



**CSEDU 2020**

# **EA and BYOD: Threat Model and Comparison to Paper-based Examinations**

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## Our Project: FLEX



**FLEX** (Framework for **FLE**xible **E**lectronic **EX**aminations)

# Electronic Examinations on Students' Devices

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## Motivation

- e-Assessment is a rather new, but actively developing topic for German Institutions of Higher Education [1]
- **FLEX** aims to enable German IHEs to conduct e-Assessment on student owned Devices (→ BYOD)
- However, BYOD introduces (security) concerns as the devices are not fully controlled by the examining institution, including ...
  - Equality of Treatment [2]
  - Student Identification / Authorship Attribution
  - Cheating Prevention

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  - However, BYOD introduces (security) concerns as the devices are not fully controlled by the examining institution, including ...
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- A Threat Model has to be developed!

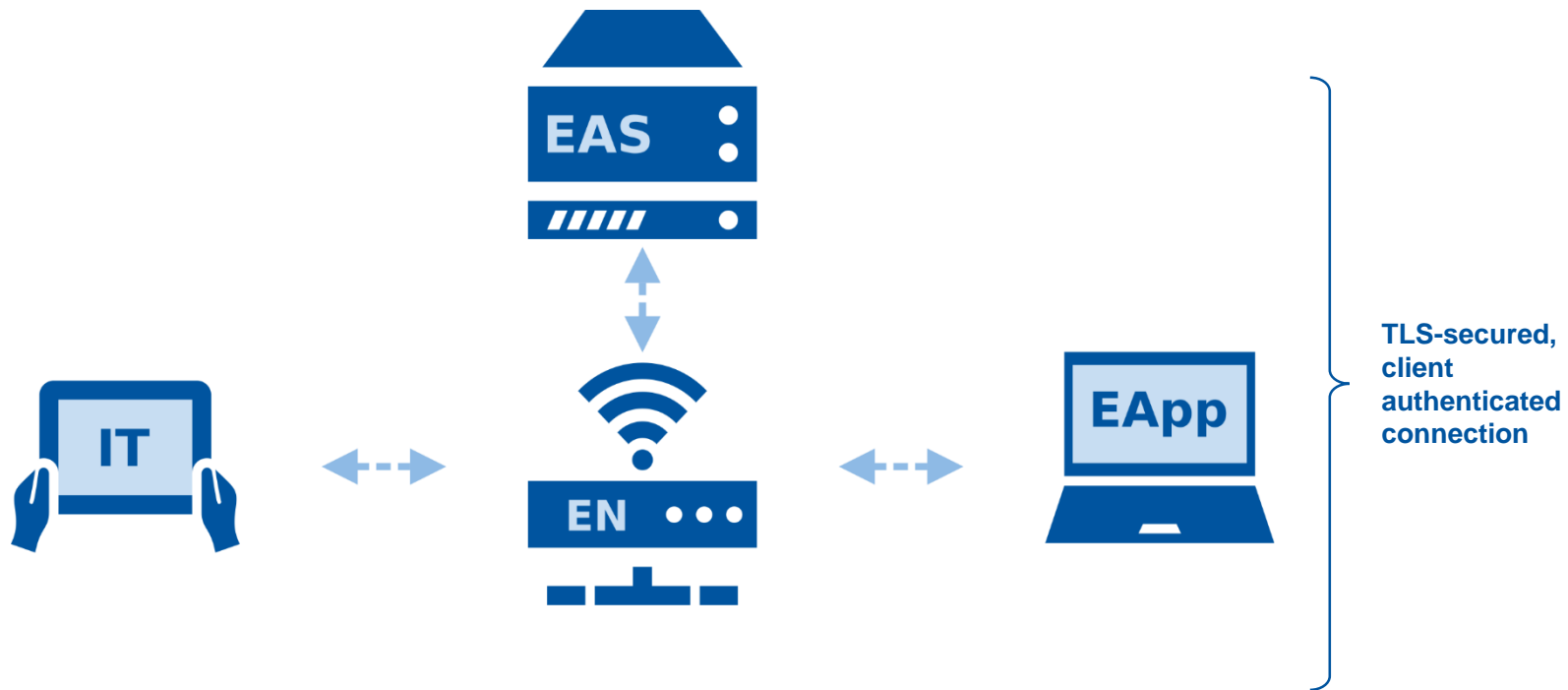
# Electronic Examinations on Students' Devices

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## Approach

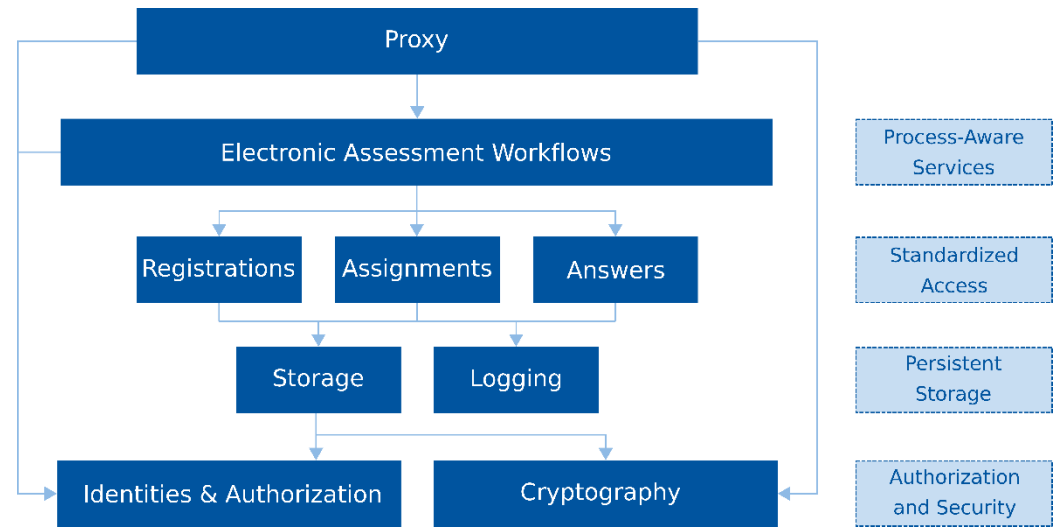
- The **FLEX** client software monitors itself and its communication channels to detect cheating
  - The students' devices are *untrusted devices*
  - Lockdown does not work reliably in a BYOD setting [3]
- Students are identified using certificates and public key cryptography
  - The private part of the certificate can be used to verify authorship of results
  - The public part of the certificate has to be stored reliably [4]
- There are still invigilators in the room, therefore **FLEX** does not have to handle everything in software, but can inform an invigilator in the exam room

## Basic Architecture



## FLEX

- Client Software
  - The software is tested for unauthorized modifications by Remote Attestation [5]
  - It has to be ensured that the execution environment is not a virtual machine [6]
- Server Software
  - The server uses a micro services pattern [7] to reduce the dependencies between different modules of the server architecture



# Electronic Examinations on Students' Devices

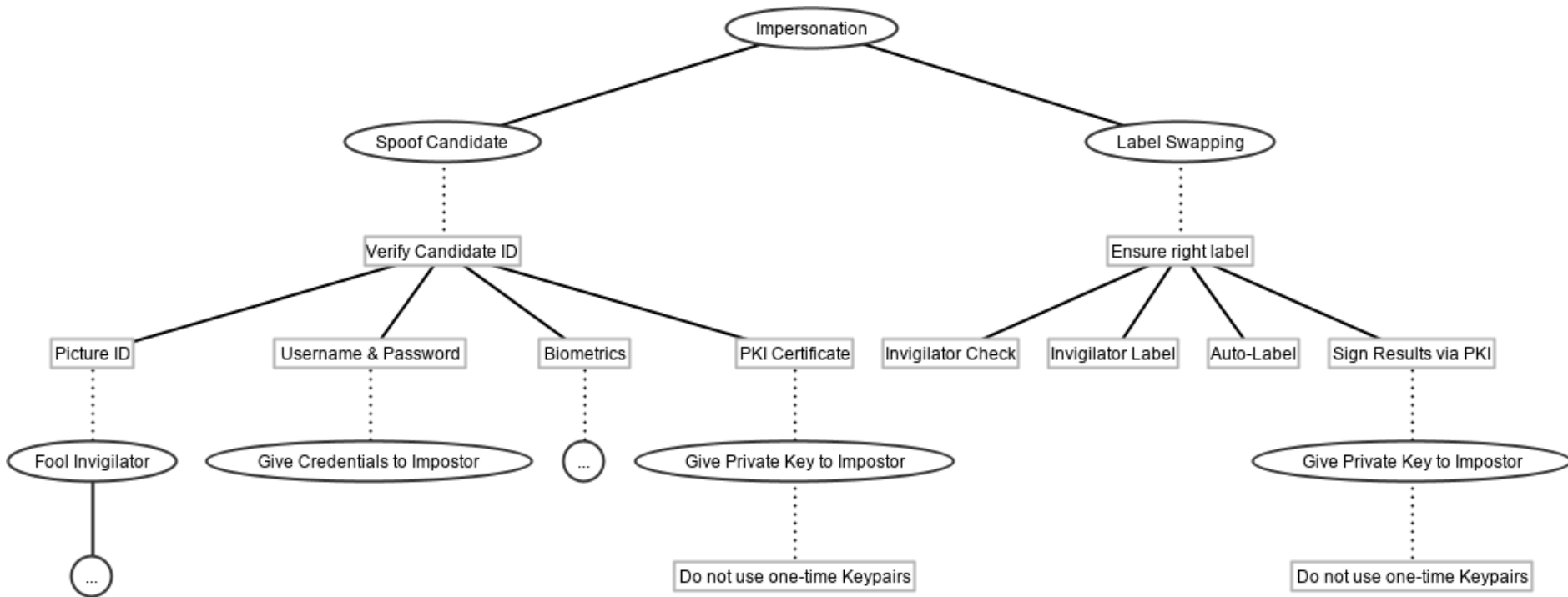
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## Threat Model

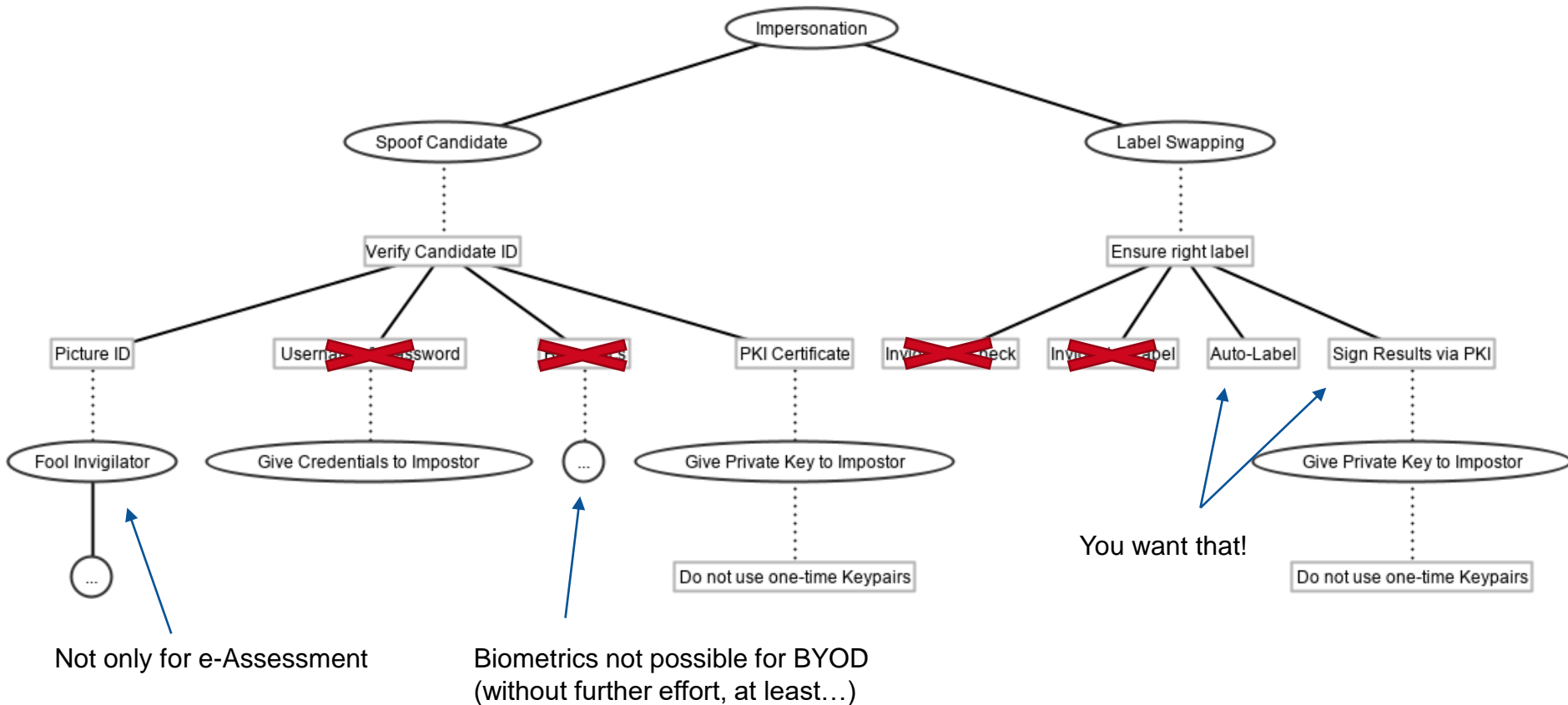
- Our Threat Model is based on previous work by Sindre and Vegendla [8]
- Identified Threats
  - **Impersonation**
  - **Assistance / Collaboration**
  - Plagiarism
  - **Using Aids not Allowed for the Exam**
  - Timing Violations
  - Lying to Proctors
  - Smuggling Out the Exam Questions



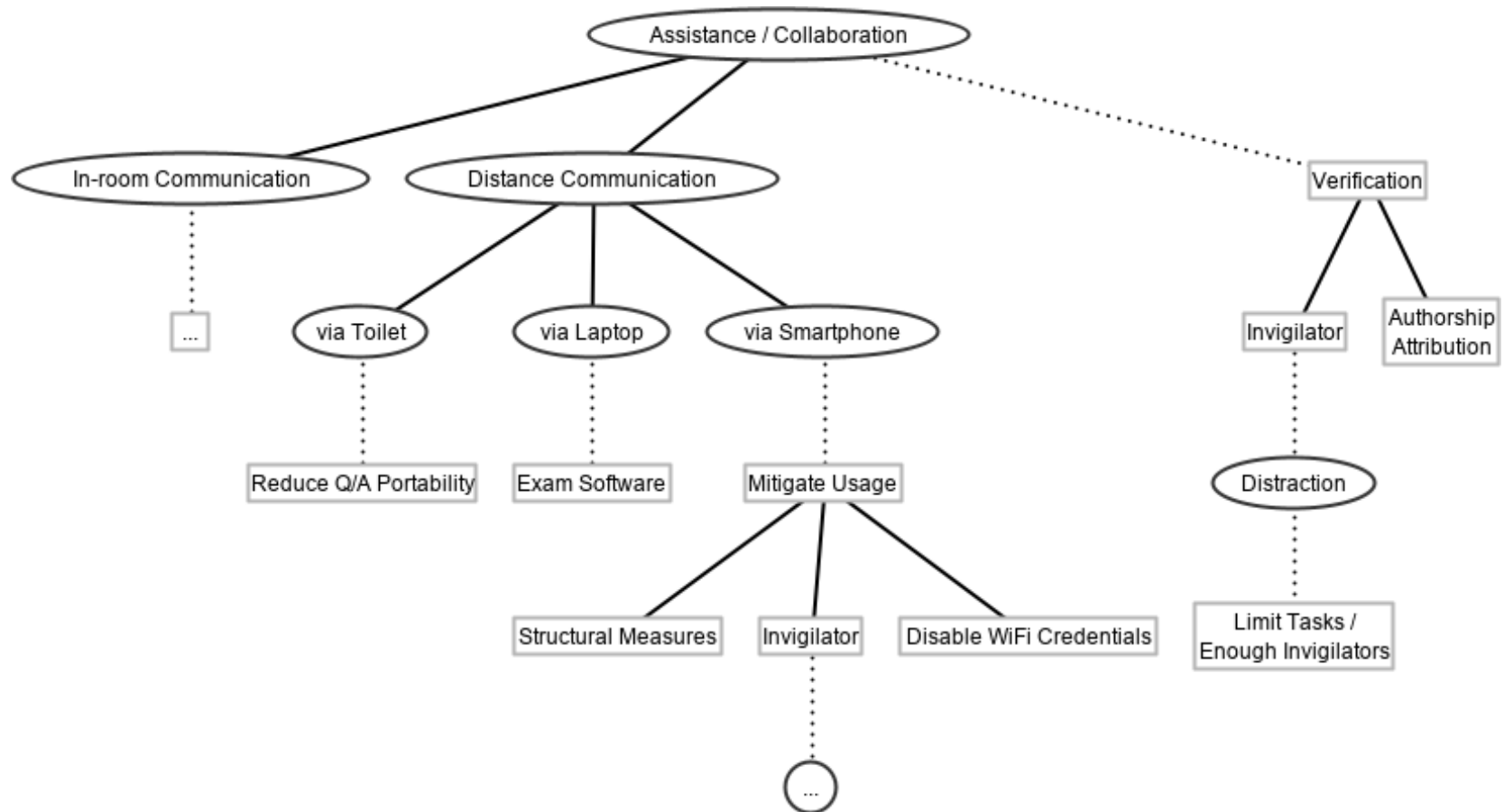
## Threat Model - Impersonation



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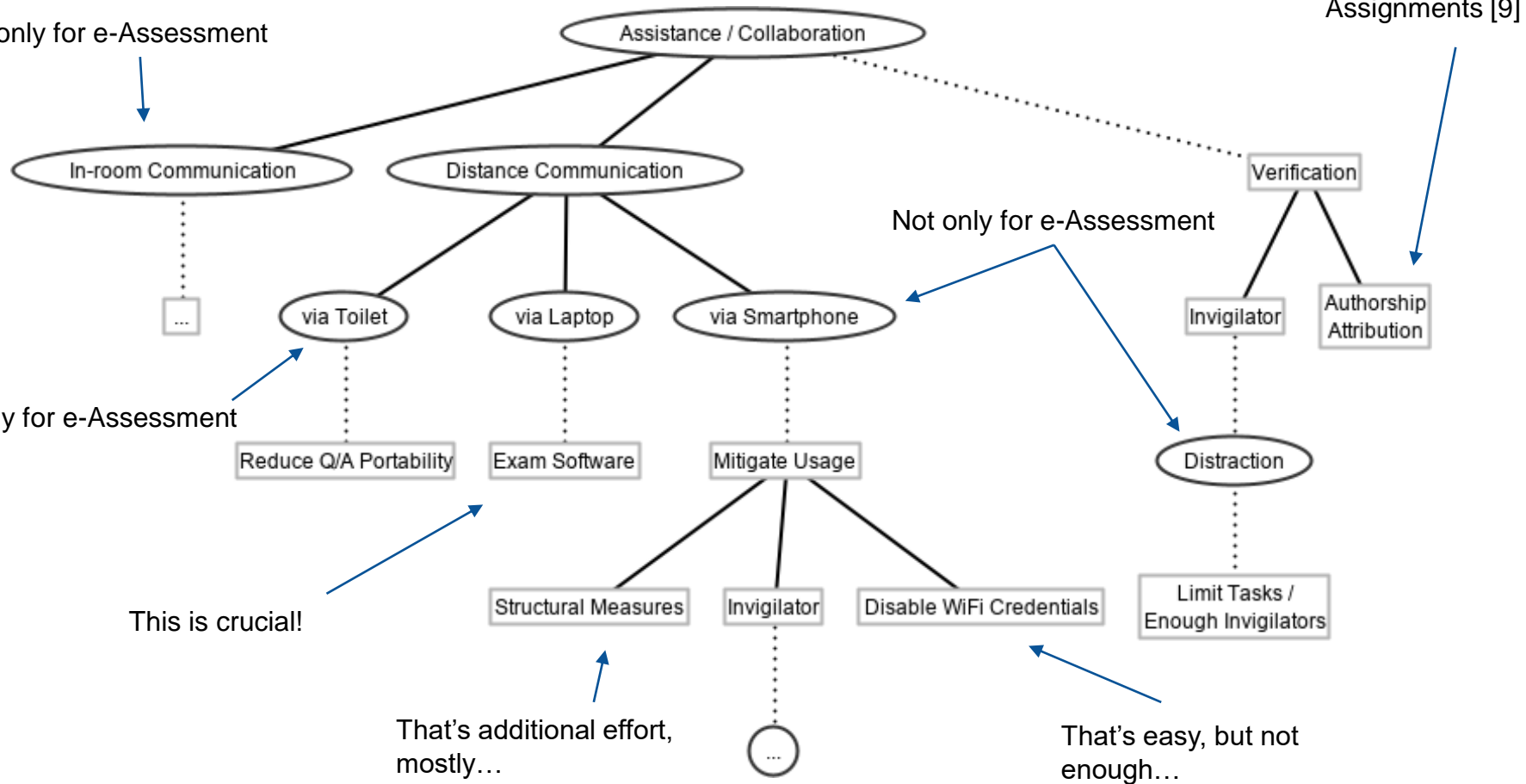


## Threat Model - Assistance / Collaboration

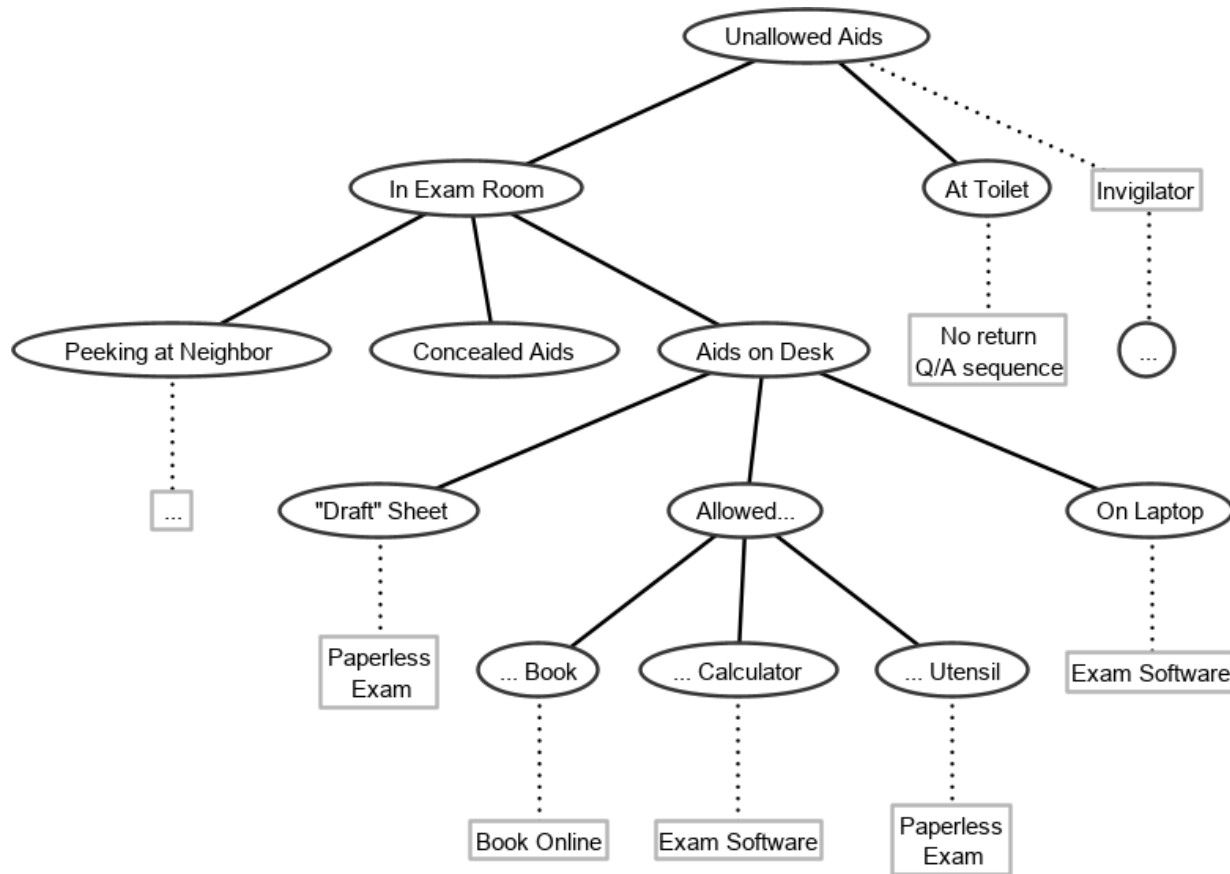


## Threat Model - Assistance / Collaboration

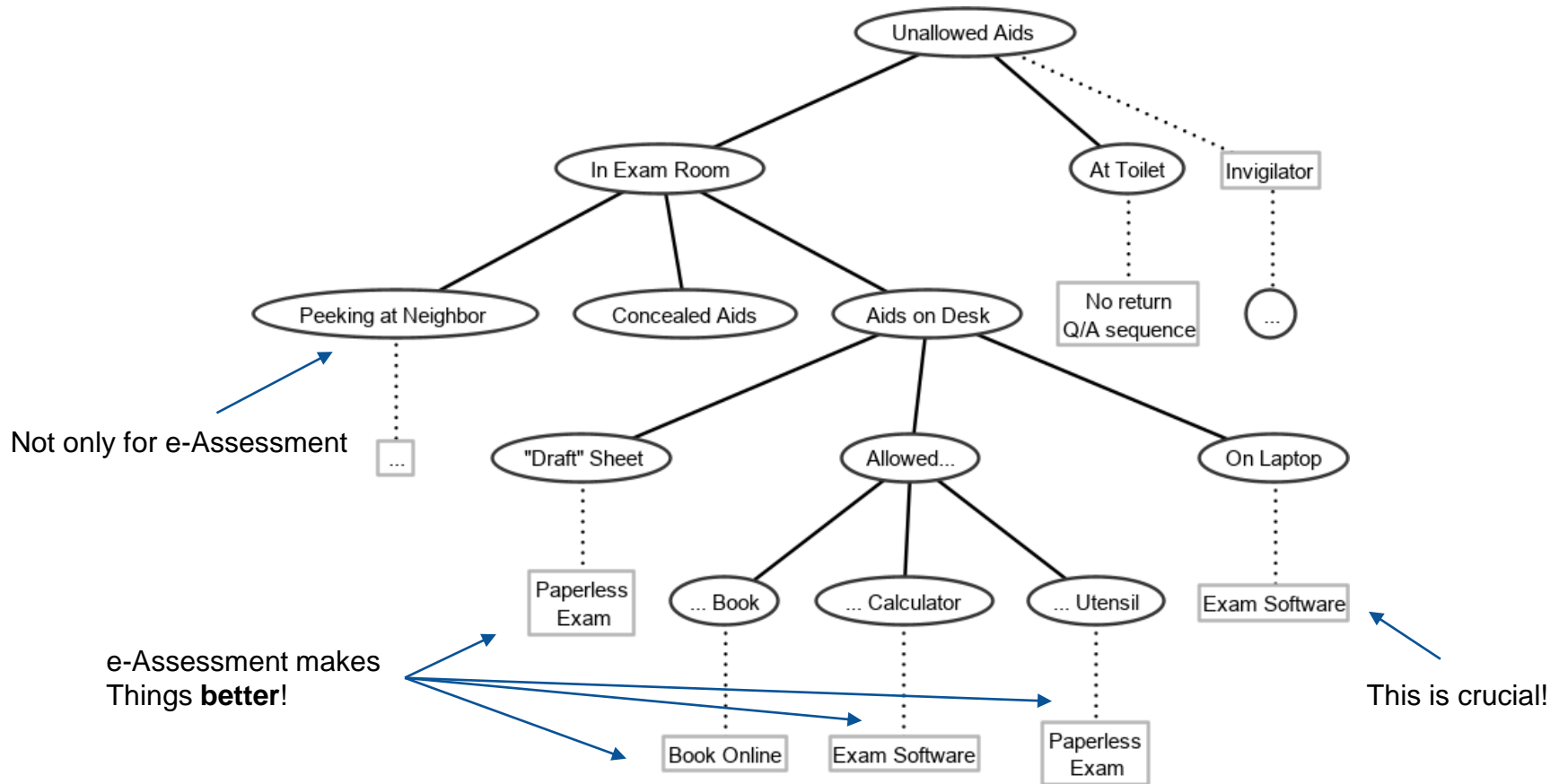
Not only for e-Assessment



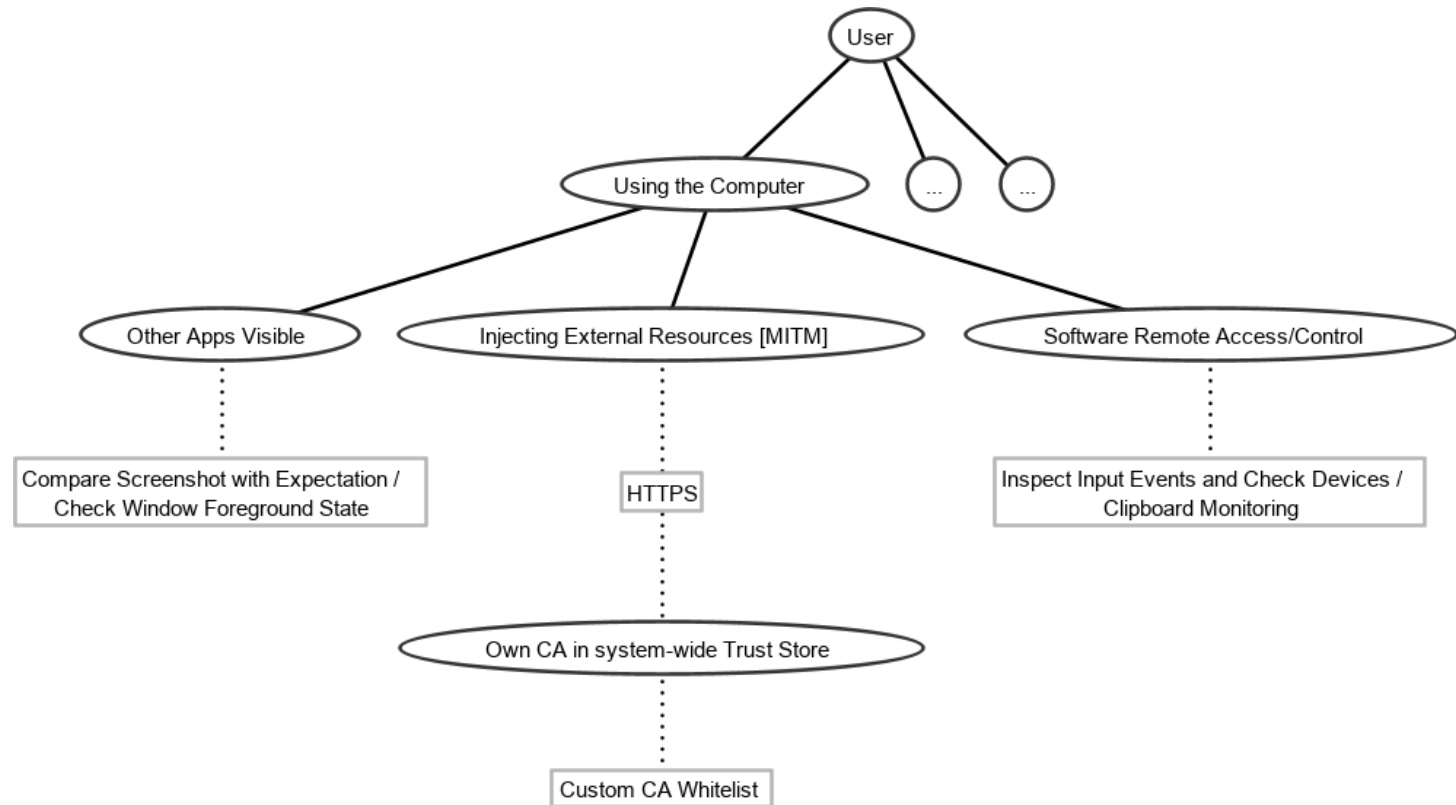
## Threat Model - Using Aids not Allowed for the Exam



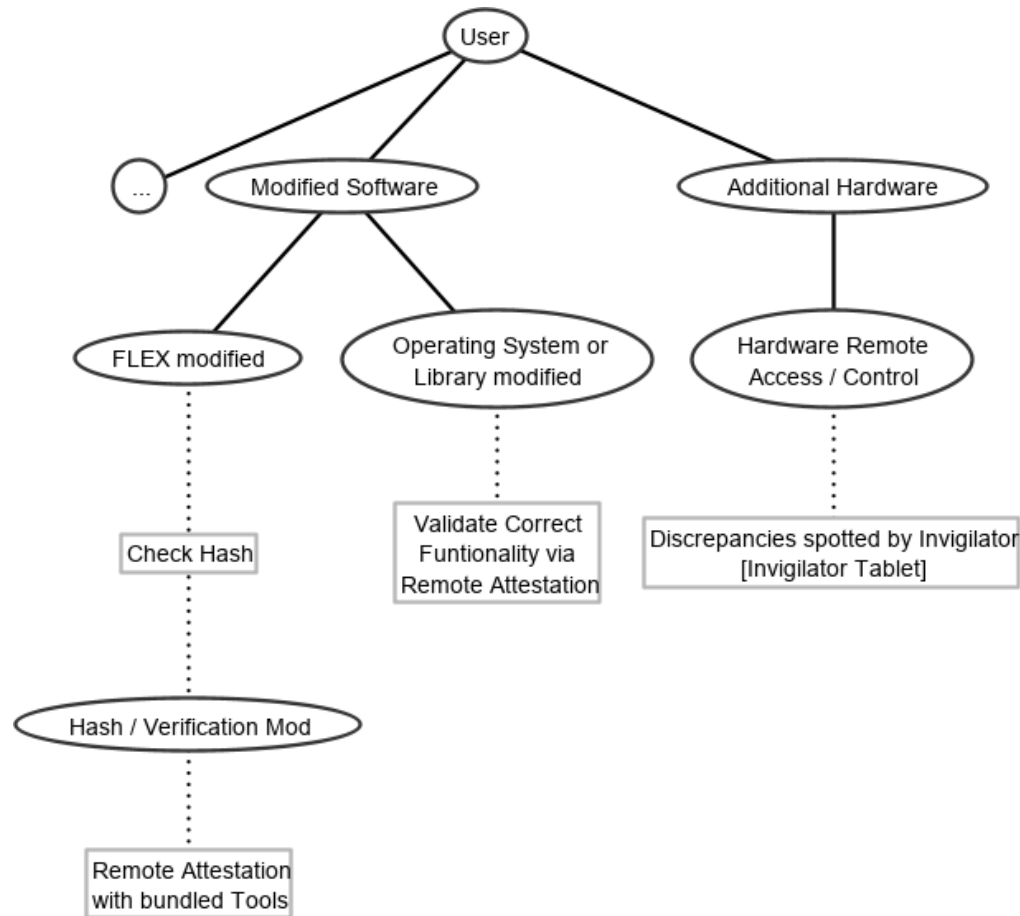
## Threat Model - Using Aids not Allowed for the Exam



## Threat Model - FLEX (1)



## Threat Model - FLEX (2)





## Summary / Outlook

- Utilizing the right countermeasures, the security of e-Assessment is not worse than for paper-based Examinations
  - For certain situations, e-Assessment can improve the security
  - For most situations, e-Assessment is capable of providing the same level of security as paper-based Examinations
  - Working and reliable exam software is crucial
- The **FLEX** project aims to provide Institutes of Higher Education with a software framework that enables them to carry out e-Assessment reliably in a BYOD setting
  - Different challenges are tackled
    - Student Identification / Authorship Attribution
    - Cheating Prevention
    - Equality of Treatment [2]
  - **FLEX** is still in development, next steps will be alpha- and beta testing
  - It is planned to release a first version of **FLEX** around mid of 2020
  - A field test is intended for September 2020

**Thanks for your attention! 😊**  
**Děkuji za pozornost! 😊**

Are there any questions or comments?

# Sources

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- [1] Hochschulforum Digitalisierung: The Digital Turn: Hochschulbildung im digitalen Zeitalter (2016) <https://hochschulforumdigitalisierung.de/sites/default/files/dateien/Abschlussbericht.pdf>
- [2] B. Küppers, R. Zameitat, U. Schroeder: e-Assessment: Ensuring Equality of Treatment in a BYOD-Setting, EUNIS 2018, Book of Proceedings (2018) <http://www.eunis.org/eunis2018/papers/>
- [3] Søgaard, T. M.: Mitigation of Cheating Threats in Digital BYOD exams, Master's Thesis (2016) <https://brage.bibsys.no/xmlui/handle/11250/2410735>
- [4] Küppers, B.; Politze, M.; Schroeder, U.: Reliable e-Assessment with git: practical considerations and implementation, EUNIS 2017, Book of Proceedings (2017) <http://dx.doi.org/10.17879/21299722960>
- [5] Garay, J. A. and Huelsbergen, L.: Software Integrity Protection Using Timed Executable Agents, Proceedings of the 2006 ACM Symposium on Information, Computer and Communications Security, pp. 189-200 (2006)
- [6] Hoffman, N.: VM Checking and Detecting (2014) <http://securitykitten.github.io/vm-checking-and-detecting/>
- [7] Namiot, D.; Sneps-Sneppe, M.: On Micro-services Architecture, International Journal of Open Information Technologies (2014)

## Sources

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- [8] Sindre, G. & Vegendla, A. (2015) E-exams versus paper exams: A comparative analysis of cheating-related security threats and countermeasures; Norsk Informasjonssikkerhetskoneranse (NISK) 2015, ISSN: 1894-773
- [9] J. Opgen-Rhein, B. Küppers, U. Schroeder: AN APPLICATION TO DISCOVER CHEATING IN DIGITAL EXAMS, Koli Calling '18, Proceedings of the 18th Koli Calling International Conference on Computing Education Research (Koli Calling '18), Article 20, 5 pages, DOI: 10.1145/3279720.3279740