SCHOPPE · ZIMMERMANN · STÖCKELER · ZINKLER & PARTNER

Patentanwälte · European Patent Attorneys · European Trademark Attorneys

Patentanwälte · Postfach 246 · 82043 Pullach bei München

E-Sang Patent & Trademark Law Firm
3F., Woodo Bldg., 82-2 Yangjae-dong
Seocho-gu, Seoul 137-130
SÜDKOREA

Fax
Confirmation
Bestätigung

Fritz Schoppe · Dipl.-Ing.
Tankred Zimmermann · Dipl.-Ing.
Ferdinand Stöckeler · Dipl.-Ing.
Franz Zinkler · Dipl.-Ing.
Markus Schenk · Dipl.-Phys.
Günter Hersina · Dipl.-Ing.
Markus Burger · Dipl.-Ing.

特許法人 E-Sang Patent & Trademark Law Firm
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New European Patent Application
Based on Korean Patent Application 10-2010-0032564
Applicant: Postech Academy - Industry Foundation
Title: METHOD OF PROVIDING AUTONOMIC MANAGEMENT OF SOFTWARE SYSTEM, RECORDING MEDIUM STORING PROGRAM FOR PERFORMING THE SAME, AND SYSTEM HAVING FUNCTION OF AUTONOMIC SOFTWARE MANAGEMENT
Your Ref.: IP100001EP
Our Ref.: POS110401PEP / ds

Dear Madams and Sirs:

Thank you very much for your letter of March 23, 2011.

Enclosed please find two copies of the European patent application which was filed with the European Patent Office on **April 1, 2011.**

As you will see from the documents as filed, we formally adapted the application documents to EPC patent practice.

The EPO amended Rule 141 EPC so that it is now required to provide the results of an earlier search for the previous Korean patent application 10-2010-0032564 upon filing the EP application. Where the EPO notes that a copy has not been filed it shall invite the applicant to file, within a period of two months, the copy or a statement

that the results of the search are not available to him. If the applicant fails to reply in due time the European patent application shall be deemed to be withdrawn.

Therefore, to avoid unnecessary objections by the EPO during the examining procedure please provide us with copies of the search results for the previous application from which the priority is claimed for submission with the EPO upon filing the case.

The case has been installed in our computerised renewal fee payment system. We shall pay future annuity fees unless you instruct us to the contrary.

A copy of the official filing receipt indicating the official filing number is enclosed.

Our debit note is enclosed herewith.

We thank you very much for having entrusted us with this case and remain with best regards.

Very truly yours,

Tankred Zimmermann

Encl.: (only via airmail)
Papers as filed
Official filing receipt
Debit note

Europäisches Patentamt
European Patent Office
Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of your request for grant of a European patent as follows:

Submission number	1153635
Application number	EP11160976.4
File No. to be used for priority declarations	EP11160976
Date of receipt	04 April 2011
Your reference	POS110401PEP
Applicant	Postech Academy - Industry Foundation
Country	KR
Title	METHOD OF PROVIDING AUTONOMIC MANAGEMENT OF SOFTWARE SYSTEM, RECORDING MEDIUM STORING PROGRAM FOR PERFORMING THE SAME, AND SYSTEM HAVING FUNCTION OF AUTONOMIC SOFTWARE MANAGEMENT

Documents submitted	package-data.xml	ep-request.xml
	application-body.xml	ep-request.pdf (4 p.)
	SPECEPO-1.pdf\Application Text.pdf (25 p.)	OTHER-1.pdf\Additional Representatives.pdf (1 p.)
	f1002-1.pdf (1 p.)	f1002-2.pdf (1 p.)

Submitted by	CN=T. Zimmermann 9619,O=Schoppe\, Zimmermann\, Stöckeler & Zinkler,C=DE
Method of submission	Online

Date and time receipt generated	04 April 2011, 13:34 (CEST)
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Correction by the EPO of errors in debit instructions filed by eOLF

Errors in debit instructions filed by eOLF that are caused by the editing of Form 1038E entries or the continued use of outdated software (all forms) may be corrected automatically by the EPO, leaving the payment date unchanged (see decision T 152/82, OJ EPO 1984, 301 and point 6.3 ff ADA, Supplement to OJ EPO 10/2007).

/European Patent Office/

Europäisches Patentamt
European Patent Office
Office européen des brevets

Request for grant of a European patent

For official use only		
1 Application number:	MKEY	
2 Date of receipt (Rule 35(2) EPC):	DREC	
3 Date of receipt at EPO (Rule 35(4) EPC):	RENA	
4 Date of filing:		

5 Grant of European patent, and examination of the application under Article 94, are hereby requested. ☒

5.1 The applicant waives his right to be asked whether he wishes to proceed further with the application (Rule 70(2)) ☐

Procedural language: en

Description and/or claims filed in: en

6 Applicant's or representative's reference: POS110401PEP

Applicant 1

7-1 Name: Postech Academy - Industry Foundation

Registration No.: 0.0

8-1 Address: San 31, Hyoja-dong, Nam-gu, Pohang-si, Gyeongbuk
Pohang-si
Republic of Korea

10-1 State of residence or of principal place of business: Republic of Korea

Representative 1

15-1 Name: Zimmermann Tankred

Company: Patentanwälte SCHOPPE, ZIMMERMANN, STÖCKELER, ZINKLER & PARTNER

16-1 Address of place of business: Postfach 246
82043 Pullach
Germany

17-1 Telephone: 089-790 445-0

17-1 Fax: 089-790 22 15

17-1 e-mail: mail@schoppe-zimmermann.com

Authorisation

20 is attached ☐

Inventor(s)

23 Inventor details filed separately ☒

24 Title of invention

Title of invention: METHOD OF PROVIDING AUTONOMIC MANAGEMENT OF SOFTWARE SYSTEM, RECORDING MEDIUM STORING PROGRAM FOR PERFORMING THE SAME, AND SYSTEM HAVING FUNCTION OF AUTONOMIC SOFTWARE MANAGEMENT

25 Declaration of priority (Rule 52)

A declaration of priority is hereby made for the following applications

	State	Filing date	Kind	Application number:	Search results required under Rule 141(1) EPC
Priority 01	KR	09.04.2010	ap	10-2010-0032564	☐

25.2 This application is a complete translation of the previous application ☐

25.3 It is not intended to file a (further) declaration of priority ☐

26 Reference to a previously filed application

27 Divisional application ☐

28 Article 61(1)(b) application ☐

29 Claims

Number of claims: 12

29.1 ☒ as attached

29.2 ☐ as in the previously filed application (see Section 26.2)

29.3 ☐ The claims will be filed later

30 Figures

It is proposed that the abstract be published together with figure No.

31 Designation of contracting states

All the contracting states party to the EPC at the time of filing of the European patent application are deemed to be designated (see Article 79(1)).

32 Different applicants for different contracting states

33 Extension of the European patent

This application is deemed to be a request to extend the European patent application and the European patent granted in respect of it to all non-contracting states to the EPC with which extension agreements are in force on the date on which the application is filed. However, the request is deemed withdrawn if the extension fee is not paid within the prescribed time limit.

33.1 It is currently intended to pay the extension fee(s) for the following states:

34 Biological material

38 Nucleotide and amino acid sequences

Further indications

39 Additional copies of the documents cited in the European search report are requested

Number of additional sets of copies:

40 Refund of the search fee under to Article 9 of the Rules relating to Fees is requested ☐

Application or publication number of earlier search report:

41 A copy of the search report is attached ☐

42 Payment

Mode of payment: Debit from deposit account

The European Patent Office is hereby authorised, to debit from the deposit account with the EPO any fees and costs indicated on the fees section below.

Currency: EUR

Deposit account number: 28002246

Account holder: Schoppe, Zimmermann, Stöckeler, Zinkler & Partner

43 Refunds

Any refunds should be made to EPO deposit account: 28002246

Account holder: Schoppe, Zimmermann, Stöckeler, Zinkler & Partner

Fees

	Factor applied	Fee schedule	Amount to be paid
001 Filing fee - EP direct - online	1	105.00	105.00
002 Fee for a European search - Applications filed on/after 01.07.2005	1	1 105.00	1 105.00
Total:		EUR	1 210.00

44-A Forms

		Details:	System file name:
A-1	Request		as ep-request.pdf
A-2	1. Designation of inventor	1. Inventor	as F1002-1.pdf
A-3	2. Designation of inventor	2. Inventor	as F1002-2.pdf

44-B Technical documents

		Original file name:	System file name:
B-1	Specification	Application Text.pdf Description; 12 claims; 7 figure(s); abstract	SPECEPO-1.pdf

44-C Other documents

		Original file name:	System file name:
C-1	Additional Representatives	Additional Representatives.pdf	OTHER-1.pdf

45 General authorisation:

46 Signature(s)

Place: **Pullach**

Date: **04 April 2011**

Signed by: **DE, Schoppe, Zimmermann, Stöckeler & Zinkler, T. Zimmermann 9619**

Capacity: **(Representative)**

Designation of inventor

User reference: POS110401PEP
Application No:

	Inventor	
	Name:	HONG, Mr. Won-Ki
	Address:	101-1702 Hyundai Hometown Apt., Daejam-dong, Nam-gu, Pohang-si, Gyeongbuk Pohang-si Republic of Korea
	The applicant has acquired the right to the European patent:	As employer

Designation of inventor

User reference: POS110401PEP
Application No:

	Inventor	
	Name:	KANG, Mr. Joon-Myung
	Address:	DPNM Lab., 4-4405 RIST, Pohang Univ. of science, Hyoja-dong, Nam-gu, Pohang-si, Gyeonbuk Pohang-si Republic of Korea
	The applicant has acquired the right to the European patent:	As employer

Additional Representatives

New European Patent Application
based on Korean Patent Application 10-2010-0032564
Title: METHOD OF PROVIDING AUTONOMIC MANAGEMENT OF SOFTWARE SYSTEM, RECORDING MEDIUM STORING PROGRAM FOR PERFORMING THE SAME, AND SYSTEM HAVING FUNCTION OF AUTONOMIC SOFTWARE MANAGEMENT
Our reference number: POS110401PEP

SCHOPPE, Fritz

ZIMMERMANN, Tankred

STÖCKELER, Ferdinand

ZINKLER, Franz

SCHENK, Markus

HERSINA, Günter

BURGER, Markus

METHOD OF PROVIDING AUTONOMIC MANAGEMENT OF SOFTWARE SYSTEM, RECORDING MEDIUM STORING PROGRAM FOR PERFORMING THE SAME, AND SYSTEM HAVING FUNCTION OF AUTONOMIC SOFTWARE MANAGEMENT

CLAIM FOR PRIORITY

This application claims priority to Korean Patent Application No. 10-2010-0032564 filed on April 9, 2010 in the Korean Intellectual Property Office (KIPO), the entire contents of which are hereby incorporated by reference.

BACKGROUND

1. Technical Field

Example embodiments of the present invention relate in general to a software development method, and more specifically, to a method of providing autonomic management of a software system capable of providing an optimized configuration for a system on the basis of information dynamically varying at runtime, a recording medium storing a program for executing the method, and a system having a function of autonomic software management.

2. Related Art

Product line engineering (PLE) is a new engineering discipline that provides an effective method of rapidly developing software variously specialized in the same domain by applying a systematic reuse technique to software development. In other words, PLE is a methodology of analyzing a domain to extract common points and different points between various applications in one domain, defining reusable product line assets on the basis of the common points and different points, and thereby developing the same product-line software.

Among methods for PLE, feature-oriented software development (FOSD) suggested by CMU SEI in 1990 is most frequently used. In FOSD, a domain expert defines a feature model by analyzing common points and different points between products according to features, so that an application program developer can develop a new product in a short time on the basis of the defined feature model.

To be specific, in conventional FOSD, a domain expert analyzes lines of products, builds a product line reuse library on the basis of the analyzed product lines, and then defines relation between the lines using a feature model. Subsequently, an application engineer readily develops new software on the basis of the feature model according to system requirements of the corresponding software system.

The above-described feature-oriented software development can effectively make use of software development time and cost. However, since a software developer passively selects a feature in consideration of a given environment and statically configures a software system, it is impossible to provide a system dynamically optimized for an environment that varies in real time when the software system runs, and user intervention is required.

SUMMARY

Accordingly, example embodiments of the present invention are provided to substantially obviate one or more problems due to limitations and disadvantages of the related art.

Example embodiments of the present invention provide a method of providing autonomic management of a software system capable of providing a system optimized for an environment that varies in real time.

Other example embodiments of the present invention provide a recording medium storing a program for executing the method of providing autonomic management of a software system.

Still other example embodiments of the present invention provide a system having a function of autonomic software management capable of providing a system optimized for an environment that varies in real time.

In some example embodiments, a method of providing autonomic management of a software system includes: receiving a request for a service from a user; obtaining all configurations of a system capable of providing the requested service from a dynamic feature model; obtaining a configuration corresponding to the requested service among all of the obtained configurations on the basis of a previously set policy; reconfiguring resources of the system on the basis of the obtained configuration; and providing the requested service on the basis of the reconfigured resources. The dynamic feature model may indicate a configuration of an object operable when the software system runs. The dynamic feature model may include a runtime feature defining values varying when the system in which the software system is installed runs. Obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy may include obtaining the most appropriate configuration for the requested service among all of the obtained configurations on the basis of the runtime feature of the system. The method of providing autonomic management of a software system may further include, before obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy, obtaining context information from the system or a surrounding physical environment. Obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy may include obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy and the obtained context information.

In other example embodiments, a recording medium stores a program for executing a method of providing autonomic management of a software system, the program performing:

obtaining all configurations of a system capable of providing a requested service from a dynamic feature model; obtaining a configuration corresponding to the requested service among all of the obtained configurations on the basis of a previously set policy; reconfiguring resources of the system on the basis of the obtained configuration; and providing the requested service on the basis of the reconfigured resources.

In still other example embodiments, a system having a function of autonomic software management includes: a dynamic feature model configured to provide all configurations of a system capable of providing a requested service; an autonomic manager configured to provide a configuration corresponding to the requested service among all of the obtained configurations on the basis of previously set policy information; and a core system configured to receive the configuration for the requested service from the autonomic manager, reconfigure resources of the system on the basis of the received configuration, and then provide the service to a user on the basis of the reconfigured resources. The system may further include: a policy manager configured to receive a policy set by the user and provide the received policy or a goal corresponding to the received policy to the autonomic manager; and a context manager configured to collect context information from the system or a surrounding physical environment and provide the collected context information to the autonomic manager. The autonomic manager may provide the configuration corresponding to the requested service among all of the obtained configurations of the system on the basis of the previously set policy information and the context information. The dynamic feature model may include a runtime feature defining values varying when the system runs. The autonomic manager may provide the configuration corresponding to the requested service among all of the obtained configurations of the system on the basis of the runtime feature of the system.

BRIEF DESCRIPTION OF DRAWINGS

Example embodiments of the present invention will become more apparent by describing in detail example embodiments of the present invention with reference to the accompanying drawings, in which:

FIG. 1 is a block diagram of a system performing autonomic software management according to an example embodiment of the present invention;

FIG. 2 is a flowchart illustrating a method for autonomic management of a software system according to an example embodiment of the present invention;

FIG. 3 is a conceptual diagram illustrating relation between a static feature model and a dynamic feature model applied to a method for autonomic management of a software system according to an example embodiment of the present invention;

FIG. 4 is a table in which a static feature model and a dynamic feature model applied to a method for autonomic management of a software system according to an example embodiment of the present invention are compared;

FIG. 5 shows a constitution of a static feature model of a mobile communication terminal illustrating an example to which a method for autonomic management of a software system according to an example embodiment of the present invention is applied;

FIG. 6 shows a constitution of a dynamic feature model of a mobile communication terminal illustrating an example to which a method for autonomic management of a software system according to an example embodiment of the present invention is applied; and

FIG. 7 illustrates states of a mobile communication terminal that is autonomously managed on the basis of the dynamic feature model of a mobile communication terminal shown in FIG. 6.

DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE PRESENT INVENTION

Example embodiments of the present invention are disclosed herein. However, specific structural and functional details disclosed herein are merely representative for purposes of describing example embodiments of the present invention, however, example embodiments of the present invention may be embodied in many alternate forms and should not be construed as limited to example embodiments of the present invention set forth herein.

Accordingly, while the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that there is no intent to limit the invention to the particular forms disclosed, but on the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention. Like numbers refer to like elements throughout the description of the figures.

It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present invention. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present. Other words used to describe the relationship between elements should be interpreted in a like fashion (*i.e.,* "between" versus "directly between," "adjacent" versus "directly adjacent," etc.).

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises,” “comprising,” “includes” and/or “including,” when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

It should also be noted that in some alternative implementations, the functions/acts noted in the blocks may occur out of the order noted in the flowcharts. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

FIG. 1 is a block diagram of a system performing autonomic software management according to an example embodiment of the present invention.

Referring to FIG. 1, a domain engineer analyzes product lines, generates a product line reuse library 110 on the basis of the analyzed product lines, and expresses a relation between the analyzed product lines using a static feature model 120.

An application engineer develops software according to requirements of the corresponding software system to be developed on the basis of the static feature model 120.

Also, the domain engineer generates a dynamic feature model 130 for decision-making for reconfiguring a product when a core system 140 runs. Here, the static feature model 120 and the dynamic feature model 130 may be generated when a software system is developed.

In a method of providing autonomic management of a software system according to an example embodiment of the present invention, a conventional feature model is designated as the static feature model 120 with the expansion of conventional feature-oriented software development (FOSD), features that can vary when the software system runs are analyzed on the basis of the static feature model, and the dynamic feature model 130 is newly defined on the basis of the analyzed features.

The dynamic feature model 130 may define all configurations with which the core system 140 operates at runtime. In other words, the dynamic feature model 130 defines how a function selected by the static feature model 120 is activated at runtime.

The core system 140 includes both of hardware in a predetermined domain and a software system installed in the hardware and controlling operation of the hardware. The core system 140 receives a new service request from a user, and provides the received service request information to an autonomic manager 150. Subsequently, the core system 140 receives configuration information for the requested service from the autonomic manager 150, reconfigures system resources on the basis of the received configuration information, and then provides the service to the user on the basis of the reconfigured system resources.

The autonomic manager 150 extracts the most appropriate configuration for the service requested by the user from information about all available configurations of the core system 140 provided by the dynamic feature model 130 on the basis of policy information provided by a policy manager 160 and context information provided by a context manager 170, and provides the extracted configuration information to the core system 140.

The policy manager 160 receives an upper-level policy from the user, and provides a detailed goal corresponding to the received policy or the upper-level policy to the autonomic manager 150.

The context manager 170 collects context information from the core system 140 and/or the surrounding physical environment, and provides the collected context information to the autonomic manager 150.

FIG. 2 is a flowchart illustrating a method for autonomic management of a software system according to an example embodiment of the present invention.

A method for autonomic management of a software system according to an example embodiment of the present invention will be described with reference to FIGS. 1 and 2. First, the core system 140 receives a service request from a user (step 210), and provides the received service request information to the autonomic manager 150.

The autonomic manager 150 obtains policy information set by the user from the policy manager 160 (step 220), and obtains context information about the core system and/or the surrounding physical environment from the context manager 170 (step 230).

Also, the autonomic manager 150 obtains information about all available configurations of system from the dynamic feature model 130 (step 240), extracts the most appropriate configuration for the service requested by the user from the information about all available configurations of the system on the basis of the obtained policy information and context information (step 250), and then provides the extracted configuration information to the core system 140.

The core system 140 reconfigures system resources on the basis of the configuration information provided by the autonomic manager 150 (step 260), and provides the service requested by the user using the reconfigured resources (step 270).

In FIG. 2, it is illustrated that after the service request is received (step 210), the policy information set by the user is obtained (step 220), and the context information is obtained (step 230). However, this is merely for convenience, and steps 210 to 230 may be performed substantially out of sequence. Also, step 220 and/or step 230 may be performed after step 240.

FIG. 3 is a conceptual diagram illustrating a relation between a static feature model and a dynamic feature model applied to a method for autonomic management of a software system according to an example embodiment of the present invention.

In FIG. 3, an upper cone denotes a static feature model for development of a software system, and a lower cone denotes a dynamic feature model whereby one product can be reconfigured at runtime.

In FIG. 3, P_1, P_2, P_3, and P_4 denote programs, and f_1, f_2, f_3, and f_4 denote static features. Also, C_1, C_2, C_3, and C_4 denote configurations, and f_1' and f_2' denote dynamic features.

A static feature model may gradually develop P_2, P_3, and P_4 from P_1, which is a basic software program, using a feature. Assuming that a calculator program having only an addition function is P_1, f_1 is a subtraction function, and f_2 is a division function, P_4 is generated as a calculator program having addition, subtraction and division functions.

A dynamic feature model denotes with which configuration a generated software system operates at runtime, as mentioned above. In other words, when a feature is a program code in a dynamic feature model, the feature is an object of the program code in a dynamic feature model. For example, while the software system runs, the program P_4 may become C_1 having only the addition function on the basis of policy and context information, or may be reconfigured as one of C_2, C_3, and C_4 by adding the subtraction and/or division function. Also, the configurations C_1, C_2, C_3, and C_4 may be modified by adding or removing a dynamic feature according to the policy and context information.

FIG. 4 is a table in which a static feature model and a dynamic feature model applied to a method for autonomic management of a software system according to an example embodiment of the present invention are compared.

Referring to FIG. 4, a static feature model is for program synthesis, and a dynamic feature model is a decision-making model for reconfiguration while a system runs.

The static and dynamic feature models are generated by a domain engineer (or domain expert) when software is developed. The static feature model is determined by a software developer when a software system is developed, and the dynamic feature model is determined by an autonomic manager or user when the system runs.

While a combination of features in a static feature model is a software system, a combination of features in a dynamic feature model is a state (or configuration) while a system runs. This is because, when the software system while the system operates is represented by a finite state machine (FSM), states are independent from each other.

FIG. 5 shows a constitution of a static feature model of a mobile communication terminal illustrating an example to which a method for autonomic management of a software system according to an example embodiment of the present invention is applied.

Software installed in a mobile communication terminal needs to provide a variety of functions according to various types of hardware of the mobile communication terminal, and thus is an appropriate example to which product line engineering (PLE) will be applied.

As a communication means between an expert and a general user in a domain or between developers, a feature model is a domain analysis model schematizing common points and different points between several systems in the domain in AND/OR graphs. In the feature model, a common feature in the domain is represented by a mandatory feature, and a different point between systems is represented by an optional feature, an alternative feature, and an OR feature which enables one or more selections.

A static feature model of a mobile communication terminal will be described with reference to FIG. 5. In a mobile communication terminal, Application is a mandatory feature, and Video Call is an optional feature. The mobile communication terminal may include Application, Network Interface, and also Policy. In this case, a new mobile communication terminal system may be made by adding Application, Network Interface, and Policy on the basis of a relation of a base feature model of the mobile communication terminal.

In the static feature model of the mobile communication terminal shown in FIG. 5, Application needs to include Voice Call. Also, the static feature model needs to include Policy and at least one network interface among code-division multiple access (CDMA), wireless local area network (WLAN), wireless broadband Internet (WiBro), and Bluetooth.

FIG. 6 shows a constitution of a dynamic feature model of a mobile communication terminal illustrating an example to which a method for autonomic management of a software system according to an example embodiment of the present invention is applied.

Referring to FIG. 6, while a static feature model is generated by analyzing functional features of products, a static feature model is generated by analyzing features of a running system. For example, when a software developer selects Voice Call and Web Browser as Application, CDMA, WLAN, and WiBro as Network Interface, and Received Signal Strength (RSS), Cost, Power, Quality, and Manual as a method for selecting a network interface in the static feature model of the mobile communication terminal shown in FIG. 5, the mobile communication terminal is manufactured to include all of the functions.

A dynamic feature model represents how a system can vary at runtime. For example, in a dynamic feature model of a running mobile communication terminal shown in FIG. 6, Application is not executed or only one of Voice Call and Web Browser can be executed. Network Interface is not activated, or only one of CDMA, WLAN, and WiBro can be activated. Only one of RSS, Cost, Power, Quality, and Manual can be selected as Policy.

In a mobile communication terminal having a dynamic feature model as shown in FIG. 6, an autonomic manager manages a system according to a policy set on the basis of the dynamic feature model. For example, the autonomic manager may select an optimum network interface on the basis of a policy set for each application.

In the dynamic feature model, values that can vary at runtime as new features that are not in a static feature model are defined as runtime features. In the case of Network Interface of FIG. 6, Availability, Signal Strength, Cost Model, Power Consumption Rate, Quality, etc. are features that can dynamically vary while a system runs, and the autonomic manager selects an optimum network interface using the above-mentioned runtime features while the mobile communication terminal runs. For example, availability of CDMA becomes "F" (false) in a place where CDMA cannot be used, and the autonomic manager selects the most appropriate network interface using such values of runtime features.

FIG. 7 illustrates states of a mobile communication terminal that is autonomously managed on the basis of the dynamic feature model of a mobile communication terminal shown in FIG. 6.

Referring to FIG. 7, when power is turned on, a mobile communication terminal is switched from a power-off state POWER_OFF to a power-on state POWER_ON, and starts operating with an idle state S1 in the power-on state POWER_ON.

Subsequently, the mobile communication terminal is switched to a voice-call state S2 or a web-browser state S3 in response to manipulation of a user.

When states are changed as described above to use voice call or a web browser, a network interface is activated. In an initial stage in which the network interface is used, the user manually selects one network interface among CMDA, WLAN, and WiBro. Thereafter, the mobile communication terminal autonomously selects an optimum network interface on the basis of a runtime feature based on a dynamic feature model, a previously set policy, and/or collected context information.

For example, when the user selects the voice-call state S2 in the idle state S1 of the mobile communication terminal and selects WiBro S6 as an initial network interface, an autonomous manager of the mobile communication terminal may autonomously select WLAN S5 as a network interface at a predetermined point in time on the basis of a runtime feature that varies while the mobile communication terminal is running and a policy previously set by the user.

The above-described method of providing autonomic management of a software system and the above-described system having a function of autonomic software management according to example embodiments of the present invention statically configure a software system, extract a configuration optimized for a requested service using a dynamic feature model including a runtime feature, which reflects an environment varying in real time while the system is running, reconfigure resources of the system using the extracted configuration, and then provide the service.

Therefore, the method and system can provide a service optimized for an environment that varies in real time without user intervention, and due to this characteristic, can be used for embedded systems, rockets, military software systems, etc. requiring a software system that can be dynamically reconfigured according to a required goal.

While the example embodiments of the present invention and their advantages have been described in detail, it should be understood that various changes, substitutions and alterations may be made herein without departing from the scope of the invention.

WHAT IS CLAIMED IS:

1. A method of providing autonomic management of a software system, comprising:

receiving a request for a service from a user;

obtaining all configurations of a system capable of providing the requested service from a dynamic feature model;

obtaining a configuration corresponding to the requested service among all of the obtained configurations on the basis of a previously set policy;

reconfiguring resources of the system on the basis of the obtained configuration; and

providing the requested service on the basis of the reconfigured resources.

2. The method of claim 1, wherein the dynamic feature model indicates a configuration of an object operable when the software system runs.

3. The method of claim 1, wherein the dynamic feature model includes a runtime feature defining values varying when the system in which the software system is installed runs.

4. The method of claim 3, wherein obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy includes obtaining a most appropriate configuration for the requested service among all of the obtained configurations on the basis of the runtime feature of the system.

5. The method of claim 1, further comprising, before obtaining the

configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy, obtaining context information from the system or a surrounding physical environment.

6. The method of claim 5, wherein obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy includes obtaining the configuration corresponding to the requested service among all of the obtained configurations on the basis of the previously set policy and the obtained context information.

7. A recording medium having a program of instructions readable and executable by a digital processor for performing autonomic software management recorded thereon, the program being tangibly embodied, wherein the program performs:

obtaining all configurations of a system capable of providing a requested service from a dynamic feature model;

obtaining a configuration corresponding to the requested service among all of the obtained configurations of the system on the basis of a previously set policy;

reconfiguring resources of the system on the basis of the obtained configuration; and

providing the requested service on the basis of the reconfigured resources.

8. A system having a function of autonomic software management, comprising:

a dynamic feature model configured to provide all configurations of a system capable of providing a requested service;

an autonomic manager configured to provide a configuration corresponding to the requested service among all of the obtained configurations on the basis of previously set policy information; and

a core system configured to receive the configuration for the requested service from the autonomic manager, reconfigure resources of the system on the basis of the received configuration, and then provide the service to a user on the basis of the reconfigured resources.

9. The system of claim 8, further comprising:

a policy manager configured to receive a policy set by the user and provide the received policy or a goal corresponding to the received policy to the autonomic manager; and

a context manager configured to collect context information from the system or a surrounding physical environment and provide the collected context information to the autonomic manager.

10. The system of claim 9, wherein the autonomic manager provides the configuration corresponding to the requested service among all of the obtained configurations of the system on the basis of the previously set policy information and the context information.

11. The system of claim 8, wherein the dynamic feature model includes a runtime feature defining values varying when the system runs.

12. The system of claim 11, wherein the autonomic manager provides the configuration corresponding to the requested service among all of the obtained configurations of the system on the basis of the runtime feature of the system.

ABSTRACT OF THE DISCLOSURE

Provided are a method of providing autonomic management of a software system, a recording medium storing a program for executing the method, and a system having a function of autonomic software management. When a request for a service is received from a user, all configurations of a system capable of providing the requested service are obtained from a dynamic feature model, a configuration corresponding to the requested service is obtained among all of the obtained configurations on the basis of a previously set policy to reconfigure resources of the system, and the requested service is provided on the basis of the reconfigured resources. Accordingly, it is possible to provide a service optimized for an environment that varies in real time without user intervention.

FIG. 1

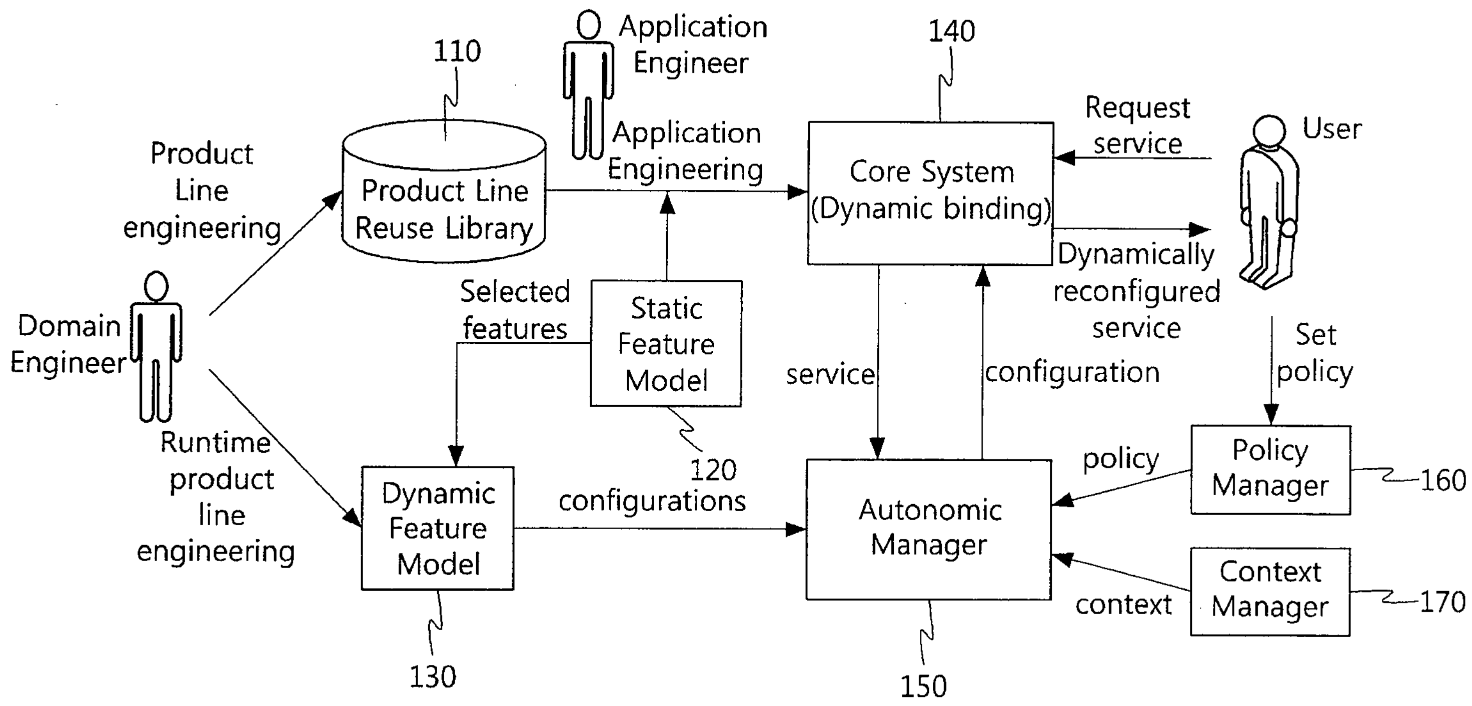
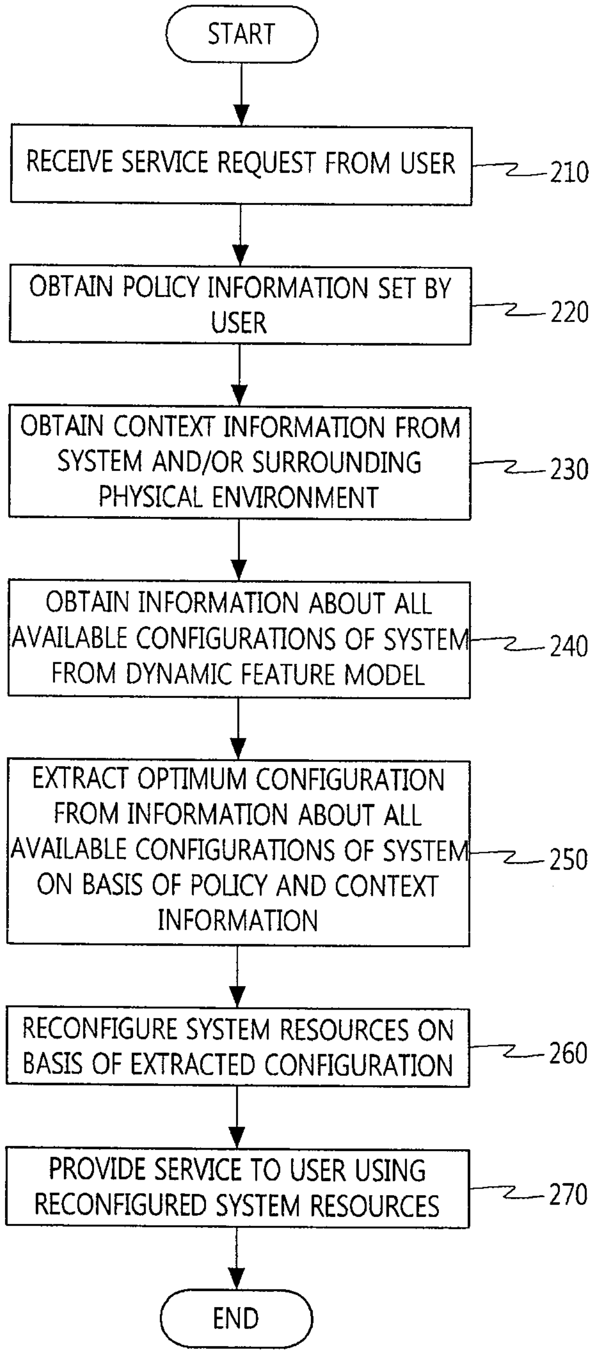

110
Application
Engineer
140
Product
Line
engineering
Product Line
Reuse Library
Application
Engineering
Core System
(Dynamic binding)
Request
service
User
Domain
Engineer
Selected
features
Static
Feature
Model
Dynamically
reconfigured
service
Set
policy
service
configuration
Runtime
product
line
engineering
Dynamic
Feature
Model
120
configurations
Autonomic
Manager
policy
Policy
Manager
160
context
Context
Manager
170
130
150

FIG. 2



START
RECEIVE SERVICE REQUEST FROM USER
210
OBTAIN POLICY INFORMATION SET BY USER
220
OBTAIN CONTEXT INFORMATION FROM SYSTEM AND/OR SURROUNDING PHYSICAL ENVIRONMENT
230
OBTAIN INFORMATION ABOUT ALL AVAILABLE CONFIGURATIONS OF SYSTEM FROM DYNAMIC FEATURE MODEL
240
EXTRACT OPTIMUM CONFIGURATION FROM INFORMATION ABOUT ALL AVAILABLE CONFIGURATIONS OF SYSTEM ON BASIS OF POLICY AND CONTEXT INFORMATION
250
RECONFIGURE SYSTEM RESOURCES ON BASIS OF EXTRACTED CONFIGURATION
260
PROVIDE SERVICE TO USER USING RECONFIGURED SYSTEM RESOURCES
270
END

FIG. 3

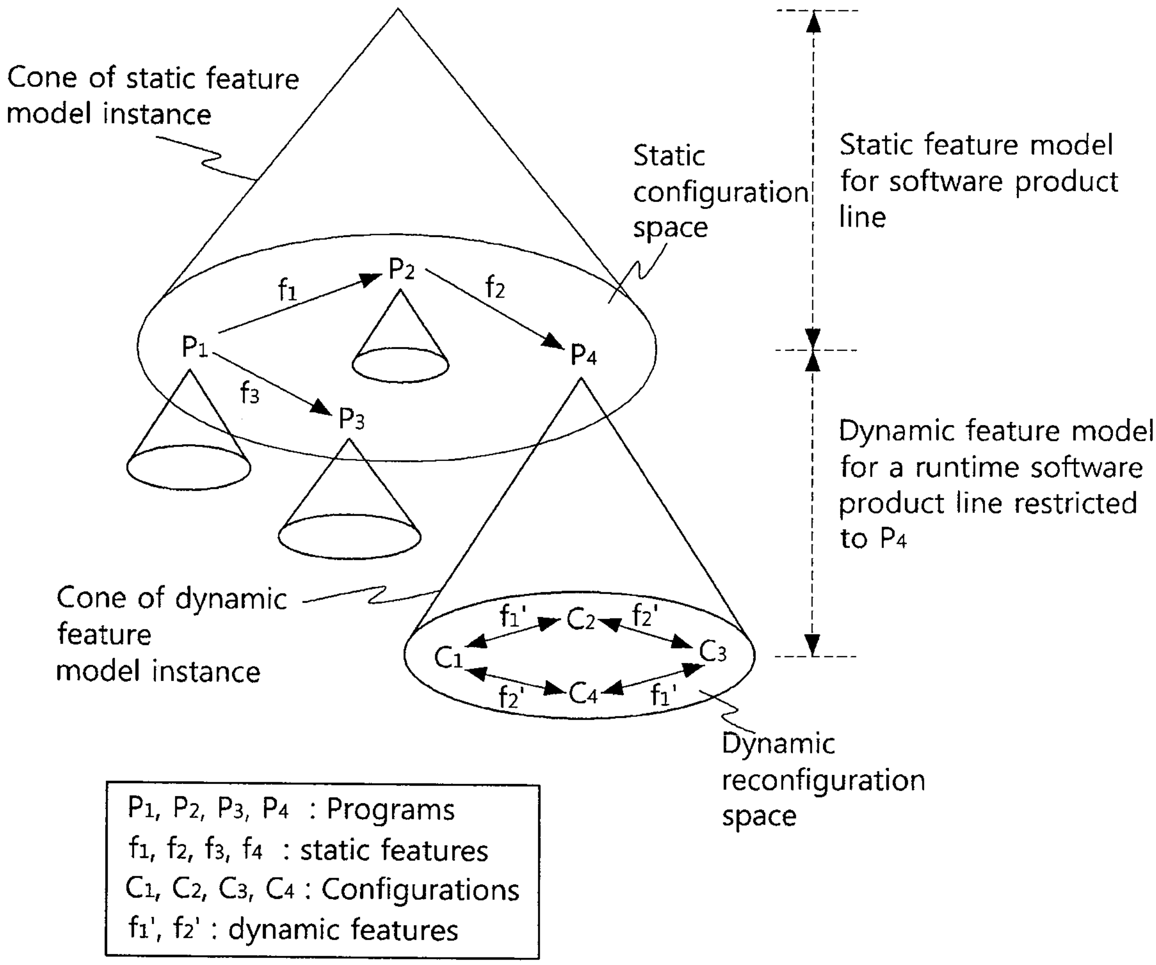
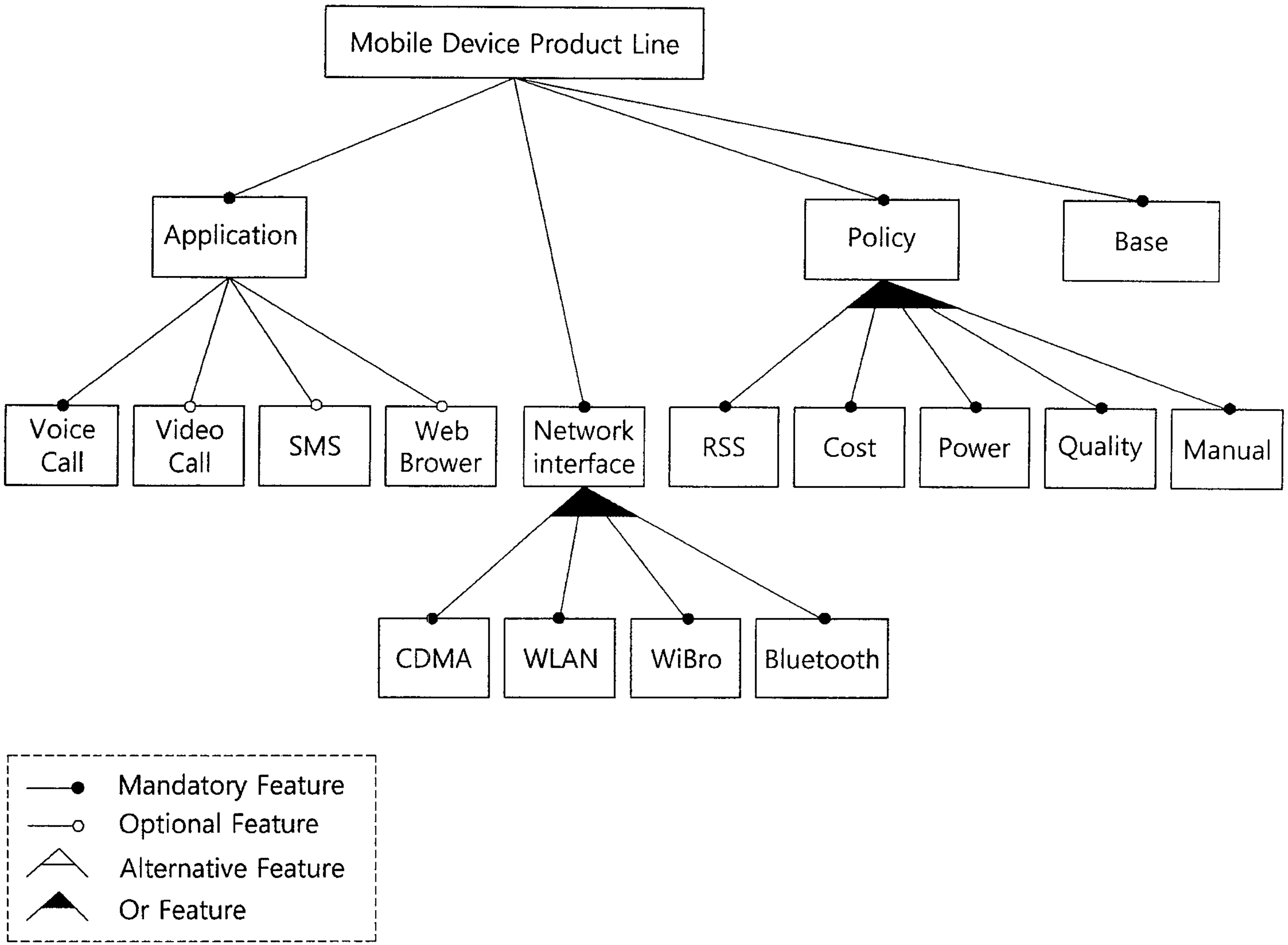

Cone of static feature model instance
Static configuration space
Static feature model for software product line
P1
P2
P3
P4
f1
f2
f3
Dynamic feature model for a runtime software product line restricted to P4
Cone of dynamic feature model instance
f1'
f2'
C1
C2
C3
C4
Dynamic reconfiguration space
P1, P2, P3, P4 : Programs
f1, f2, f3, f4 : static features
C1, C2, C3, C4 : Configurations
f1', f2' : dynamic features

FIG. 4

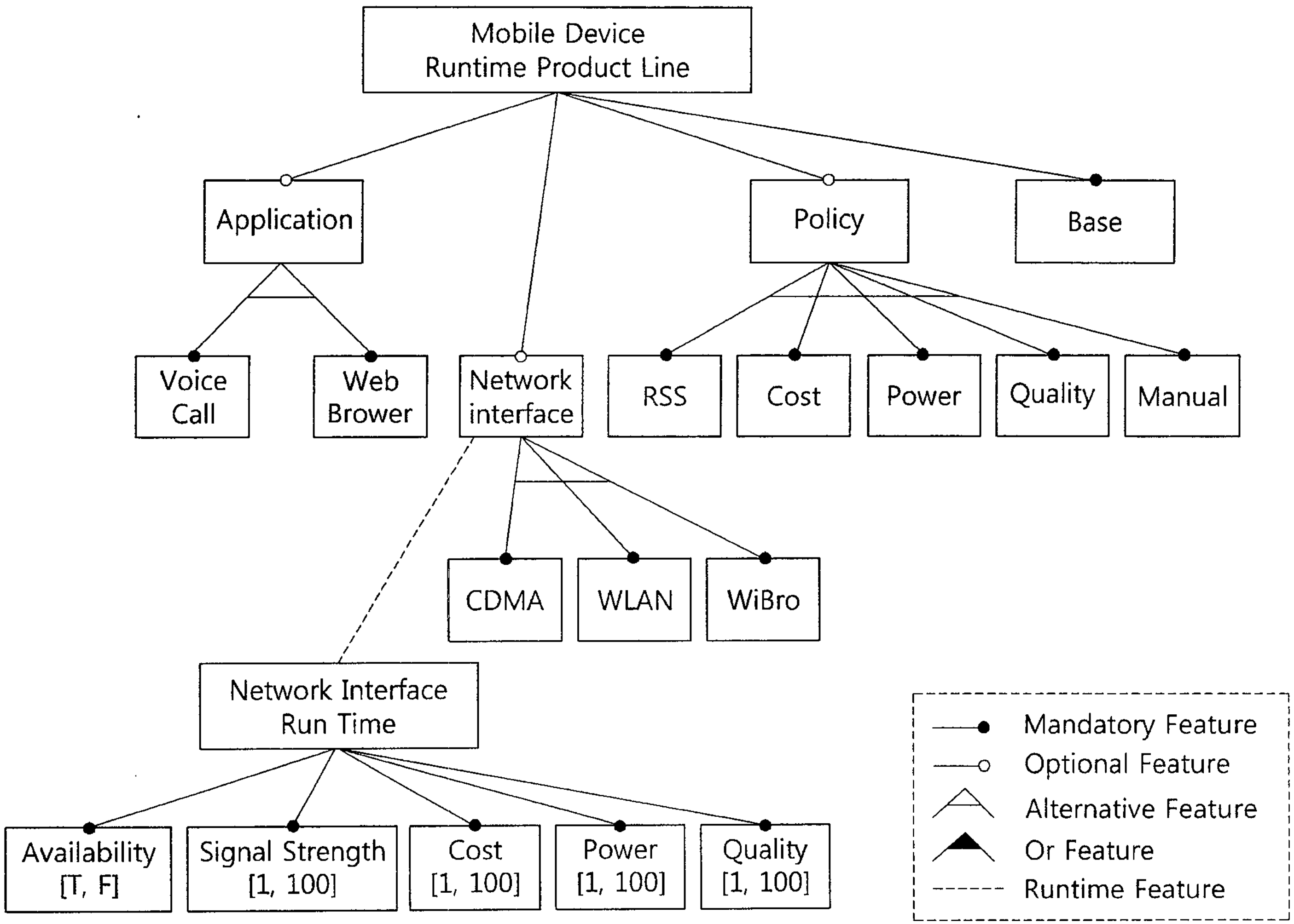
	STATIC FEATURE MODEL	DYNAMIC FEATURE MODEL
GOAL	DECISION-MAKING MODEL FOR SOFTWARE PROGRAM SYNTHESIS	DECISION-MAKING MODEL FOR PRODUCT RECONFIGURATION AT RUNTIME
GENERATOR	Domain Engineer	
FEATURE	MINIMUM UNITS CAPABLE OF INDICATING ALL AVAILABLE FUNCTIONAL AND NON-FUNCTIONAL ELEMENTS OF PRODUCT	MINIMUM UNITS THAT CAN BE ACTIVATED OR DEACTIVATED AT RUNTIME
USER	SOFTWARE DEVELOPER	AUTONOMIC MANAGER (OR USER)
TIME FOR DETERMINATION	POINT IN TIME OF DEVELOPMENT	AT RUNTIME
COMBINATION	SOFTWARE SYSTEM	STATE (OR CONFIGURATION) OF SOFTWARE SYSTEM

FIG. 5



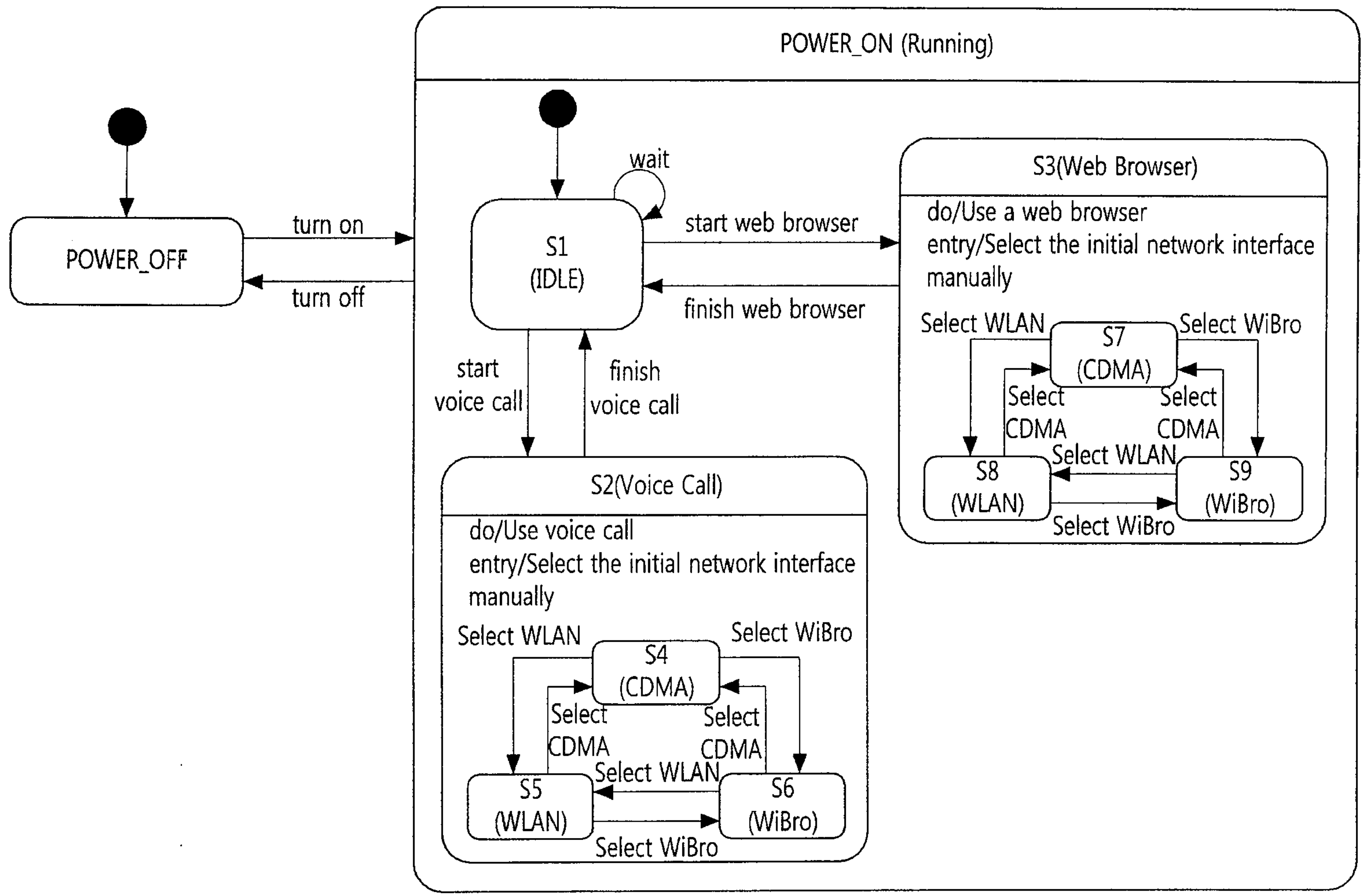
Mobile Device Product Line
Application
Policy
Base
Voice Call
Video Call
SMS
Web Brower
Network interface
RSS
Cost
Power
Quality
Manual
CDMA
WLAN
WiBro
Bluetooth
Mandatory Feature
Optional Feature
Alternative Feature
Or Feature

FIG. 6



Mobile Device
Runtime Product Line
Application
Policy
Base
Voice Call
Web Brower
Network interface
RSS
Cost
Power
Quality
Manual
CDMA
WLAN
WiBro
Network Interface Run Time
Availability [T, F]
Signal Strength [1, 100]
Cost [1, 100]
Power [1, 100]
Quality [1, 100]
Mandatory Feature
Optional Feature
Alternative Feature
Or Feature
Runtime Feature

FIG. 7


POWER_OFF
turn on
turn off
POWER_ON (Running)
wait
S1
(IDLE)
start web browser
finish web browser
start
voice call
finish
voice call
S3(Web Browser)
do/Use a web browser
entry/Select the initial network interface
manually
Select WLAN
Select WiBro
S7
(CDMA)
Select
CDMA
Select
CDMA
Select WLAN
S8
(WLAN)
S9
(WiBro)
Select WiBro
S2(Voice Call)
do/Use voice call
entry/Select the initial network interface
manually
Select WLAN
Select WiBro
S4
(CDMA)
Select
CDMA
Select
CDMA
Select WLAN
S5
(WLAN)
S6
(WiBro)
Select WiBro