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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Frameworks and functional architecture models

Overview of ubiquitous networking and of its support in NGN

Recommendation ITU-T Y.2002

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Recommendation ITU-T Y.2002

Overview of ubiquitous networking and of its support in NGN

Summary

Recommendation ITU-T Y.2002 provides an overview of ubiquitous networking and of its support in NGN. This Recommendation describes objectives and fundamental characteristics of ubiquitous networking and identifies capabilities required for the support of ubiquitous networking in NGN.

Source

Recommendation ITU-T Y.2002 was approved on 29 October 2009 by ITU-T Study Group 13 (2009-2012) under Recommendation ITU-T A.8 procedures.

Keywords

Next generation network (NGN), ubiquitous networking.

FOREWORD

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1 Scope

This Recommendation provides an overview of ubiquitous networking in NGN. More specifically, this Recommendation covers the following:

- definition of ubiquitous networking;
- objectives of ubiquitous networking;
- fundamental characteristics of ubiquitous networking;
- communication types required for ubiquitous networking;
- overview of the support of ubiquitous networking in NGN in terms of high-level capabilities and corresponding high-level architectural model.

The capabilities which are required for supporting ubiquitous networking in NGN and which are identified in this Recommendation need to be mapped to NGN capabilities as defined in [ITU-T Y.2201]. This mapping is provided in Appendix I.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Q.1300] Recommendation ITU-T Q.1300 (1995), *Telecommunication applications for switches and computers (TASC) – General overview*.

[ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN*.

[ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks*.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2006), *Functional requirements and architecture of the NGN release 1*.

[ITU-T Y.2201] Recommendation ITU-T Y.2201 (2009), *Requirements and capabilities for ITU-T NGN*.

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

[ITU-T Y.2702] Recommendation ITU-T Y.2702 (2008), *Authentication and authorization requirements for NGN release 1*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 generalized mobility [ITU-T Y.2001]: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment. The degree of service availability may depend on several factors including the Access Network capabilities, service level agreements between the user's home network and the visited network (if applicable), etc. Mobility includes the ability of telecommunication with or without service continuity.

3.1.2 next generation network (NGN) [ITU-T Y.2001]: A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

3.1.3 object [ITU-T Q.1300]: An intrinsic representation of an entity that is described at an appropriate level of abstraction in terms of its attributes and functions.

NOTE 1 – An object is characterized by its behaviour. An object is distinct from any other object. An object interacts with its environment including other objects at its interaction points. An object is informally said to perform functions and offer services (an object which makes a function available is said to offer a service). For modelling purposes, these functions and services are specified in terms of the behaviour of the object and of its interfaces. An object can perform more than one function. A function can be performed by the cooperation of several objects. See [b-ITU-T X.902] for further information.

NOTE 2 – Objects include terminal devices (e.g., used by a person to access the network such as mobile phones, personal computers, etc.), remote monitoring devices (e.g., cameras, sensors, etc.), information devices (e.g., content delivery server), products, contents, and resources.

3.1.4 user [ITU-T Y.2201]: A user includes end user (ITU-T Y.2091), person, subscriber, system, equipment, terminal (e.g., FAX, PC), (functional) entity, process, application, provider, or corporate network.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 context: The information that can be used to characterize the environment of a user.

NOTE – Context information may include where the user is, what resources (devices, access points, noise level, bandwidth, etc.) are near the user, at what time the user is moving, interaction history between person and objects, etc. According to specific applications, context information can be updated.

3.2.2 ubiquitous networking: The ability for persons and/or devices to access services and communicate while minimizing technical restrictions regarding where, when and how these services are accessed, in the context of the service(s) subscribed to.

NOTE – Although technical restrictions to access services and communicate may be minimized, other constraints such as regulatory, national, provider and environmental constraints may impose further restrictions.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ANI Application to Network Interface

API Application Programming Interface

BT Bio Technology

CT Content Technology

ISDN Integrated Services Digital Network

IT Information Technology

ITS Intelligent Transportation System

NGN Next Generation Network

NNI Network to Network Interface

NT Nano Technology

PC Personal Computer

PDA Personal Digital Assistant

PSTN Public Switched Telephone Network

QoS Quality of Service

RFID Radio Frequency Identifier

SCM Supply Chain Management

UNI User to Network Interface

5 Conventions

None applicable.

6 Overview and objectives of ubiquitous networking

The term "ubiquitous networking" as defined in clause 3 is used for naming the networking capabilities which are needed to provide the support of various classes of applications/services which require "any services, any time, any where and any objects" type of operation.

One of the ultimate objectives of ubiquitous networking is to meet the challenge of seamless communications of "anything" (e.g., persons and objects). Ubiquitous networking will have to encompass the following:

- ubiquitous connectivity allowing for whenever, whoever, wherever, whatever types of communications;
- pervasive reality for effective interface to provide connectable real world environments;
- ambient intelligence allowing for innovative communications and providing increased value creation.

As a result, ubiquitous networking will also enable innovative services involving the use of technologies such as bio-technologies (BT), nano-technologies (NT) and content technologies (CT), thus allowing the provision of services that go beyond traditional telecommunication and information technology (IT) services. These innovative services will require extensions in terms of networking capabilities as well as the availability of any types of objects.

Appendix II provides further information regarding the potential directions for network evolution and a vision of ubiquitous networking services, applications and capabilities.

7 Fundamental characteristics of ubiquitous networking

Fundamental characteristics of ubiquitous networking are as follows:

- *IP connectivity*

IP connectivity will allow objects involved in ubiquitous networking to communicate with each other within a network and/or when objects have to be reachable from outside their network. Particularly, as many new types of objects will be connected to networks, IPv6 will play a key role in object-to-object communications and also mitigate against address exhaustion of IPv4.

- *Personalization*

Personalization will allow to meet the user's needs and to improve the user's service experience since delivering appropriate contents and services to the user. User satisfaction is motivated by the recognition that a user has needs, and meeting them successfully is likely to lead to a satisfying client-customer relationship and re-use of the services offered.

- *Intelligence*

Numerous network requirements in terms of data handling and processing capabilities will emerge from various industries involved in the field of ubiquitous networking (e.g., the car industry, semi-conductor industry or medical industry). Making these capabilities available for use by business and assisting this business in terms of efficient and timing decision making is very important. Intelligence which enables network capabilities to provide user-centric and context-aware service is therefore essential. Introduction of artificial intelligence techniques in networks will help to accelerate the synergies and ultimately the "fusion" between the involved industries.

- *Tagging objects*

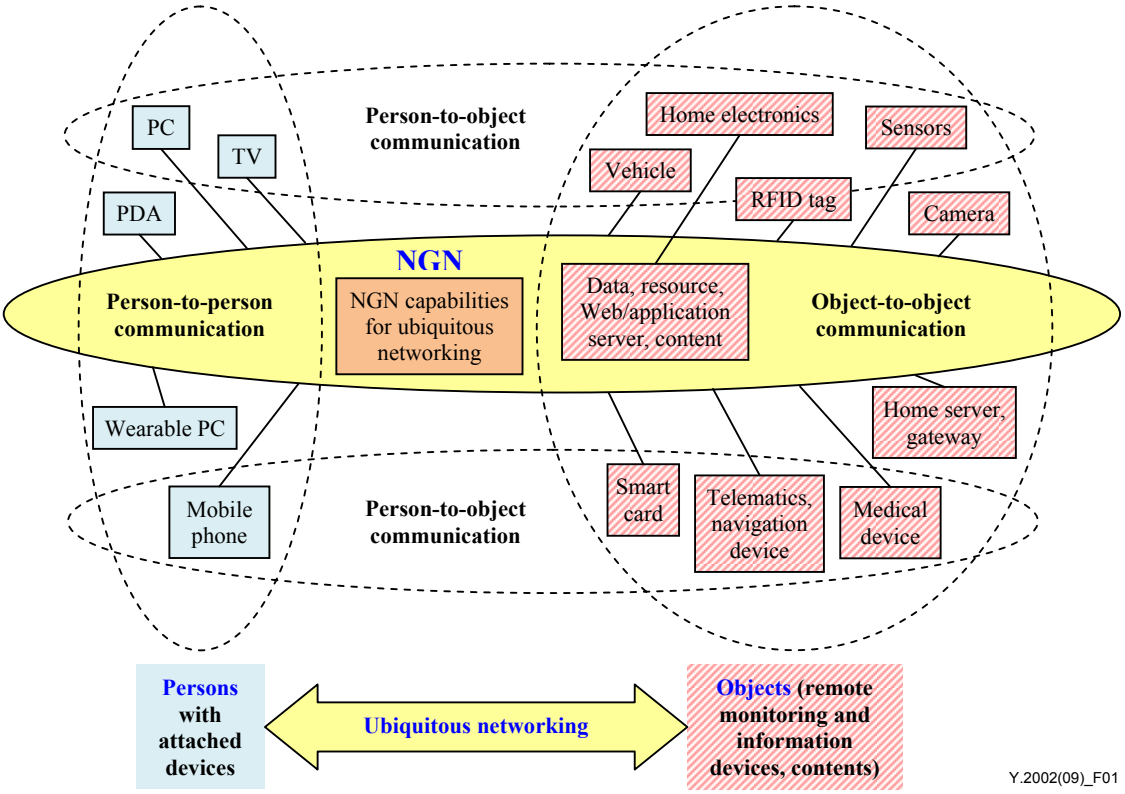
Radio frequency identifier (RFID) is one of tag-based solutions for enabling real-time identification and tracking of objects. Tag-based solutions on ubiquitous environment will allow to get and retrieve information of objects from anywhere through the network. As active tags have networking capabilities, a large number of tags will need network addresses for communications. As IP technology will be used for ubiquitous networking, it is essential to develop mapping solutions between tag-based objects (e.g., RFIDs) and IP addresses.

- *Smart devices*

Smart devices attached to networks can support multiple functions including cameras, video recorders, phones, TVs, music players. Sensor devices which enable detection of environmental status and sensory information can utilize networking functionalities to enable interconnection between very small devices, the so-called 'smart dusts'. Specific environments such as homes, vehicles, and buildings will also require adaptive smart devices.

8 "Ubiquitous networking" communication types

Figure 1 illustrates the different types of communications for ubiquitous networking.



Note that objects include all things that are attached to the network.
Some objects can be attached to persons and others can be located remotely with persons.
"person-to-person" communication relies on "object-to-object" communication.

Figure 1 – Ubiquitous networking communication types

Figure 1 makes a distinction between the following users of ubiquitous networking: persons (using attached devices such as PC, PDA, mobile phones) and objects (such as remote monitoring and information devices, contents).

As shown in Figure 1, ubiquitous networking supports three types of communications:

- person-to-person communication: persons communicate with each other using attached devices (e.g., mobile phone, PC);
- person-to-object communication: persons communicate with a device in order to get specific information (e.g., IPTV content, file transfer);
- object-to-object communication: an object delivers information (e.g., sensor related information) to another object with or without the involvement of persons.

Ubiquitous networking aims to provide seamless communications between persons, between objects as well as between persons and objects while they move from one location to another.

As this Recommendation also focuses on the NGN capabilities required for the support of ubiquitous networking in NGN, Figure 1 identifies a group of capabilities called "NGN capabilities for the support of ubiquitous networking". This group of capabilities is built upon capabilities defined in [ITU-T Y.2201], with the necessary extensions and/or modifications of capabilities required for the support of ubiquitous networking services and communications.

9 High-level capabilities for ubiquitous networking in NGN

The following high-level capabilities identified in this clause are required in order to support ubiquitous networking in NGN. Appendix I provides a mapping of these high-level capabilities to the capabilities of the NGN defined in [ITU-T Y.2201].

The high-level capabilities for the support of ubiquitous networking in the NGN are listed as follows:

- *Connecting to anything capabilities*

The capabilities of "connecting to anything" refer to the support of the different ubiquitous networking communication types as described in clause 8 and include the support of tag-based devices (e.g., RFID) and sensor devices. Identification, naming, and addressing capabilities are essential for supporting "connecting to anything".

- *Open web-based service environment capabilities*

Emerging ubiquitous services/applications will be provided based upon an open web-based service environment as well as on legacy telecommunication and broadcasting services. In particular, application programming interface (API) and web with dynamics and interactivities will be supported. Such a web-based service environment will allow not only the creation of retail community-type services but also the building of an open service platform environment which third-party application developers can access to launch their own applications. Using interactive, collaborative and customizable features, the web can provide rich user experiences and new business opportunities for the provision of ubiquitous networking services and applications.

- *Context-awareness and seamlessness capabilities*

Context-aware means the ability to detect changes in the status of objects. Intelligence systems associated with this capability can help to provide the best service which meets the situation using user and environmental status recognition.

Seamlessness is a key capability for "5Any" (i.e., any time, any where, any service, any network, and any object). Seamlessness is a capability that can be supported in many different ways: at the network level using handover and roaming in heterogeneous networks, at the device level with no service interruption during device changing and recognition, and at the content level for providing personalized content delivery services, e.g., based on the user's situation, the user's device, and network conditions.

- *Multi-networking capabilities*

Transport stratum needs multi-networking capabilities in order to simultaneously support unicast/ multicast, multi-homing, and multi-path, etc.

Because of high traffic volume and the number of receivers, ubiquitous networking requires multicast transport capability for resource efficiency.

Multi-homing enables the device to be always best connected using multiple network interfaces including different fixed/mobile access technologies. These capabilities can improve network reliability and guarantee continuous connectivity with desirable QoS through redundancy and fault tolerance.

- *End-to-end connectivity over interconnected networks*

For ubiquitous networking, it is critical to develop the solution to provide end-to-end connectivity to all objects over interconnected heterogeneous networks such as NGN, other IP-based networks, broadcasting networks, mobile/wireless networks, PSTN/ISDN, etc. IPv6, with its large address space, can be considered a good candidate for providing globally unique addresses to objects. IPv6 offers the advantages of localizing traffic with unique local addresses, while making some devices globally reachable by also assigning them globally scoped addresses.

10 High-level architectural model for ubiquitous networking in NGN

Figure 2 shows the high-level architectural model for ubiquitous networking in NGN. This model is based upon the NGN overall architecture as described in [ITU-T Y.2012] and includes the capabilities identified in clause 9.

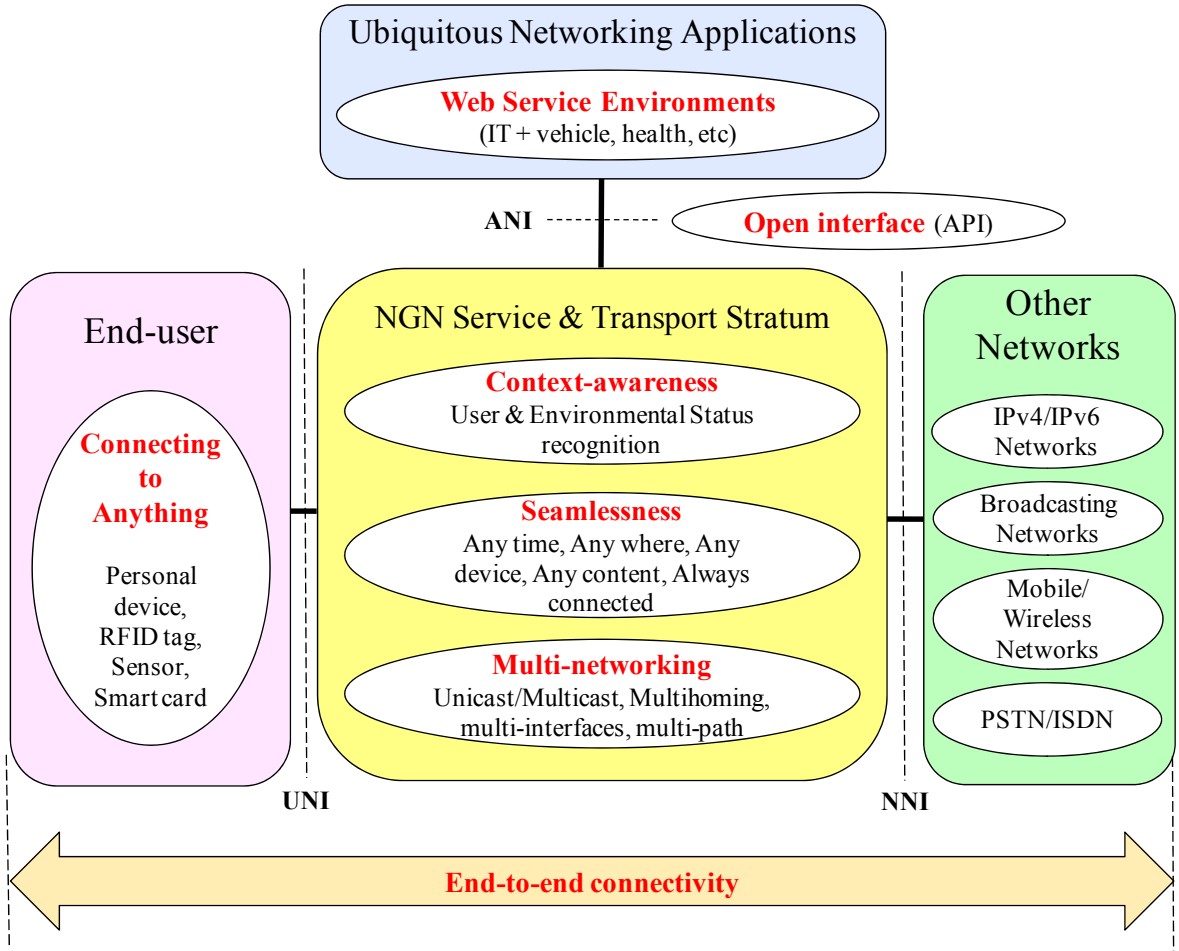


Figure 2 – High-level architectural model for ubiquitous networking in NGN

Further study is required in order to describe the NGN functional entities needed for the support of innovative ubiquitous networking services and applications by the NGN. In particular, in order to support ubiquitous networking, the NGN architecture is required to be capable of accommodating to the large number of involved objects as well as to the environment changes of these objects.

11 Security considerations

Basic considerations on security architecture for NGN are addressed in [ITU-T Y.2001], while security requirements of the NGN are described in [ITU-T Y.2701]. Concerning the specifics of ubiquitous networking, the various kinds of terminals, devices and contents that can be involved will have to conform to the security requirements of the network they are willing to attach to. When attaching to the NGN, the corresponding authentication and authorization requirements are described in [ITU-T Y.2702].

Objects involved in ubiquitous networking have their own identities and are interconnected involving more interactions throughout a dynamic and heterogeneous environment. Accordingly, security including the design of the security architecture for a secure information discovery and delivery to users, including persons and objects, is very crucial. Security measures should take into account, for all use, cases that rely upon NGN capabilities, but in line with the guidelines and principles for ubiquitous networking.

Appendix I

Correspondence between capabilities for ubiquitous networking and NGN capabilities

(This appendix does not form an integral part of this Recommendation)

This appendix provides a correspondence between the high-level capabilities for ubiquitous networking as described in clause 9 and the more detailed capabilities of the NGN as specified in [ITU-T Y.2201]. See Table I.1 for further information.

In Table I.1, each column represents a high-level capability as described in clause 9, while each row corresponds to relevant NGN capabilities [ITU-T Y.2201]. A cross indicates a correspondence between a high-level capability and a NGN capability.

Table I.1 – Correspondence between capabilities for ubiquitous networking and NGN capabilities

Ubiquitous networking / **NGN**	**Connecting to anything**	**Open web-based service environment**	**Context awareness**	**Seamlessness**	**Multi-networking**	**End-to-end connectivity**
Transport Connectivity					X (IPv4/IPv6, unicast/ multicast, multi-homing, multi-path)	
Communication modes	X (one-to-one, one-to many)					
Open Service Environment		X				
Personal information management			X			
Session handling	X					
Web-based application support		X				
Context awareness			X			
Routing	X	X			X	
QoS	X	X	X	X	X	
Identification	X	X				
Authentication	X	X				
Authorization	X	X				
Mobility handling				X		
Interconnection and interworking						X

Appendix II

The vision of ubiquitous networking

(This appendix does not form an integral part of this Recommendation)

This appendix provides a description regarding directions for network evolutions and visions of ubiquitous networking.

II.1 Directions for network evolution

New paradigms for future mobile and ubiquitous environments imply decisions regarding the direction for the evolution of networks as well as investigating technologies that will allow an efficient support of new services by the NGN.

Most network providers already support basic offers such as simple access to services (e.g., Internet access) based on user devices such as PCs. Users also expect to access NGN value-added services, which enhance quality of life and work standards. Ubiquitous service capabilities as well as network-based utility monitoring and billing are examples of such value-added services. Accordingly, the simple and basic broadband "access" oriented business will transition to NGN-based business opportunities.

The following represents key features of evolving NGN business-driven services:

- ubiquity: for providing anywhere/anytime service with the "connecting to anything" feature, e.g., seamless mobility between heterogeneous networks using convergence devices;
- personalization: for personalizing features of applications and services;
- handy access: for easing access to services through various terminals using easy, simple, intuitive and consistent user interface(s);
- intelligence: for providing convenient services with automatic recognition of user's interests and preferences;
- broadband: for delivering multimedia information including data with large traffic volume due to the increase of connected devices and of the bandwidth required by services and applications;
- convergence: for offering services in an integrated way that include fixed, mobile, and broadcast accesses as well as services;
- quality: for providing differentiated services from end-to-end (i.e., guaranteed QoS across different provider networks).

Based on network evolutions, NGN needs to support the architectural principles of both vertical (from transport to services/applications) and horizontal (one end-user to other end-user through user-to-network and network-to-network interfaces) perspectives.

Looking at the vertical perspective, studies are required in the area of networking capabilities for the control and operation of various multimedia services over complex stacks involving different layer technologies. From a horizontal perspective, further enhancements in the area of user-centric communication capabilities should take into account complex user situations including various devices connected to home networks and various access technologies which support convergence. These capabilities are necessary to support ubiquitous networking and to provide seamless interconnection between persons and objects, i.e., providing for any time, any where, any service, any network and any object.

II.2 Vision – "Fusion revolution crosses over industries"

Figure II.1 illustrates the vision of ubiquitous networking.

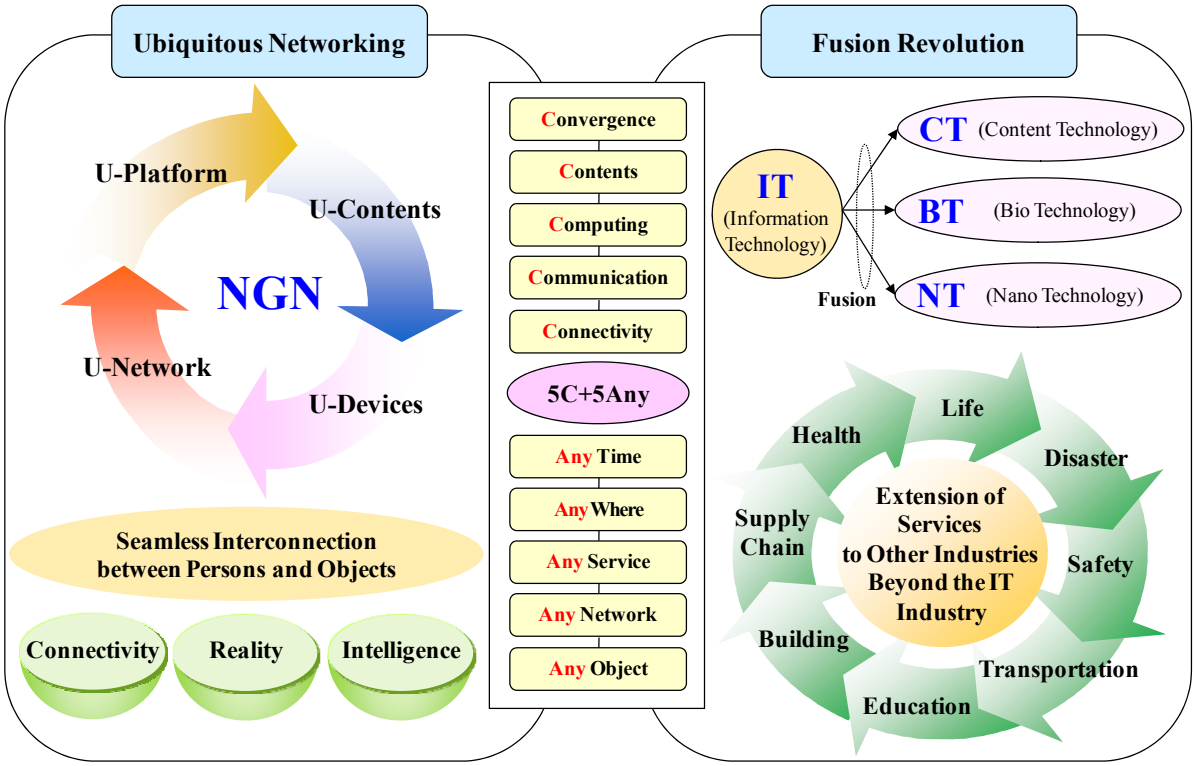


Figure II.1 – The vision of ubiquitous networking

The concept of "5C+5Any", illustrated in Figure II.1, represents key characteristics of ubiquitous networking.

New businesses using ubiquitous networking require multiple technologies to operate together such as RFID/sensors, protocols, security, and data processing. In order to communicate with related technical parties accommodated in new business relationships, one of the most urgent needs consists in the integration and combination of technologies such as biotechnology (BT), nanotechnology (NT) or content technology (CT). In particular attention needs to be paid to "fusion" technologies which combine BT, NT, CT as well as IT using ubiquitous networking capabilities. Thus, integrated engineering for new "Fusion Revolution" will emerge allowing for extension of services to other industries beyond the IT industry, and constituting the vision of ubiquitous networking.

Communication networks have been mainly supporting the evolution of information processing and service capabilities within IT industries. However, the capabilities of networks benefiting from ubiquitous networking should impact other industries such as the medical industry, the education industry, the finance industry or the transportation/distribution industry, resulting in new requirements for medical or education networks and services taking into consideration IT technologies. There are several examples of "fusion" services using ubiquitous networking: remote medical services, intelligent transport systems (ITS), supply chain management (SCM). U-Building or U-City providing "fusion services" in NGN will require that the following capabilities be supported: location tracking, sensing, surveillance and management capabilities.

Businesses using ubiquitous networking will impact on many other industries. Thus, standards related to architectural functions and enhanced capabilities for the support of "fusion services" using ubiquitous networking capabilities need to be developed once the basic concept and principles will be ready. Case studies for each service area are also required for helping future developments of NGN standards.

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