An Architectural Approach to Autonomic Computing

CBSS Course Presentation

Provided by: Sepinood H. Gashti

July 2005

References

- Steve R. White, James E. Hanson, Ian Whalley, David M. Chess, and Jeffrey O. Kephart. **An Architectural Approach to Autonomic computing** , *IBM Thomas J. Watson Research Center,* ICAC'04.

- An Architectural blueprint for autonomic computing, IBM 2004.
- Architectural blueprint for autonomic computing, IBM 2003
- David M. Chess, Alla Segal, Ian Whalley, Steve R. White.**Unity: Experiences with a Prototype Autonomic Computing System,** *IBM Thomas J. Watson Research Center,* ICAC'04.

- Mazeiar Salehie, Ladan Tahvildari. **Autonomic Computing: Emerging Trends and Open Problems**, Dept.of Elect.Comp.Eng,University of Waterloo, DEAS'05.

- Shang-Wen Cheng, An-Cheng Huang, David Garlan, Bradley Schmerl, Peter **Steenkiste.An Architecture for Coordinating Multiple Self-Management System**, School of Computer Science, Carnegie Mellon University, WICSA'04.

Outline

- Introduction
- Autonomic Computing
- Autonomic System Architecture
  - Autonomic Element
  - Interaction
  - Infrastructure Elements
- Common Design Patterns
- Related Works
- Summary

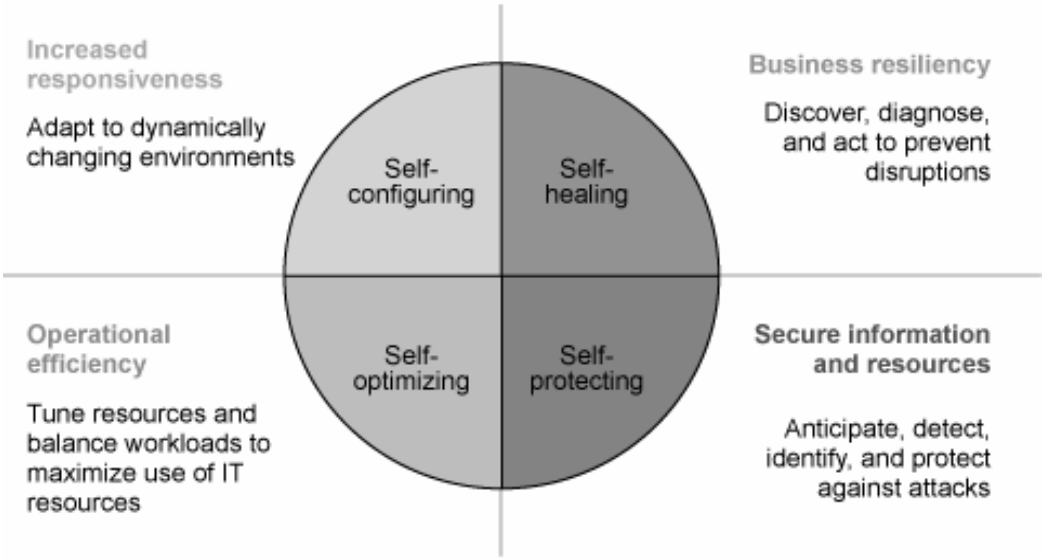
Introduction

- Management problems
  - Cost & time for administration and troubleshooting
  - Complexity crisis
- Self-managing system
  - Behaviour specified by sys admins via high-level policies
  - System and its components figure out how to carry out policies

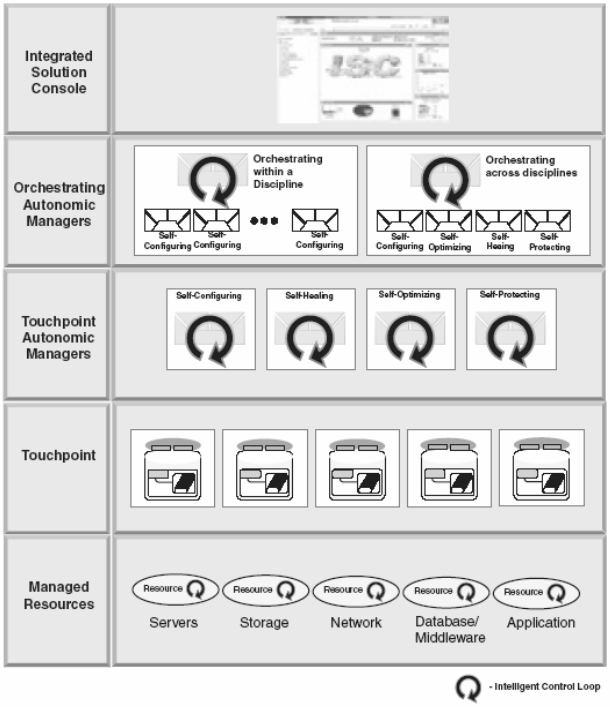
Autonomic Computing

- *A computing system that senses its operating environment, models its behaviour in that environment, and takes action to change the environment or its behaviour.*
- *A Self-managing autonomic system has the properties of* ***self-configuring***, ***self-healing***, ***self-optimization*** *and* ***self-protection****. (self-CHOP)*
- Inspired from autonomous behaviour of the human body

Self-CHOP



Reference Architecture



Source: Architectural blueprint 2004, IBM

Autonomic System Architecture

- Autonomic element
- External interfaces and behaviour for individual component
- Interaction among components

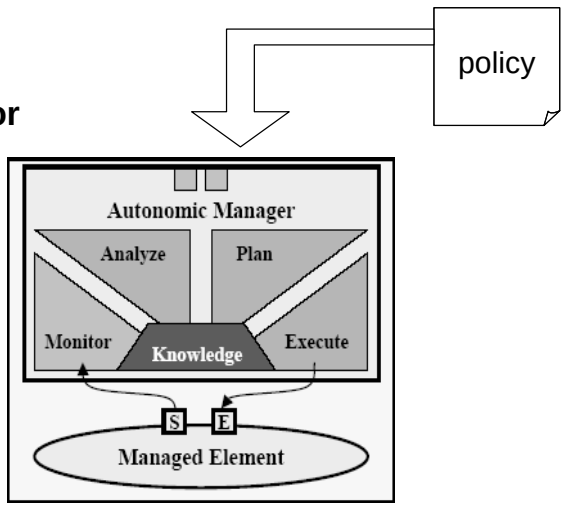
Autonomic Systems

How to build a system with autonomic behaviour?

1. A collection of autonomic elements that implement the desired function.
2. Additional autonomic elements to implement system functions that enable the needed system level behaviours.
3. Design patterns for system self-CHOP.

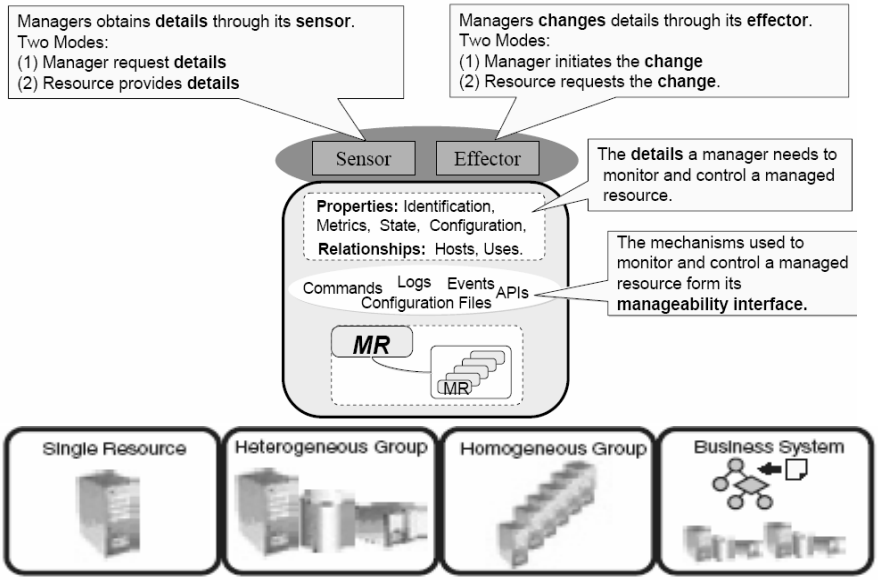
Autonomic Element (AE)

- **AEs are responsible for:**
  - **Managing their own behavior**
  - **Interacting with other autonomic elements**
- **AEs contain:**
  - ***one* autonomic manager**
  - **Zero or more managed element (s)**



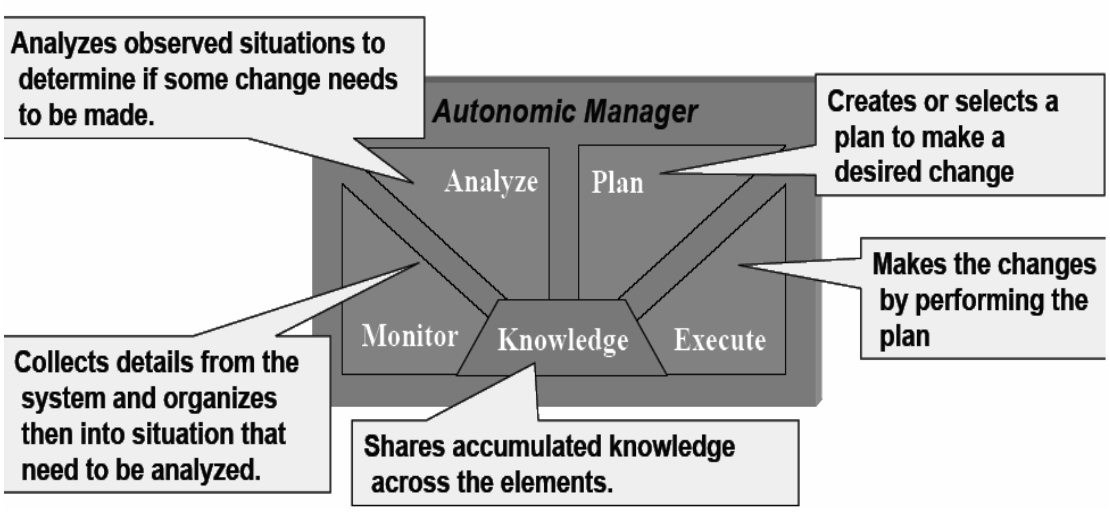
Managed Elements

Controlled through its sensors and effectors by manager



Autonomic Manager

A component that implements the control loop



Knowledge

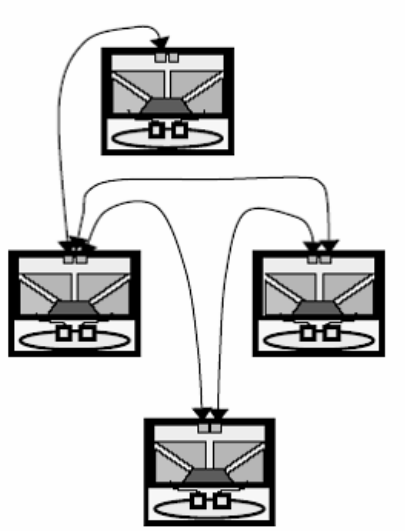
- Knowledge Types
  - Solution Topology Knowledge
  - Problem Determination Knowledge
  - Policy Knowledge
- Two Mechanisms to obtain knowledge
  - Effector Interface
  - Monitor Part

Policy

- Policy
  - Action policy: If (Condition) THEN (Action)
  - Goal policy: direction
  - Utility function policy: Priority

Interaction Between Components

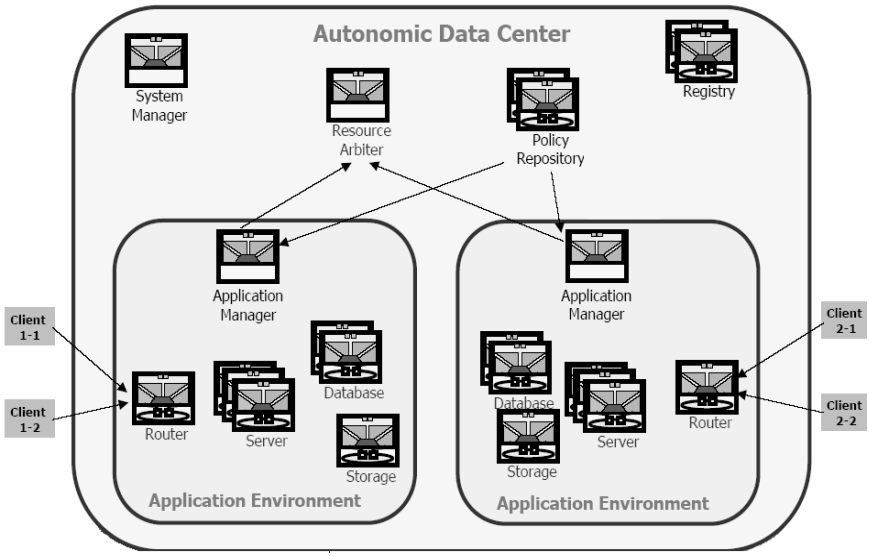
- Interfaces
  - Monitoring and testing interfaces
  - Lifecycle interfaces
  - Policy interfaces
  - Negotiation interfaces



Infrastructure Elements

Assist other element in doing their tasks

- Sentinel
- Aggregator
- Broker
- Negotiator



Design Patterns

- Self-Configuring
  - Goal driven self-Assembly
    - Initialization
    - Registration
- Self-Healing
  - Self-regenerating cluster
  - Required interfaces
    - Sending state
    - Receiving state,
    - Querying planned outage (Availability management)
    - Scheduling planned outages (Availability management)

Design Patterns (2)

- Self-optimization
  - Market-based control (buyer &seller)
  - Resource arbiter
  - Required interfaces
    - Query service
    - Query service level bounds
    - Requesting a service level
- Self-Protecting
  - Some aspects are similar to self-healing
  - Prevention: Policy-based management
    - Security policy

Related Works

- Shang-Wen Cheng, An-Cheng Huang, David Garlan, Bradley Schmerl, Peter Steenkiste. **An Architecture for Coordinating Multiple Self-Management System**, Carnegie Mellon University, WICSA'04.
- Dharini Balasubramaniam, Ron Morrison, Graham Kirby, Kath Mickan, Brian Warboys, Ian Robertson, Bob Snowdon,R Mark. **A Software Architecture Approach for Structuring Autonomic Systems**, University of Manchester, *DEAS 2005.*
- Richard Anthony, Alun Butler, Mohammad Ibrahim. **Layered Autonomic Systems,** *University of Greenwich,* ICAC'05

Summary

- Needs for AC
- Describing a proposed architecture for AC
  - AE
  - Infrastructure AE
  - Design patterns for self-CHOP

An Architectural Approach to Autonomic Computing

CBSS Course Presentation

Provided by: Sepinood H. Gashti

July 2005