New Access System Architecture (FASA)—Enabling Provision of Services Flexibly and Promptly

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Abstract

Flexible Access System Architecture (FASA) is a new access system architecture that satisfies various requirements from service providers and end users and enables prompt provision of services. NTT Access Network Service Systems Laboratories materialized this architecture, created a list of functions to be modularized, and investigated common API (application programming interface) specifications using use cases and dynamic bandwidth assignment as an example. A white paper was created as a reference. This article introduces some of the main elements of the white paper.

Keywords: FASA, access network element, modularization

1. Introduction

As the diversification of telecommunications usage, in addition to the B2C (business-to-consumer) telecommunications services that are directly provided to end users by telecommunications carriers, B2B2C (business-to-business-to-consumer) telecommunications services are on the increase, where telecommunications services are provided to the end user via various service providers. NTT announced the Hikari Collaboration Model in 2014 [1]. Since then, we have been providing new services through co-creation with various business players. Access network systems must be capable of quickly coping with such changes in these situations. However, conventional access network elements have been developed so that they are specific to each service, which has made it difficult to quickly satisfy requirements that are becoming more and more diverse due to changes in the business models of telecommunications services. Because of this, it was necessary to redevelop the entire access network element.

NTT proposed the NetroSphere concept [2] in order to satisfy the increase in diverse requirements and provide services promptly. To implement this concept, we are currently carrying out research and development (R&D) of technology that enables us to modularize the functions of the access network elements and also enables these functions to be combined. On February 8, 2016, we announced our new access system architecture called Flexible Access System Architecture (FASA), which is based on the NetroSphere concept [3]. In addition to announcing the concept of FASA, we also explained that a draft plan for common application programming interfaces (APIs) for implementing FASA would be released, and we stated our intention to call for partners to collaborate in defining the FASA specifications. Since this press release, NTT Access Network Service Systems Laboratories has been investigating the FASA concept, a list of functions to be modularized, use cases, and common API specifications using dynamic bandwidth assignment (DBA)[*1] as an example. On May 31, 2016, we unveiled the white paper as a

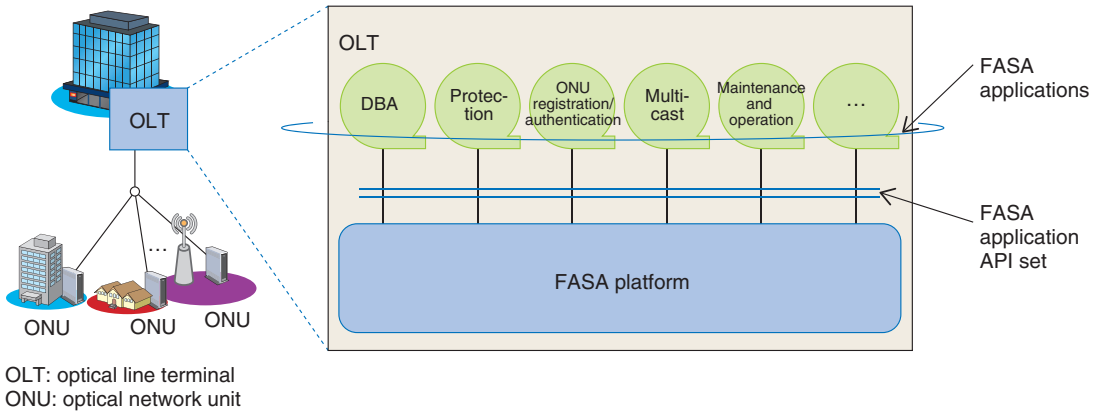

Fig. 1. Concept and component of modularization by FASA.

reference and also called for collaborative partners to work on the FASA specifications [4].

2. Summary of white paper

Here, we briefly describe the main sections of the white paper.

2.1 Concept of FASA

Conventional access network elements are developed specifically for individual services. Therefore, when functions are added or replaced, it is necessary to redevelop the entire access network elements. In addition, spare equipment and maintenance skills specific to each access network element are required for maintenance and operation. For that reason, access network elements need to be more flexible and expandable in order to be able to promptly satisfy requirements from various telecommunications carriers and services.

In consideration of these requirements, we are positioning FASA as a new access system architecture and concept with the following characteristics:

(1) Functions in access network elements are modularized, thus avoiding the development of equipment specific to a service or a service provider.
(2) The functions that differ from service to service and/or among service providers are realized by software modules[*2] with common interfaces.
(3) The dependency among software modules is minimized, and the replaceable software modules run on a platform.

By achieving the above items, we can provide functions quickly and economically that are tailored to the service, while still maintaining service quality.

2.2 Structure of access network element based on FASA and target of investigation

The concept of FASA modularization and its components are illustrated in **Fig. 1**. As the diagram shows, the access network element based on FASA consists of FASA applications[*3] and a FASA platform[*4].

The FASA applications abstract the functions, which vary according to the services or service providers, and are implemented as a software module using common input/output interfaces (FASA application APIs[*5]). Because the input/output interfaces are commonalized, it is easy to add or replace functions and enables quick provision of various services.

The FASA platform is a basic component of the access network element, which provides FASA application APIs to the FASA applications and also provides functions that do not need to be changed for each service because those functions are standardized.

*1 DBA: A function that dynamically assigns the upstream bandwidth of PON.
*2 Software module: A module that forms necessary functions as software in a replaceable unit.
*3 FASA application: A replaceable software module that is implemented using FASA application APIs.
*4 FASA platform: A basic component of an access network element that provides FASA application APIs to the FASA applications, while providing functions that do not depend on requirements from particular services or service providers because of standardization.
*5 FASA application API: An API that connects the FASA applications and the FASA platform.

The white paper lists the FASA application APIs, which are common interfaces that link the FASA applications and the FASA platform. These FASA application APIs can be commonly used and do not depend on the access transmission system, for example, P2P (point-to-point) or passive optical network (PON), or on standards such as Ethernet PON or NG-PON2 (Next Generation PON2).

2.3 Functions to be implemented by FASA applications

In the white paper, we organized the main functions of the access network element and extracted the functions to be implemented by the FASA applications (**Table 1**). Of the functions indicated in the table, we classified those that should be implemented by the FASA applications that need to be replaced or extended to satisfy requirements unique to the service or service provider. Some functions that do not need to be replaced or extended because they are specified in the standardization are classified as functions to be implemented on the FASA platform.

For example, a function to satisfy service requirements in DBA is a function that should be part of the FASA applications. An example of a requirement that differs with each service or service provider is a policy that indicates which communication quality (low delay or high bandwidth efficiency) is to be given preference. The policy for bandwidth assignment differs according to the service or service provider; hence, this should be implemented as a FASA application. DBA is a process to adaptively assign bandwidth (the time slot in which the data signal can be transmitted) in the upstream direction from optical network units (ONUs) to an optical line terminal (OLT) to each ONU. This can be classified into status reporting (SR)-DBA, which assigns bandwidth based on reports from the ONUs, and non-status reporting (NSR)-DBA, which assigns bandwidth without the reports. With SR-DBA, it is possible to assign bandwidth with high bandwidth efficiency based on ONU reporting; hence, it is often used for fiber-to-the-home (FTTH). However, the round trip for control signals traveling between the ONU and the OLT takes time. Hence, when low delay is preferred, such as in mobile fronthaul (MFH), another method is chosen.

A function for DBA frame processing conforming to the given standards in the DBA function should be implemented on the FASA platform. To achieve an access network element of the 40-Gbit/s class, which conforms to the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) G.989 series, basic processing functions such as frame processing need to be implemented according to the standard. Such basic functions are common, regardless of the service or service provider, and should therefore be implemented on the FASA platform.

2.4 Example of FASA application API: DBA

In the white paper, we listed possible FASA use cases by using DBA as an example application. We organized APIs and the functional blocks to obtain necessary functions to realize each use case and then compiled the common API set so that they could cover all of the use cases.

The assumption in the white paper is that use cases such as multi-service (e.g., MFH, FTTH) are provided by PON. For example, the maximum delay tolerance specified for the data signals of MFH is stricter than for FTTH. With FASA, even if the access network element was developed for FTTH aiming for high bandwidth efficiency, by replacing FASA applications of DBA, it is possible to satisfy the strict delay specifications of MFH. To add and replace FASA applications according to the requirements from the service or service provider, it is necessary to have an API set that covers all the assumed use cases of the services and service providers.

For the DBA to meet MFH requirements, we can use optical-mobile cooperative DBA [5] that assigns bandwidth by obtaining necessary information for bandwidth assignment from external equipment, or NSR-DBA that assigns bandwidth based on statistical traffic data and traffic patterns.

The APIs and functional blocks of DBA in these use cases are shown in **Fig. 2**. The functional blocks consist of policy determination, assignment calculation, cooperative control, traffic monitoring, report processing, and grant processing.

In the SR-DBA for FTTH, the whole DBA will be implemented as a FASA application (fully software). In addition, we also assume an implementation where part of the DBA (policy determination) is to be implemented as a FASA application (partially software), which has a similar structure to the conventional PON.

To handle these use cases, we stipulated FASA application APIs for traffic information, request information, assigned amount, transmission start time, parameters for assignment calculation, parameters for policy determination, and cooperative information.

Table 1. Main functions of access network element and classifications of implementation.

Functional group	Function	FASA application or FASA platform
PON data signal processing function	Basic function	Platform
PON access control function	ONU registration/authentication	Application
	DBA	Platform
		Application
	DWA	Platform
		Application
	DoS attack prevention	Application
L2 data signal processing function	SNI port	Platform
	Bridge function	Platform
	Traffic monitor	Platform
	Aggregation	Platform
		Application
	Precedence control	Platform
		Application
	VLAN management	Application
Maintenance and operation function	Maintenance and operation frame processing	Platform
	Maintenance and operation port/monitoring control port	Platform
	SBI	Application
	Settings	Platform
		Application
	Management	Application
	Maintenance and operation	Platform
		Application
	Test	Application
PON multicast function	IP multicast	Platform
	Filter settings	Application
	Multicast proxy	Application
Power-saving control function	ONU power saving	Platform
		Application
	OLT power saving	Platform
		Application
Frequency/time-of-day synchronization function	Means of synchronization	Platform
		Application
Protection function	Protection	Platform
		Application

DoS: denial of service
DWA: dynamic wavelength assignment
IP: Internet protocol
L2: layer 2
SBI: south bound interface
SNI: service node interface
VLAN: virtual local area network

3. Future development

On May 31, 2016, we released the white paper on the FASA home page, and we posted the white paper and called for partners in the TOPICS section on the NTT Group website. We released the English version of the white paper on June 29, 2016 [6].

In the future, we will collaborate with partners to clarify specifications for access network elements such as the architecture, carrier requirements, use cases, and APIs. We plan to demonstrate a proof of concept and complete the API set by February 2017 (**Fig. 3**).

Use case	Optical-mobile cooperative DBA for MFH	NSR-DBA for MFH	SR-DBA for FTTH	
			(1) Fully software	(2) Partially software
Functional configuration Legend : DBA-API : Functional part	Policy determination Assignment calculation Cooperative control Grant processing	Policy determination Assignment calculation Traffic monitoring Grant processing	Policy determination Assignment calculation Report processing Grant processing	Policy determination Assignment calculation Report processing Grant processing
DBA-API Get	Cooperative information …	Traffic volume …	Request information …	Parameters for policy determination
DBA-API Set	Assigned amount, transmission start time …			Parameters for assignment calculation

Fig. 2. API and functional blocks of DBA in each use case.

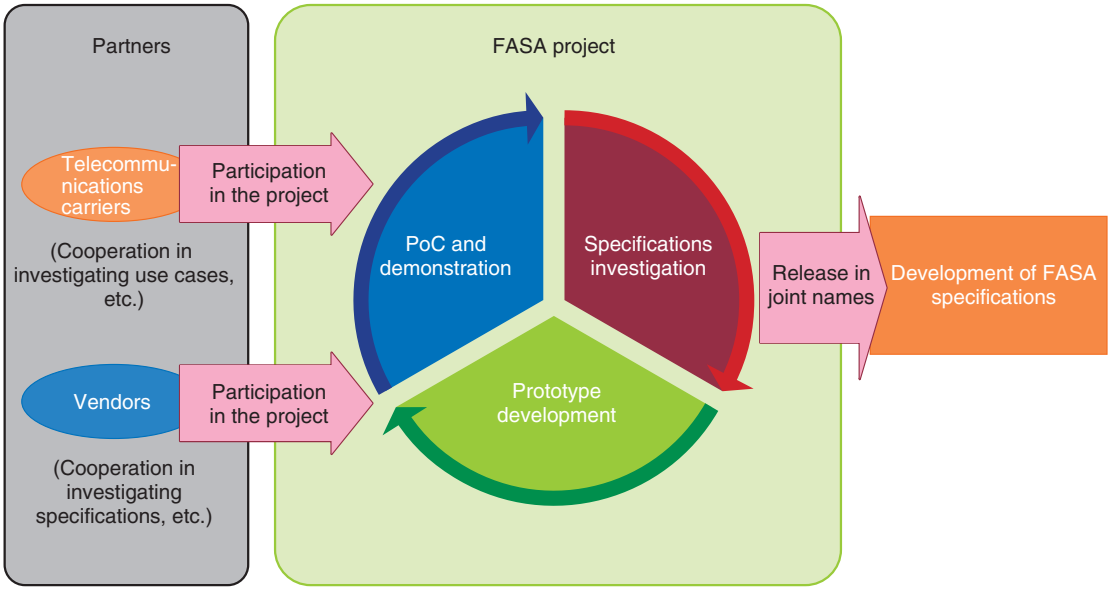

Fig. 3. Cooperation activities in FASA project.

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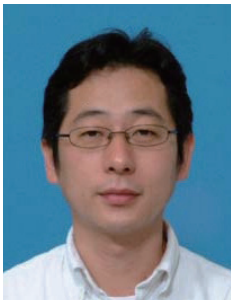

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