Course Plan

Title of the Phd Course: **Future Network Security (5G/6G, IoT)**
Credits: 3ECTS; Corresponding to 3 högskolepoäng;
Studieinsats: approx. 80h

Objectives

The objective of the course is to broaden the Phd students' understanding of the area of future network security. In detail, the course aims at:

- Understanding the general and new security threats to 5G systems incl. the risks to its MEC and NFV subsystems
- Being able to categorize and understand important security mechanism in 5G systems (incl. the one of MEC and NFV subsystems)
- Understand the future security issues of 6G and B5G systems, incl. its space- and satellite subsystem
- Understand the security threat and security mechanisms of smart networked infrastructures such as SCADA based-IoT systems

Grading and Examination

The course is grade on as "pass/fail" on the presentation at the final seminar, which is typically an in-presence meeting.

Format, Learning and Teaching

The course is organized into two parts:

- Part 1: four online lectures each approx. 75min which provide an introduction in the area and explains technologies. In addition, literature is given to the students for self-studying to deepen the understandings given in the lectures.

- Part 2: an in-presence seminar day with student presentations on selected advanced scientific topics addressed in the course.

The presentation should detail how future network security is related to the cybersecurity research contacted by the student.

Content of the Course

Part one of the course promises the following content:

- Lecture 1: Introduction and 5G Security Threats and Concepts
    o Today's 5G, NFV, and MEC architecture [1]
    o General network and distributed systems security threats and concepts [2]
    o Threats to the current 5G architecture [3]
    o Additional literature: [3-8]
- Lecture 2: 5G Security Mechanisms
    o NFV and MEC security mechanisms [8-9]
- Lecture 3: 6G Security Threats
    o Preparation: recorded lecture from Stefan Köpsell on" To be sensed or not to be sensed – that's the question: Security and Privacy of Joint Communication and Sensing in upcoming 6G mobile networks."
    o Future 6G architecture [10-12]
    o 6G security [13-15]
    o Privacy issue in 6G due to the systems joint communication- and sensing capabilities, e.g. [20]
    o 6G's space- and satellite-based subsystems and their cybersecurity threats [16-17]
- Lecture 4 (Wednesday, Dec. 18, 15-16:30; 75min, remote): Architecture and Security of SCADA based-IoT systems
    o Recent developments in SCADA [18]
    o Threats to SCADA systems and security mechanisms in SCADA-based IoT systems [19]

Course Literature

[1]   Horner, L. J., Tutschku, K., Fumagalli, A., & Ramanathan, S. (2023). *Virtualizing 5G and Beyond 5G Mobile Network*. Artech House.

[2]   Anderson, Ross J. *Security engineering: a guide to building dependable distributed systems*. 3rd Edt. John Wiley & Sons, 2020.

[3]   Ahmad, I., Shahabuddin, S., Kumar, T., Okwuibe, J., Gurtov, A., & Ylianttila, M. (2019). Security for 5G and beyond. *IEEE Communications Surveys & Tutorials*, *21*(4), 3682-3722.

[4]   Khan, R., Kumar, P., Jayakody, D. N. K., & Liyanage, M. (2019). A survey on security and privacy of 5G technologies: Potential solutions, recent advancements, and future directions. *IEEE Communications Surveys & Tutorials*, *22*(1), 196-248.

[5]   Cao, J., Ma, M., Li, H., Ma, R., Sun, Y., Yu, P., & Xiong, L. (2019). A survey on security aspects for 3GPP 5G networks. *IEEE communications surveys & tutorials*, *22*(1), 170-195.

[6]   Ericsson: A guide to 5G network security 2.0; Available at: https://www.ericsson.com/en/security/a-guide-to-5g-network-security

[7]   Madi, T., Alameddine, H. A., Pourzandi, M., & Boukhtouta, A. (2021). NFV security survey in 5G networks: A three-dimensional threat taxonomy. *Computer Networks*, *197*, 108288.

[8]   Tang, Q., Ermis, O., Nguyen, C. D., De Oliveira, A., & Hirtzig, A. (2022). A systematic analysis of 5g networks with a focus on 5g core security. *IEEE Access*, *10*, 18298-18319.

[9]   Dogra, A., Jha, R. K., & Jain, S. (2020). A survey on beyond 5G network with the advent of 6G: Architecture and emerging technologies. *IEEE access*, *9*, 67512-67547.

[10]   R. Giuliano, "From 5G-Advanced to 6G in 2030: New Services, 3GPP Advances, and Enabling Technologies," in *IEEE Access*, vol. 12, pp. 63238-63270, 2024, doi: 10.1109/ACCESS.2024.3396361.

[11]   Cagenius, T., Mildh, G., Rune, G., Vikberg, J., Wahlqvist, M., & Willars, P. (2023). 6G Network Architecture–A Proposal for Early Alignment. *Ericsson Technology Review*, *2023*(11), 2-7.

[12]   Jiang, W., Han, B., Habibi, M. A., & Schotten, H. D. (2021). The road towards 6G: A comprehensive survey. *IEEE Open Journal of the Communications Society*, *2*, 334-366.

[13]   Ericsson: 6G Security – drivers and needs; While paper; GFTL-24:000588, May 2024; Available at https://www.ericsson.com/en/reports-and-papers/white-papers/6g-security-drivers-and-needs

[14]   6G IA SNVC-SG: What societal values will 6G address? Available at: https://doi.org/10.5281/zenodo.6557534

[15]   Nguyen, V. L., Lin, P. C., Cheng, B. C., Hwang, R. H., & Lin, Y. D. (2021). Security and privacy for 6G: A survey on prospective technologies and challenges. *IEEE Communications Surveys & Tutorials*, *23*(4), 2384-2428.

[16]   Guo, H., Li, J., Liu, J., Tian, N., & Kato, N. (2021). A survey on space-air-ground-sea integrated network security in 6G. *IEEE Communications Surveys & Tutorials*, *24*(1), 53-87

[17]   Siriwardhana, Y., Porambage, P., Liyanage, M., & Ylianttila, M. (2021, June). AI and 6G security: Opportunities and challenges. In *2021 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)* (pp. 616-621). IEEE.

[18]   Pliatsios, D., Sarigiannidis, P., Lagkas, T., & Sarigiannidis, A. G. (2020). A survey on SCADA systems: secure protocols, incidents, threats and tactics. *IEEE Communications Surveys & Tutorials*, *22*(3), 1942-1976.

[19]   Yadav, G., & Paul, K. (2021). Architecture and security of SCADA systems: A review. *International Journal of Critical Infrastructure Protection*, *34*, 100433.

[20]   Stefan Köpsell: "To be sensed or not to be sensed – that's the question: Security and Privacy of Joint Communication and Sensing in upcoming 6G mobile networks.", Recorded Presentation, Colloquium at Karlstad University, Sweden, Nov. 22nd, 2024.