



Context-aware Trust in Component-based Systems

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Dependability of all-IP networks: A multi-disciplinary workshop
VTT, Digitalo, 18.5.2006



VTT TECHNICAL RESEARCH CENTRE OF FINLAND

General

- Work conducted in terms of the ITEA/Trust4All project
- Joint work with Telematica Instituut (The Netherlands)
- Work in progress
- **Observation:** Contextual information often has influence on trust
- **Research subject:** How to take context into account in trustworthiness evaluation?

18.5.2006



Outline

- Trust4All in a nutshell
- Terminology
- Motivation and point of departure
- Example
- Trust functions
- Ongoing and future work

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ITEA/Trust4All

- In the Trust4All project, a **middleware software architecture** specifically targeted to embedded systems requiring defined trust levels is being developed
- The project focuses on the **trustworthiness**-related aspects of this middleware software architecture in application domains that require trust, such as home medicare and home security
- Duration: 7/2005 - 6/2007
- Consortium: Philips (NL), TU/E (NL), U Leiden (NL), Océ (NL), Telin (NL), CWI (NL), VTT (FIN), Nokia (FIN), Solid (FIN), Robotiker (ESP), Fagor (ESP), Ikerlan (ESP), Visual Tools (ESP), ESI (ESP)
- Total:161 person-years

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Project History Preceding Trust4All

- **ITEA-Robocop** (<http://www.extra.research.philips.com/euprojects/robocop/>):
 - defined a component-based software architecture for the middleware layer of high volume embedded appliances
 - and to support developments based on constrained, robust, reliable and manageable components

- **ITEA-Space4U** (<http://www.extra.research.philips.com/euprojects/space4u/>)
 - fault prevention, power management and terminal management
 - secure downloading aspects
 - Space4U completed the implementation and validation from the prototype level of the ROBOCOP project results into a full ROBOCOP compliant component-based framework
 - the project continued the standardisation process and supported the preparation of the deployment of ROBOCOP-compliant framework

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Trust4All Terminology

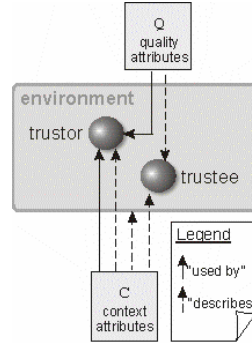
Term	Explanation
Trust	Subjective unidirectional relationship between the trustor and the trustee.
Trustor	The subject of the trust relationship.
Trustee	The object of the trust relationship.
Trustworthiness	The degree of which the trustor considers the trustee as trustworthy, preferably expressible with a (numerical) value.
Trustworthiness evaluation	The process executed by the trustor in order to determine the trustworthiness of the trustee.
Quality attributes	Attributes of the trustee, which are "mandatory" for executing the trustworthiness evaluation, typically maintain more static values than the context attributes.
Context attributes	"Optional" attributes used for tuning the trustworthiness evaluation process.
Trust scope	An instrument used case by case for dividing trustee's attributes into quality attributes and context attributes.
Reputation	Trustor's opinion on the trustee, based on past experiences.
Recommendation	Reputation of the trustee in the eye of someone else than the trustor, but transmitted to the trustor.

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Motivation and Point of Departure

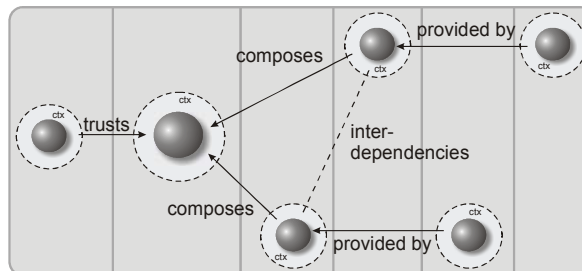
- Degree of trust varies based on the situational details
 - → Take this into account in trustworthiness determination process
- Trust scope σ
 - Trust evaluation is performed given some σ
 - "goal" of the trustor
- Set of Attributes (A)
 - Quality Attributes (Q) $Q \subseteq A$
 - Context Attributes (C) $C \subseteq A$
 - $C_\sigma \cap Q_\sigma = \emptyset$
- "Context-insensitive" trust evaluation utilizes only Qs
- Context-aware trust evaluation tunes this with Cs
- Division into Cs and Qs depends on the current σ



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Example: Game Component Download



	Player / Game Application	Composition	Game Manager (GM)	Game Scenario (GS)	GM Provider	GS Provider
Quality Attributes	- device profile - user profile	- ?	- type / category - version - CPU usage (est.) - memory usage (estimated) - dependencies	- type / category - version - CPU usage (est.) - memory usage (estimated) - dependencies	- recommendation set - behavior history	- recommend. set - behavior history
Context Attributes	- network status - device status - location (player) - activity (player)	- network status - CPU usage (actual) - memory usage (actual)	- network status - CPU usage (actual) - memory usage (actual)	- network status - CPU usage (actual) - memory usage (actual)	- network status - site availability	- network status - site availability

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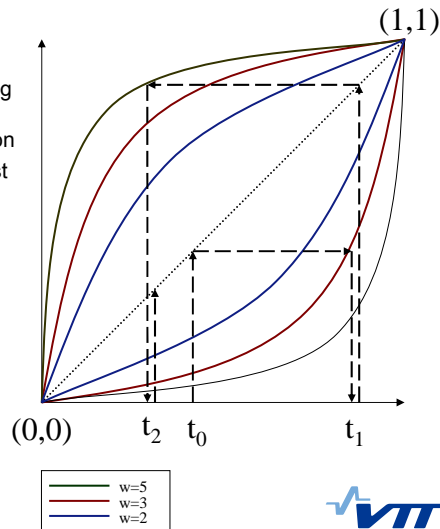


Context-aware Trustworthiness Evaluation

- Trustworthiness defined as a value in $[0,1]$
- Functions $inc(t,w)$ and $dec(t,w)$ for increasing and decreasing the initial trustworthiness based on the available contextual information
 - value for each context attribute c is first assigned with a binary predicate p
 - each context attribute is then weighted with w , w in $[0,\infty[$
 - 0 meaning "no importance"
 - assigning is order-insensitive
 - $inc(dec(t,w),w)=t$
 - $dec(inc(t,w),w)=t$
- Implementing the functions for example as

$$inc(t,w) := t^{w+1}$$

$$dec(t,w) := t^{w+1}$$



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Context-aware Trustworthiness Evaluation (contd.)

- In addition to the context attributes (C), the context-aware trust function (ctrust) takes into account the quality attributes (Q), reputation (r), and recommendations (R) within a certain scope σ at a certain time i

$$ctrusts_{\sigma}^i(Q) := ctrusts_{\sigma}(Q, C^i, r^i, R^i)$$

- for the sake of simplicity, we assume here that Q does not change over time
- Reputation is considered via past "compatible" contexts in which trustworthiness evaluation has taken place
 - compatibility defined in terms of the the contexts, in which the predicates (p) deliver similar results as the current one
 - if many to choose from, apply the most recent one (or do avg on them)
- Recommendations can be context-related, too
 - "When the device has little processing power available, this component performs better than others"
 - "He is a regular navigator in good weather conditions, but performs exceptionally well in storm or at night"

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Ongoing and Future Work

1. Consider other function families for trustworthiness evaluation
2. Consider coping with indirect and incomplete information, for example in cases:
 - a) Trustee is unknown to the trustor across contexts → consider reputations of entities **similar** enough with the trustee
 - b) Trustee unknown in the current context → consider the reputation of the trustee in contexts **similar** to the one currently at hand
 - can be combined with a)
 - presupposes that the context is accessible
 - c) Recommender is unknown to the trustor → consider **links** connecting the trustor with the recommender
 - social links, professional systems, etc.

18.5.2006



Thank You!

- Questions?

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18.5.2006

