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Next Generation Protocol (NGP);
Evolved Architecture for mobility using Identity Oriented Networks

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Foreword

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Executive summary

This work item focuses on using Identity Oriented Networks (ION) for next generation architectures toward 5G and beyond. The basic concept and goal behind ION is to dissociate the identifier and temporal location information for an entity. Ideally, this goal should endeavour for deployment to support current architectures while also enabling more optimal future architectures. The work aims to examine and propose recommendations to improve and simplify the network infrastructure to support mobility natively by adopting ION. In addition, the work item may require the development of new protocols and/or modification of existing protocols.

Introduction

The Internet is seminal for communication technologies and is a powerful enabler for modern applications with connectivity needs. However, when the Internet was designed the requirements were wildly different from the applications to be enabled by 5G infrastructure. Forty years ago, no one expected the user behaviour to evolve from text based fixed Internet access to streaming 4K quality media over a mobile device with session continuity. Mobility support is today the norm and new solutions should be examined for the network to support these new capabilities. As the Internet is pervasive and therefore these solutions should still interoperate with the current architecture.

Today the user's expectation and experience is at the forefront driving the requirements of applications such as session continuity, augmented reality, virtual reality or high definition video. Most importantly perhaps, the future deployment of 5G gives a unique opportunity to examine how core technologies may be modified, enhanced or replaced for a more secure, robust and optimized architecture for the future mobile networks.

With this in focus, the present document reviews the current state-of-art of Identity-oriented solutions (ION), and provides recommendations toward new protocols and/or modification of existing ones in the context of ION.

1 Scope

The present document provides an overview of existing identity oriented protocols, mapping systems and proposes next generation mobility with a generic and resilient identity services infrastructure.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Number of Mobile-Only Internet Users Now Exceeds Desktop-Only in the U.S.

NOTE: Available at https://www.comscore.com/Insights/Blog/Number-of-Mobile-Only-Internet-Users-Now-Exceeds-Desktop-Only-in-the-U.S.

[i.2] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016-2021 White Paper.

NOTE: Available at http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html.

[i.3] M. Hoefling, M. Menth, and M. Hartmann: "A Survey of Mapping Systems for Locator/Identifier Split Internet Routing", IEEE Communications Surveys & Tutorials, vol. 15, n. 4, Fourth Quarter 2013.

[i.4] International roaming explained.

NOTE: Available at http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Africa-International-roaming-explained-English.pdf.

[i.5] IETF draft-herbert-nvo3-ila: "Identifier-locator addressing for network virtualization", T. Herbert.

NOTE: Available at https://tools.ietf.org/html/draft-herbert-nvo3-ila-00.

[i.6] IETF draft-padma-ideas-problem-statement: "Problem Statement for Identity Enabled Networks", P. Pillay-Esnault, M. Boucadair, C. Jacquenet, G. Fioccola, A. Nennker.

NOTE: Available at https://datatracker.ietf.org/doc/draft-padma-ideas-problem-statement-01.

[i.7] ETSI GS NGP 001: "Next Generation Protocol (NGP); Scenario Definitions".

[i.8] IETF RFC 6301 (July 2011): "A Survey of Mobility Support in the Internet", Z. Zhu, R. Wakikawa, and L. Zhang.

[i.9] IETF RFC 3753 (June 2004): "Mobility Related Terminology", J. Manner, and M. Kojo.

[i.10] ETSI TS 124 301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS) (3GPP TS 24.301)".

[i.11] ETSI TS 136 300: "Access Network (E-UTRAN); Overall description; Stage 2 (3GPP TS 36.300)".

[i.12] ETSI TS 123 060: "Access General Packet Radio Service (GPRS); Service description (3GPP TS 23.060)".

[i.13] ETSI TS 129 060: "General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp Interface (3GPP TS 29.060)".

[i.14] IETF RFC 6275 (July 2011): "Mobility Support in IPv6", C. Perkins, D. Johnson, and J. Arkko.

[i.15] IETF RFC 5213 (August 2008): "Proxy Mobile IPv6", S. Gundavelli, K. Leung, V. Devarapalli, K. Chowdhury and B. Patil.

[i.16] IETF RFC 5949 (September 2010): "Fast Handovers for Proxy Mobile IPv6", H. Yokota, K Chowdhury, R. Koodli, B. Patil, and F. Xia.

[i.17] IETF RFC 6740 (November 2012): "Identifier-Locator Network Protocol (ILNP) Architectural Description", Atkinson, RJ. and SN. Bhatti.

[i.18] IETF RFC 6830 (January 2013): "The Locator/ID Separation Protocol (LISP)", D. Farinacci, V. Fuller, D. Meyer and D. Lewis.

[i.19] IETF RFC 7401 (April 2015): "Host Identity Protocol Version 2 (HIPv2)", R. Moskowitz, T. Heer, P. Jokela and T. Henderson.

[i.20] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[i.21] IETF draft-ietf-lisp-predictive-RLOCs: "LISP Predictive RLOCs", D. Farinacci, P. Pillay-Esnault.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

binding: process of binding an identifier to its associated LOC(s), based on a lookup/query of the NMS

entity: device or node or a process, which needs to be identified in a network

Identifier (IDf): name that can be used to identify an entity unambiguously within a scope

Identity(IDy): identity of an entity used to securely access the mapping system and to enhance anonymity and privacy

locator: routable address in a network

3.2 Abbreviations

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

3GPP	3rd Generation Partnership Project
5G	Fifth Generation Mobile Networks
BGP	Border Gateway Protocol
DHT	Distributed Hash Table
DNS	Domain Name System
DNSSEC	Domain Name System Security Extensions
EMM	EPC Mobility Management
EPC	Evolved Packet Core

GMM	GPRS Mobility Management
GPRS	General Packet Radio Service
GRIDS	Generic Resilient Identity Services
HLR	Home Location Register
IDf	Identifier
IDMS	Integrated Database Management System
IDy	device identity
ION	Identity Oriented Network
IoT	Internet of Things
IP	Internet Protocol
ISP	Internet Service Provider
LTE	Long Term Evolution
MIP	Mobile IP
NMS	Network Mapping System
NMSFK	Network Mapping System with Full Knowledge
NMSPK-LL	Network Mapping System with Partial Knowledge using Local Lookup
NMSPK-SRL	Network Mapping System with Partial Knowledge using Single Remote Lookup
NMSPK-IRL	Network Mapping System with Partial Knowledge using Iterative Remote Lookup
NMSPK-HSO	Network Mapping System with Partial Knowledge with Hierarchically Structured Overlay
NMSPK-DHT	Network Mapping System with Partial Knowledge with Distributed Hash Table
NMSPK-MCO	Network Mapping System with Partial Knowledge with Multicast Overlay
PKI	Public Key Infrastructure
UE	User Equipment
VLR	Visitor Location Register
VPN	Virtual Private Network

4 Identity Oriented Networks (IONs): Architecture Overview

4.1 Introduction

The current Internet architecture, which has been built with and on top of the Internet Protocol (IP), was designed for a very different environment from modern networks. Early versions of the Internet Protocol were designed in the 1970's. The Internet protocol architecture has evolved over time since then, largely as a result of the Internet Engineering Task Force (IETF) organization. However, the landscape of networks has changed dramatically and many of the initial Internet architecture tenets have changed too.

As an example of one of these dramatic Internet architectural changes, today many Internet references cite that 70 % of the access sessions setup towards it are originated on a mobile device. However, at the start of the Internet design, the notion of mobility was not even considered.

Today, mobility is a major Internet requirement, and the number of users operating mobile devices has exploded, overtaking the number of fixed PC connections in 2014 [i.1]. According to reference [i.2], the projected growth of mobile devices is 1,5 per person, reaching a staggering total number of 11,6 billion connections by 2020. To cement a more near-term understanding of this trend, that global mobile data traffic has increased by 74 % in 2015 (according to reference [i.2]). Indeed, ubiquitous mobility is the norm and here to stay.

It is also very important to highlight that both the definition of mobility and its correlated requirements in the networks have drastically changed over time. For instance, in order to transit from LTE to 5G, the network requirements have become more stringent with respect to KPIs for latency, reliability, throughput, etc. [i.20]. This increase, in conjunction with evolving user behaviour, presents many technical challenges in the current Internet architecture in order to meet the requirements of future networks. Furthermore, due to the huge success of the Internet, there are many other non-technical issues that impact the Internet architecture: for instance those related to economical, or user behaviour. All of these technical and non-technical aspects need to be taken into account in the future solutions for any Internet architecture and protocol evolution (as detailed in ETSI GS NGP 001 [i.7]). In order to meet the aforementioned challenges of the current architecture based on IP, the present document introduces Identity Oriented Networks (IONs) as a candidate solution and provides a novel framework for next generation networks using a holistic approach. Furthermore, the present document extends some of the recommendations provided in ETSI GS NGP 001 [i.7] with respect to IONs.

4.2 Key Aspects of the Architecture

4.2.1 Identifier and Location Decoupling

This clause, introduces the key aspects of the ION architecture focusing on the fundamental importance of separating:

i) identifier; and

ii) location for each Entity within the network.

Furthermore, it provides an overview of the possible Entity identifier binding approaches and listing the pro and cons for each solution.

A mobile entity that intends to operate mobility needs three basic components (see references [i.7] to [i.11]):

a) An identifier, which univocally identifies an entity in the network. This is a static mobile entity identifier, in the context of the mobility system it wants to use.

b) A locator, which provides information regarding the current location of an entity. This is typically the static address of the Access Point that the mobile entity wants to connect to or be reachable from.

c) A network mapping system that creates a temporal binding of the identifier and the locator.

Additionally, new optional services can be possible with an Identity (IDy) (see reference [i.6]) for identifiers associated with it. These services namely access control, authorization of who can resolve location of an identifier use policy and metadata tied to Identity.

In a fixed network, an IP address has an overloaded semantic and it represents both the identifier and location of an entity. In the Internet Protocols, these two components were effectively bound, co-located, and somewhat immutable. As the network evolved, new breeds of devices have been introduced, which are increasingly highly mobile, and there has been an increased need to individually distinguish a multitude of applications that run on a device. However, the traditional methodologies, which use well-known ports and data forwarding, such as in mobile IP (MIP), [i.8] and [i.14] to [i.16] or 3GPP EPC mobility management (EMM) and GPRS mobility management (GMM) [i.12], solve the problem inefficiently. MIP binds a temporary IP address to a static IP address while in 3GPP (EMM and GMM) a temporary IP address to 3GPP Base Station IP address and Mobile Identifier. In 3GPP, the mobility structured Hierarchy of Identifiers is as follows:

1) Cells;

2) Tracking Areas;

3) Networks; and

4) Countries.

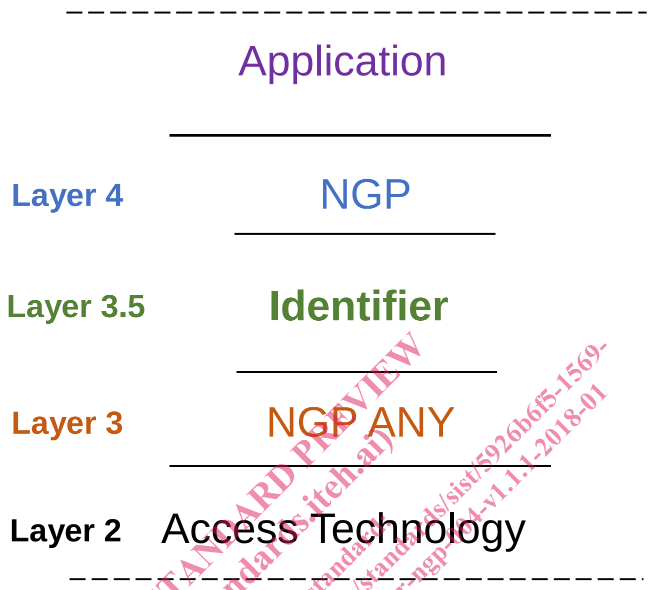
In order to maintain session continuity, the mobile device needs to retain some identifier that allows the communication to be seamless. In fact, when a device moves, the only component that changes is its location or its access point and not its identifier, however, today's overloaded semantic of an IP address for identifier and locator make them indistinguishable, therefore the only solution is to retain the IP address. However, holding on to an IP address during mobility requires solutions such as anchoring or reforwarding that introduce delays.

In order to overcome these issues, the ION architecture proposes to separate the identifier and location components. In ION the following components are present:

1) Entity identifier - identifies unambiguously entities within a scope.

2) Locator address -provides a location that is decoupled from the entity identifier.

This proposal does not intend to change the IP infrastructure, and proposes to work in a backward compatible manner with the current Internet, since the concept behind ION is applicable to any underlying network infrastructure. The basic idea beyond our proposal is to insert a naming/identifier sub-layer in the protocol stack, generally as an over-layer of IP stack as shown in figure 1. The Identity oriented architecture relies on defining the identifier of the entity and a mapping or binding to the location of the entity in order to forward traffic. The identifier namespace comprises the whole IPv4 and IPv6 address space to enable it to interoperate with traditional applications, while newer applications can use the newly defined identifier, which may not be necessarily IP address namespace. In alternative, the Identity oriented architecture may also reside directly on the L2 level: in this case the mapping is between the identifier and the L2 layer. The evolved architecture using Identity oriented networks aims at using the IP addressing, but inserting an Identifier layer and gives new possibilities to change the upper layer by having identifier aware applications above the identifier layer.



NOTE: In reality the Identifier layer can be mapped to any layer used for forwarding or route locators.

Figure 1: Proposed stack

It is possible to have multiple locations for an identifier in case an entity is multi-homed. This case brings lot of complexity in today's IP networks because of the already overloaded semantics of identifier and location with IP. However the decoupling will give greater flexibility for multi homing cases.

An important characteristic of the identifier format is that it needs to satisfy or facilitate several requirements, which are both technical and non-technical. One approach is to have a "dumb" identifier, which only serves the purpose of identifying an entity, and nothing more. Another alternative is format the identifier by conferring to it some properties inherently. Table 1 captures the main pros and cons of some of the characteristics the format could have. While table 1 is not exhaustive, it provides an idea of the number of parameters, which are potentially connected to the identifier infrastructure.