

ANIMA WG
Internet-Draft
Intended status: Informational
Expires: January 9, 2017

Z. Du
S. Jiang
Huawei Technologies Co., Ltd
J. Nobre
Federal University of Rio Grande do Sul
L. Ciavaglia
Alcatel Lucent
M. Behringer
Cisco Systems
July 8, 2016

ANIMA Intent Policy and Format
draft-du-anima-an-intent-04

Abstract

One of the goals of autonomic networking is to simplify the management of networks by human operators. Intent Based Networking (IBN) is a possible approach to realize this goal. With IBN, the operator indicates to the network what to do (i.e. her intent) and not how to do it. In the field of Policy Based Management (PBM), the concept of intent is called a declarative policy. This document proposes a refinement of the intent concept initially defined in [RFC7575] for autonomic networks by providing a more complete definition, a life-cycle, some use cases and a tentative format of the ANIMA Intent Policy.

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1. Introduction

One of the goals of autonomic networking is to simplify the management of networks by human operators. Intent Based Networking (IBN) is a possible approach to realize this goal. With IBN, the operator indicates to the network what to do (i.e. her intent) and not how to do it. In the field of Policy Based Management (PBM), the concept of intent is called a declarative policy. This document proposes a refinement of the intent concept initially defined in [RFC7575] for autonomic networks by providing a more complete

definition, a life-cycle, some use cases and a tentative format of the ANIMA Intent Policy.

An Autonomic Network must be able to operate with minimum intervention from human operators. However, it still needs to receive some form of guidance (e.g. ANIMA Intent Policies) in order to fulfil the operator requirements.

In PBM, the Policy Continuum defines the levels at which the policies are defined (policy creation point), consumed (policy execution point) and translated (policy refinement point). Using PBM, the operator can manage the network as a whole, and does not need to configure each individual devices in the network. The transformation of the high-level/abstract policies to the low-level device configurations is realized automatically by a set of functions usually regrouped inside a Policy Engine.

The use of policies and in particular of declarative policies assumes that the entities in the Autonomic Network receiving the ANIMA Intent Policy are capable of processing (refining and/or executing) the policy with no ambiguity. For that, the format of the ANIMA Intent Policy and the hierarchy of policy levels must be specified.

This document proposes a base format of the ANIMA Intent Policy. Application-specific extensions of the base format should be defined on a per need basis in dedicated documents.

2. Requirements Language and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119] when they appear in ALL CAPS. When these words are not in ALL CAPS (such as "should" or "Should"), they have their usual English meanings, and are not to be interpreted as [RFC2119] key words.

Autonomic Function: A feature or function which requires no configuration, and can derive all required information either through self-knowledge, discovery or through Intent.

Autonomic Node: A node which employs exclusively Autonomic Functions.

Legacy Node: A non-autonomic node, i.e., a node which employs some non-autonomic functions.

Autonomic Network: A network containing exclusively Autonomic Nodes. It may contain one or several Autonomic Domains.

Autonomic Domain: A collection of autonomic nodes that instantiate the same Intent.

Autonomic Service Agent: An agent implemented on an Autonomic Node which implements an Autonomic Function.

Intent: An abstract, high-level policy used to operate the network.

ANIMA Intent Policy: A declarative type of policy used in Autonomic Networks.

Administrative Intent: Intent that is used to manage the network infrastructure. (definition to be revised)

Service Intent: Intent that is used to intervene the network services running over the network infrastructure. (definition to be revised)

3. Concept of ANIMA Intent Policy

In the scope of autonomic networking, the definition of intent can be found in [I-D.ietf-anima-reference-model], in which intent is described as "an abstract, declarative, high-level policy used to operate an autonomic domain, such as an enterprise network."

An Autonomic Network will comprise multiple ANIMA Intent Policies. Different ANIMA Intent Policies will be "interpreted" by different entities in autonomic networks, and the "level" of understanding of the intent will impact how the intent will be presented to this entity. So there should be "intermediate" mechanisms/functions that cater for the intent translation continuum across the heterogeneity (in policy capabilities) of the network entities. Also, ANIMA Intent Policies will possibly overlap and this overlapping should be managed (e.g., avoid conflicts, resolve applicable policies in context).

4. Intent Life Cycle

This section describes a top-down flow about how an ANIMA Intent Policy is derived through an autonomic network.

1. **Business goals:** The network owner wants the network to follow some business goals. These goals are initially not formalised in a particular way. A Domain Specific Language (DSL) is used to format these goals in a form subsequent components can interpret and process.

2. ANIMA Intent Policy (or Intent): Is the formalisation of business goals so that computer can deal with them. It is encoded as a file (or several files), and this file must be "given to the network".
3. Ingestion: The Intent file(s) get instantiated on an autonomic node. On a particular node, an intent file is "ingested". After that, it needs to be distributed.
4. Intent Distribution: Intent is flooded to all nodes in a network. Every node has a copy of the original "Intent" file(s), without modification. Each node re-distributes the original Intent files, without modification. Therefore, Intent is optional and transitive in nature. The Intent files must now be interpreted by each node. Editor's note: need to better defined meaning of "optional" and "transitive".
5. Intent splitting (on each node): Intent is split into sections, one for the ANI itself, others for specific Autonomic Functions. ASAs are notified if there is new Intent for them. Some intent sections may not apply to a particular node. Now each component of a node (ANI, all ASAs) know their respective Intent.
6. Intent Interpretation (on each node, by each function): The ANI as well as all ASAs on a node interpret their respective Intent section(s). It gets translated into a "target configuration", taking into account local state. For this translation, it may be necessary for ASAs to communicate with ASAs on other nodes, to pass on resources (IP addresses), to negotiate, etc. All such communications may be triggered by Intent, but the communications themselves are not Intent. (NB: This interpretation could also be done centrally, and the resulting configurations distributed; This is of course an option, but out the scope of ANIMA.) After interpreting Intent locally on each node, each node has target configlet to apply. Editor's note: define new terms such as "configlet"
7. Conflict Resolution with non-autonomic management (on each node): The target configlet resulting from Intent has the lowest priority; meanwhile, any other management method (CLI, NETCONF, etc.) overrides Intent.
8. Conflict Resolution between autonomic components (on each node): Each autonomic function needs to register with a "conflict resolution function" which parameters it modifies; in case of conflict, the conflict resolution function takes a decision and feeds that back to the autonomic functions. This may modify the target configlet.

9. Applying the target configlet.
10. Feedback loops to NOC: The NOC needs to know about certain conditions, such as conflicts with non-autonomic management. Not all conflicts can be resolved automatically, so they may require NOC actions. Undesirable states (deviations from expected default behaviour) may have to be communicated too. To some extent, Intent itself can specify which conditions should trigger feedback loops to the NOC. Feedback loops may happen at other phases as well (ex: 8).

5. Use Cases for ANIMA Intent Policy

In this section, some use cases are introduced to clarify the concept of ANIMA Intent Policy.

5.1. Role-based Intent Example

A typical ANIMA Intent Policy can be found in [I-D.ietf-anima-prefix-management]. It is suggested that the prefix lengths for the CSG, ASG, RSG (different roles in IP RAN) can be assigned as an "intent". The information carried in the intent are distributed in the autonomic domain to influence the detail configurations on each autonomic node.

Intent could perfectly well cover a high level policy such as "all nodes of type x do this; type y does that". However, it should not be abused. For example, policies like "node 17: here is your CLI; node 23: here is your CLI; node 37: here is your CLI" should not be considered as an intent.

5.2. Coordination of Multiple Intents Example

This example is about "arranging VM guest distribution". The autonomic network is supposed to be able to monitor the CPU/power utilization on each host machine, and control the status of each host machine (e.g. turn on/off). The operator may have an intent "there should be enough hosts to keep CPU utilization less than 70%", and also another one "there are few enough hosts powered so that electricity isn't wasted".

These two intents can both influence the ASA responsible for controlling how many hosts are needed. The decision is made according to multiple factors, including network environment and intents entered by the operators.

In this case, the first intent should have a higher priority than the later one. The two intents should be analyzed and coordinated to ensure the ASA act rightly.

5.3. Intent per Domain Example

Autonomic Network of Operator A is composed of Autonomic Function Agents such as load balancing (LB_AFA) and energy saving (ES_AFA). Operator A wants to limit the proportion of links loaded over a certain threshold and thus defines an Intent to activate load balancing if the load is superior to 0.6 on more than 30% of the links.

Meanwhile, operator A wants different load balancing policies per (technology, administrative, topology) domain. Let's consider a metropolitan network domain and a core network domain, or different LB policy for border routers than interior routers. For the metropolitan network domain, Operator A defines an Intent to minimize the link load variance. For the core network domain, Operator A applies the previously defined intent (activate load balancing if the load is superior to 0.6 on more than 30% of the links).

The intents will be distributed to the right network domain, and take effect after being interpreted and coordinated, and it is easy to change them without the need to configure every device manually.

6. Scope of ANIMA intent

In the development of ASAs, some network-level parameters for a specific autonomic function can also be defined in an ANIMA Intent Policy. GRASP is a candidate protocol for distributing and synchronizing these ASA parameters (or ANIMA Intent Policies) after the definition by human administrators.

{Editor Notes: it is still at a preliminary stage, and the owner of an autonomic function should decide what is needed when the autonomic function is developed. A better understanding of what Intent can and cannot contain requires more research and experience. At this moment we include any item (parameter, policy, etc) which should be flooded across the network.}

7. ANIMA Intent Policy Hierarchy

The Autonomic Networks are supposed to be self-managed. It includes managing the network infrastructure, and also the network services that are running over the network infrastructure. However, the network services have different features against network administration, as listed below. Hence, it may be better introduce a

hierarchy and to organize them into separated Administrative (Network) Intent and Service Intent.

- o A Service Intent has a different scope than the Administrative Intent because only the nodes related to the service need to know this intent. Although it may only affect a few nodes, the Service Intent may also be propagated domain wide.
- o A Service Intent may have a limited lifetime, while the Administrative Intents are normally permanent although the content of the Administrative Intent may be updated from time to time.
- o There could be many Service Intents in the Autonomic Domain.

8. Distribution of ANIMA Intent Policy

The distribution of intent can be done by using GRASP [I-D.ietf-anima-grasp] and ACP [I-D.ietf-anima-autonomic-control-plane]. The operator can issue a new intent or modify an intent through any authorized nodes in the autonomic network. After that, the intent will be flooded to all the nodes in the autonomic network, or more accurately, to a group of nodes that are influenced by that intent.

Another scenario is that when a new node joins into an autonomic domain, it may receive an intent from its neighbor.

As mentioed in Section 3.1, the intent may consist of different parts, so that partial updating should also be supported. Detailed mechanisms for intent distribution can be found in [I-D.liu-anima-grasp-distribution].

9. Management of ANIMA Intent Policy

Every Autonomic Node in the Autonomic domain should own an intent with the same version. Any updating of intent, even partial updating, will cause the change of the intent version number. To ensure all the nodes own the same intent, the nodes should be able to communicate with neighbors in the domain about the version of the intent. If its neighbor has a newer version of intent, it can request an intent update.

If the operator issues a new intent or modify intents, it will trigger a domain level updating of intent. Nodes in the Autonomic Network should be aware which domain it belongs to, and accept intent for that domain.

{Editor Notes: talk about the questions as follows. When/on which triggers are intents generated, updated? How the domain(s) are defined and recognized (if I am an AFA, how do I know I am part of domain x, y or z...?). }

10. Interpretation of ANIMA Intent Policy

After receiving an intent, the Autonomic Node should confirm whether it is acceptable, according to the domain name information, intent version, signature, and so on. If it passes the validation, an intent interpretation module will be involved to decide which ASAs will be involved in. Coordination of intents may be needed before the execution of the policies interpreted from the intent.

{Editor Notes: talk about the questions as follows. How the AFAs receive, understand and react to an intent? }

11. Uniform Format of the ANIMA Intent Policy

{Editor Notes: It is still remaining an open issue for the way that intent may be organized. Should the intent be a single one in a given AN domain with a hierarchical version, or multiple intents, each of which targets different Autonomic Service Agent? For now, the below text takes the later approach.}

This section proposes a uniform intent format. It uses the tag-based format.

Autonomic intent: The root tag for the Autonomic Network Intent.

Intent type: It indicates the intent type, which is associated with a specific Autonomic Service Agent.

Autonomic domain: It indicates the domain of the Autonomic Network. It is also the scope of the Autonomic Network Intent.

Intent version: It indicates the version of the ANIMA Intent Policy. This is an important feature for synchronization.

Model version: The version of the model used to define the intent.

Name: The name of the intent which describes the intent for human operators.

Signature: The signature is used as a security mechanism to provide authentication, integrity, and non-repudiation.

Timestamp: The timestamp of the creation of the intent using the format supported by the IETF [TBC].

Lifetime: The lifetime in which the intent may be observed. A special case of the lifetime is the definition of permanent intents.

Content: It contains the main information of the intent. It may include objects, policies, goals and configuration data. The detailed contents and formats should be defined under their specific situations by documents that specifies the Autonomic Service Agent. Within the content, there may be sub_intents.

{Editor Notes: JSON is one of the term candidates for the Autonomic Network Intent format.}

12. Security Considerations

Relevant security issues are discussed in [I-D.ietf-anima-grasp]. The ANIMA Intent Policy requires strong security environment from the start, because it would be great risk if the ANIMA Intent Policy had been maliciously tampered. The Autonomic Intent should employ a signature scheme to provide authentication, integrity, and non-repudiation.

13. IANA Considerations

This document defines one new format. The IANA is requested to establish a new assigned list for it.

14. Acknowledgements

The authors of this draft would like to thank the following persons for their valuable feedback and comments: Bing Liu, Brian Carpenter, Michael Richardson, Joel M. Halpern, John Strassner, and Jason Coleman.

This document was produced using the xml2rfc tool [RFC2629].

15. Change log [RFC Editor: Please remove]

draft-du-anima-an-intent-00: original version, 2015-06-11.

draft-du-anima-an-intent-01: add intent use case section, add some elements for the format section, and coauthor Jeferson Campos Nobre and Laurent Ciavaglia, 2015-07-06.

draft-du-anima-an-intent-02: add the intent concept section, and some other sections, 2015-10-14.

draft-du-anima-an-intent-03: modify the use case section, and add some other contents, 2016-03-17.

draft-du-anima-an-intent-04: modify the use case section, add the procedure section, and reorganize contents, 2016-07-08.

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Authors' Addresses

Zongpeng Du
Huawei Technologies Co., Ltd
Q14, Huawei Campus, No.156 Beiqing Road
Hai-Dian District, Beijing, 100095
P.R. China

Email: duzongpeng@huawei.com

Sheng Jiang
Huawei Technologies Co., Ltd
Q14, Huawei Campus, No.156 Beiqing Road
Hai-Dian District, Beijing, 100095
P.R. China

Email: jiangsheng@huawei.com

Jeferson Campos Nobre
Federal University of Rio Grande do Sul
Porto Alegre
Brazil

Email: jcnobre@inf.ufrgs.br

Laurent Ciavaglia
Alcatel Lucent
Route de Villejust
Nozay 91620
France

Email: laurent.ciavaglia@alcatel-lucent.com

Michael Behringer
Cisco Systems
Building D, 45 Allee des Ormes
Mougins 06250
France

Email: mbehring@cisco.com