# Landscape of Autonomics for Network Management (Autonomics 3.0)

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# Outline

- Introduction
- Academic Research
- Standardization @ IETF
  - Autonomic Networking @ NMRG
  - UCAN BoF
  - ANIMA WG
- Outlook

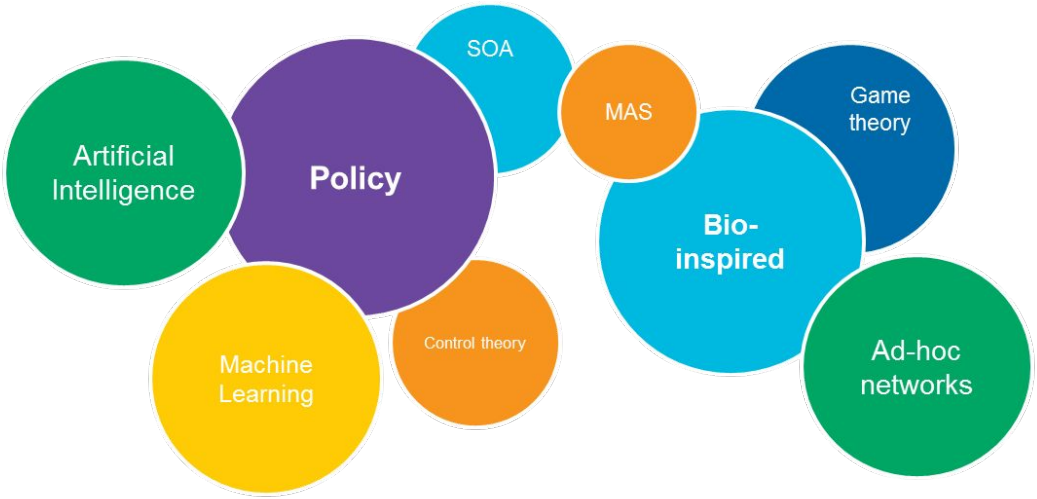
# Introduction

- Minimum set of properties of an Autonomic System (AS)
  - Automatic, i.e. it can "self-control its internal functions and operations"
  - Adaptive, i.e. it can change its "configuration, state and functions"
  - Aware, i.e. it can "monitor its operational context"
- Different set of definitions for an AS
  - E.g., self-CHOP, MAPE-K, OODA
- Application to the complete network lifecycle (e.g. installation, commissioning, operating) → Autonomic Networking (AN)
- AN usually addressed by the Network Management Area (IM, NOMS, CNSM)

# Academic Research

- First mentions → *circa* 2005, 2006
- Several antecedentes
  - Artificial Intelligence in NM (90s)
  - Self-Organisation Networks, Declarative Policies, etc
- Papers
  - Strassner, J.(2004) Autonomic networking - theory and practice. IM 2005 (NOMS 2004?)
  - Mortier, R., & Kiciman, E. (2006). Autonomic network management: some pragmatic considerations. ACM SIGCOMM INM
  - Agoulmine, N. et al (2006). Challenges for autonomic network management. IEEE MACE
  - Balasubramaniam, S. et al (2006). Towards integrating principles of molecular biology for autonomic network management. HP OVUA

# Research scope




AN research span the whole ICT spectrum

- IT and network, infrastructures and services, fixed and wireless, access to core…

AN research investigates

- Evolutive and clean-slate architectures, models, functions, processes…

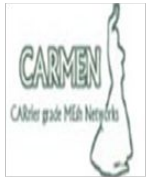
# Academic Research

- A lot of momentum → *circa* 2007-2009
- Papers
  - Pavlou, G. (Ed.) (2007). Key Research Challenges in Network Management. IEEE communications magazine
  - Samaan, N., & Karmouch, A. (2009). Towards autonomic network management: an analysis of current and future research directions. IEEE Communications Surveys & Tutorials
  - Agoulmine, N. (Ed.). (2010). Autonomic network management principles: from concepts to applications. Academic Press
- Projects
  - Charalambides, M., Pavlou, G.  (2009). Management of the Internet and Complex Services European 6h Framework Network of Excellence. Deliverable D9.5 Autonomic Management: Challenges and Solutions

# Research projects

Many research projects and initiatives…











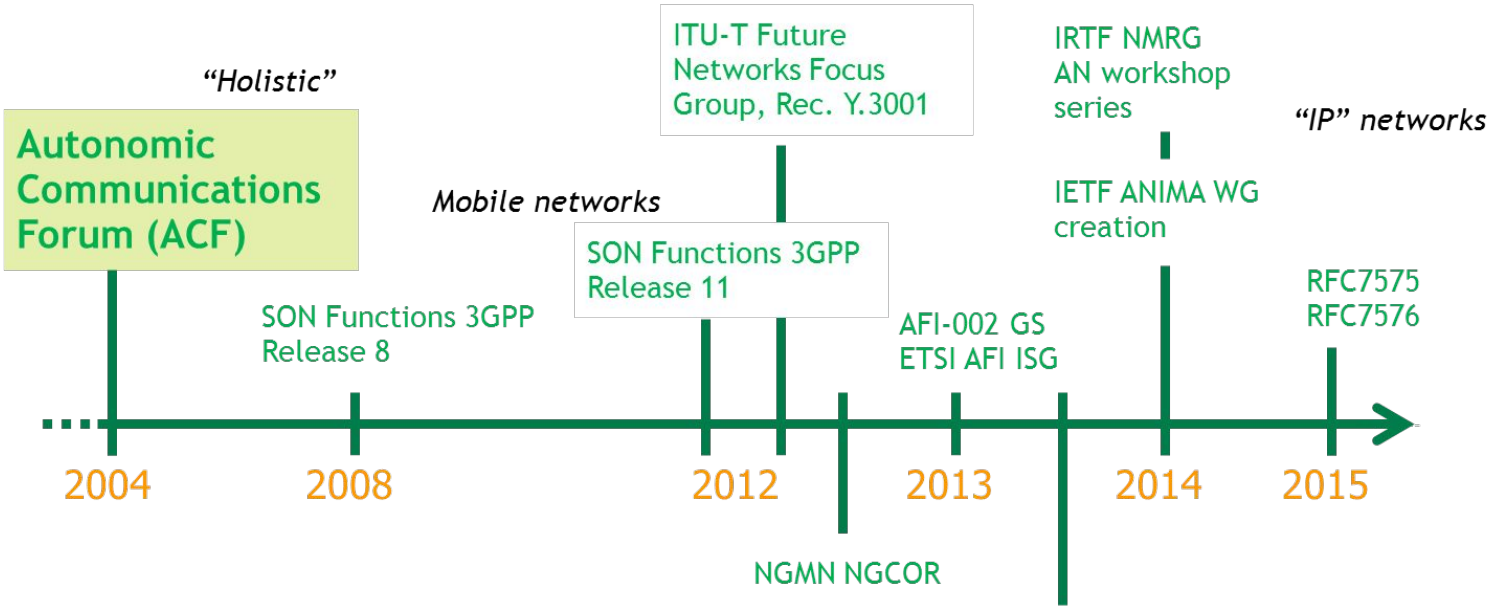
# Academic Research

- Decrease in interest → *circa* 2011-2013
- Possible reasons?
  - Other technology gaining momentum? →
    - SDN, NFV...
  - New terms?
    - Cognitive,Intelligence-driven...
  - Lack of successful deployment cases?
- Standardization
  - ETSI GANA, **IETF ANIMA**...

# Overview of AN standardization

AN standards landscape

- Different SDOs, time, scope, importance and degrees of success…



# Standardization @ IETF

- First efforts
  - 3 Autonomics for Network Management meetings: 32nd NMRG (Vancouver, Nov 2013), 33rd NMRG (London, Mar 2014), 34th NMRG (Toronto, July 2014)
    - Gap analysis, definitions, network configuration, bootstrapping trust, P2P detection of SLA violations, Lessons learned, Real world experiences
- Related efforts in different IETF WG and IRTF RG
  - SUPA, HOMENET, SDNRG, NFVRG, I2RS...
- NMLRG (proposed), IDN (BoF?)
- UCAN BoF (IETF 90) → ANIMA WG

# Autonomic Networking @ NMRG

- Focus on the definition of autonomic networking terms
- Internet-Drafts and RFC
  - Set of design goals and non-goals for AN [irtf-nmrg-autonomic-network-definitions] → **RFC 7575**
  - Standardization →open question and deployment limited to specific mechanisms [irtf-nmrg-an-gap-analysis] → **RFC 7576**
- UCAN BoF
  - Important outcome of the NMRG work
  - Good popularity of the BoF (IETF 90)
  - UCAN docs

# ANIMA WG

- Development of protocol specifications (or extensions)
  - Discovery and Negotiation for autonomic nodes
    - GRASP [draft-ietf-anima-grasp-15]
  - Bootstrapping a trust infrastructure
    - BRSKI [draft-ietf-anima-bootstrapping-keyinfra-16]
  - Separated Autonomic Control Plane
    - ACP [draft-ietf-anima-autonomic-control-plane-16]
- Limited initial set of work items → avoid "boiling the ocean"
  - Additional (“unchartered”) docs
    - E.g., (Policy) Intent, Use Cases, Autonomic Service Agents (ASAs)
- Encouraged as individual submissions or **NMRG submissions**

# Outlook for Autonomic Networking

Potential application areas:

- Highly-virtualized, programmable infrastructures
  - Lots of interest on SDNRG (defunct) and NFVRG
  - I-D: [draft-pedro-nmrg-anticipated-adaptation-02]
- Areas of application: 5G, IoT, Smart X (factory, city, health…)
- Better link with real-world operations (NANOG, RIPE, etc)
- Effective deployment
  - Reasons for lack of wide-scale deployment?

# Outlook for AN @ NMRG

- Is there a need/interest/energy for **Autonomics 3.0**?
- If yes, 4 proposed efforts:
  - Intent-Based Networking
    - I-D: [draft-clemm-nmrg-dist-intent-01]
  - AI/ML for Network Management
    - I-D: [draft-kim-nmrg-rl-03]
  - Integration with network automation approaches
    - ETSI Zero Touch Network and Service Management
  - “Eat your own dog food” approach → revisit RFC 7575/7576
    - What is out of ANIMA scope in a long term (after recharter)?

# Thank you.

Questions?