Autonomic Networking Issues

WCNC Session "Autonomics for Future Internet"

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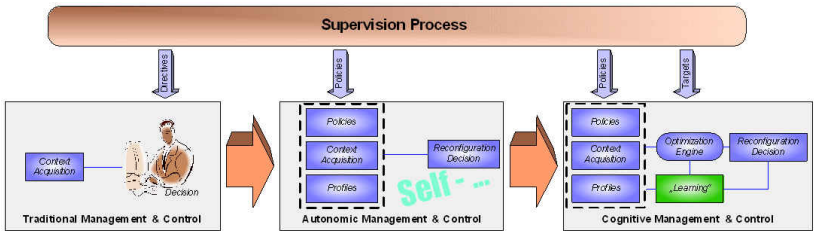
Introduction



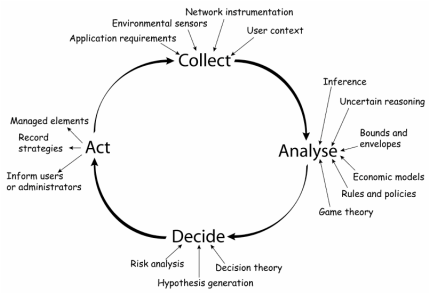
Source: E3 Project

Evolution of Network / Device Management

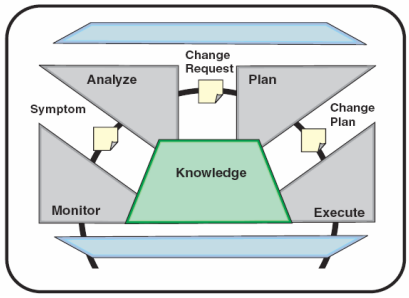
- Traditional via human intervention
- Autonomic systems detect context changes and adapt to relevant context
  - pre-defined controls available
- Cognitive systems are autonomic and learn to adapt
  - 'detect' and apply new controls

Autonomic Networking

FCAPS turns into
- self-healing
- self-configuration
- self-optimization
- self-protection



Autonomic Communication [Dobson]:
Collect-Analyze-Decide-Act



Autonomic Computing [IBM]:
MAPE - Monitor-Analyze-Plan-Execute

Different Terminology:

Autonomic Networking, Cognitive Networks, Self-* Features of Networks

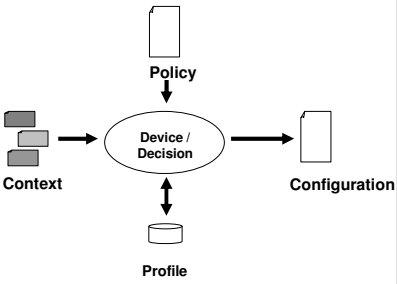
Relation to Artificial Intelligence (AI)

but domain-specific approach needed

System Model / Overview – a closer look…

Policy:
- ⇨ management of device
- ⇨ different sources, e.g. operator, regulator, …

Context:
- ⇨ in general any information that can be used to characterize the situation of an entity or the environment



Profile:
- ⇨ description of device settings
- ⇨ capabilities or resources associated with a user, application or a group of these
- ⇨ local settings, can also be seen as local data base

Configuration:
- ⇨ output to system, e.g. update of routing table or configuration of radio interface

In this presentation: Single Device (e.g. Terminal, Network Node) as an example for network sub- systems, discussed principles can be applied to networks

Context / Information Management

Context information is the basis for decisions in autonomic network elements

Information bottleneck

- ⇨ many information in networks/systems available, but cannot be accessed
- ⇨ huge information demand by innovative application, but this cannot be expressed

(compare with "IP Hourglass" discussion)

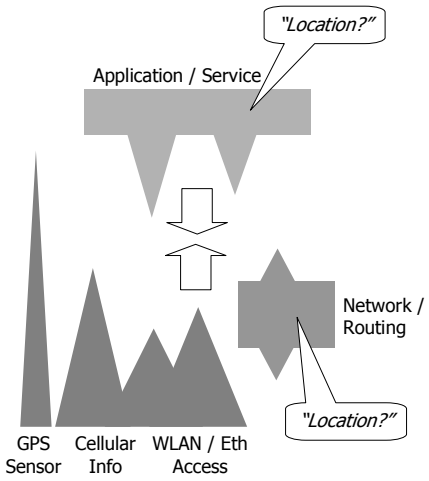
Information management needs to mediate between information sources and services/applications

- ⇨ Lookup and addressing of information
- ⇨ Clustering of information
- ⇨ Information transport and security issues

Both directions, cross-layer concept

Example: VPN

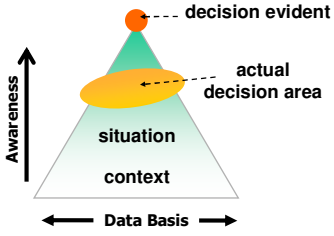
two IP addresses: logical & physical domain



Approach: Situation Awareness

Assumptions:

- ⇨ Necessity of decision – in application, but more often inside the network while offering services (note: also an evolutionary path, without touching applications)
- ⇨ Dynamic and complex networks imply decisions based on unreliable or incomplete information
- ⇨ Aggregation is already part of decision
- ⇨ it is not possible not to decide, not to change anything is already a decision



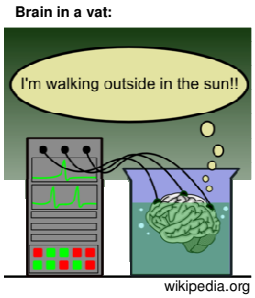
Challenges:

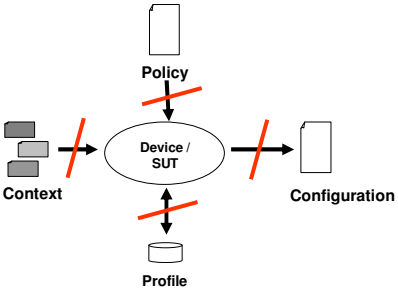
- ⇨ Light-weight description of Quality of Context or Meta-Context
- ⇨ Mechanisms to boost the development and deployment of information aggregators
- ⇨ Data-driven decision algorithms (in every stage of aggregation…), able to work with incomplete, imprecise and/or alternative information

System Interfaces

Do we know to engineer autonomic systems?

Our definition from Intro: "Autonomic systems detect context changes and adapt…"





Approach:

- ⇨ Injection: isolate the cognitive/autonomic algorithm for testing / assessment
- ⇨ Situation Generation: replace (part of) real sensor information (context) with generated artificial events, but also higher level, aggregated information → situation

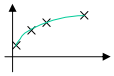
Approach: New Area of Testing – Assessment

Conformance Test – show correctness of system operation

- ⇨ result depends on Specification & Implementation
- ⇨ example: correctness of a communication protocol

✘ / ✓

Performance Test – show characteristics of system operation



- ⇨ result depends on Specification & Implementation & Situation
- ⇨ example: system throughput vs. packet size

Assessment – show changes of system operation

- ⇨ result depends on Specification & Implementation & Situation & Knowledge
- ⇨ example: throughput of detected priority traffic of QoS-enabled network node

Tests can be used to describe the system and/or to evaluate the system

Conclusion

Need to understand autonomic network elements

- rich toolset of algorithms available (neural networks, fuzzy logic, …)
- need for domain specific approach,
  - there is no "general problem solver" at the moment

One key is

- Context Information Management and Situation Awareness

Better Understanding of System Characteristics needed

- Our approach: describe the (correct) behavior and test the system

Acknowledgement

E3 – End-to-End Efficiency

"Evolving current heterogeneous wireless system infrastructures into an integrated, scalable and efficiently managed B3G cognitive system framework."

More Information

- ⇨ https://ict-e3.eu/
- ⇨ White Paper on Self-X functionalities available: "Self-x in Radio Access Networks"

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Thank You!

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