EU perspective of IPv6 advancement: Industry and Research Aspects

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Overview

- Transition/migration/evolution
- Communication from European Commission
- Industry perspective through mobile communication
- EU research perspective through EFIPSANS:
  - Make use of IPv6 features
  - IPv6++ enrich for special purposes
  - Standardisation of Autonomic Networking
- Summary

Transition/migration - evolution

Personal reflection over 3 decades in (tele)communication business

- 80s – telecom to data (CS)
- 90s – telecom to mobile (Subrate CS)
- 2000s – CS to PS & All-IP(v6)

It's a natural process, normal part of technology advancement and even our life

Communication from EC

http://ec.europa.eu/information_society/policy/ipv6/docs/european_day/communication_final_27052008_en.pdf

- Objective of this Action Plan is to support widespread introduction of the next version of the Internet Protocol (IPv6) because
  - Timely implementation of IPv6 is required as the pool of IP addresses provided by the current protocol version 4 is being depleted
  - IPv6 with its huge address space provides a platform for innovation in IP based services and applications

Communication from EC (cont)

- Rationale for action
  - Preparing for the growth in Internet usage and for future innovations (limit 4 b IPv4 addresses)
  - Maintaining Europe's competitiveness
  - Contributing to the Lisbon strategy
- The current situation
  - Increasing scarcity of IPv4 addresses: difficulty for users, an obstacle to innovation
  - IPv4 is only a short term solution leading to more complexity
  - IPv6: the best way forward

Communication from EC (cont)

- What needs to be done?
  - Solve co-existence to support transition phase
  - Coordinate/motivate the many actors worldwide
    - Internet organisations
    - ISPs
    - Infrastructure vendors
    - Content and service providers
    - Business and customer application vendors
    - End-users

Communication from EC (cont)

- The need for policy driving at European level
  - Largely decentralised and market driven process on a global scale
  - To overcome the ”wait and see” position on IPv6
  - Policy measures give market stimulus, more effective when taken collectively by all actors
- Actions: IPv6 to become widely implemented in Europe by 2010
  - Actions to stimulate IPv6 accessibility to content, services and applications

Communication from EC (cont)

  - Actions to generate demand for IPv6 connectivity and products through public procurement
  - Actions to ensure timely preparation for IPv6 deployment
  - Actions to tackle security and privacy issues
- Execution of the Action Plan
  - Over the next 3 years
  - Review in 2010 to decide if any follow-up actions are required

Communication from EC (cont)

- This powerful, concise communication was followed by an IPv6 launching day in Brussels, 30 May 2008 with many players participating
- The combined effect of these actions was strong, achieved the desired goal: made the industry executives/decision makers aware of the seriousness of the situation and got clarified the advantage/opportunities

Industry perspective

- Intensive work up to 2003-2004
  - Participation in EU projects, standardisation, white papers, product implementations, demos/trials...
- Deployment is ultimately a business decision: lack of market interest
- Not entirely wasted time: worked on general All-IP issues, improved mobility mechanism, matured IPv6 competence
- Network convergence & new emerging technologies (RUNES) increased the technology demand, mobile internet capable handsets and increasing dataspeed
- Wake-up call: IPv4 address depletion
- Feels like Back to Future!!

EU research project EFIPSANS

- Making use of existing IPv6 features for needed functions as autonomic in-network management
- One of the largest EU supported FP7 Call1 Integrated Project, 15 partners 10m€ budget (6.8 m€ EU contribution), part of Future Networks cluster
- EFIPSANS stands for**:** **E**xposing the **F**eatures in **IP** version **S**ix protocols that can be exploited/extended for the purposes of designing/building **A**utonomic **N**etworks and **S**ervices
- Possible extension/enrichment of basic features for even more efficient Autonomic Networks & Services functions: IPv6++

Self-Management Activities in the EFIPSANS Project

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Self-Management Workshop, 2nd Concertation Meeting of the FP7 Future Internet Cluster, 30 September 2008– Av. de Beaulieu 25, 0/S1, Brussels

Motivation and Issues

- **Why is the project working on self-management?**
  - **Background**: In which context does the project sees a need for self-management?

    Self-Managing Network —nodes/devices are designed/engineered in such a way that all the traditionally so-called network management functions defined by the FCAPS management framework, as well as the fundamental network functions such as routing, forwarding, monitoring, supervision, fault-detection and fault-removal, etc, are made to automatically feed each other with information (knowledge) such as *events,* in order to effect *feedback processes* among the diverse functions, thereby enabling reactions in individual diverse functions of the network and of individual nodes/devices, in order to achieve and strive to maintain some well defined goals of the network.

    Therefore: **Autonomicity is an enabler for self-manageability of networks.**

    EFIPSANS envisions that the current IPv6 and the extensibility of the IPv6 protocol framework opens the door to engineering autononomicity (self-managing properties) in systems, services and networks, and should be seen as a Starting Point towards the long-term Evolution of Networks towards fully Self-Managing Networks.

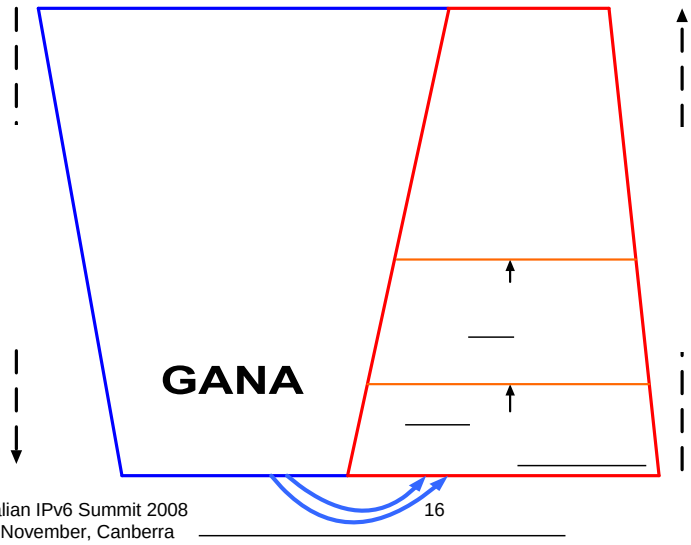
Motivation and Issues

- **Where are improvements expected? Where are technology gaps?**
  - **New Concepts, Components and Architectural Design Principles that facilitate Self-Management at different levels of node/device and network *functionality and Abstractions,* are REQUIRED.**

Motivation and Issues

- **Goals**: **What does the project expect to achieve with its activity? [Specifications, Methodologies, Validations]**
  - The development of a **Generic Autonomic Network Architecture (GANA)** as **Reference Model for Autonomic Network Engineering**. This includes the specification of the **Context-aware autonomic Decision-Making-Elements (DMEs or DEs in short),** their interactions, their interfaces, their Control-Loop behaviors (which determine autonomic behaviors), and their associated **Managed-Entities (MEs).**
  - The development of the **GANA Meta-Model and associated Advanced Methodologies for the engineering of** Context-aware autonomic Decision-Making-Elements (DMEs), their Control-Loops, etc, *including the application of OMG's MDA approaches and Formal Description Techniques (FDTs) towards Simulations and Validations* of complex autonomic behaviours and *Code-Generation* for DMEs.
  - The definition of a viable **Roadmap of an evolution path for today's network models, protocols (e.g. IPv6) and**

Motivation and Issues



Motivation and Issues

- **Concrete Issues**: **What are the big challenges to overcome during project lifetime?**
  - **EFIPSANS** is a 3-year project and we do not have enough resources **to produce detailed Specifications** of all the issues we have identified as requiring **detailed specifications in the GANA Reference Model**. Therefore, we are calling for co-operation with multiple players through an ISG Group: **Autonomic Network Engineering for the Self-Managing Future Internet** to be established in ETSI.
- **Size of the activity**
  - full project on self-management? **Yes, EFIPSANS is a full scale project on self-management**

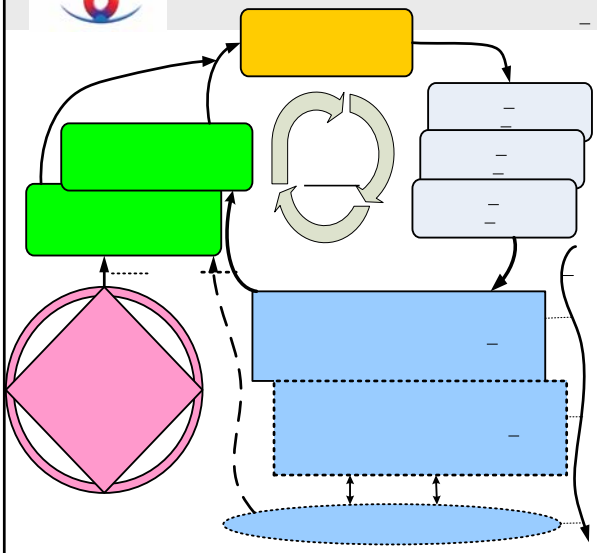
GANA Principles and Envisioned Use Cases

- **Restrictions of the state of the art and potential improvements to be achieved by applying self-management**
  - The **Management Paradigms of today** are based on the Relationship: **NMS** (Network Management System) ←→ **NE** (Network Element) and do not provide for the definition and implementation of **Manager** ←→**Managed-Entity** Concepts and Relations and issues **at different microscopic levels of abstractions, including within individual node architectures**, **down to the level of individual Protocols and System Functions.**
  - **In EFIPSANS we introduce the GANA, which defines management and manageability aspects at different levels of node/device and network functionality and introduces Autonomic Manager Components that are designed following *Hierarchical*, *Peering*, and *Sibling Relations* among each other and are characterised by autonomic control of their associated Managed-Entities, and co-operate with each other in driving the Self-Managing features of the Network(s)**

GANA Principles and Envisioned Use Cases

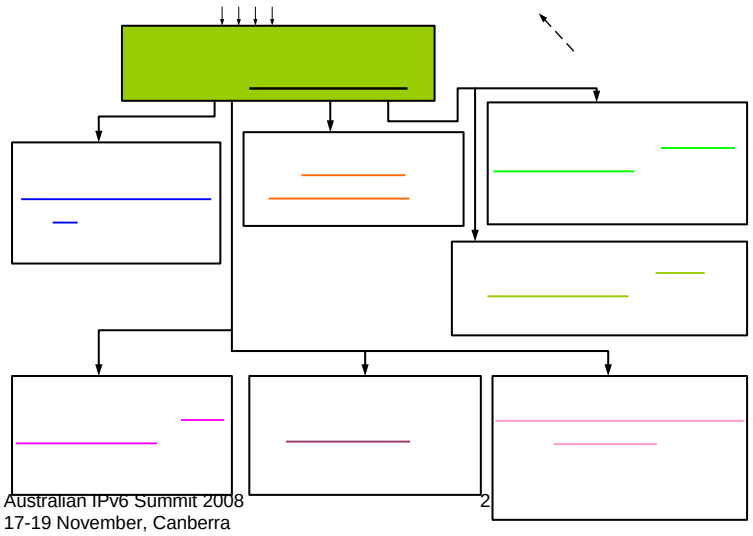
- **Elaborate difference to today's best known approaches**
  - **EFIPSANS reviewed a number of approaches including clean-slate approaches (both pure and non-pure): such as 4D, ANA, CONMan, Knowledge plane for the internet, etc, and concluded that non of these approaches proposes a holistic Reference Model that defines and distinguishes between diverse Autonomic Managers and their associated Managed-Entities for different levels of abstractions within node/device architectures and network architectures.**
  - **GANA (being introduced by EFIPSANS) is a holistic Generic Autonomic Network Architecture that defines the structures (diverse Decision-Making-Elements (DMEs) i.e. Autonomic Managers and their associated Managed-Entities (MEs), including Interfaces between DMEs (DEs in short) of the GANA's Decision Plane and interfaces between DMEs and their associated MEs and Control Loops.**
  - **GANA is also meant to address the problems of (1) Complexity—by defining the Abstractions for autonomic/self-management functionality; (2) implementing Conflict-free decision-making-processes that drive autonomicity/self-management behaviours within a node/device and the network; (3) the kind of *Perspectives* offered to Users/Operators of Autonomic Networks, such as Interfaces for defining Network-level**

Architecture View

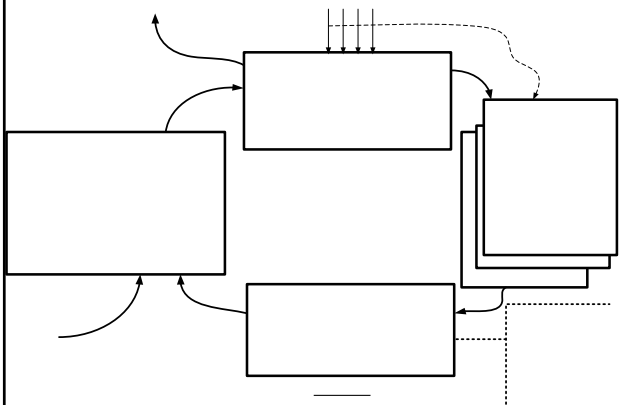


How does the project intend to introduce self-management in the network?

Architecture View (DEs Hierarchy in a Node/Device)



Architecture View (Example of a DE inside a Node/Device)



Some of the Issues calling for Specifications (as depicted on the diagram)

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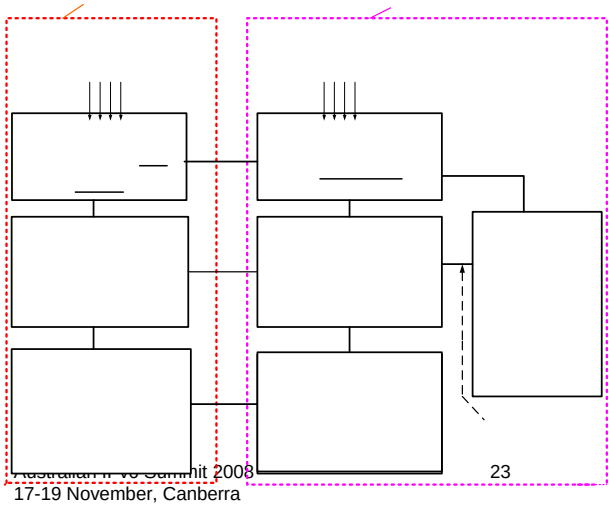
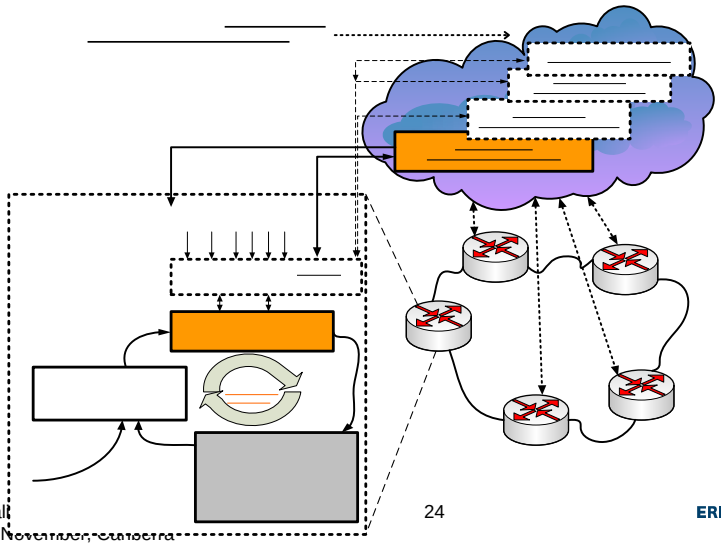
Architecture View (Hierarchy, Peering and Sibling Relations between DEs)



The Interfaces depicted are calling for Specifications

Architecture View (Example instantiation of GANA: **Routing and Autonomicity**)



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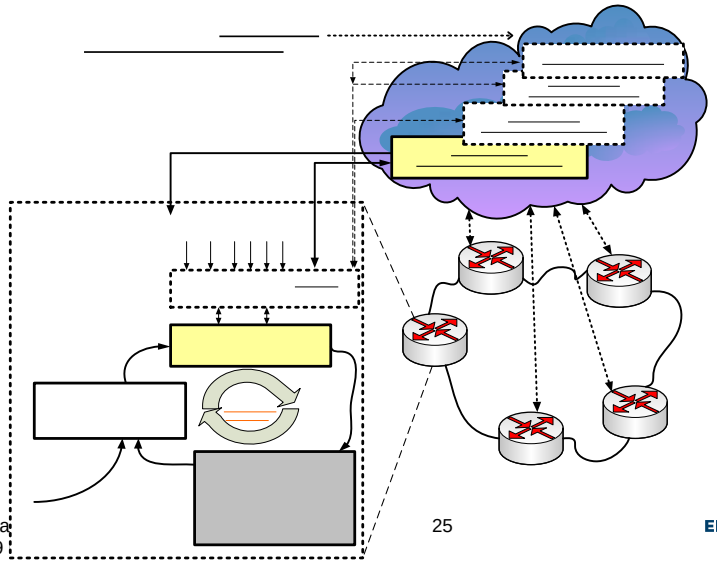
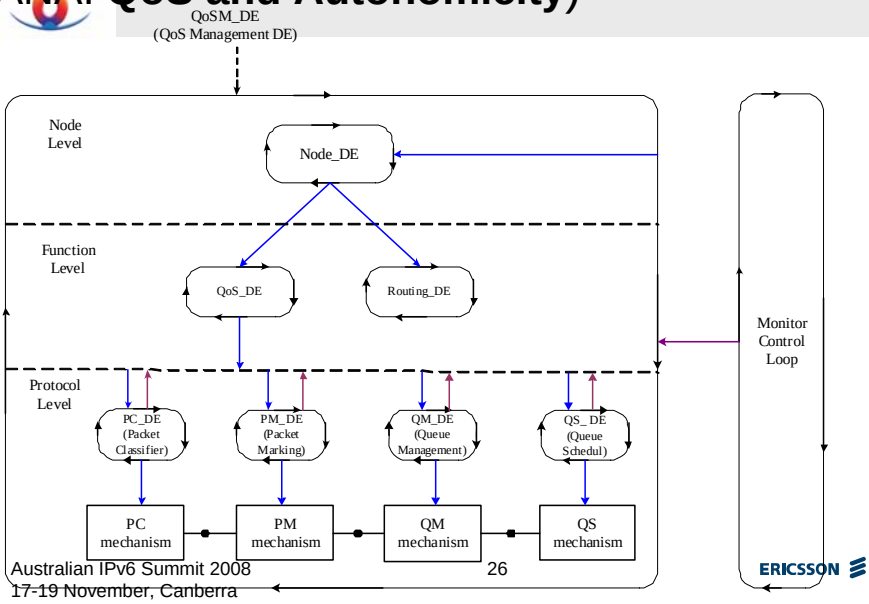
Architecture View (Example instantiation of GANA: **Forwarding and Autonomicity**)



Architecture View (Example instantiation of GANA: **QoS and Autonomicity**)



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Innovations

- **Which innovations to self-management does the project expect to create?**
  - The introduction of the GANA as a Reference Model for Autonomic Network Engineering, and Specifications of Autonomic Behaviours of diverse DEs for Diverse Network Environments.
  - The development of the GANA Meta-Model and associated Advanced Methodologies for the engineering of Context-aware autonomic Decision-Making-Elements (DMEs), their Control-Loops, etc, including the application of OMG's MDA approaches and Formal Description Techniques (FDTs) towards Simulations and Validations of complex autonomic behaviours, and Code-Gen.
  - The use of the current IPv6 Protocols, the creation of Extensions to IPv6 protocols as necessitated by GANA and the creation of a viable Roadmap for the evolution of today's

Design Principles and Engineering

- **Does the project support self-management innovations by new design principles or engineering methods?**

1. **Yes:** The GANA, as our Reference Model, establishes some Design Principles.
2. **EFIPSANS is developing Advanced Methodologies for the engineering** of Context-aware autonomic Decision-Making-Elements (DMEs), their Control-Loops, etc, including the application of OMG's MDA approaches and Formal Description Techniques (FDTs) such as SDL.

Validation

- **Which methods of validations does the project plan to apply?**
  - **Analytical study?** EFIPSANS has defined the following Tasks that are carrying our analytical studies: (1) **IPv6 as an enabler for Large Scale Autonomic Networks (2) The Implications of Autonomicity on the performance of applications and services;**
  - **Simulation?** EFIPSANS aims at simulating Decision-Making-Elements (DMEs/DEs), their associated Control Loops on Managed-Entities, and Interactions with other DMEs/DEs, which govern Self-Management of Networks, in SDL-based Simulation environments such as the Telelogic TAU environment.

Validation

- **Which methods of validations does the project plan to apply?**
  - **Prototyping and Measurements**? EFIPSANS is prototyping the DMEs/DEs that govern Self-Management of the Networks.
  - **We will also attempt to go for Validations of Formal Models** in an SDL-based environment.
  - **Trials?** Testbeds for Trials will be established by EFIPSANS Partners

Validation

- **Deployability**
  - **Is the solution scalable, robust, secure?** We consider the solution to be scalable and robust due to the fact that these two issues are part of the issues being addressed in our research. The issue of security is complex and we are covering some limited aspects of security such as *self-protecting network functionality*.
  - **Is there a migration path?** EFIPSANS is creating Extensions to IPv6 protocols as necessitated by GANA and is also creating a viable Roadmap for the evolution of today's protocols and Network Architectural Principles towards Self-Managing Networks.

Standardisation with ETSI

- Forming an Industry Specification Group (ISG): Autonomic Network Engineering for the Self-Managing Future Internet
- Specification work resulting from the following topics:
  - The Generic Autonomic Network Architecture (GANA) as Reference Model for Autonomic Network Engineering. This will include the specification of the Decision-Making-Elements (DMEs or DEs in short), their interactions, their interfaces, their Control-Loop behaviors (which determine autonomic behaviors), and their associated Managed-Entities (MEs).
  - The GANA Meta-Model and associated Advanced Systems Engineering Methodologies for the engineering of Context-aware autonomic Decision-Making-Elements (DMEs), their Control-Loops, etc, including the application of OMG's MDA approaches and Formal Description Techniques (FDTs) towards Simulations and Validations of complex autonomic behaviours.
  - The definition of a viable Roadmap of an evolution path for today's network models, protocols (e.g. IPv6) and paradigms, as guided by the GANA Reference Model

Standardisation with ETSI

- The following ETSI members have indicated that they are willing to support the ISG (at least four required):
  - Alcatel-Lucent, Ericsson, Fraunhofer FOKUS, Fujitsu Labs of Europe, Telcordia, Waterford Institute of Technology (TSSG), France Telecom, Chunghwa Telecom, Telefonica T+D
- The following non-members of ETSI have also expressed an interest in participating in the work of the ISG:
  - IPv6 Forum, GRNET, ICCS,
- First meeting to finalise the Term of Reference (ToR) is planned for the beginning of 2009
- Work will be carried out in close collaboration with other standardisation bodies (3GPP, TISPAN, IETF, ACF...)
- The difference: Focus will entirely be on Autonomic Network Management (long term concept) and the evolution path to achieve it

Summary

- Forceful coordination action to get the many, widely different actors moving synchronously
- Make IPv6 attractive by implementing functions not available in IPv4
  - Self-financing: the saving when using the implemented IPv6 features will finance the upgrade
- Step-by-step introduction while caring for coexistence


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