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CONTENTS

1 GENERAL INFORMATION 3

2 MAIN OBJECTIVES 3

3 SCIENTIFIC CONTENT AND PROGRAMME 3

4 SPONSORS 5

5 SCIENTIFIC COMMITTEE 5

6 ORGANISING COMMITTEE 5

7 NUMBER AND LIST OF PARTICIPANTS 5

7.1 Number of Participants 5

7.2 List of Participants 5

8 COMPREHENSIVE SUMMARY FOCUSING ON THE MAJOR OUTCOMES 6

8.1 Session 1: Virtualization Concepts for Future Networks 6

8.2 Session 2: Smart Resource Management in Future and/or Virtualized Wireless Networks 9

8.3 Summary 13

9 OVERALL QUALITATIVE ASSESSMENT 13

10 FINANCIAL ASPECTS 13

APPENDIX 1: CALL FOR PARTICIPATION 14

APPENDIX 2: MATERIAL FOR DISSEMINATION 16

1 GENERAL INFORMATION

Workpackage Number:	SEA 7.2
Full name of the event:	Fifth Future Internet Cluster Workshop
Date:	June 11, 2011
Place:	Warsaw University of Technology, Warsaw, Poland (co-located with the 20th Future Network and Mobile Summit)
Web page for the event:	http://euronf.enst.fr/p_en_Events_Concertati_INSTFP7_Clust11Jun_606.html

Partner in charge of the organization: Kurt Tutschku (UNI WIEN, Partner 04)

Chairpersons:	Paulo de Sousa (European Commission)
	Kurt Tutschku (UNI WIEN, Partner 04)

2 MAIN OBJECTIVES

In the recent years, several initiatives have proposed views on what the networks of the future could be. Recent concertation meetings were devoted to introduce the projects contributing to this domain as well as their own visions and roadmaps. These meetings were fruitful as facilitators for information exchange and for promoting synergies among the projects.

The natural next step was to propose to join forces in facing the key challenges to transform these visions into reality, both from the scientific and technological as well as from the socio-economic points of view. Considering the very broad scope of the networks of the future, it appeared much more realistic and promising to address successively specific topics with a broad potential impact for Europe through dedicated workshops, which would enable focused exchange of information and views among experts with strong interest in the respective fields. In close cooperation with the European Commission, Euro-NF promoted this idea and revisited the format of the Future Internet Cluster meetings held under the auspices of the Commission about every three months as part of the overall concertation process. This led to the concept of Future Internet Cluster Workshops (FICW), four of which were held already during 2010 and 2011:

- the first one at ETSI in Sophia-Antipolis on March 09, 2010;
- the second one in Florence on June 15, 2010, co-located with the Future Network & Mobile Summit;
- the third one at the European Commission's premises in Bruxelles on October 18, 2010;
- the fourth one back to back with the Future Internet Assembly in Budapest on May 16, 2011.

The organizational and promotion support by the European Commission are gratefully acknowledged.

3 SCIENTIFIC CONTENT AND PROGRAMME

In the recent years, several Future Internet initiatives have proposed views on what the architectures of the networks of the future could be. The aim of the workshop is to review

recent results on future network architectures. Therefore two complementary sessions have been defined:

1) "Virtualization Concepts for Future Networks"
2) "Smart Resource Management in Future and/or Virtualized Wireless Networks"

Following a global introduction, each topic was assigned roughly a half-day track, starting with a session of presentations (five talks in the morning, two talks in the afternoon) followed by a panel discussion.

Following a call in April/May 2011, the talks were chosen and invited by a programme committee (PC) consisting of the Project Officer, members of the Euro-NF Steering Board, and representatives from the Future Internet Cluster, cf Section 5.

Programme

Time	Title	Who/Project
9:00	Introduction and objectives	Kurt Tutschku / Paulo de Sousa
9:20	Future Internet architecture based on virtualization and co-existence of different data and control planes	W. Burakowski
9:40	Generalized Architecture for Dynamic Infrastructure Services	R. Nejabati / GEYSERS
10:00	The role of virtualization in future network architectures	A. Kapovitis / CHANGE
10:20	*Coffee*	
10:40	SAIL - Cloud Networking and Open Connectivity Services	B. Tremblay/ SAIL
11:05	Future Smart Connectivity: considering stakeholder interests and conflicts in the design of federated network architectures	C. Kalogiros / SESERV
11:30	*Lunch*	
12:30	Panel and audience discussion on "Design for Sharing: Cooperation and Interworking of Virtualization Concept"	All presenters of Session 1 and moderator
14:00	User-Driven Wireless Mesh Networks by Virtualization	S. Sargento / MOMO
14:20	Functional Architecture Overview for the Cognitive Management of Opportunistic Networks in the Context of Future Internet	P. Demestichas / OneFIT
14:40	Panel and audience discussion on "Design for Choice: Future Resource Management "	All presenters of Session 2 and moderator
15:30 16:00	Wrap-up	Kurt Tutschku / Paulo de Sousa

4 SPONSORS

None

5 SCIENTIFIC COMMITTEE

Partner Number	Partner Acronym	Contributor Name	Contributor e-mail address
01	GET	Daniel Kofman	daniel.kofman@telecom-paristech.fr
04	UNI WIEN	Kurt Tutschku	guenter.haring@univie.ac.at
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External	EC	Paulo de Sousa	paulo.desousa@ec.europa.eu
External	Ericsson AB	Henrik Abramowicz	henrik.abramowicz@ericsson.com

6 ORGANISING COMMITTEE

Partner Number	Partner Acronym	Contributor Name	Contributor e-mail address
04	UNI WIEN	Kurt Tutschku	Kurt.tutschku@univie.ac.at
11	BTH	Markus Fiedler	markus.fiedler@bth.se
External	EC	Paulo de Sousa	Paulo.Desousa@ec.europa.eu
External	Ericsson AB	Henrik Abramowicz	henrik.abramowicz@ericsson.com

7 NUMBER AND LIST OF PARTICIPANTS

7.1 Number of Participants

- Total number of participants: 41
- External Participants: 23
- Euro-NF Members: 18

7.2 List of Participants

Partner Number	First Name	Last Name	Organization
External	Paulo	de Sousa	European Commission
External	Tinku	Rasheed	CREATE-NET
External	Eric	Tsang	Communications Research Centre Canada
04	Kurt	Tutschku	Universität Wien - Chair of Future Communication
External	Alex	Galis	University College London
External	Henrik	Abramowicz	Ericsson Research

13	George	Polyzos	AUEB-RC
External	Didier	Bourse	Alcatel-Lucent
03	Petia	Todorova	Fraunhofer-FOKUS
External	Marios	Logothetis	University of Piraeus Research Center
29	Halina	Tarasiuk	Warsaw University of Technology
External	Arkadiusz	Sitek	Nokia Siemens Networks
20	Susana	Sargento	Instituto de Telecomunicações
External	Sergi	Figuerola	Fundació i2CAT
11	Markus	Fiedler	Blekinge Institute of Technology
External	Reza	Nejabati	University of Essex
External	Nicolas	Chuberre	Thales Alenia Space - France
13	Costas	Kalogiros	Athens University of Economics & Business
External	Benoit	Tremblay	Ericsson AB
30	Augusto	Casaca	INESC-ID
29	Wojciech	Burakowski	Warsaw University of Technology
29	Andrzej	Beben	Warsaw University of Technology
29	Piotr	Krawiec	Warsaw University of Technology
29	Jan	Rogowski	Warsaw University of Technology
External	Jordi	Mongay Batalla	Politechnika Warszawska
29	Lukasz	Grabowski	Warsaw University of Technology
External	Andrzej	Chydziski	Silesian University of Technology
External	Adam	Kapovits	Eurescom
29	Piotr	Wisniewski	Warsaw University of Technology
29	Jaroslaw	Sliwinski	Warsaw Univeristy of Technology
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External	Maria	Guta	ESA ESTEC
External	Przemysaw	Gomb	IITiS PAN
29	Witold	Góralski	Warsaw University of Technology
External	Wojciech	Szymak	National Institute of Telecommunications
External	Manuel	Villen	Technical University of Madrid
External	Mariusz	Rawski	Warsaw University of Technology
01	Jean-Paul	Lefèvre	Arches
External	Henryk	Gut	National Institute of Telecommunications
29	Aneta	Fabijanska	Warsaw University of Technology
External	Eleni	Patouni	National & Kapodistrian University of Athens - NKUA

8 COMPREHENSIVE SUMMARY FOCUSING ON THE MAJOR OUTCOMES

8.1 Session 1: Virtualization Concepts for Future Networks

The first session was devoted to the topic "Virtualization Concepts for Future Networks". The session included five talks and was concluded by a panel.

1) **W. Burakowski: Future Internet architecture based on virtualization and co-existence of different data and control planes**
   This is a Future Internet Engineering National project in Poland. It proposes the support of parallel Internets each working in a different data and control plane. Three parallel Internets are considered:
   - IPv6 QoS (based on DiffServ);
   - Content Aware Networking;
   - Data Streams Switching (emulation of classical circuit switching).

According to W. Burakowski, the main problem is the isolation between parallel Internets. The second problem is the implementation of the virtual links. The third problem is the organization of the virtual nodes. W. Burakowski claims that the Polish architecture is scalable and that it is an open virtual network infrastructure for new post IP solutions. The problems that are not yet solved are at least isolation between virtual nodes and provisioning for each parallel Internet.

Discussion:

+ There are doubts on why this is better than multiplexing already done in optical fiber.
+ Need to take care of isolation although this should not be a big problem.
+ An end user would like to have only one network node. This is solved at level 4 virtualization.

2) R. Nejabati (GEYERS): Generalized Architecture for Dynamic Infrastructure Services

The GEYERS project proposes an architecture with an optical network plus IT resources virtualization. It has 4 layers. The physical layer consists of optical network plus IT infrastructure. At this layer we have optical resource slicing and aggregation. Above it we have the logical infrastructure creation layer. Above this layer we find the IT aware network control plane. Finally on top we find the service middleware layer, which supports the applications.

GEYSERS advances the state of the art by optical network virtualization, on-demand and automatic optical network plus IT virtual infrastructure composition and on-demand automatic IT plus optical network resource control and provisioning over the virtual infrastructure enabled by GEYSERS. It is interoperable with other virtualization approaches.

Discussion:

+ How do we get isolation between nodes and links? Wavelength allocation per application in future.

3) A. Kapovitis (Change): The role of virtualization in future network architectures

The objectives of CHANGE were compared with an Eurescom study done by 4 operators on Network virtualization. CHANGE explores the capabilities of Open Flow to enable more innovation in the Internet. It introduces a flow processing platform instantiated at critical points in the network. The GEYSERS concept is a scalable solution as only traffic of interest is processed, the only operation at packet level is classification and flow processing is deployed only when needed, exploiting virtualization.

Discussion:

+ OpenFlow works on a specific hardware. OK, but we can interoperate with other platforms?
+ Why does Europe need to deal with Open Flow? If it is a good solution Europe should “jump into the boat”!

4) A. Tremblay (SAIL): SAIL – Cloud networking and open connectivity services

The identified problems by SAIL for cloud computing and connectivity services are: Rapid fluctuation in application demand, centralized data centers not ideal for many applications and cost of connectivity high compared to computing and storage.

Probably a distributed control plane architecture will be a solution that will contribute to solve some of these problems. The inclusion of server virtualization like making VMs in a data center equal to VMs in a distributed cloud and network virtualization are virtualization mechanisms that can be used. However, new virtualization techniques like OpenFlow should be investigated.

There is also a need to evaluate the benefit of having the information in the cloud instead of local data centers.

Discussion:

+ What is the meaning of dynamic resource allocation? It allocates resources in minutes not weeks
+ Discussion on the guarantees given when referring to minimum guaranteed bandwidth for services.

5) A. Kalogiros (SESERV): Future Smart Connectivity

The basic idea for analysis is on how economics can help to design a better Internet. For this purpose an analysis of the ETICS project was done.

Discussion:

+ What is the SESERV contribution, besides reporting on ETICS? They will feedback the analysis to ETICS project.
+ ETICS is on network operators, we should include users too. What type of data modelling should we introduce to reflect this? No reply.

PANEL: Design for Sharing – Cooperation and Interworking of Virtualization Concept

Participants: W. Burakowski (WB), R. Nejabati (RN), A. Kapovitis (AK), B. Tremblay (BT), C. Kalogiros (CK); Chair: Kurt Tutschku (KT)
Questions from the floor: Augusto Casaca (AC), Henrik Abramowicz (HA)

- KT: Is this the end of architecture and collaboration? What is really achieved by virtualization? Are we not doing it for a number of years already? What kind of language do we need to interwork?
- RN: Geysers focused into circuit switch virtualization (optical layer) including IT virtualization. In Geysers we can choose a route on top of a topology. It studies how the physical network should look like to simplify virtualization.
- CK: SESERV indicates that socio-economic issues should be considered for virtualization.
- WB: need to design new mathematical models for virtualization. For instance, ATM and IP QoS had these models. Our project does not include the development of these models. Need also to uniform the different terminologies. All the benefits from virtualization nobody knows yet.
- CT: The SAIL plan is to base the development on existing IP technologies. It will use the old VPN concept. They are looking how to get rid of the different PCI in the

different PDUs. They are looking also into new forwarding methods to see how the technology can help on this.

- AK: For an operator, virtualization can be the way into the future Internet. What problems do we face with congestion? A solution can be at IP level as an IETF proposal indicates, not at the virtualization level. Interoperabilty is required.
- CK: data centers are not more advanced in virtualization than telecommunications.
- RN: mathematics might not be a solution as many heuristic inputs need to come from operators.
- KT & AC: What should the SLAs describe and at what points of the network should be standardized?
- CK: there should be an SLA for each function of the system.
- KT: many streaming services are using TCP.
- HA: SLAs are one thing and the way we achieving performance is another. We really need to reach standardization agreements for this virtualization.
- WB: SLA between user-network and between network- network are different. An SLA between virtualized networks is only possible when we have isolation. We should define at what point in the network we really need the SLAs.
- CT: we need measurements tools for the different parts of the virtualized network to be able to provide SLAs.
- KT: what is the scalability of this virtualization? Centralization versus decentralization of management?
- RN: A distributed system is more scalable. It is also more robust. Do we need a scalable system for core network?
- CK: in a decentralized environment there is the problem of trust between providers. Signalling aspects need to be considered.
- WB: Diffserv is a good example of a scalable system. The number of parallel internets in our solution can be up to 5, for example. This means that there are limits for this approach. We need mathematical approaches to check scalability.
- BT: centralized is a simpler solution. Distributed solutions have also scalability issues. We might go for a mixed solution.
- AK: the answer depends on what you are going to centralize.
- HA: we need to find a balance as a complete decentralized solution might have problems.

8.2 Session 2: Smart Resource Management in Future and/or Virtualized Wireless Networks

The afternoon session addressed the topic “Smart Resource Management in Future and/or Virtualized Wireless Networks”. The session included two talks and was concluded by a panel.

1) S. Sargento (MOMO): User-Driven Wireless Mesh Networks by Virtualization

The talk is about bringing Wireless Mesh Networks, context-awareness, and network virtualization together.

A novel architecture for WMNs is presented that consists of a multitude of context-based *Virtual Networks* (VNs), each one providing personalized communications for a user or group of users, according to their requirements, which are part of the user context.

Virtualisation is used in both the physical infrastructure as well as on the user side to provide multi-access. A context information model has been developed. A distributed global discovery process to find VNs in the WMN has been introduced. A semantically controlled ring is used for the discovery to find a point of attachment according to the user requirements. The latency for discovery was 60 ms. The VNs will compete for bandwidth and an optimisation model that is probabilistic has been developed both for the data path as well as for the control path.

Some results:

+ Total delay for user connectivity establishment is affected by the distributed discovery
+ VN discovery processes are independent from data traffic (separate data vs control)
+ Extension and update of a VN are dependent of the type/volume of data traffic
+ Each VN performs optimisation independent of the other nodes looking at utilities at each node, cost for using each channel, flows are conserved at each node and reservations of channel must correspond to the actual usage by the flows.
+ Each VN solves the problem, in a distributed way, based on Lagrangian duality. The optimal flow of one VN depends on the flows on the other VNs! The VNs interact with each other, trying to reach a Nash equilibrium.
+ Flows try to avoid each other and Convergence is achieved in 5-6 iterations.

Scalability:
There is a trade-off between user demands and the number of VN and currently it is threshold based to get a manageable situation.

Resource management:
Model based decision considering user association, router service time model, VN discovery and extension and VN resources Optimisation. Benchmarking has not really been done yet but is expected being based on E2E delay, overhead, QoE, resources availability and robustness.

Fairness:

+ Nash equilibrium for optimisation of resources
+ Controllability
+ Threshold based for limited VNs and limited Context
+ Efficiency
+ Considered small delays in extension reconfiguration
+ Utilisation
+ Sharing physical resources and isolation

Questions

+ Why use distributed DHT (answer: it is easy)
+ Discussion on what type of user the User driven WMNs really are applicable for.

2) M. Logothetis (The OneFIT project): Functional Architecture Overview for the Cognitive Management of Opportunistic Networks in the Context of Future Internet

Opportunistic Networks are operator governed through resources, policies, and information/knowledge and can be coordinated extensions of the infrastructure for a particular time interval. The terminals will act as relays in an opportunistic fashion.

The followings scenarios were addressed:

+ Opportunistic coverage extension
+ Opportunistic capacity extension
+ Infrastructure supported opportunistic ad-hoc networking
+ Opportunistic traffic aggregation in the RAN
+ Opportunistic traffic aggregation in the backhaul

A functional architecture has been developed based on the following building blocks:

+ Cognitive management System for the Coordination of the infrastructure (CSCI)
+ Cognitive Management system for the Opportunistic Network (CMON)
+ Dynamic Spectrum Management (DSM)
+ Dynamic, Self-Organising Network Planning and Management (DSONPM)
+ Joint Radio Resources Management (JRRM)
+ Configuration Control Module (CCM)

.

The building blocks are both in the terminal at the user side as well in the RAN except for the DSM as this is operator controlled.

Some indicative performance figures for the traffic aggregation scenario for users?

- Power consumption reduction by 22% and delivery latency gain 10.7 sec.

What is the scalability of control of your resource management concept?

- Local problems
  + distributed solution for ON Creation
- More extended hot spots
  + Semi-Distributed Approach (ON Creation)
  + Classical Resource Management
- At the demonstration booth one could see both distributed and semi-distributed approaches

How (fast) can it adapt to dynamicity?

- Fast adaptation (as well as stability), through proper distribution of functionalities

How can your approach interoperate with other resource management concepts?

- Functional blocks ETSI RRS (Reconfigurable Radio System Architecture) :
  + DSM (Dynamic Spectrum Management)
  + JRRM (Joint Radio Resources Management)
  + DSONPM (Dynamic, Self-Organizing Network Planning and Management)

Which resource description is used?

- OneFIT extends the FA(Functional Architecture) and interfaces of ETSI RRS and E3(End-to-End-Efficiency)

- Ontology (representing FA and messages) provides virtualization
  + Protégé
  + Jade

Please compare your approaches with some of the other approaches presented here or in literature?

- Infrastructure Extensions through ONs ,Operator-governed, CMSs and C4MS
  + Complementary solution is planning of the infrastructure, in conjunction with self-x capabilities for dynamically finding the best reconfigurations
  + OneFIT enables higher flexibility in the situations that can be handled , and higher efficiency
  + Hybrid Networks: The possibility of extending ad-hoc networks with the support of infrastructure, has been considered as a way of improving the connectivity in large-scale ad-hoc networks

What are the expected performance figures?

- Increased Utilization
- Lower Transmission Power
- Cost efficient
- Value creation
  (see also above regarding performance)

Please detail on the key resource management features of fairness, controllability, efficiency and utilization?

- Fairness**:** the impact of our technologies is on the device energy consumption
- Controllability: operator governed
- higher utilization of spectrum, lower transmission powers, high QoS

What are the threats to the adaptation of your technology?

- Security issues in the relay
- Changing business model of operator

What are the relevant results in 10 years?

- Highly applicability due to:
  + Internet of things
  + M2M

Discussions regarding user compensation and fairness since the users are lending their terminals to create ON as major issues.

PANEL: Design for Choice – Future Resource Management

Summary of the discussion:

- User control and business issues were considered a problem for the wireless mesh network.
- Network selection would take some 100ms according to S. Sargento.
- W r t One fit some issues regarding ill-behaving nodes that might disturb traffic. Issues with time-delays for re-establishment of the opportunistic networks

8.3 Summary

The 5th FICW was attended by 41 persons and provided a set of impulses for the subsequent future research:

1. the need for cooperation of future virtualized network architectures and control schemes;
2. the investigation of the performance of virtualized systems;
3. the specification of operational procedures.

9 OVERALL QUALITATIVE ASSESSMENT

The 5th FICW was mainly attended by non-Euro-NF delegates, most of them participating in the Future Network & Mobile Summit 2011 (June 15—17, 2011).

The overall format appeared to be well-adapted to the goal of triggering a brainstorming of open (research) issues in the selected areas. Lively exchanges of points of view followed the talks and continued during the discussion sessions.

10 FINANCIAL ASPECTS

Euro-NF supported its key contributors through the following flat grants, covered from the respective partners' budget:

- Moderator acting as chair of sessions: 1 200 € (1 grant)
- Session rapporteur: 950 € each (1 grant)
- Euro-NF presenter: 700 € (1 grant)

APPENDIX 1: CALL FOR PARTICIPATION

See also http://ec.europa.eu/information_society/events/cf/fnc7/item-display.cfm?id=6734

5th Future Internet Cluster Workshop with Special Focus on Future Network Architectures

Call for Contributions

Tuesday June 14, 2011 - Warsaw, Poland (collated with FNMobile Summit)

Context

In the recent years, several Future Internet initiatives have proposed views on what the architectures of the networks of the future could be. Recent concertation meetings were devoted to introduce the projects contributing to this domain as well as their own visions and roadmaps. These meetings were fruitful as facilitators for information exchange and for promoting synergies among the projects.

Since March 2010, the European Commission and the FP7 Network of Excellence "Euro-NF" have organised four Future Internet Cluster Workshops (FICWs) on specific topics with a broad potential impact for Europe, ranging from Future Network Architectures (First FICW) via mobility and security (Second FICW) to socio-economic aspects of Future Internet (Third FICW) and ICT and Sustainability (Fourth FICW).

The Fifth FICW on Future Network Architectures aims at an update and the discussion of the achievements of projects presented at the previous event as well as on the discussion of future work.

Technical Objectives

This Fifth Future Internet Cluster Workshop on June 14, 2011 will consist of sessions devoted to Future Internet architectures, specifically:

- Information-centric networking
- The role of virtualization in future network architectures
- Future Smart Connectivity, e.g.: seamless connectivity of fixed and mobile networks, network federation, smart multi-homing.

Organisation of the workshops

The meeting will be structured as follows:

- A session will last one half-day and is composed of 2-4 presentations.
- In each session, the presentations will be followed by a significant amount of brainstorming on identification of key challenges :

1. possible methodologies to face these challenges;
2. possible synergies to establish among the projects and with other initiatives.

Call for Contributions

All the projects of the cluster are invited to submit a proposal for a presentation (maximum two pages) indicating:

- The content of the proposed presentation
  The presentation should include a section on "what strategies and tactics your project recommends to pave the way towards the future applications, services and usages"
- The ongoing activities in the project related with the topic
- Existing collaborations with other projects and initiatives
- A self-assessment of the interest of the presentation for the meeting.

Contributions not connected to a specific project are also welcome, as long as they are within the scope.

Submission deadline (extended): May 9, 2011

Notification (expected): May 21, 2011

The proposals should be sent to the following mailbox:

INFSO-FUTURE-NETWORKS@ec.europa.eu

With copy to:

paulo.desousa@ec.europa.eu

APPENDIX 2: MATERIAL FOR DISSEMINATION

Slides from the presentations are enclosed hereafter, and are also available on the Euro-NF Web site http://euronf.enst.fr/p_en_Events_Concertati_INSTFP7_Clust11Jun_606.html