

# **APPLICATION OF NETWORK KNOWLEDGE FOR CONTEXT-AWARE SERVICES IN NGN**

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## **ABSTRACT**

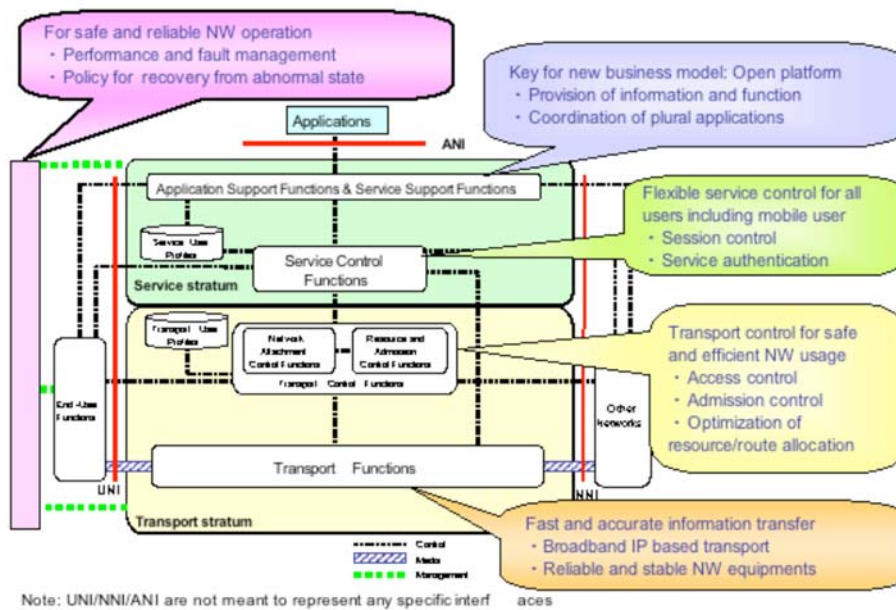
One of expected business models based on NGN is to provide a function or information such as user's location information from service platform of NGN to various applications and to get compensation from applications which provide value added services. On the other hand, network is carrying variety of information, and it can be said that network reflects the real world. Therefore the operation based on sensing the network could have much knowledge about not only network behavior but also real world. Now, we are aiming to change such network knowledge to business value such as the context-awareness. For example, network can know the demand change of an application server. Such information is useful not only for stable network operation but also for marketing analysis. In this paper, we'd like to propose to use network knowledge in various ways. Especially we'd like to show what kind of value context information generated from network knowledge can provide. Finally we will show the functional model in service platform of NGN to realize context-aware services.

## **KEYWORDS**

NGN, Service platform, Context-awareness, Network knowledge

# 1. INTRODUCTION

Next generation network (NGN), which much people are remarking, is defined in ITU-T “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” [1]. Many organizations such as telecom operators and network equipment vendors are expecting to make new business on NGN instead of telephony. Further, ITU-T has specified the basic functional architecture as Figure 1 [2]. There are transport stratum consisting of transport functions and transport control functions, service stratum consisting of service control and application/service support functions, and management function. Our interpretation on the main role of each functional group is added in Figure 1.



Our interpretation is added into original diagram of Y.2012

**FIGURE 1 ARCHITECTURE AND ROLE OF NGN FUNCTIONAL GROUP**

On the other hand, network has much knowledge on traffic patterns such as event-driven demand increasing or the change due to malicious usage or faults through the operation. This knowledge is useful to design or to operate the network [3]-[6]. We are targeting to apply such network knowledge not only for network operation but also other applications such as location aware advertisement services based on location information.

In this paper, we'd like to show our understanding of NGN and the directions of our technical challenge to build NGN. Next, we will discuss the potentiality of network knowledge and show business patterns using it. After that, we will show values of context information generated from network knowledge. Finally, we will show the functional model in NGN service stratum for the provision of context-aware services.

## 2. ROLES AND TECHNICAL REQUIREMENTS OF NGN

As far as our understanding goes, NGN aims to provide a safe information service environment based on robust IP based networks. One of roles of NGN is to provide a robust information infrastructure by which people can communicate with any targeted information or partner independent on situation such as location, time and belongings. Another NGN role is to provide an open service platform on which new and attractive applications can quickly be developed. Actually the service stratum of NGN is having ANI (application network interface) which allows for third-party application provider to use information or functions of NGN. This may create a new business model.

We are challenging to deepen technologies in the following directions as Figure 2 in order to build the safe service environment based on NGN.

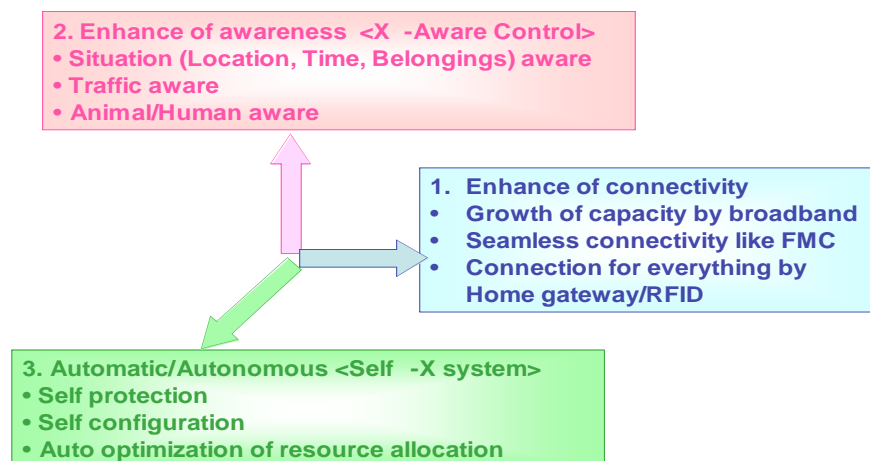


FIGURE 2 DIRECTIONS OF TECHNICAL CHALLENGE

First direction is to enhance the capability to connect. In order to absorb growing internet traffic carrying rich contents, the capacities of the access and core transport network must increase for example by broadband wireless technology and optical wavelength technology. NGN must support mobility. Seem-less continuity of communication or application is supported by “generalized mobility” that is one of key technological requirements of NGN. “Generalized mobility” is defined as “the ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment” [1]. Not only electric equipment but also goods will be connected to network by home gateway or RFID.

Second direction is to enhance the capability of awareness, which is called context-awareness. In order to enhance robustness against various abnormal caused by faults or malicious usage, the awareness of abnormal situation of traffic on the transport network is fundamental and the dynamic control should be done based on the awareness capability to recover the abnormal. Further in order to optimize services to a user, service control system must select how to serve by awareness of the environment surrounding user. This paper is focusing on how to enhance capability on awareness for the optimization transport control or service control.

Third direction is to aim automatic operation and autonomous resource allocation. In order to reduce capital or operation expenditure, various convergences will happen in future network environment such as the convergence transport network by IP and the convergence at service level as FMC (fixed mobile convergence). Then, the complexity due to such convergences could increase from the view point of control and management of it. Therefore, the operation and management should introduce an automatic system as much as possible. Further, autonomous optimization of resource allocation is expected for efficient and robust resource usage.

### **3. NETWORK KNOWLEDGE AND BUSINESS PATTERNS**

#### **3.1 NETWORK KNOWLEDGE**

Almost all information will be carried on network. Network will carry not only traffic for basic communication service such as VoIP or VPN but also information on contents using search engine, e-commerce and real-world using RFID/sensors. Then it can be

said that network can reflect on real human world. For example, much access to a contents server reflects people's interest on the content in the server. Therefore network has much knowledge through the intentional operation to collect information on real world by RFID /sensor and the network operation itself for stable network operation.

We'd like to propose to use network knowledge for three layers at least.

Network knowledge can be applied for context-aware transport control and management. Network operation system has knowledge on traffic patterns such as event-driven demand increasing or the change due to malicious usage or faults through the operation. This knowledge on traffic is useful to design or to operate the network [3]-[6]. For example, by knowing how the demand increase for a past event such as the new release of a popular program, the service provider can suitably provision cache server for a planed similar event. Further transport should be controlled by reflecting the status of real world. For example, if a big earthquake happens in an area, much voice calls concentrate on the area. Then transport should be controlled such that much voice calls can be connected to the area for example by detouring other traffic. That is, transport should dynamically be controlled based on the knowledge on real world for human life.

Network knowledge is useful for context-aware service control. If a caller wants to communicate with a called party, the network should select communication ways, such as voice call to mobile phone or fixed phone and e-mail or short message, dependent upon situation of called party such as the location, belongings and nearby people. Thus context-ware service control can add value such as enhancement of reach-ability of interested information to called party.

Network knowledge is useful for context-aware application. For example, if user's location information database is open to application provider through ANI, location aware applications such as location aware advertisement insertion or navigation service can be provided.

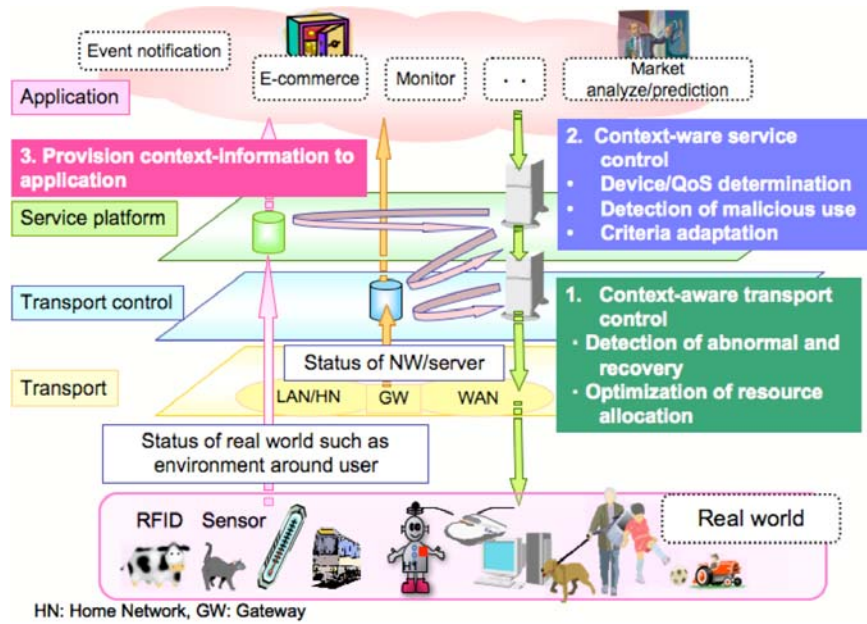


FIGURE 3 THREE WAYS TO APPLY NETWORK KNOWLEDGE

### 3.2 BUSINESS PATTERNS USING NETWORK KNOWLEDGE

This section discusses what kind of business patterns is possible by using network knowledge. Figure 4 summarizes typical models where three kinds of business players exist: transport provider, service platform provider and application provider.

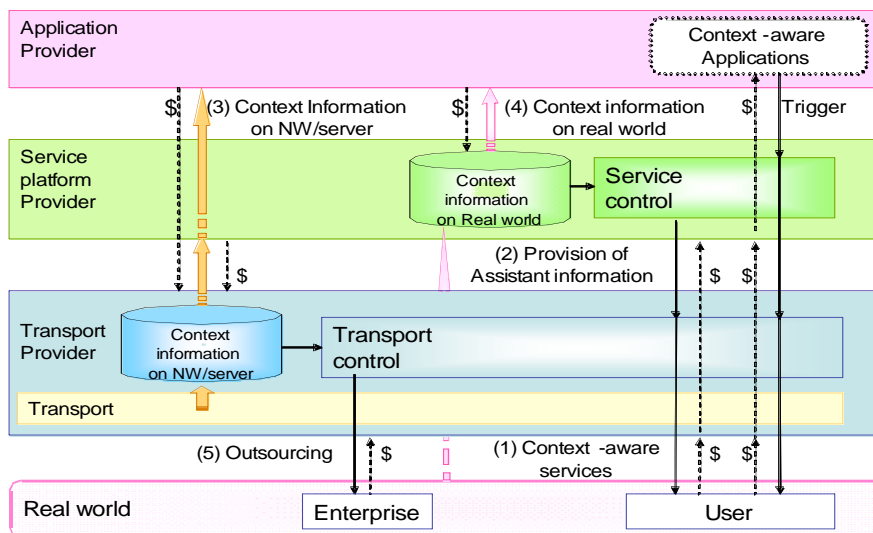


FIGURE 4 BUSINESS PATTERNS USING NETWORK KNOWLEDGE

## **(1) CONTEXT-AWARE SERVICES**

Network knowledge is useful to provide context-aware services. There are two patterns to trigger context-aware services to end users. First pattern is that an application provider is responsible of a context aware service and triggers it. Practically these are done through transport network, sometime through service platform. Therefore the fee is paid to the application provider, but a part of the fee is paid to transport provider and service platform provider for the usage. Second pattern is that service platform provider is responsible a context aware service and triggers it. For example, the service control system determines how to handle a message service dependent on the called party's age for (D2) in chapter 4. Therefore the fee is paid to the service platform provider, but a part of the fee is paid to transport provider for the usage.

## **(2) PROVISION OF ASSISTANCE**

If transport control is responsible of a context aware service and triggers it but needs assistance of service control, a part of the fee is paid to the service platform provider from the transport provider. For example, the service control system determines how to handle an incoming call dependent on the called party's situation.

## **(3) PROVISION OF CONTEXT INFORMATION ON NETWORK OR SERVER**

Context information on network or server is useful for transport control, service control and application and is given to them. In the latter 2 cases, network context information is charged to service platform provider or application provider which uses them to add value.

## **(4) PROVISION OF CONTEXT INFORMATION ON REAL WORLD**

Context information on real world including environment of a person is useful for service control and application and is given to them. In the latter case, real world's context information is charged to the application provider which uses them to add value.

## **(5) ROBUST AND EFFICIENT TRANSPORT CONTROL**

Needless to say context information on network or server is useful for robust and efficient control of transport resource to generate a reliable network service and to reduce network cost. Further when an enterprise out-sources the enterprise network to a transport provider, the enterprise pays the fee for the enterprise network operation.

## **4. VALUES AS CONTEXT-AWARENESS BASED ON NETWORK KNOWLEDGE**

“Context-awareness” is thought one of possible potentiality of future’s network using network knowledge. The original meaning of “context-awareness” is as follows: Context-aware systems adapts according to the location of use, the collection of nearby people, hosts and accessible devices, as well as to changes to such things over time. A system with these capabilities can examine the computing environment and react to change to the environment [7]. We would like to define “context information” as any information which is used by a system in order to suppose something such as user’s intention or demand change when the system determines the next action. What kind of values will be created with such context information generated from network knowledge?

[A] Convenience by automatic notification of status change of remarked object

(A1) If a calling party knows the status of a called party (presence) before making a call,

- It can reduce incomplete call and can reduce stress for calling party
- It does not need answering task instead of called person

(A2) It is convenient if people can automatically be informed what they want to know but waiting to be notified. For example, if someone is automatically informed that his/her turn is closed when he/she is waiting in a queue such as hospital or bank, he/she can freely enjoy until the notification.

[B] Enhancement of flexibility by context-aware criteria change

(B1) Context-aware authentication: Authentication level can be more stringent, for example, by a combination of different kinds of authentication methods such as user’s ID/password and biometrics. However it could take longer time to judge acceptance or reject of the stringent authentication, and so it could take longer

time to set-up a connection. This causes a serious problem to the necessity of quick handling, for example, for an emergency call. The level of authentication should dynamically be changed. The level should be weakened for emergency call.

(B2) Context-aware admission control: Let's suppose that the threshold of utilization for admission control is normally 70% for assuring good QoS (quality of service). However it should be 90% at an abnormal situation such that big earthquake happens because much more calls should be accepted and connectivity should be taken account of rather than QoS.

[C] Enhancement of fineness by context-aware monitoring granularity

(C1) Increase of monitoring granularity at necessity: For example, normally just sound through microphone flows to a monitoring station, but video through camera is added to catch the detail if a monitor catches the abnormal sound like explosion or accident. Similarly, sampling frequency of monitoring should be higher when abnormal is roughly sensed.

(C2) Monitoring of dominant component of congestion: A traffic monitoring system normally monitors aggregated traffic as in LSP (label switched path) of MPLS. When the congestion of a LSP is detected, it monitors traffic of each flow in the LSP in order to detect a flow that dominantly causes the congestion and should be regulated.

[D] Enhancement of comfort by context-aware transport or media control

(D1) The call process of an incoming call is automatically determined dependent on the called party's status. For example, forward the call to TV telephone if the called party is in home, translate the call to e-mail to PC at a meeting, translate the call to SMS in commuting train.

(D2) Display or expression is automatically determined dependent on the age or the necessity assistance of the called party. Big font size is kind for elder people. Sound media is suitable for visual impairments and text media is suitable for hearing-impairments.

[E] Distribution of impressed information or advertisement by receiver's context

(E1) Select news or advertisement of such as restaurant or store by referring time, location and personal purchase history.

(E2) Possible range should automatically be focused for search engine. For example, if a user just starts to search a climate by access a server, select and show just the climate of the area which the user will go. The area is assumed by the history of the user's accessing site of server.

[F] Defense against information pollution by context-aware disposal of information

(F1) Let's suppose an e-mail system such that the mail server informs users of just the arrival, the title and the sender of the e-mail. E-mail which most people dispose without downloading to their PC is automatically determined unsolicited e-mail by network, and, is automatically disposed by network.

(F2) Finer context-ware e-mail disposal is such that e-mail which Mr. Fukuda disposes is automatically disposed to members in Fukuda's team.

[G] Convenience by context-aware service arrange (concierge)

(G1) If a user is calling a taxi, the service arrange system is selecting a taxi which is the nearest to the requester and having the taxi pick up the requester.

(G2) If a user wants to have a meeting about a subject, the service arrange system is selecting related persons, determining time and date by referring their schedules, reserving a meeting room and sending a mail them for the announcement of the meeting.

[H] Demand analysis or prediction using statistics

(H1) Statistical marketing analysis: Analysis of statistics of book/DVD purchase like best seller ranking: If the probability that a purchaser of book titled "Internet QoS" buys book titled "Network QoS" is high, send advertisement of "Network QoS" to people searching "Internet QoS".

(H2) Demand prediction: If it can be predicted to rain in 30 minutes, we can prepare the demand increase of instant umbrella or transportation such as taxi/bus. Similarly a popular TV program or the result of sport game in the previous day will impact on the demand in the next day. Therefore if the relationship between the event and demand change due to the event is investigated as much as possible, it is useful for demand prediction.

The following table summarizes what context information is used and what kind of system uses such context information generated from network knowledge about above

patterns.

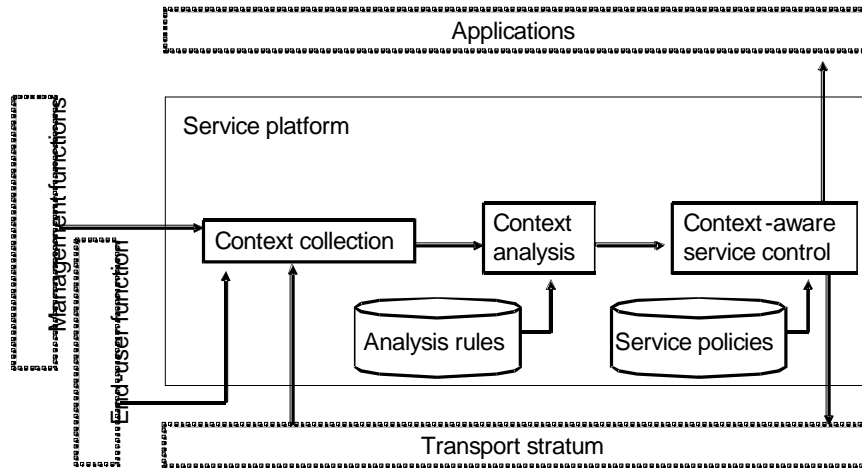
**TABLE 1 APPLICATION OF NETWORK KNOWLEDGE**

Value	Services	Context information	Example of system using the context information
Automatic notification	(A1) Presence notification	Status of called party	Application for enterprise network
	(A2) Notification of interested event	Status of interested event such as the turn in queue which they are waiting.	Application such as notification of interested event
Criteria change	(B1) Dynamic change of authentication level	Disaster, Accident, Infrastructure such as NW/transportation faults, Health etc	Service control such as access control
	(B2) Dynamic change of admission level	Disaster, Accident, Infrastructure such as NW/transportation faults, etc	Service control to decide how to control transport
Monitoring granularity	(C1) Addition of monitoring method	Sound, Smell, Chemical entity, Brightness	Application such as public monitoring
	(C2) Change of monitoring granularity	Congestion state of transport or computer resource	Transport control to control congestion
Service optimization	(D1) Selection of handling of incoming call	Location, belongings and nearby people of called party	Service control to determine requirement of transport control
	(D2) Selection of human interface	Age or necessity of assistance of called party	Service control to determine requirement of transport control
Delivery of impressed	(E1) Delivery of advertisement or news d	Time, Location and Personal purchase history	Application for individual option of content push service
	(E2) Contents search	Personal history on contents search	Application for individual option of contents search
P r	(F1) Spam	Rate of instant disposal of	Service control to

	identification based on public tendency	e-mail	identify and dispose unsolicited information
	(F2) Spam identification based on friend tendency	Handling of e-mail in the community	Application to protect unsolicited information for community
Concierge	(G1) Taxi reservation service	Locations of taxi and requester	Application of taxi calling
	(G2) Meeting arrangement	Interested persons, Schedule of them, Availability of meeting room	Application for office task
Market analysis	(H1) Statistical market analysis	Statistical trend about purchasers' behavior	Application of marketing research
	(H2) Demand prediction	Relationship between event and demand change	Application and control using prediction

## 5. FUNCTIONAL MODEL OF SERVICE PLATFORM

In order to provide values mentioned in the previous chapter, a situation of a target user/object should be analyzed and appropriate actions should be determined to adopt services for the situation. In some cases, such context-aware functionality is better to be implemented in end-user devices as far as it only needs limited local information. But in other cases, such functionality needs to be implemented as a network service, especially when it requires information that only networks can provide. In this chapter, hence, we focus on a service platform in the service stratum. We set three functional entities (FEs) in the service platform, i.e. context collection FE, context analysis FE and context-aware service control FE.



**FIGURE 5 FUNCTIONAL MODEL OF CONTEXT-AWARE SERVICE PLATFORM**

The context collection FE has three interface points to gather context information. The first point is connected to an end-user function to get output from RFID readers or sensors, e.g. user identification, temperature of an object, etc. The second and third points are connected to transport stratum and management functions to obtain network management information, which may contain user's attributes stored in user profile database.

The context analysis FE derives a high-level context describing the situation of the target user/object from low-level contexts provided by context collection FE. For example, if several user identifications were tracked in a meeting room and the meeting room was in high temperature, then a situation, "The meeting room is now unpleasant for some participants", is derived. The context analysis FE may need rules to interpret low-level contexts for getting high-level context.

The context-aware service control FE determines actions based on the situation passed from the context analysis FE. Action is either control of services or notification to applications in applications servers, which can be followed with a service control message from the servers. For example, activation of actuator to open windows, report to an air-condition management server, etc. The appropriate action is influenced with the user's intention. Policy-based decision making mechanism can be applied to achieve

such service customization. Thus, policy decision function (PDF) will be located not only in a transport stratum but also in a service stratum.

Figure 5 shows a functional model of the context aware service platform. It depicts interactions between a service platform and other functional components, and context information flows within the service platform. To collect context information from numerous devices, we have examined user-side FEs for supporting context collation FE. But these are not shown to make the figure simple.

## **6. CONCLUSION**

The realization of NGN has become a world-wide topic, especially in ITU-T, because it is expected to bring new business opportunities to telecommunications service providers. A trend shifting from basic network services to advanced application services seems to be getting obvious. In this paper, we identified the role and technical target of NGN. We believe that one of capability in NGN is awareness to build robust network and to customize services. To enhance it, we proposed three ways to utilize network knowledge and discuss business patterns in terms of three players, transport provider, service platform provider and application provider. We listed up eight categories of values of context-awareness based on the network knowledge. We also showed a functional model of context-aware service platform in NGN service stratum. Refinement of the business models of context aware services and a detailed functional architecture are for further study.

## **ACKNOWLEDGEMENT**

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