Development, Implementation and Evaluation of a Security Concept for the Secure Transfer of Sensitive Personal Data Between Different Devices

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Outline

Motivation

- With advances in information technology more personal data is gathered, stored and shared
- Disclosed sensitive personal data endangers an individuals right to self-determination
- Regulations, such as the General Data Protection Regulation (GDPR), implement law to protect an individuals right to privacy

Outline of Contribution

- Design of a security concept for the transfer of sensitive personal data complying with the GDPR
- Design of the concept as part of the CliniScale project
- Evaluation of the security level of the concept by performing a security risk assessment
- Creation of a guideline for the implementation of identified security measurements

The **Microsoft Threat Modeling Tool (MTMT)** is a core element of the Microsoft Security Development Lifecycle. It allows software architects to identify and mitigate security issues early in the process of designing a software architecture.

Microsoft **STRIDE** is a threat model that supports security analysts in identifying possible threats in six different categories.

The **Yakindu Security Analyst** is a tool created by the Itemis AG to perform risk assessments.

Related Work [1/2]

- **J. Eichler and D. Angermeier.** “Modular Risk Assessment for the Development of Secure Automotive Systems”. In: *31. VDI/VW-Gemeinschaftstagung Automotive Security*, 2015 [1]
- **J. Eichler, D. Angermeier, and A. Nieding.** “Systematic Identification of Security Goals and Threats in Risk Assessment”. In: *Softwaretechnik-Trends 36.3*, 2016 [2]
- **J. Eichler, D. Angermeier, and A. Nieding.** ”Supporting Risk Assessment with the Systematic Identification, Merging and Validation of Security Goals”. In: *Risk Assessment and Risk-Driven Quality Assurance. RISK 2016*, 2017, pp. 82–95 [3]

Related Work [2/2]

- **M. de Gramatica, K. Labunets, F. Massacci, F. Paci, and A. Tedeschi.** "The role of catalogues of threats and security controls in security risk assessment: an empirical study with ATM professionals". In: *International Working Conference on Requirements Engineering: Foundation for Software Quality.* Springer. 2015, pp. 98–114 [4]
- **W. Wilkowska and M. Ziefle.** "Privacy and data security in E-health: Requirements from the user's perspective". In: *Health Informatics Journal 18.3*, 2012, pp. 191–201 [5]

General Data Protection Regulation [1/3]

https://www.zdnet.com/article/gdpr-an-executive-guide-to-what-you-need-to-know/

- Consists of 99 articles, 173 recitals and 14 key issues [6]
- Investigated for regulatory specifications concerning a system collecting and processing sensitive personal data

Article 4: Personal Data Defines personal data as any information relating to an identified or identifiable natural person [7]

Article 9: Sensitive Personal Data Special category of personal data [8]

Article 6: Lawfulness of Processing Defines conditions under which the processing of personal data is lawful [9]

Article 7: Conditions for Consent Defines that consent by the data subject to processing has to be given by a clear affirmative act that is freely given, specific, informed and unambiguous [10]

Article 25: Security of Processing Places the responsibility to implement appropriate technical and organizational measures to secure personal data on the controller [11]

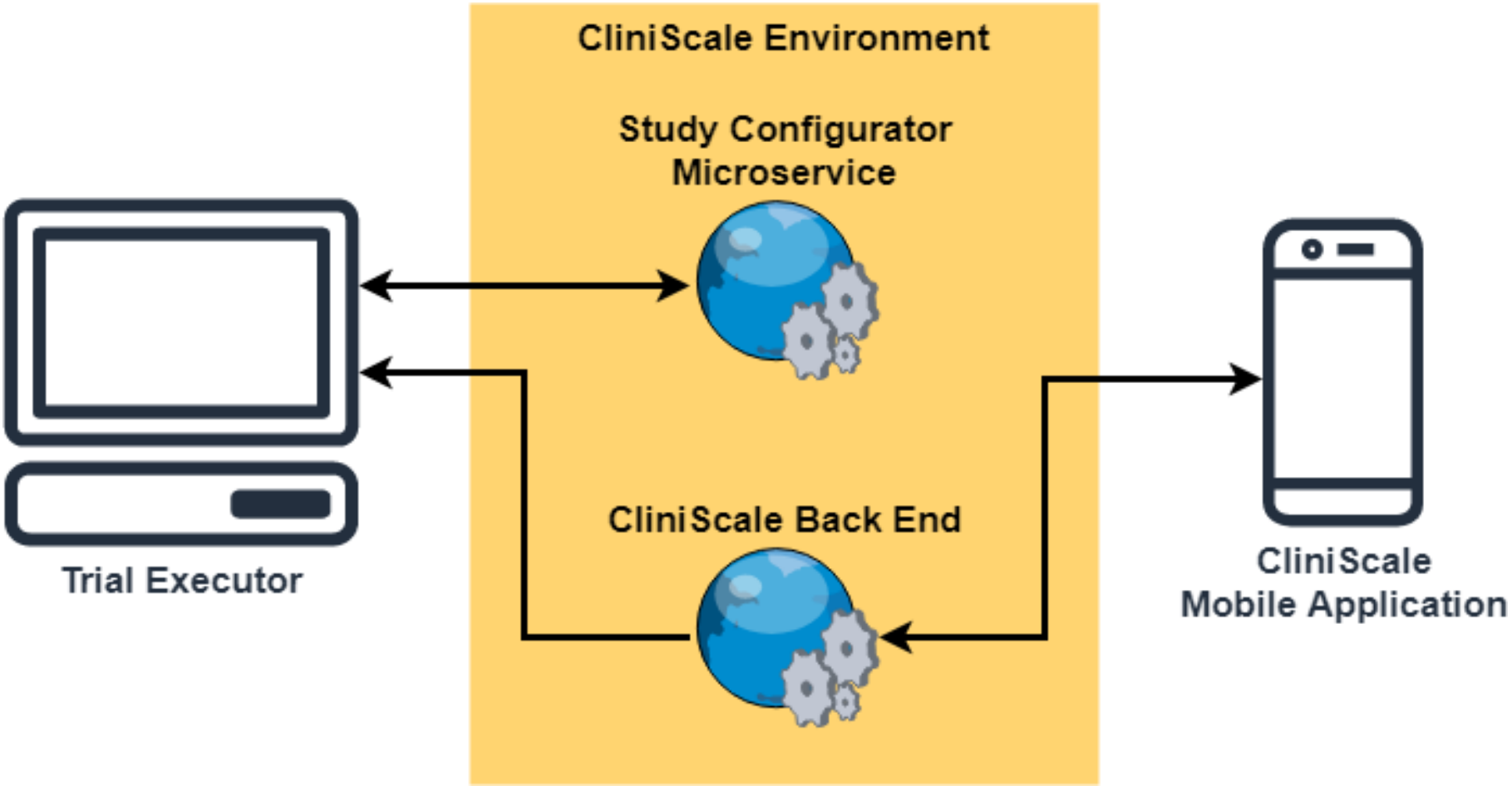
General Data Protection Regulation [3/3]

- Personal and sensitive personal data has to be secured in a manner appropriate for the risks
- State of the art security measurements
- Consent given by a clear affirmative act that is freely given, specific, informed and unambiguous

https://www.mi.fu-berlin.de/en/inf/groups/ag-db/projects/CliniScale/index.html

- Project by the Databases and Information Systems Group at Freie Universität Berlin
- Run scalable and user-friendly clinical trials in the population
- Mobile devices paired with specific sensors

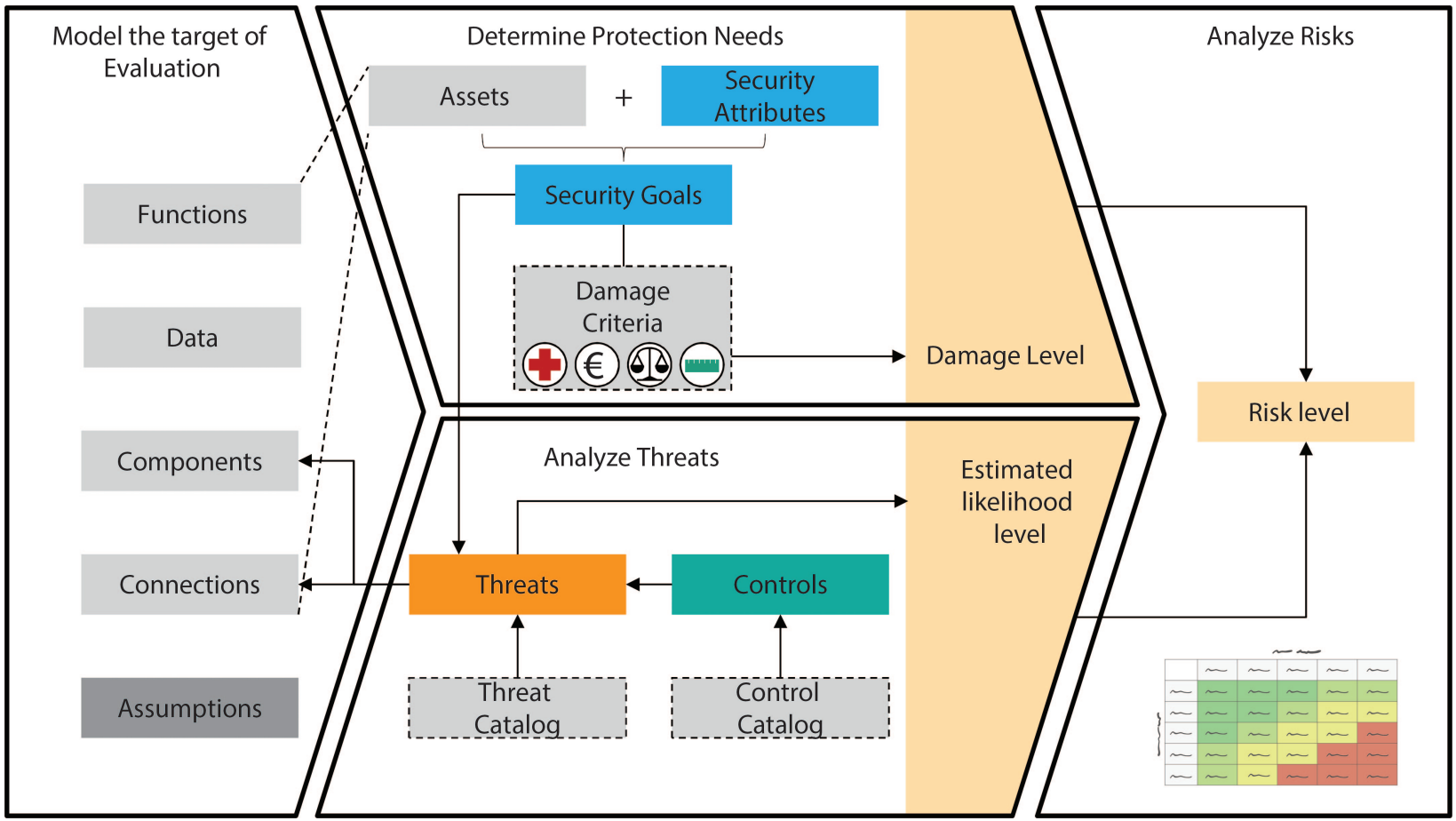
CliniScale Project [2/2]



Modular Risk Assessment (MoRA)

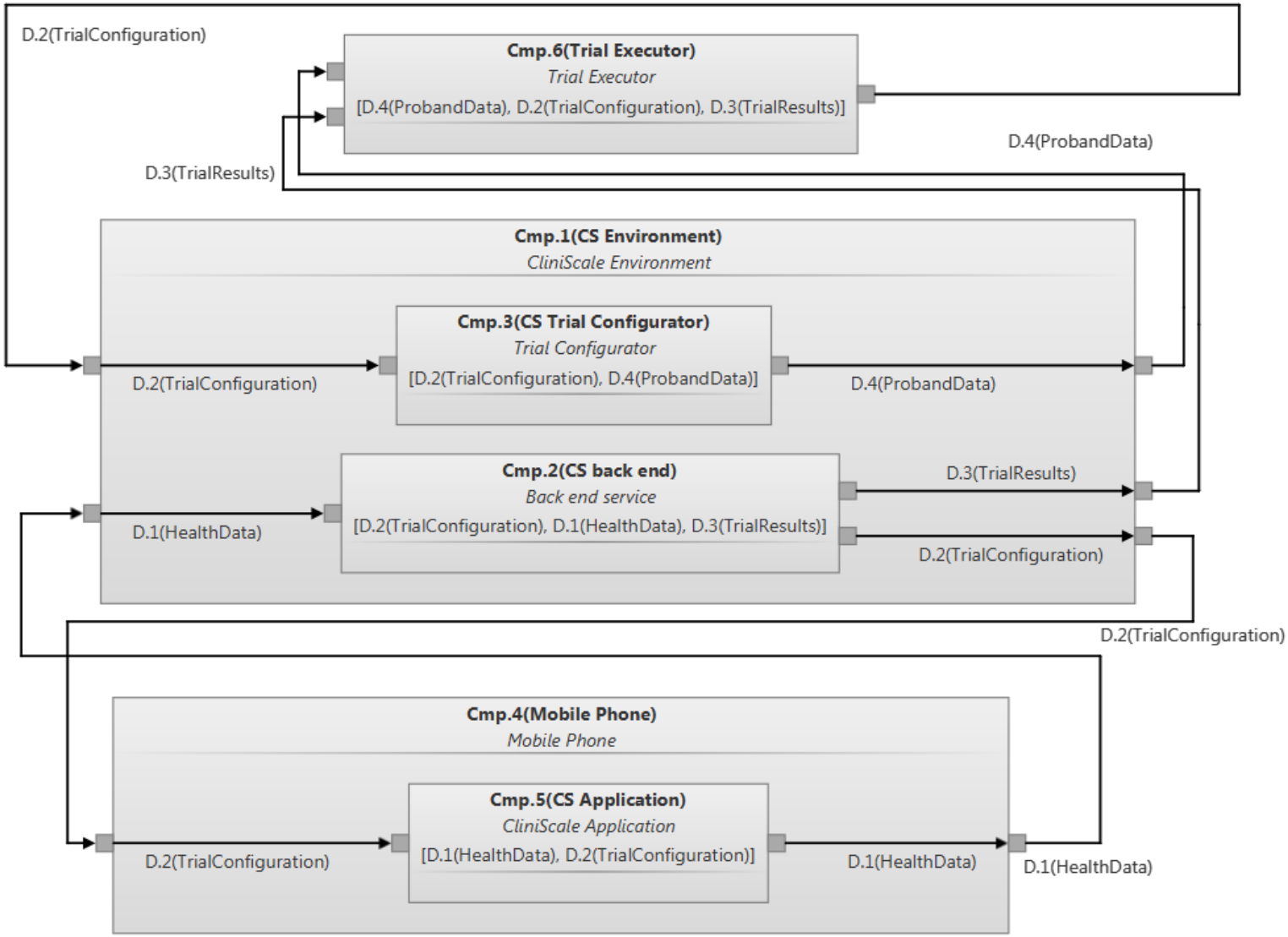
- Method for security risk assessment developed by Jörn Eichler and Daniel Angermeier at Fraunhofer AISEC in 2015
- Flexibility of application in different environments
- Customized in order to integrate the MTMT as threat and control catalogue

Methodology Overview

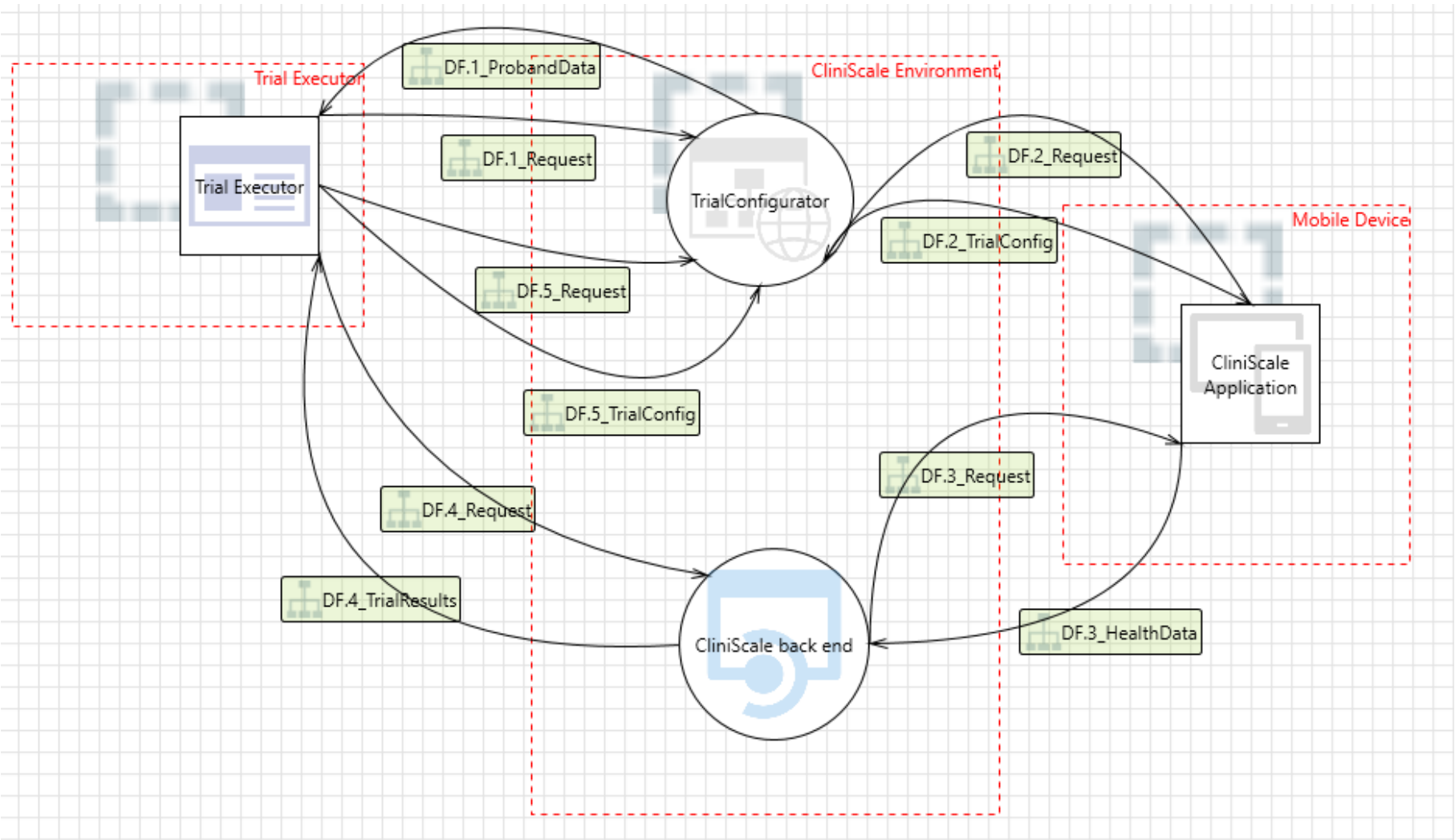


https://www.aisec.fraunhofer.de/de/presse-und-veranstaltungen/presse/pressemitteilungen/2018/it-sa2018.html

System Under Development [1/2]



System Under Development [2/2]



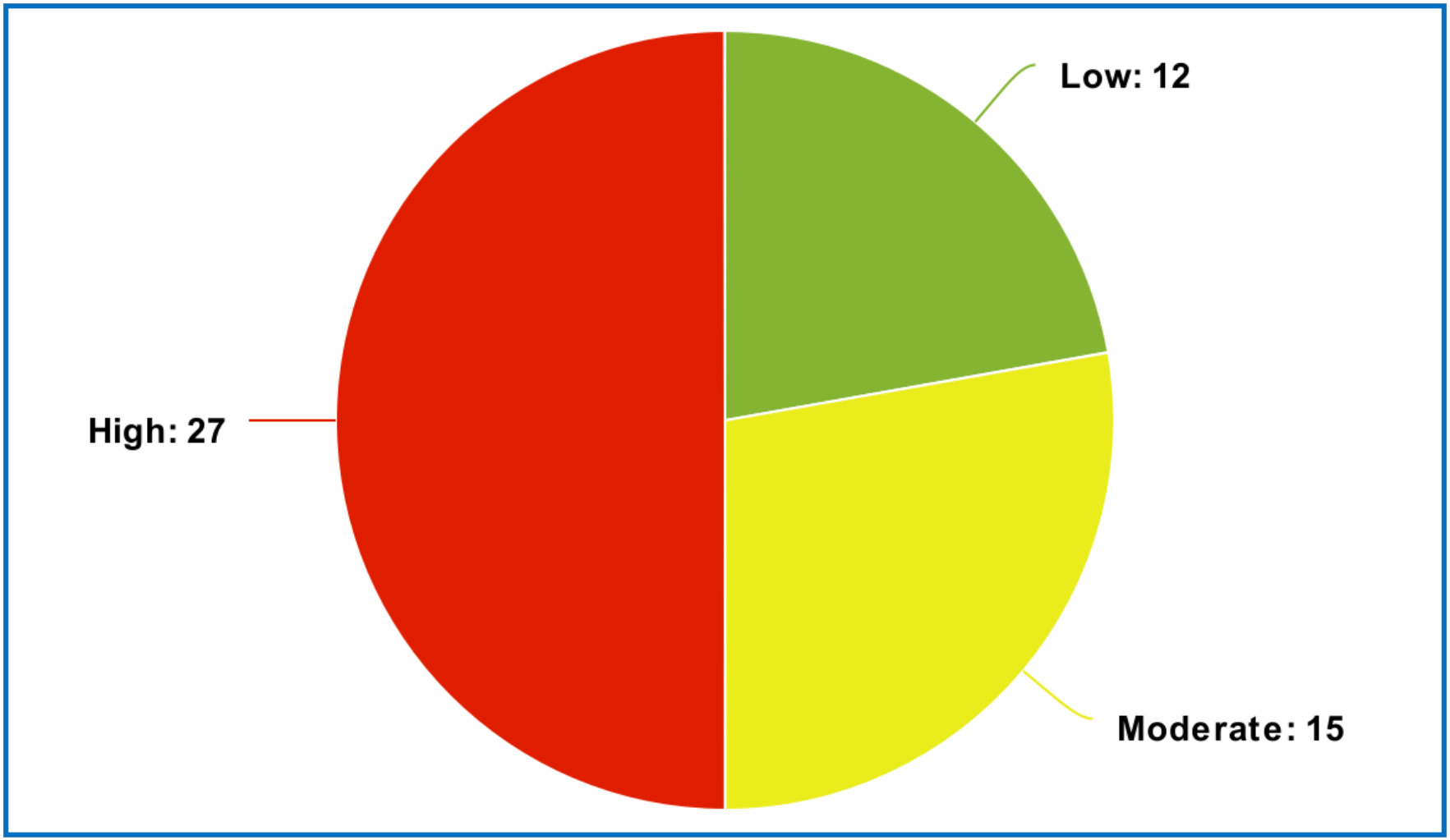
Determine Protection Needs [1/2]

- Process of identifying and defining security goals
- Assessment Model: Security Goal Classes, Damage Criteria

```
security goal G.31: Confidentiality HealthData instantiates CON: Confidentiality damage potential: High
  concerns         D.1(HealthData): HealthData
  damage criteria  SelfDet: Right to self-determination:
                     SensDat: Leak of sensitive personal data (High) rationale: <no rationale>
                   FinCon: Financial consequences:
                     ExcFine: Existence-threatening fine               (High) rationale: <no rationale>
                     ExcRep: Existence-threatening reputational damage (High) rationale: <no rationale>
  depends on       G.13 || G.34 || G.36
  threatened by    <no expr>
```

Determine Protection Needs [2/2]

- 54 security goals



Analyze Threats [1/2]

- Process of identifying and defining threats
- Import threats generated by MTMT

1	An adversary may jail break into a mobile device and gain elevated privileges	Elevation of Privileges	DF.3_HealthData
2	An adversary may gain unauthorized access to Web API due to poor access control checks	Elevation of Privileges	DF.3_HealthData
3	An adversary can gain access to sensitive information from an API through error messages	Information Disclosure	DF.3_HealthData
4	An adversary can gain access to sensitive data by sniffing traffic from Mobile client	Information Disclosure	DF.3_HealthData
5	An adversary can gain access to sensitive data by sniffing traffic to Web API	Information Disclosure	DF.3_HealthData
6	An adversary can gain sensitive data from mobile device	Information Disclosure	DF.3_HealthData

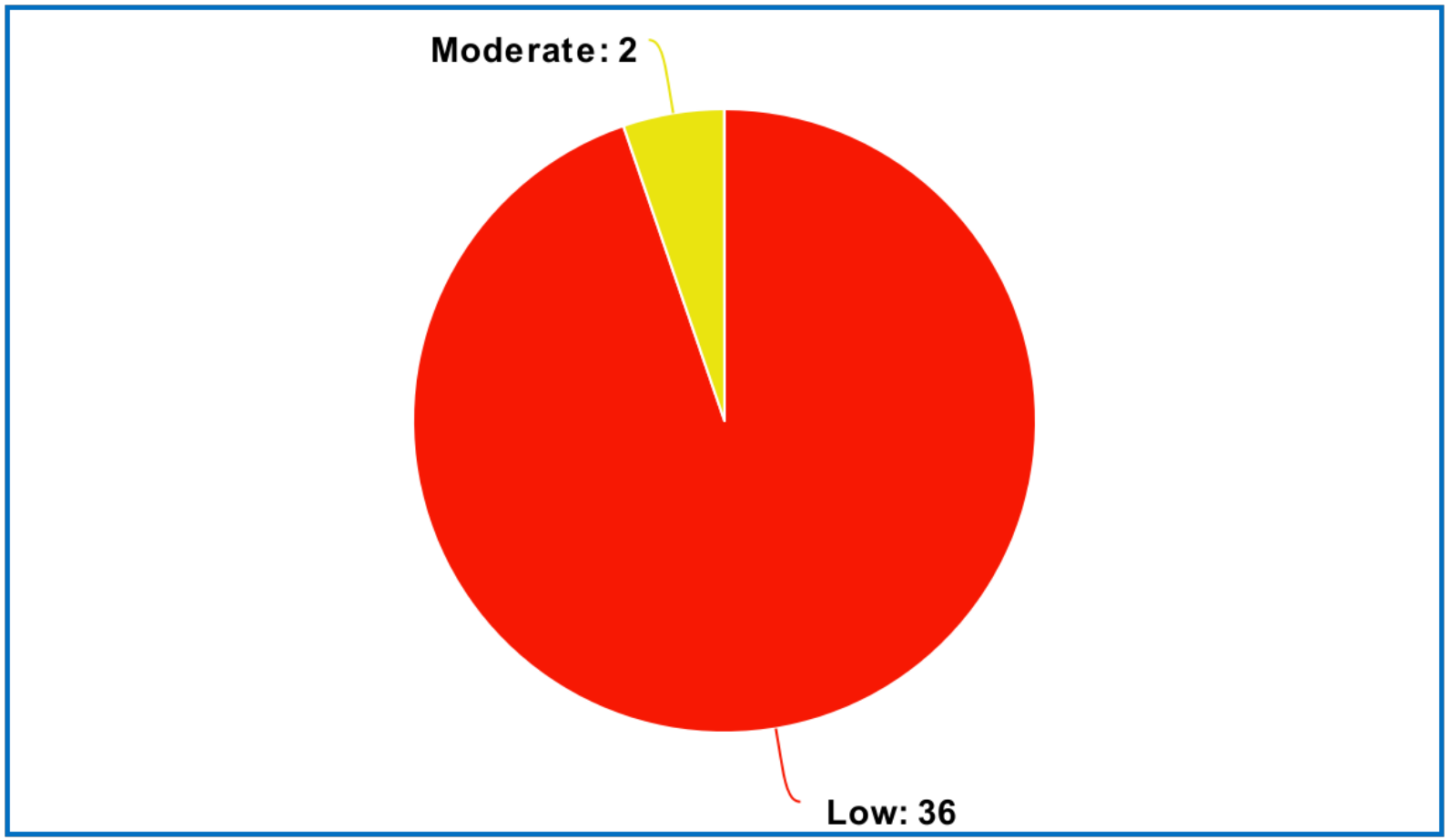
threat T.2: Gain access to API end points due to unrestricted cross domain requests instantiates
TC.1.2: An adversary can gain unauthorized access to API end points due to unrestricted cross domain requests
required attack potential: High

threatens + G.22
acts on << ... >>
mitigated by C.29 || C.70
risk factors

	Risk factors					Required attack potential	-> explicit
	SPEX	ACCS	TIME	EQUIP	KNOW		
Initial						none	<no attack effort>

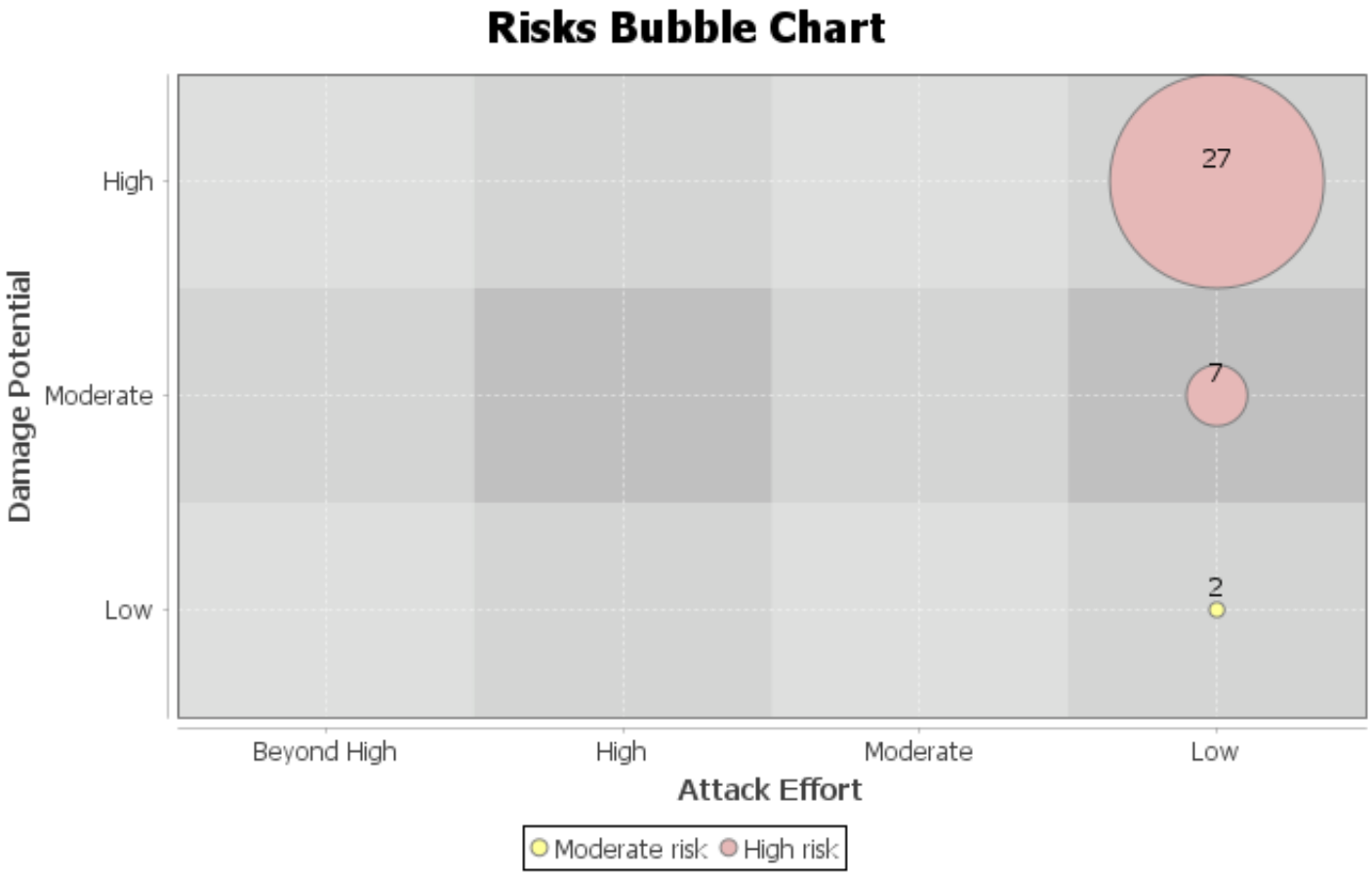
Analyze Threats [2/2]

- 100 threats generated by MTMT
- 38 aggregated threats imported



Analyze Risks

- Process of identifying and defining risk elements
- Risk elements provide a summary of the overall risk level



Establish controls [1/2]

- Process of identifying and defining security control elements

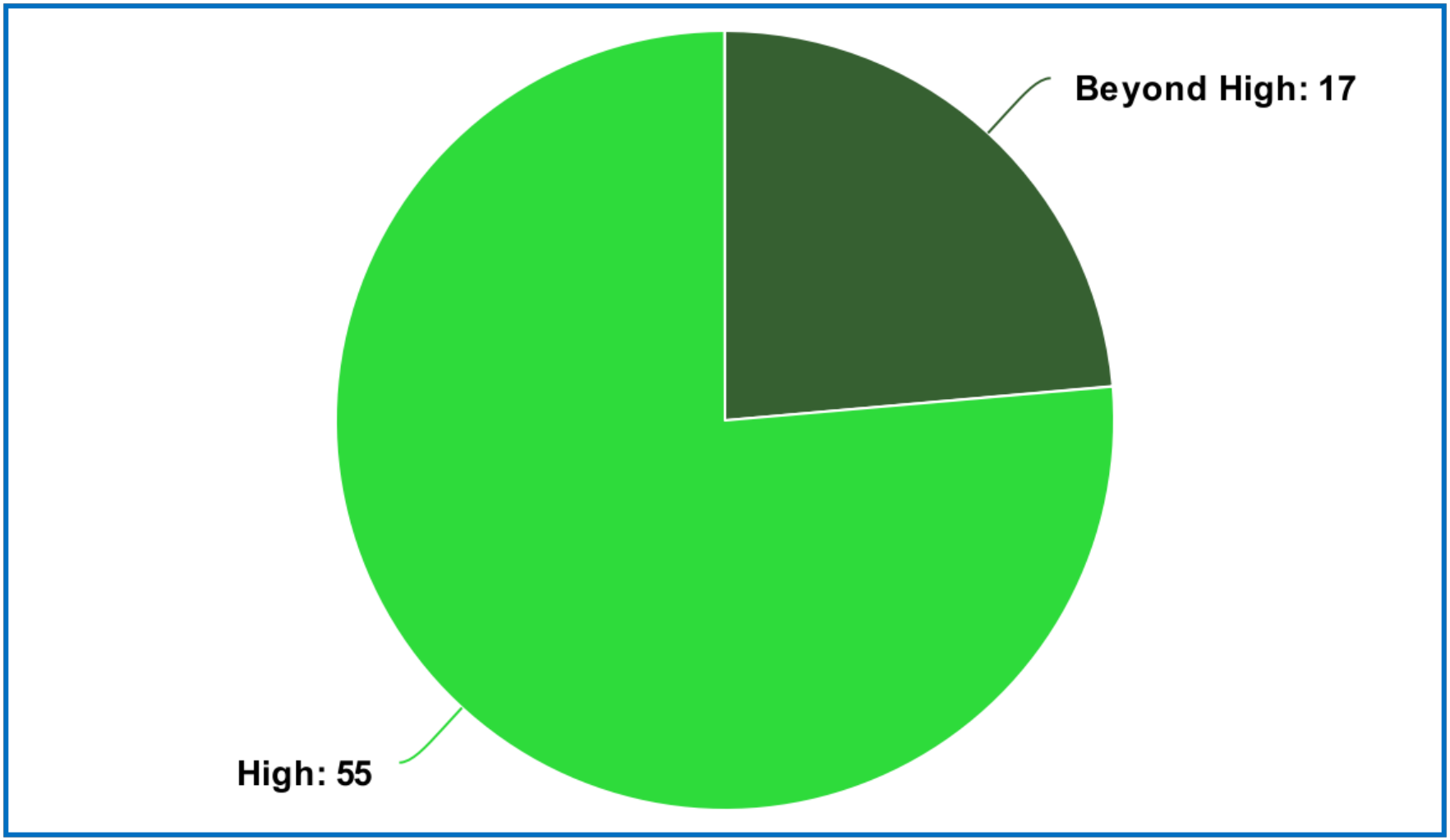
1	Elevation of Privileges	DF.3_HealthData	Implement implicit jailbreak or rooting detection. Refer: <a href="https://aka.ms/tmtauthz#rootin...
2	Elevation of Privileges	DF.3_HealthData	Implement proper authorization mechanism in ASP.NET Web API. Refer: <a href="https://aka.ms/t...
3	Information Disclosure	DF.3_HealthData	Ensure that proper exception handling is done in ASP.NET Web API. Refer: <a href="https://aka.ms/...
4	Information Disclosure	DF.3_HealthData	Implement Certificate Pinning. Refer: <a href="https://aka.ms/tmtcommsec#cert-pinning">https:...
5	Information Disclosure	DF.3_HealthData	Force all traffic to Web APIs over HTTPS connection. Refer: <a href="https://aka.ms/tmtcommsec...
6	Information Disclosure	DF.3_HealthData	Encrypt sensitive or PII data written to phones local storage. Refer: <a href="https://aka.ms/tmtda...

```
control C.68: Applications available over HTTPS must use secure cookies instantiates
    CC.10.1: Applications available over HTTPS must use secure cookies required attack potential: High
  depends on    <no expr>
  mitigates     + T.33, T.8
  risk factors
```

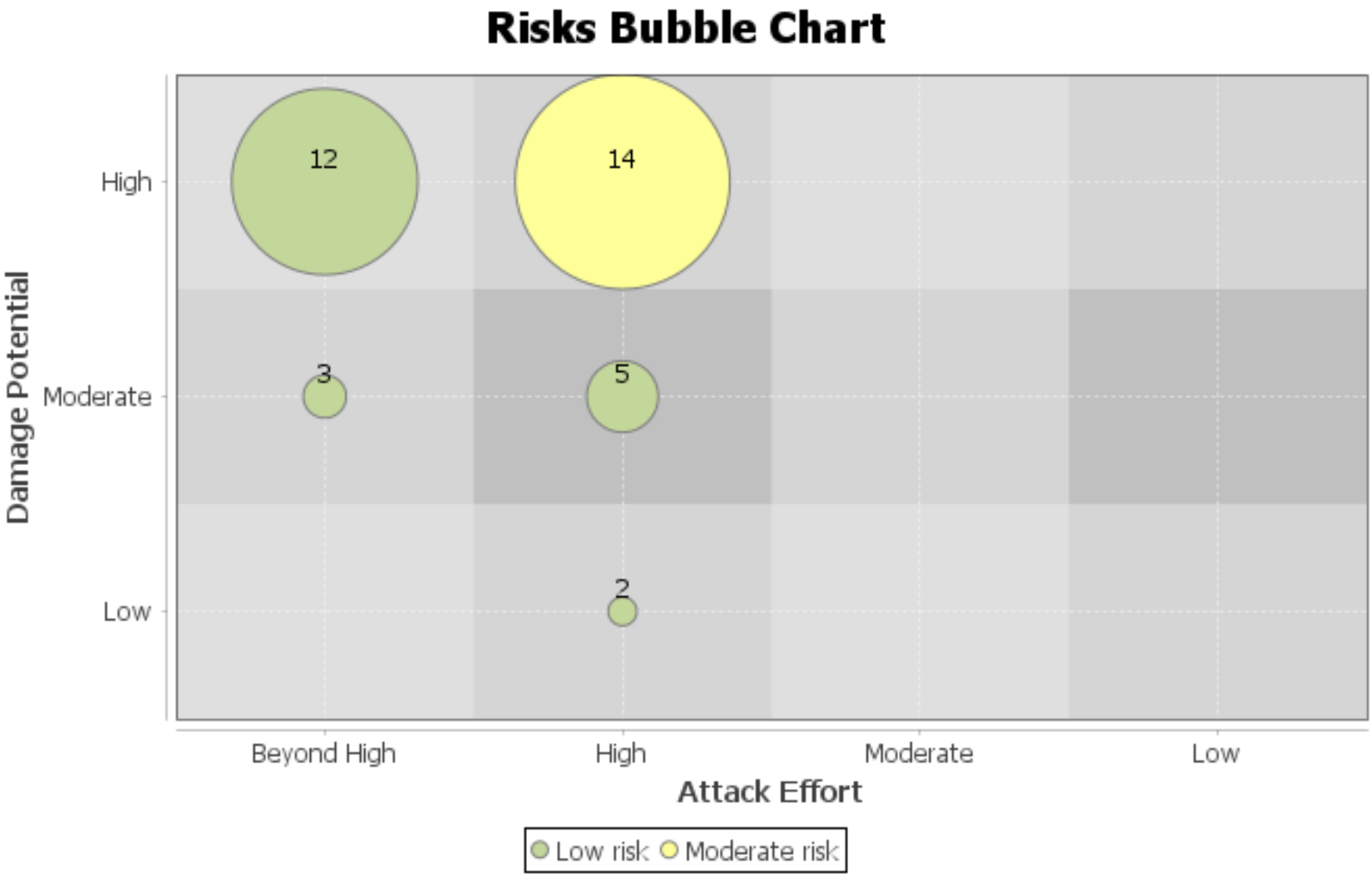
	Risk factors					Required attack potential	-> explicit
	SPEX	ACCS	TIME	EQUIP	KNOW		
Initial						none	<no attack effort>

Establish controls [2/2]

- 72 security controls



Analyze Need for Further Iterations [1/2]



- Mitigations recommended by the MTMT
- Ten categories of mitigations: **Auditing and Logging**, **Authentication**, **Authorization**, **Communication Security**, **Configuration Management**, **Cryptography**, **Exception Management**, **Input Validation**, **Sensitive Data**, **Session Management**
- Recommendations on implementation for every control

CC.4.4: Force all traffic to Web APIs over HTTPS connection

- Hypertext Transfer Protocol Secure
- BSI Technical Guidelines [12]
- Implementation supported by the Spring Security Framework

Conclusion

- Compliance with the GDPR
- Successful integration of the MTMT as threat and control catalogue into the MoRA methodology
- Implementation guideline applicable to any client-server infrastructure gathering, storing and processing sensitive personal data

Limitations

- GDPR investigated for regulations concerning this thesis
- Missing information on the required attack potential

Future Work

- Domain specific threat and control catalogues
- Complete security risk assessment of the CliniScale system

Questions?

References I

[1] **J. Eichler and D. Angermeier**. “Modular Risk Assessment for the Development of Secure Automotive Systems”. In: *31. VDI/VW-Gemeinschaftstagung Automotive Security* (2015).

[2] **D. Angermeier, A. Nieding, and J. Eichler**. *Supporting Risk Assessment with the Systematic Identification, Merging, and Validation of Security Goals*. Ed. by J. Großmann, M. Felderer, and F. Seehusen. Cham: Springer International Publishing, 2017, pp. 82–95.

[3] **D. Angermeier, A. Nieding, and J. Eichler**. “Systematic Identification of Security Goals and Threats in Risk Assessment”. In: *Softwaretechnik-Trends* 36.3 (2016).

References II

[4] **M. de Gramatica, K. Labunets, F. Massacci, F. Paci, and A. Tedeschi**. "The role of catalogues of threats and security controls in security risk assessment: an empirical study with ATM professionals". In: *International Working Conference on Requirements Engineering: Foundation for Software Quality*. Springer. 2015, pp. 98–114.

[5] **W. Wilkowska and M. Ziefle**. "Privacy and data security in E-health: Requirements from the user's perspective". In: *Health informatics journal* 18.3 (2012), pp. 191–201.

[6] **General Data Protection Regulation**. *(Online; Last accessed January 15, 2020)*. URL: https://eugdpr.org/.

References III

[7] **General Data Protection Regulation Article 4**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-4-gdpr/.

[8] **General Data Protection Regulation Article 9**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-9-gdpr/.

[9] **General Data Protection Regulation Article 6**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-6-gdpr/.

[10] **General Data Protection Regulation Article 7**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-7-gdpr/.

References IV

[11] **General Data Protection Regulation Article 25**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-25-gdpr/.

[12] **BSI TR-02102-2**. *(Online; Last accessed January 15, 2020)*. URL: https://www.bsi.bund.de/SharedDocs/Downloads/EN/BSI/Publications/TechGuidelines/TG02102/BSI-TR-02102-2.pdf.

[13] **General Data Protection Regulation Article 32**. *(Online; Last accessed January 15, 2020)*. URL: https://gdpr-info.eu/art-32-gdpr/.