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Contents

Foreword

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Introduction

In the last couple of years an increasing number of heterogeneous network types have come to the focus of attention, e.g. heterogeneous access systems (otherwise known as multi-access), Personal Area Networks (PANs), Personal Networks (PNs),moving networks etc. This trend is expected to continue. Different scenarios have been studied in the All-IP Network (AIPN) Feasibility Study in TR 22.978 [5], which lists "network extensibility/composition " as a key aspect of AIPN. The integration of PANs and Personal Networks will be specified within the scope of the Personal Network Management (PNM) work item. Related Technical Specification work is ongoing within the AIPN Stage 1 in TS 22.258 [6] and Personal Network Management Stage 1 in TS 22.259 [7]. It would be desirable for 3GPP networks to be able to integrate many of these heterogeneous network types, or to interwork with them, in an efficient manner that for operators is easy to manage and control.

This Technical Report is the result of a feasibility study on Network Composition, the concept of heterogeneous network/system integration and interworking. It builds on the work of AIPN and studies Network Composition in more detail. This includes integration of networks with different administrative domains, and the dynamic and flexible integration of ad-hoc networks, PANs, WLANs etc. Particularly, the possibility for a uniform Network Composition procedure is explored, independent of what kind of network is "composed" with the 3GPP system. Complementing the AIPN work, in this report a concrete dynamic “plug&play” and flexible Network Composition procedure is described.

1 Scope

The present document explores the feasibility of a uniform procedure for the integration of, and the interworking with, a large variety of heterogeneous network types. This uniform procedure is called Network Composition. It focuses on ad-hoc networks, PANs, moving networks etc., but also includes access systems. The goal is to avoid the need for defining a new procedure for integration / interworking with each newly emerging network type and to explore the feasibility of making the Network Composition procedure dynamic and to minimize human intervention ("plug and play"). Of course, the high security (authentication, authorization) standards of 3GPP must thereby be maintained. Finally, it is desirable for the Network Composition procedure to be flexible regarding what functionality is assumed in the composing network.

It is conceivable that roaming within a pre-set commercial and technological environment could be established dynamically using the same procedure.

This Feasibility Study covers the following aspects:

- Description of purpose and benefits of composition
- Composition use cases highlighting uniformity, dynamicity, security, manageability, scalability, flexibility, as well as business aspects
- Study of potential composition requirements
- Description of the composition process
- Definition of traits and/or implications of introducing this functionality into the 3GPP system, covering subjects such as management, multi-link radio access, mobility, context & policy awareness, security, and media transcoding & adaptation capabilities.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] "D7-2 Ambient Networks Security Architecture", IST–2002-507134-AN/WP7/D02, F. Kohlmayer et al
http://www.ambient-networks.org/publications/D7-1_PU.pdf

[2] "Host Identity Protocol Architecture", R. Moskowitz, P. Nikander
http://www.ietf.org/rfc/rfc4423.txt

[3] "D3-2: Connecting Ambient Networks – Architecture and Protocol Design", IST–2002-507137-AN/WP3/D/3-2, J. Colás et al
http://www.ambient-networks.org/publications/AN D3-2 for publication.pdf

[4] 3GPP TR 21.905: "Vocabulary for 3GPP specifications"

[5] 3GPP TR 22.978: "All-IP Network (AIPN) feasibility study"

[6] 3GPP TS 22.258: "Service Requirements for the All-IP Network (AIPN); Stage 1"

[7] 3GPP TS 22.259: "Service Requirements for Personal Network Management; Stage 1"

[8] 3GPP TS 22.278: “Service requirements for evolution of the 3GPP system (Release 8)”3G

[9] “D8-A.3: Business Role Models”, FP6-CALL4-027662-ANP2/D8-A.3”, O. Rietkerk et al, January 2007
http://www.ambient-networks.org/publications/

[10] “D7-A.2: Draft System Description”, FP6-CALL4-027662-ANP2/D7-A.2”, M Johnsson, R Hancock, A Schieder et al, January 2007
http://www.ambient-networks.org/publications/

[11] 3GPP TS 22.228: "Service requirements for the Internet Protocol (IP) multimedia core network subsystem".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [4] and the following apply.

Editors note: need to add definition of Compensation

Composition Agreement (CA): A Composition Agreement is an electronic agreement between CCNs. It includes the policies to be followed by the composed CCNs, the identifier of the composed CCNs, how logical and physical resources are controlled and/or shared between the composing CCNs, compensation information, etc. Where the CA includes commercial and legal factors, the CA should be digitally signed by both CCNs (to support non-repudiation and legal enforcement).

Composition Capable Network (CCN): A network or user device capable of Network Composition. A network may be a 3GPP network or non-3GPP network.

Composition Process: A set of phases that all together describes the necessary procedures to perform a Network Composition between CCNs. The phases may not need to be strictly ordered, and one or more of the phases can be omitted depending on how the Network Composition is applied and its purpose.

Decomposition Process: A set of phases that all together describes the necessary procedures to cancel a Network Composition between CCNs. The phases may not need to be strictly ordered, and one or more of the phases can be omitted depending on how the Network Composition is cancelled.

Network Composition: A dynamically created cooperation between an evolved 3GPP network and another network or user device, or between networks/user devices in general. This cooperation is ruled by the Composition Agreement agreed during the Composition Process.

Resource, resource control, resource usage, and resource access provisioning: A resource is an entity provided by a CCN, e.g. bandwidth, AAA (Authentication, Authorisation, and Accounting) functionality and mobility functionality. It is characterized by the following: A resource is controlled – in the sense of configured and administered - by a CCN (e.g. a PLMN controls its AAA and mobility functionality) in order to show a certain specified behaviour. A resource can be used by a CCN (e.g. a User Equipment (UE) or PAN using the AAA and mobility functionality provided by a PLMN). The access to usage of the resource is provided (e.g. a Visited PLMN (VPLMN) provides access to the AAA functionality in the Home PLMN (HPLMN), or a mobile network provides access to the mobility functionality of a PLMN). Usage, control and access provisioning to a given resource can be performed by different CCNs. A resource may have inherent, resource type-specific properties that may be subject to CA negotiation.

Virtual Composition: Network Composition between CCNs that are not in direct physical contact but exchange information (e.g. through packets) via another transport network(s).

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [x] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [x].

For the purposes of the present document, the following abbreviations apply:

AAA	Authentication, Authorisation, and Accounting
AIPN	All-IP Network
AN	Access Network
CA	Composition Agreement
CCN	Composition Capable Network
CD	Control Delegation
CN	Core Network
CS	Control Sharing
DSL	Digital Subscriber Line
GANS	Generic Ambient Network Signalling
GRX	GPRS Roaming eXchange
GSMA	GSM Association
HIP	Host Identity Protocol
HLR	Home Location Register
HPLMN	Home PLMN
HSS	Home Subscriber Server
IKE	Internet Key Exchange
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPSec	Internet Protocol Security
IPX	IP eXchange
ISIM	IM Services Identity Module
I-WLAN	Interworked WLAN
PAN	Personal Area Network
PDG	Packet Data Gateway
PLMN	Public Land Mobile Network
PN	Personal Network
PNM	Personal Network Management
QoS	Quality of Service
RAT	Radio Access Technology
RC	Roaming Consortium
RNC	Radio Network Controller
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SLA	Service Level Agreement
UE	User Equipment
UICC	UMTS IC Card
USIM	UMTS Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network
VPLMN	Visited PLMN
WLAN	Wireless Local Area Network

4 Principles, Purpose and Benefits of Network Composition

4.1 Principles

4.1.1 General

3GPP networks of today cooperate with other networks: For example, they exchange user traffic with other Public Land Mobile Networks (PLMNs), fixed network and the Internet, they cooperate with these networks on the basis of roaming agreements, and cooperate with non-3GPP Radio Access Technologies (RATs), e.g. Interworked WLAN (I-WLAN). 3GPP networks will also cooperate with user-owned networks, e.g. Personal Networks and PANs. The cooperation of 3GPP networks with other networks however is mostly of a static, preconfigured nature. For example, the cooperation with a I-WLAN Access Network is based on manual configuration, and the I-WLAN is expected to be immobile, i.e. the access point is statically installed and does not roam. Moreover, the process to (both technically and administratively) achieve cooperation with other networks is highly dependent on the nature of the network and the goal of the cooperation. Network Composition is about making this process both dynamic and uniform.

Network Composition is a uniform procedure that allows cooperation of two or more Composition Capable Networks. These other networks may be of a rather heterogeneous nature, ranging e.g. from PLMNs over fixed networks to Personal Area Networks and including 3rd party operated access networks. The cooperation enabled through Network Composition can be quite loose, as in the case of a dynamic roaming agreement between PLMNs. It can also be very tight, as in the case of the dynamic integration of a non-3GPP RAT into the evolved 3GPP network. The point is that, despite these differences, the basic procedure for achieving the cooperation in all scenarios is identical.

Network Composition furthermore is a procedure that allows a dynamic cooperation of the CCN with heterogeneous other networks. While an established framework agreement (e.g., a contract written on paper)between the composing parties that defines the context (e.g., legal or commercial) within which Network Composition is carried out may be required prior to composition, the actual composition is automated and "on the fly". This may include the dynamic, automated renegotiation and adaptation of certain parameters, e.g. bandwidth, within the limits pre-set in the framework agreement. However, also fully electronically negotiated agreements without prior framework agreement may be feasible.

The dynamically negotiated agreement between the composing CCNs is called Composition Agreement (CA). It contains the detailed parameters of the cooperation between composed networks. Together with a possible framework agreement, the CA reflects both business (contractual interaction points, payment method) and technical (management, QoS, technical capabilities) issues and also specifies the rights and duties for each party. Since potentially a large number of parameters would have to be negotiated, the (partial) re-use of CAs that have been used in previous compositions of the same parties, or that were pre-established offline, is anticipated in order to speed up the process.

4.1.2 Types of Network Composition

The cooperation of CCNs can happen on both the user plane and the control plane. Dynamic cooperation on the user plane is already possible today. It means user traffic originating from one network is forwarded in the other network. However, cooperation across network boundaries to achieve end-to-end control functions like QoS and security as well as mobility iscurrently very difficult to establish.

Cooperation on the control plane can take many forms. Individual control functionalities, e.g. mobility control, authentication and authorization, QoS control or charging, can be left unchanged by the composition process, or they can be delegated, or even integrated. Several types of composition can be distinguished based on how resources are contributed:

- **Network Interworking:** The composing CCNs stay separate networks also after composition. They maintain control of their own resources. An example for this composition type is interworking at the control plane to establish QoS. Here each of the composing networks accepts user traffic from the other network and provides a particular QoS. QoS control remains in each network. It is not delegated, integrated or shared. All resources that are contributed according to Networking Interworking have their control unchanged. Who has rights to provide the access to use the contributed resources is subject to the CA between composed CCNs and is not affected by

the composition type. For example, in this case, CCN 2 may provide access to use the contributed resources by CCN 1, and vice versa.

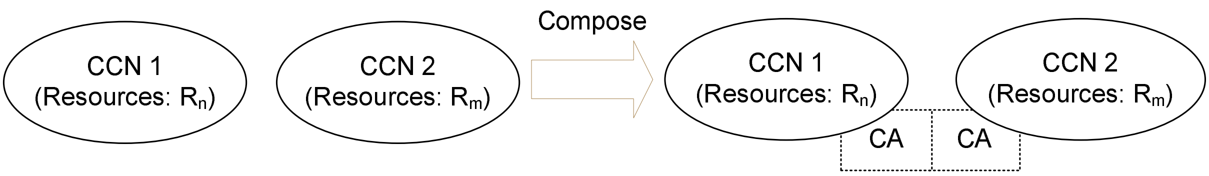

Figure 1: Network Interworking

- **Control Sharing:** Two CCNs stay separate, but share their resources. If a common control of any resources is involved, then a new common/virtual CCN (CCN 12) is created on top of the member CCNs. This new common/virtual CCN controls only the resources contributed to the new CCN. No member CCN has abilities to control the contributed resources, thus this is always done by the new common/virtual CCN. Also in this case, it is subject to the CA between CCN 1 and CCN 2 who is going to provide the access to use the contributed resources. Instead of exercising common control, control of certain resources can also be delegated to another CCN, which is defined below, so that after a composition has taken place, a CCN does not have control of the delegated resources anymore.

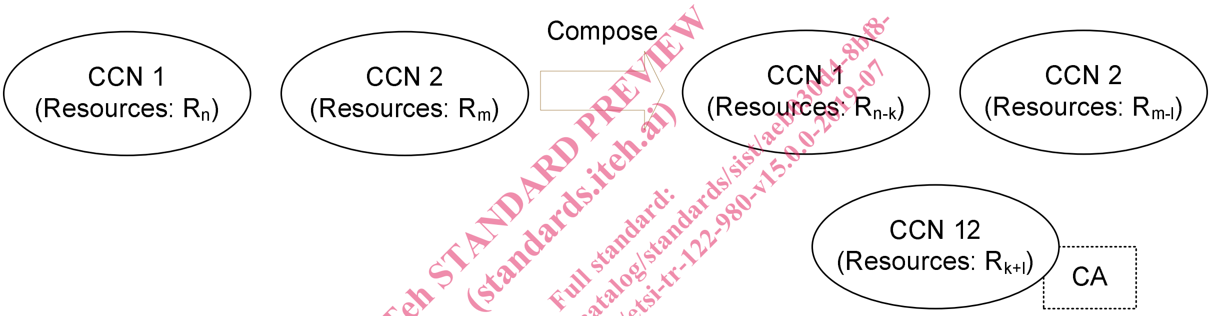

Figure 2: Control Sharing

- **Control Delegation (a special type of Control Sharing):** Here at least control of one resource is delegated from one CCN to the other CCN. The delegated resource control may also be located in a new (logical) CCN. Control delegation can be realized e.g. between a WLAN access network and the 3GPP network in a 3GPP-WLAN interworking scenario. Here, the AAA control for the WLAN access is delegated to the 3GPP network. Another example is the delegation of mobility control for mobile devices of a moving network to a mobile router. This allows network mobility in a way that is transparent to the mobile devices. All resources that are contributed according to Control Delegation follow the same set of rules defined for Network Interworking with the exception that right to control of the contributed resources are delegated to the other CCN who was not in control of the resource(s). Also in this case, it is separate issue on who has rights to do access provisioning and it is defined in the CA.

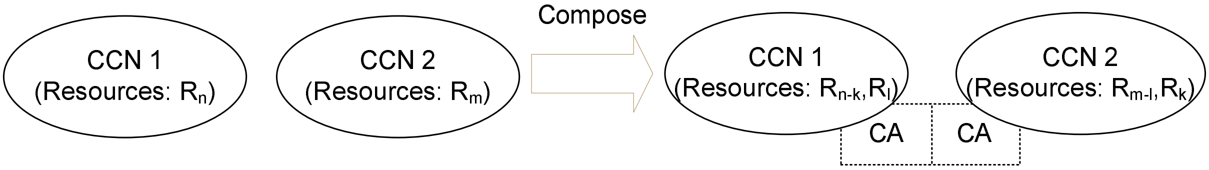

Figure 3: Control Delegation

- **Network Integration:** Two CCNs are merged to form one new CCN. All resources are inherited from the original CCNs, which are now controlled jointly. From the perspective a network or network element outside the new CCN, the original CCNs are no longer distinguishable. An example is the dynamic extension of the network of a single operator to include a new access network. All resources are controlled by a new common/virtual CCN, and access provisioning is done by this new CCN and/or another CCN.

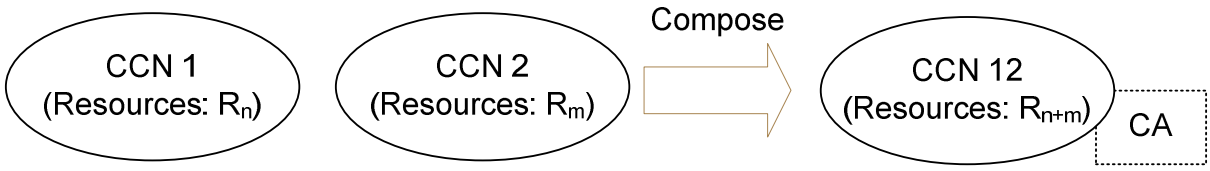

Figure 4: Network Integration

The composition types defined above can be also combined such that logical and physical resources are contributed in different ways. For example, if two resources A and B are contributed to a composition and A has its control delegated and B is under a common control, then the composition type is derived from the contributed resource requiring the highest level of co-operation. In this case, resource B represents the highest level of cooperation and therefore the composition type is control sharing with a new CCN.

The only exception is network integration where all resources are contributed in the same way; i.e. they are all under common control

The different composition types should be seen only as a rough classification to help understand a particular use case. They are not meant to be formal definitions and should not be used as such .

The Composition Process proceeds through a number of phases which are described in more detail in Sec. 6. They include a first advertisement and discovery phase in which composition is triggered, a phase in which the CA is negotiated, and a phase in which the CA is realized.

Network Composition does not prerequisite physical vicinity of the composing networks. Given adequate security, also a “virtual composition” via a connecting bearer is conceivable.
However, in order to define the context (e.g., legal or commercial) within which Network Composition Network Composition is carried out, it is expected that the composing parties have already established a framework agreement before the actual Network Composition takes place. The substance of such a framework agreement and how it is set up is outside the scope of 3GPP. This can for example be done in a similar way as roaming agreements are negotiated today.

4.1.2 Other common styles

4.2 Purpose and Benefits

The purpose of Network Composition is a uniform, dynamic procedure for achieving dynamic network cooperation, particularly on the control plane. Such a procedure is expected to offer the following benefits:

- The Network Composition procedure enables new business opportunities as it facilitates flexible and more dynamic cooperation of heterogeneous networks on the control plane.

- As the network landscape becomes increasingly diverse, for example, due to the appearance of heterogeneous access network technologies (e.g., WLAN, WiMAX, etc.) and network types, the need for a uniform procedure that facilitates co-operation between the different networks arises. Network Composition defines precisely such a uniform procedure for co-operating between heterogeneous networks in a standardized way, which helps saving development time and cost..

- The uniformity of the Network Composition procedure furthermore saves infrastructure costs as the same infrastructure can be reused in all network cooperation scenarios.

- The dynamicity of the Network Composition procedure allows the network operator to quickly react to changing resource demands by extending network resources in an ad-hoc way.

- Electronic CAs based on pre-negotiated framework agreements are expected to save on transaction costs compared to completely manually prepared and negotiated agreements. They are especially suitable for dynamic business environments with many providers.