Active Networks Enterprise Model

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Abstract: *The FAIN "Future Active IP Network" project is an ongoing, three-year collaborative research project aiming to develops and validate an open, flexible, programmable, and dependable active network architecture. This paper addresses the Enterprise reference model for FAIN.*

1. Introduction

Active Networks (AN) have been originally proposed [7] as an architectural solution for the fast and flexible deployment of new network services. The basic idea of active networks is to enable third parties (end users, operators, and service providers) to inject application-specific services (in the form of code) into the networks. Applications are thus able to utilise these services to obtain required support in terms of network and network management resources, thus becoming network-aware. As such, active networks allow *dynamic injection of code* as a promising way to realise application-specific service logic, or perform dynamic service provision on demand. But the dynamic injection of code can only be acceptable by network providers if it does not compromise the integrity, the performance and /or the security of networks. Therefore viable architectures for active networks have to be carefully engineered to achieve suitable trade-offs among flexibility, performance, security and manageability.

The FAIN project [2], [3] is an ongoing, three-year IST collaborative research project aiming to develop an open, flexible, programmable and dependable (reliable, secure, and manageable) network architecture based on novel active node concepts. It proposes a new generic architecture for active networks with an innovative integration of active networking, distributed object and mobile agent technology with added security. Its main emphasis is to give the consumer some level of control over network use and processes. The FAIN architecture is based on a novel enterprise model, which is the focus of this paper.

The main purpose of an Enterprise model in FAIN is to identify interfaces that are likely to be of commercial importance generally. In order to achieve this, a reasonably well-defined business activity must be described by a number of identified roles. Each role can be thought of as value adding entity to the various inputs it buys from suppliers.

2. FAIN Enterprise Model

The FAIN Enterprise Model is based on the TINA model [8] and the initial analysis carried out by the FAIN Consortium. It specifies a common framework for all parties that involved in the FAIN interactions.

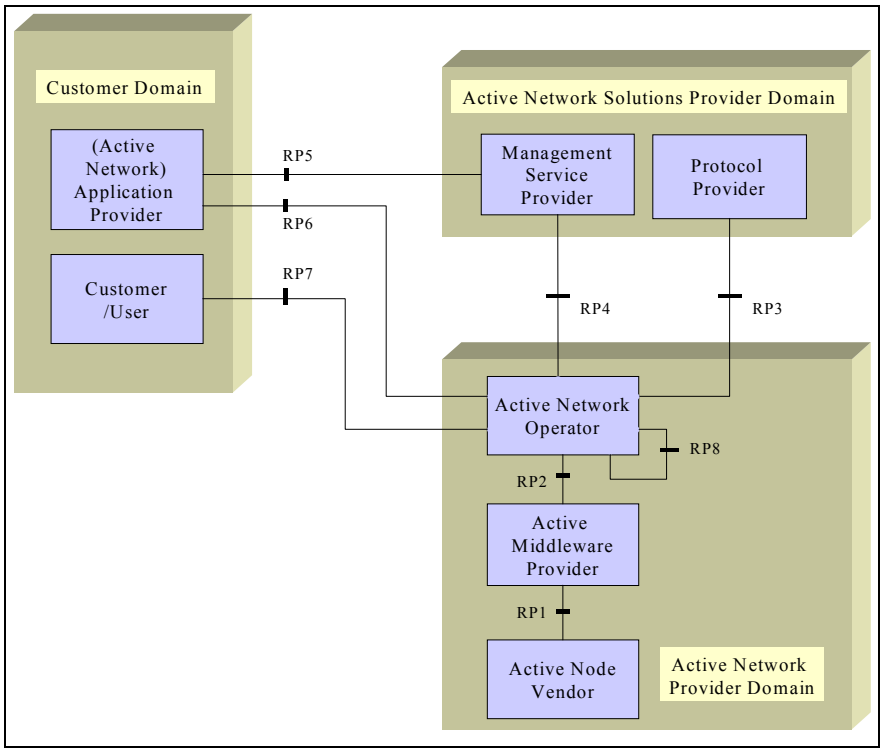

Figure 2.1 Initial FAIN Enterprise Model

Figure 2.1 shows the various domains involved in the Enterprise Model of the FAIN project. There are three businesses domains in the initial enterprise model

Here is a short comparison between the roles in the Enterprise Model of FAIN and TINA:

- The FAIN Consumer is equivalent to the TINA Consumer
- The FAIN Active Network Solution Provider is equivalent to the TINA 3rd Party Service Provider
- The FAIN Active Network Provider is equivalent to the TINA Connectivity Provider.

The following new types of roles were identified:

- **Application Provider** (AP) enterprise role, which aims at the development and provision of new applications services, new service logic, protocols or content to the to the Solution Provider domain either on its own or in collaborations with other AP.
- The **Management Service Provider** enterprise role, which aims at the provisioning of management functions to the network and to manage each successfully connected session between the customer and the A N Operator. It validates and holds a database application services provided by AP.
- The **Active Network Operator** enterprise role provides the underlying physical connection between all the parties within the enterprise model. It also provides physical connections between AN and non-AN domains.
- The **Active Middleware Provider** enterprise role focuses on the active middleware infrastructure service.
- **Active Node Vendor** enterprise role provide all necessary active network equipment that meet the requirements requested by the AN Middleware provider.

For the business roles in the model, the consumer role is determined by the contract governing the interactions between the consumer and its use of an active service in a particular session. The interactions between each business roles in this model are mapped into eight sets of reference points.

2.1 Reference Points

There are eight reference points being identified in the FAIN Enterprise model.

- **Reference Point 1 – A Node Vending (ANV)** defines business relationship between the Active Node Vendor and Active Middleware Provider role, physically selling active nodes to the AN middleware provider. This relationship has no direct interaction with the network.
- **Reference Point 2 – AN Platform Provision (ANP)** defines business relationship between the Active Middleware Provider and the AN Operator. The Middleware provider repackages and sells the active network to the Operator.
- **Reference Point 3 – Connectivity service business relationship.** The AN operator maintain connectivity service to the network and dynamically deploy new service with new protocols which were provided by the Protocol Provider. This is the ConS reference point from the TINA model.
- **Reference Point 4 – Terminal connection business relationship** defines the link management between the AN Operator and the Management Service Provider in a Physical Connection table. This is the TCon reference point from the TINA model.
- **Reference Point 5 – New Application Service Provision (NASP)** the Application Provider is the client of the Management Service Provider. The AP "advertise" new applications and the protocols used to the MSP. Then the MSP validates and store the new applications. It also stores a copy of the new application policy. The MSP also produce a new Protocol policy and store it at the Protocol Provider.
- **Reference Point 6 – Terminal connection business relationship** defines the link management between the AN Operator and the Application Provider in a Physical Connection table. This is the TCon reference point from the TINA model.
- **Reference Point 7 – Terminal connection business relationship** defines the link management between the AN Operator and the Customer in a Physical Connection table. This is the TCon reference point from the TINA model.
- **Reference Point 8**
    - **Layer network federation business relationship (LNFed)** is a federation relationship between AN Operator roles. This allows provisioning of a connectivity service operate across multiple AN Operator domains through the ConS business relationship of the other.
    - **Client-server layer network relationship (CSLN)** provides the use of layer networks between each AN Operator domain.

3. FAIN Network Architecture

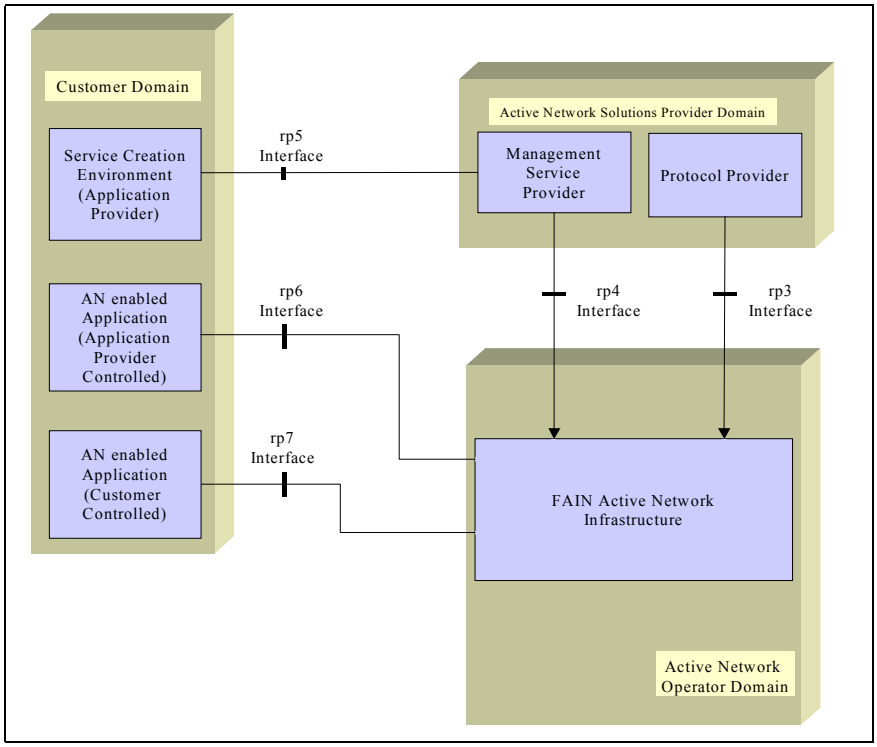

Figure 3.1. Initial FAIN Active Network Architecture

The Network Architecture for FAIN addresses the interface between AN Providers and Users of the system. Three interfaces (rp5, rp6 and rp7) from the FAIN network Architecture are derived directly from the three reference points (RP5, RP6 and RP7) from FAIN Enterprise Model. The rp3 and rp4 interfaces are the high level (ConS) and low level (TCon) connectivity interfaces from the TINA model, respectively between the solution provider and the operator domain.

The FAIN project will addresses the requirements of functions that play key roles in the provision of an active network:

- Service Provision. The architectural requirement for this activity is to support a wide range of flexible application and network services with emphases on management and service execution environment. The interface between these two environments is the rp3 and rp4 interfaces.
- Security Provision. The following are considered for a secure FAIN system:
    - Trust-based software distribution. It has been defined that only trusted parties are allowed to download their components into the network for dynamic provisioning of services. This is realised by user/code/node authorisation and authentication processes that could be predefined service level agreement (SLA). The software application is first created in from the Service Creation Environment within the consumer domain and passed on to the AN solution Provider domain via the rp5 interface. The software then got passed to the FAIN AN node via the rp4 interface.

- Trust-based software execution allows the only trusted components (based on a component level agreement) to access and configure a particular set of network and private information resources. This process will involve rp3 and rp4 interfaces for underlying interconnections between the AN solution Provider and the AN Operator in order for the activity to be able to carry out.
- Policy-controlled resource access, and runtime resources management should support this interference-free software execution. This activity run independently for provision of services, and will be policed and controlled in order to make sure that any abnormal execution of one component will not affect the integrity of the system and execution of other component.

- Management Service specifies the requirements for managing the active nodes, nodes resources and services via the rp3 and rp4 interface.
- Network Integration maintains the integrity of the system in terms of the functions for service provision, security, and management within an active node and the entire active network.

4. An Example of Use Cases

Different use cases have been defined to describe the various interactions between the different actors in the enterprise model. One such use case is given below. All use cases will be used in the design of the FAIN systems.

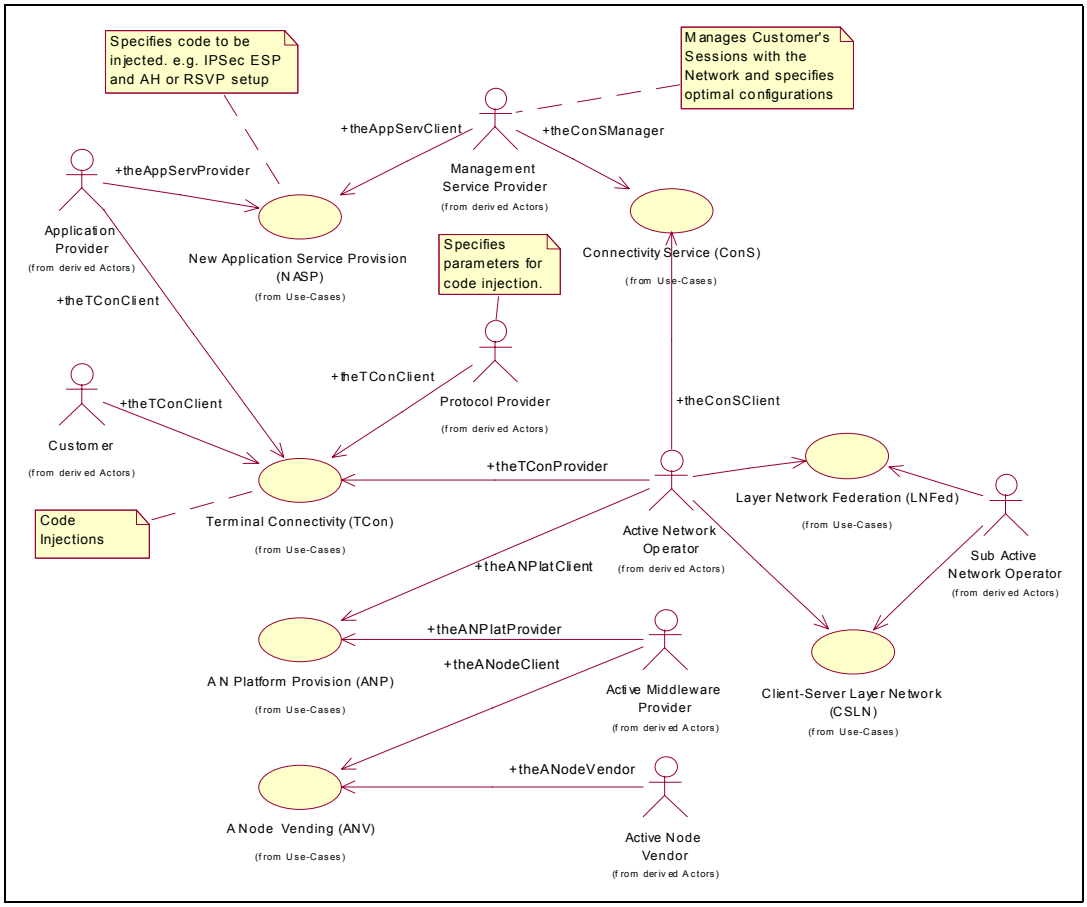

Figure 4.1. Initial FAIN Use Case

This example Use Case addresses the activities carried out between each business role. Customer in this model has the ability to inject pre-determined application codes into the network in order to obtain the service he/she required dynamically.

- New Application Service Provision: The AP provides new application to the management service provider. This use case begins when the application provider request the management service provider to validate and accept a new application it has created. The AP also specifies code to be injected onto the network. The MSP then either accept or reject the application service with sets of predefined policies.
- Terminal Connectivity: The use begins when the consumer request agreed service provision from the AN Operator, and to dynamically inject approved code into the parts of the AN Operator's network. The service is under signed a connectivity contract between the two party.
- Connectivity Service: The use begins when the Management service provider instruct the AN Operator to configure the network resources to it's requirement. The AN Operator then validates the MSP's identity and then let the MSP to carry out necessary modifications.
- Within the realm of the AN Provider, there exist two use cases, and they are Layer Network Federation and Client-Server Layer Network. The two use cases are the interactions between one AN Operator and another of a different network. It enables multiplayer integrations between the networks of the two operators.
- AN Platform Provision: This use case does not directly involved with the AN provision value chain, but has effects of the compatibility of active nodes across the AN Operator's network and also with other AN Operator's network. The use case begins when the AN Operator request an active network platform purchase. The Active Middleware provider then provides the AN Operator with the requested equipment.
- A Node Vending: This use case does not directly involved with the AN provision value chain. The use begins when the middleware provider request active network hardware components. The Active node then provides it with the hardware.

References

[1] AN Working Group, Architectural Framework for Active Networks, 3rd July 1998.

[2] FAIN Project Server –https://face.ee.ucl.ac.uk/fain

[3] A. Galis, B. Plattner, J. M. Smith, S. Denazis, H. Guo, C. Klein, J. Serrat, G. T. Karetsos, C. Todd, "A Flexible IP Active Networks Architecture", in the Proceedings Second International Working Conference, IWAN'2000 – Japan, November 2000, Springer.

[4] D. Kulak and E. Guiney, "Use Cases – requirement in context, 2000 by ACM Press.

[5] D. Raz and Y. Shavitt, Lucent "An Active Network Approach to Efficient Network Management" (Extended Abstract).

[6] D. L. Tennenhouse - MIT, J. M. Smith – Upenn, W. D. Sincoskie – Bell Communications Research, "A Survey of Active Network Research".

[7] D. Tennenhouse, D. Wetherall – "Towards an active network architecture" Computer Communications Review, 26, 2 (1996), pp 5-18

[8] TINA Consortium, "TINA Business Model and Reference Points", 22nd May 1997.