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Overview

SELF-MANAGEMENT

- SELF-CONFIGURING
- SELF-OPTIMIZING
- SELF-HEALING
- SELF-ADAPTIVE
- SELF-PROTECTING
- SELF-ORGANIZING

Autonomic Computing Initiative by IBM, 2001

Self-* (selfware)

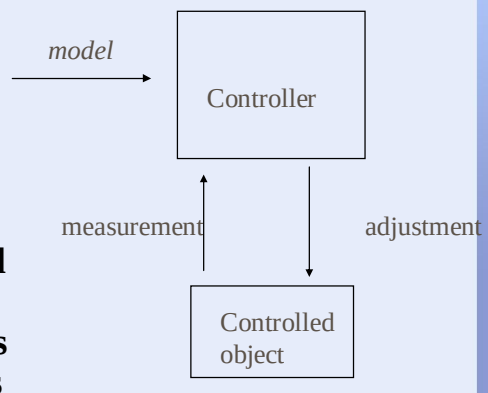
- **Self-configuring**
- **Self-healing**
- **Self-optimising**
- **Self-protecting**
- **Self-aware**
- **Self-monitor**
- **Self-adjust**
- **Self-adaptive**
- **Self-governing**
- **Self-managed**
- **Self-controlling**
- **Self-repairing**
- **Self-organising**
- **Self-evolving**
- **Self-reconfiguration**
- **Self-maintenance**

Eight Goals for a System

1. System must know itself
2. System must be able to reconfigure itseld within its operational environment
3. System must pre-emptively optimise itself
4. System must detect and respond to its own faults as they develop
5. System must detect and respond to intrusions and attacks
6. System must know its context of use
7. System must live in an open world
8. System must actively shrink the gap between user/business goals and IT solutions

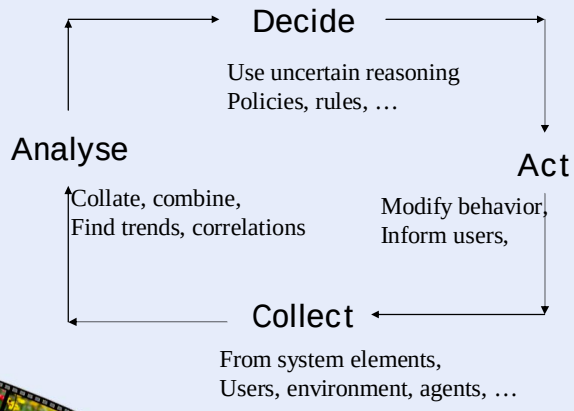
Autonomic Computing

- Basic model: closed control loops
  - Based on Process Control Theory
- Controller continuously compares the actual and expected behavior and makes needed adjustments



SEE: Any control-theory books

Autonomic Control Loop



Elements of Self-Healing 1/2

Fault model	Fault duration Fault manifestation Fault source Granularity Fault profile expectations
System response	Fault Detection Degradation Fault response Fault recovery Time constants Assurance

Philip Koopman: Elements of the Self-Healing System Problem Space. In Proceedings of ICSE WADS 03.

Elements of Self-Healing 2/2

System completeness	Architectural completeness Designer Knowledge System self-knowledge System evolution
Design context	Abstraction level Component homogeneity Behavioral predetermination User involvement in healing System linearity System scope

Size of the self-healing unit?

- **Component**
  - **Focus on connectors and component discovery**
- **Service**
  - **Service interfaces, Service discovery, restart**
- **Node**
  - **Network and interface failures, change to new connection**

Architectural approach

- The healing or recovery part often requires reconfiguration and adaptation
- They change the architecture
  - Locate and use alternative component
  - Restart (or rejuvenation or resurrection) the failed component
- Self-healing can be build on reflective middleware

Experiments

- OSAD – model (On-demand Service Assembly and Delivery)
- MARKS – Middleware Adaptability for Resource discovery, Knowledge usability and Self-healing
- PAC – Autonomic Computing in Personal Computing Environment
- Using self-healing components and connectors

Life-cycle of Self-Healing

- **OSAD – On-demand Service Assembly and Delivery**
- **Prototype in JINI environment**
- **Looking for alternatives only by name**

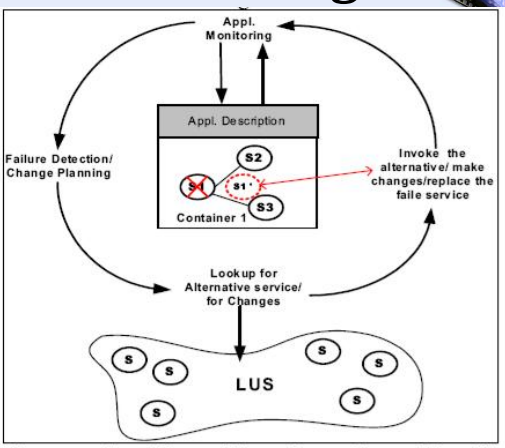


Figure 1. The lifecycle of self-healing behaviour in OSAD model.

Grishikashvili, E.; Pereira, R.; Taleb-Bendiab, A.; **Performance Evaluation for Self-Healing Distributed Services**Parallel and Distributed Systems, 2005. Proceedings. 11th International Conference on
Volume 2, 20-22 July 2005 Page(s):135 - 139

MARKS

- Middleware Adaptability for Resource Discovery, Knowledge Usability and Self-healing
- Marks is targeted at embedded and pervasive, small mobile handheld devices.
- New Services: Context, Knowledge Usability and Self-Healing
- Prototype: Dell Axim 30 pocket PC & .NET

Sharmin, M.; Ahmed, S.; Ahamed, S.I.;**MARKS (Middleware Adaptability for Resource Discovery, Knowledge Usability and Self-healing) for Mobile Devices of Pervasive Computing Environments**
Information Technology: New Generations, 2006. ITNG 2006. Third International Conference on
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MARKS Architecture

- Services
- Core components
- ORB

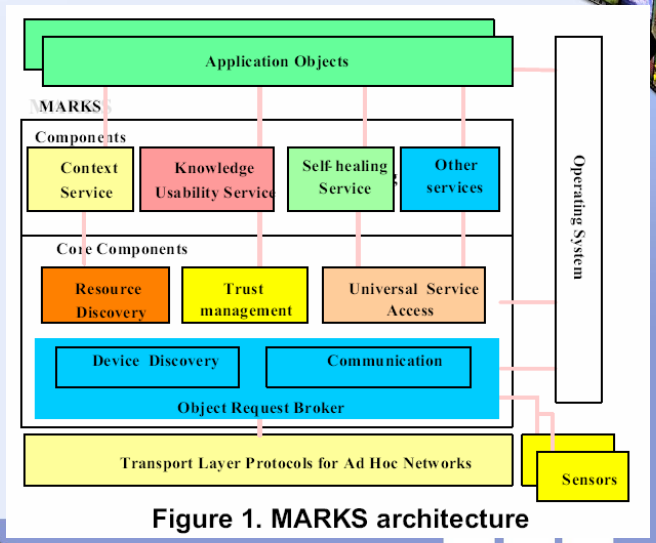


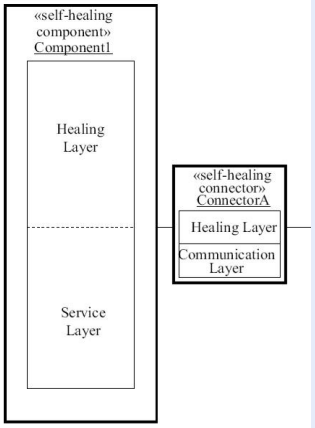
Figure 1. MARKS architecture

Self-healing in MARKS

- *Healing manager* (of the network) to handle all fault types
  - To isolate faulty device (Fault containment)
  - Select surrogate device or share load among working members
- Resource manager used as repository of information for backup purposes
- *Self-healing unit* (on each device)
  - One process named *rate of change of status*
  - For monitoring the device and announcing the conditions

Self-healing components and connectors

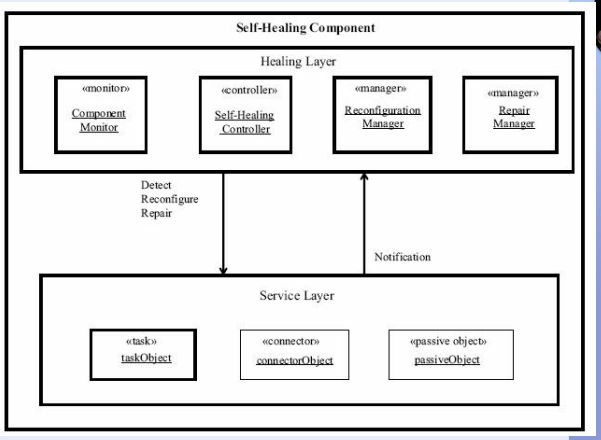
- **Healing layer**
  - **Monitoring and reconfiguration decisions**
- **Service layer**
  - **Normal functionality**
  - **Report all events to healing layer**



Shin, M.E.; Jung Hoon An; **Self-Reconfiguration in Self-Healing Systems** Engineering of Autonomic and Autonomous Systems, 2006. EASe 2006. Proceedings of the Third IEEE International Workshop on 27-30 March 2006 Page(s):89 - 98

Self-healing component

- **For healing:**
  - **Self-Healing controller**
  - **Component monitor**
  - **Reconfiguration manager**
  - **Repair manager**



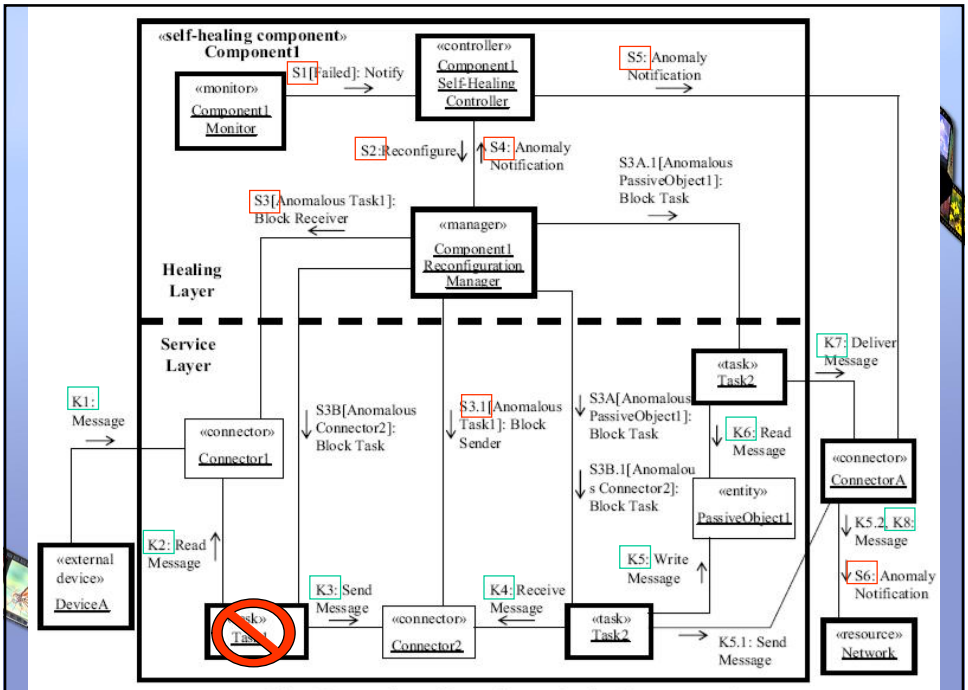


Fig.4 Dynamic self-configuration in Component1

Reconfiguration decision

- **Anomaly detection:**
  - **Compare observed and expected behavior**
- **Isolate the ’faulty’ object**
- **Repair or replace the faulty object (and return back to normal operation)**

Conclusions

- Self-healing has three roots:
  - Autonomic and self-management world
  - Distributed systems world (especially middleware)
  - Dependable and fault-tolerance world
- The failure recognition and repair decisions might be faster if autonomic
- However: effects of incorrect decisions can be large (and correct them time consuming)

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