

A Framework for Evaluating Quality-Driven Self-Adaptive Software Systems (SAS)

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How are we evaluating our approaches for SAS?

Lack of standard mechanisms to certify adaptive software systems

No clear assessment methods for self-adaptation

Performance as the de facto assessment mechanism

No explicit definition of evaluation properties

Lack of separation of concerns in the assessment

United States Air Force Chief Scientist (AF/ST). Technology Horizons a Vision for Air Force Science & Technology During 2010-2030. Technical report, U.S. Air Force, 2010.

2/20

A Relevant Problem for SEfSAS

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3/20

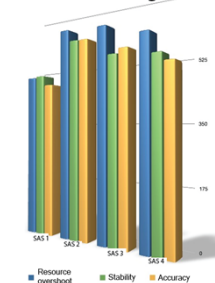
A Relevant Problem for SEfSAS

It is time to develop standard mechanisms for the assessment of self-* goals achievement !

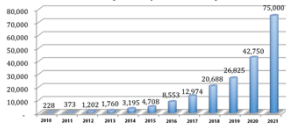
4/20

Why?

SAS Benchmarking



Self-Adaptive Systems Adoption



5/20

Outline

- 1 Methodology
- 2 Characterization Dimensions
- 3 Properties & Metrics
- 4 Evaluation Process
- 5 Conclusions and Future Work

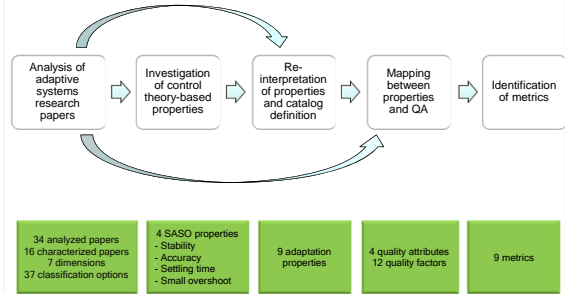
6/20

THE EVALUATION FRAMEWORK

An initial catalog of adaptation properties and the foundations of a process to drive the assessment of adaptive software systems

7/20

Our Methodology



8/20

Characteristic	Count [list of approaches]
Spectrum Classification	
Control Engineering	1 [20]
Hybrid	5 [3, 4, 5, 8, 27]
Hybrid-Software	1 [24]
Software Engineering	9 [1, 6, 9, 10, 14, 15, 18, 23, 25]
Monitoring Mechanisms	
Monitor internal context	15
Monitor external context	2 [14, 18]
Non specified	1 [23]
Controller's Structure	
Feedback control	2 [20, 23]
Adaptive control	9 [1, 3, 4, 8, 9, 10, 14, 24, 27]
Reconfigurable Control	4 [5, 6, 15, 18, 25]
Managed System's Structure	
Non-modifiable	4 [3, 8, 20, 27]
Modifiable with reflection	12 [1, 4, 5, 6, 9, 10, 14, 15, 18, 23, 24, 25]
Adaptation Properties	
Settling time	4 [1, 4, 14, 27]
Small overshoot	4 [1, 4, 14, 20]
Scalability	3 [1, 6, 9]
Stability	2 [1, 20]
Accuracy	2 [5, 24]
Termination	2 [8, 25]
Consistency	3 [15, 18, 25]
Robustness	1 [6]
Security	0

Summary of Our Systematic Review



cf. Paper Tables 1, 2: The Characterization Model

9/20

Applying Our Framework

Application case: Appleby et al. Océano [1]

Dynamic allocation of infrastructure resources to guarantee contracted SLAs

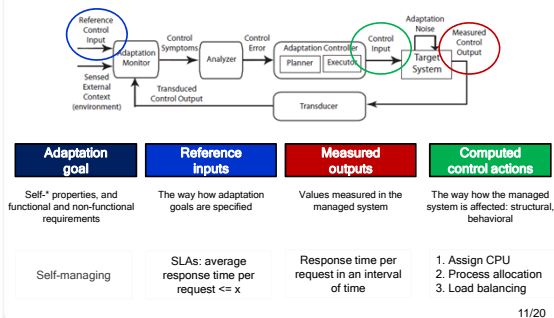


cf. Sections 2, 3 : for the proposed definition and possible values for each of the characterization dimensions

Appleby et al. Océano - SLA based management of a computing utility. In 7th IFIP/IEEE International Symposium on Integrated Network Management, pages 855-868, 2001

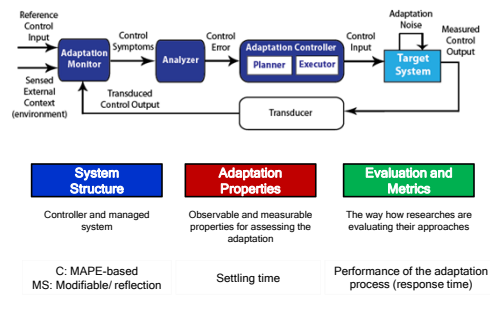
10/20

The Characterization Model

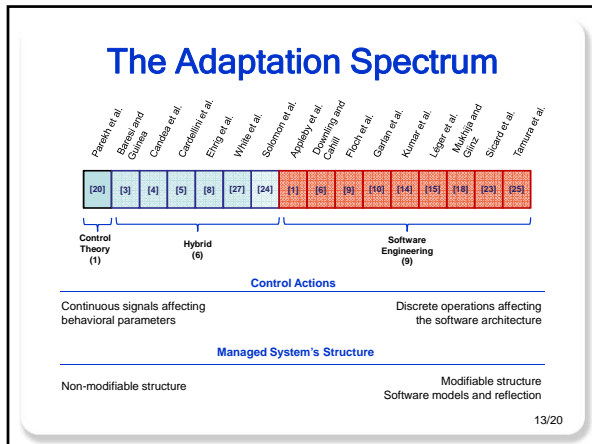


11/20

The Characterization Model



12/20



Catalog of Adaptation Properties

	Adaptation Property	Property Verification Mechanism	Where the Property is Observed
From Control Theory	Stability	Dynamic	Managed system
	Accuracy	Dynamic	Managed system
	Settling Time	Dynamic	Both
From seminal SAS papers	Small Overshoot	Dynamic	Managed sys
	Robustness	Dynamic	Controlled
	Termination	Static	Controlled
	Consistency	Both	Managed system
	Scalability	Dynamic	Both
	Security	Dynamic	Both

1. Assign CPU
 2. Process allocation
 3. Load balancing

DETAILED INFO cf. Paper Section 4.2: Adaptation Properties

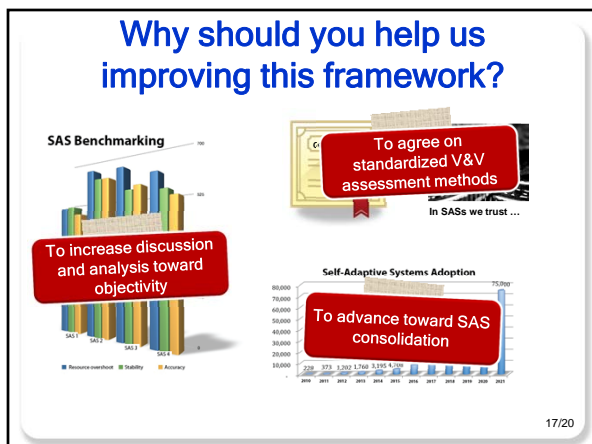
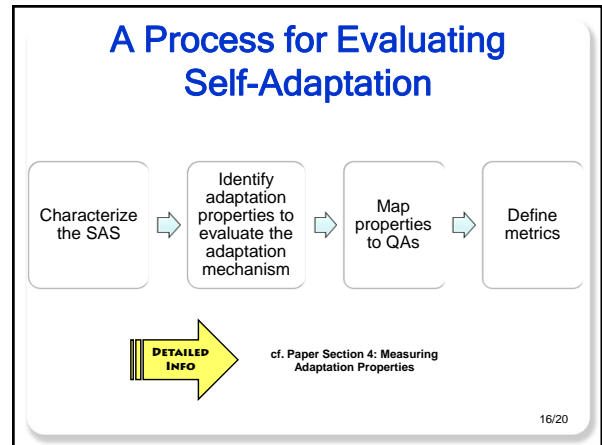
14/20

Mapping Properties and QAs

Adaptation Property	Quality Attributes
Stability	Performance: Latency, Throughput, Capacity
	Dependability: Safety, Integrity
	Security: Integrity
Accuracy	Performance: Latency, Throughput, Capacity
Settling Time	Performance: Latency
Small Overshoot	Performance: Performance of the adaptation process (response time)
Robustness	Dependability: Availability, Reliability
	Safety: Interact. Complex, Coupling Strength
Termination	Dependability: Reliability, Integrity
Consistency	Dependability: Maintainability, Integrity
Scalability	Performance: Latency, Throughput, Capacity
	Security: Confidentiality, Integrity, Availability

DETAILED INFO cf. Paper Section 4.3: Mapping properties to quality attributes

15/20



Conclusions

No properties → no standard metrics → no evaluation
 Is performance all about it?

Many promising adaptation approaches!
 can we trust them?

Control theory properties and QAs as cornerstones

Our evaluation framework paves the way toward improving SAS assessment

18/20

Summary

A Relevant Problem for SEISAS

It is time to develop standard mechanisms for the assessment of self-* goals achievement!

Why?

Our Methodology

Catalog of Adaptation Properties

A Process for Evaluating Self-Adaptation

Why should you help us improving this framework?

19/20

Future Work

Refinement and application of the adaptation properties catalog

Standardization of properties and metrics

Trade-off considerations when assessing multiple adaptation properties

Adaptive instrumentation for supporting run-time monitoring and run-time V&V

20/20

Thank you!

This work has been inspired in part by many of the discussions that took place in Dagstuhl seminar 10431 on SEISAS. We thank all of the seminar participants!

21/23