Is able to determine the basic parameters and properties of synchronization signals and assess their impact on the security and integrity of data in teleinformatic networks. K1_U05, K1_U09.
Is able to design a synchronization subsystem in wired and wireless networks, taking into account protection mechanisms against attacks aimed at disrupting synchronization, ensuring the integrity and availability of transmission. K1_U02, K1_U08, K1_U11.
Is able to ensure network synchronization, supervise their operation and use synchronization technologies that enable secure data transmission. K1_U03.

Social competences:
Recognizes changes resulting from technological progress and understands the need to follow new standards regarding synchronization and protection of telecommunications networks. K1_K01.
Has a sense of responsibility for designed IT systems, is aware of social threats related to their improper design or implementation, especially in the context of protecting privacy and data integrity. K1_K05.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
The learning outcomes are verified through an exam in fomr of multiple choice test. The assessment topics, based on which the questions are developed, will be made available to students via the university's remote learning platform. To obtain a grade of 3.0, it is necessary to obtain more than half of the possible points.
Laboratory:
The learning outcomes are assessed through:
1. Continuous assessment - each verification of knowledge through oral answers to questions asked during the laboratory exercises.
2. Reports on the exercises performed, including an analysis of the correctness of synchronization and the identification of potential threats.
3. The grade obtained from the test summarizing the exercises, checking both theoretical knowledge and practical skills in configuring and analyzing synchronization systems.
4. Additional points for activity during laboratory classes, e.g. for initiative in solving problems related to the security of synchronization in ICT networks.
Project:
1. Assessment of the project report: each project should be delivered in the form of a report containing full project documentation.
2. Project presentation: the presentation should include the main project objectives, the methodology used, the results and conclusions, as well as the justification for the technical choices and solutions.
3. Demonstration of the project's operation: launching the application, presenting the implementation of the algorithm, or demonstrating the operation of the system in the case of technical projects.
The share of assessment criteria in the final assessment:
1. Functionality and technical quality (40%) - project operation, efficiency, correctness of implementation, optimization.
2. Documentation quality (30%) - completeness, clarity, report structure, substantive correctness.
3. Presentation quality (30%) - clear presentation of the project, answers to questions, communication skills, presentation aesthetics.
The course completion rules and the exact passing thresholds will be communicated to students at the

beginning of the semester through the university's electronic systems and during the first class meeting (in each form of classes).

Programme content

The course introduces key issues related to the role of synchronization in ensuring operational consistency in ICT networks, directly affecting the integrity and availability of systems. The program covers various synchronization techniques and their importance in the context of protecting ICT infrastructure. An important element of the course are time and frequency signal sources, such as GNSS, PTP, SyncE, White Rabbit and Open Time Protocol, which are analyzed in terms of their susceptibility to attacks and interference. The course also discusses the challenges related to synchronization in 5G networks and over-the-air synchronization mechanisms. Thanks to a thorough understanding of these technologies, students learn to identify and counteract potential threats. They gain skills in configuring and securing synchronization devices and practical log analysis to detect unusual events. The course ends with a project on anomaly detection and a knowledge test, which allows for the practical application of the acquired knowledge and skills.

Course topics

Lectures:
1. Introduction to synchronization and its role in ICT network security (1 hr).
2. Phase-locked loop for continuous and discrete signals (4 hrs).
3. Model of the synchronization signal, its parameters and threats related to signal manipulation (4 hrs).
4. Sources of time and frequency signals and their vulnerabilities to attacks (4 hrs).
5. Assessment of the quality of device synchronization and detection of security anomalies (4 hrs).
6. Ethernet-based synchronization: SyncE, PTP (2 hrs).
7. New synchronization technologies White Rabbit, OTP (2 hrs).
8. Synchronization in 5G networks - challenges and security (2 hrs).
9. Assessment - multiple choice test (1 hr).

Laboratory:
1. Timing signal sources - configuration and security (4 hrs).
2. Synchronization signal sources - analysis of susceptibility to interference and attacks (4 hrs.).
3. Measuring the quality of device synchronization and detecting security anomalies (6 hrs.).
4. Lab test (2 hrs.).

Project:
1. NTP anomaly detection system - log analysis, spoofing and synchronization attack detection (8 hrs.).
2. Classification of anomalies in time signals - machine learning model for detecting unusual events (8 hrs.).

Teaching methods

Lectures:
1. Multimedia presentation: the lecturer presents the material using slides, supplemented with photos, videos and other visual elements, real devices/measurements of synchronization systems.
2. Interactive lecture: the lecturer engages students in discussion, asks questions and encourages them to share their own thoughts, supporting a better understanding of the material and developing critical thinking skills.
3. Case study: the lecturer discusses a specific example, analyzing the problem and proposing solutions. This allows for the application of theoretical knowledge in practice.

Laboratories:
1. Simulations: Students work with computer programs that imitate real situations.
2. Practical exercises: students perform tasks under the supervision of the lecturer, learning how to use their knowledge in practice.
3. Group work: students cooperate on solving the problem, sharing knowledge and developing communication and teamwork skills.

Project:
1. Project work: students carry out a project under the supervision of a supervisor, gaining experience in planning, organizing and implementing tasks, developing managerial and organizational skills.
2. Project presentation: students present the results of their work, developing communication and self-presentation skills.

Bibliography

Basic:
[1] ETSI, "Synchronization in telecommunication networks," ETSI TS 102 031, 2018.
[2] IEEE, "IEEE Standard for Precision Clock Synchronization Protocol for Networked Measurement and Control Systems," IEEE Std 1588-2008, 2008.
[3] ITU-T, "Timing and synchronization in packet networks," ITU-T Rec. G.8272, 2016.

Additional:
[4] S. Galli and L. Musumeci, "Synchronization of Digital Telecommunication Networks," Academic Press, 2003.
[5] L. Shu and M. Youssef, "Time Synchronization in Wireless Sensor Networks," Springer, 2012.

Breakdown of average student's workload

	Hours	ECTS
Total workload	116	4,00
Classes requiring direct contact with the teacher	56	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,00