# **Towards Measuring Maturity of Privacy-Enhancing Technologies**

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> Unabhängiges Landeszentrum für Datenschutz Schleswig-Holstein





- Motivation
- PET Maturity Scales
- PET Maturity Assessment
- Evaluation
- Conclusions



# Motivation







# NASA Technology Readiness Level



Actual system "flight proven" through successful mission operations

Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)

System prototype demonstration in a space environment

System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

Component and/or breadboard validation in relevant environment

Component and/or breadboard validation in laboratory environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

Basic principles observed and reported



### **Technology Maturity**



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# **Technology Maturity**



Time



# PET Maturity Scales





Quality

# Maturity







### **PET Maturity: Readiness Scale**





# **PET Maturity: Quality Scale**







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# PET Maturity: Quality Scale





### **PET Maturity Scale**





# PET Maturity Assessment



#### How to Assess Maturity?





#### **Expert Questionnaire**

#### **Measurable Indicators**



## PET Maturity Assessment: Expert Questionnaire



PET Technology Readiness Assessment - Expert Questionnaire													
Assessor: DrIng. Meiko Jensen Expert:													
Target of Asse	RMACa	ard											
Readiness Assessment													
⊖idea ⊖r	prot	otype	Opil	ot Oprodu	t 🔾 outdat	ted							
Comments on the Readiness Assessment:								Techn	ology R	eadine	ss Asses	sment - Expert Questionnaire	
							Assessor:	Assessor: DrIng. Meiko Jensen				Expert:	
							Target of	Target of Assessment: IRMACa					
Quality Assessment						<u>ient</u>							
Overall Score:/-/0/+/++				••				Readiness Assessment					
Comments on the Quality Assessment:							Oidea	Oidea Oresearch Oprototype Opilot Oproduct Ooutdated					
Quality Characteri	cteristics S		R	elevant?		Com	Comment	Comments on the Readiness Assessment:					
Protection		/-/0/+/	0/+/++ ye				Assessme						
Trust Assumptions	umptions/-		••	yes/no									
Side Effects	DET Technology Deadinger Assessment						ant Funan	+ 0	ti on a l		lity Ass	essment	
Reliability		Assessed by Tee Helle Terrer							stionnai	re	++		
Performance Effici	Effici						pert:	n:					
Operability Target of Assessment: IRMACard											ļ		
Maintainability											Relevant?	Comment	
Transferability		<u>Readiness Asse</u>					<u>ssment</u>	<u>sment</u>			yes/no		
Scope	0	⊖idea ⊖research ⊖prototype ⊖pi						lot ) product ) outdated			yes/no		
	Comments			s on the							yes/no		
Readiness Assessment:			t:								yes/no		
										yes/no			
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	Overall Score: -/-/0/+/++									yes/no			
	Comments on the			0							yes/no		
	Quality Asse			essment:							yes/no		
	Quality Cha		aracteristics 5		icore Relevant?		c	Comment					
	Protection		/-/	0/+/++	yes/no					1			
	Trust Assumptions		ions	/-/0/+/++		yes/no							
Side Effects				/-/0/+/++		yes/no							
Reliability				/-/0/+/++		yes/no							
Performance Efficiency			cy/-/	0/+/++	yes/no								
Operability			/-/	0/+/++	yes/no								
Maintainability				ty/-/0/		yes/no							
	Transf	terability		-/-/	0/+/++	yes/no							



# PET Maturity Assessment: Measurable Indicators

#### <u>Measurable Indicators:</u>

- Number of scientific papers?
- Number of products?
- Lines of code?
- Size of market?
- Number of privacy certifications?
- Number of downloads?
- ...?



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- ...?





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# **Evaluation**



#### TOR Study

# **PET Maturity – The Onion Router**



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Tor Browser

Orbot

Businesses



### TOR Study: Readiness



UL

### TOR Study: Quality





#### **IRMACard Study**

# **PET Maturity – The IRMACard**





# **IRMACard Study: Readiness**





# IRMACard Study: Quality





# Conclusions



#### Conclusions

- **PET Maturity Assessment is a tricky field!**
- Maturity ≈ Readiness + Quality
- Expert Questionnaire vs. Measurable Indicators
- Ideal approach: combine both!
- Two successful pilot studies indicate feasibility...

...but what about utility?





Shaping the Future of Electronic Identity

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#### www.futureid.eu



Forum Privatheit und selbstbestimmtes Leben in der Digitalen Welt (Privacy Forum Germany)

GEFÖRDERT VOM



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References

#### www.forum-privatheit.de



### Thank You!



#### **Towards Measuring Maturity of Privacy-Enhancing Technologies**

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#### **Archiv**



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# **PET Maturity: Readiness**

**IDEA:** Lowest level of readiness. The PET has been **proposed as an idea in an informal fashion**, e.g. written as a blog post, discussed at a conference, described in a white paper or technical report.

**RESEARCH:** The PET is a serious **object of rigorous scientific study**. At least one (but preferably more) serious academic paper(s) have been published in the scientific literature, discussing the PET in detail and at least arguing its correctness and security and privacy properties.

**PROOF-OF-CONCEPT:** The PET has **successfully been implemented**, and can be tested for performance and other properties in practice. ``Running code'' is available.



## **PET Maturity: Readiness**

**PILOT:** The PET is or has (recently) been used in some small or larger scale **pilot applications with real users**. The scope of application, and the user base may have been restricted (e.g. to power users, students, etc.).

**PRODUCT:** The highest readiness level. The PET has been incorporated in one or more **generally available products** that have been or are being used in practice by a significant number of users. The user group is not a priori restricted (by the developers).

**OUTDATED:** The PET is **not used anymore**, e.g., because the need for the PET has faded, because it is depending on another technology that is not maintained anymore, or because there are better PETs that have superseded that PET.



*protection:* The **degree of protection offere**d (in terms of for example unlinkability, transparency, and intervenability) to prevent privacy infringements while allowing access and normal functionality for authorised agents. Also depends on the type of threats and attacks against which the PET offers protection.

*trust assumptions:* The number of components and/or agents that need to be trusted, and the **nature and extent of trust that must assumed** in order to use the PET. Also depends on whether these assumptions are legal, organisational, procedural, or technical.

*side effects:* The extent in which the PET introduces (undesirable) side effects. Measured in terms of composability.



*reliability:* The degree to which a system or component performs specified functions under specified conditions for a specified period of time. Measured in terms of **fault tolerance, recoverability, and compliance.** Also measured in terms of the number of vulnerabilities discovered.

*performance efficiency:* The performance relative to the amount of resources used under stated conditions. Measured in terms of resource use (storage, CPU power, and bandwidth) and speed (latency and throughput).



operability: The degree to which the product has attributes that
enable it to be understood, and easily (and in particular securely)
integrated into a larger system by a qualified system developer.
Measured in terms of appropriateness, recognisability, learnability, technical accessibility, and compliance.

*maintainability:* The degree of **effectiveness and efficiency with which the product can be modified**. Measured in terms of modularity, reusability, analysability, changeability, modification stability, and testability. Open source software typically scores high on this characteristic. Also, systems that have an active developer community, or that have official support, score high.



*transferability:* The degree to which a system or component can be effectively and efficiently transferred from one hardware, software or other operational or usage environment to another. Measured in terms of portability and adaptability.

*scope:* The number of different application domains the PET is applied in or is applicable to.