

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

IPWorks ASDNS Function Overview

Contents

1	Introduction	3
1.1	Document History	3
1.2	Purpose	3
1.3	Scope	3
1.4	Document Structure	3
2	Survey of Included Functions	4
2.1	Overview	4
2.2	List of Actors	7
2.2.1	Actor:Administrator	7
2.2.2	Actor:Monitored Resource	7
2.2.3	Actor:AS DNS	7
2.2.4	Actor:AS Monitor	7
2.2.5	Actor:DNS Client	7
2.2.6	Actor:Network Management Station	7
2.3	List of Sub-Functions	7
2.3.1	Configure AS Monitor	7
2.3.2	Status Monitoring	8
2.3.3	Load Monitoring	8
2.3.4	AS Report	8
2.3.4.1	Status	8
2.3.4.2	Load	8
2.3.5	Configure AS DNS	11
2.3.6	Process Report	11
2.3.6.1	Status Update	11
2.3.6.2	Node Load Update	11
2.3.6.3	Grouping Function	14
2.3.6.4	Site Load Update	16
2.3.7	AS Alarms	17
2.3.8	Query Resolve	17
3	Detailed Description	19
3.1	Configure AS Monitor	19
3.1.1	Main Scenario	19
3.2	Status Monitoring & Load Monitoring	20
3.2.1	Main Scenario	20
3.3	AS Report	21
3.3.1	Main Scenario	22
3.3.2	Alternative Scenarios	23
3.3.2.1	Node DOWN	23
3.3.2.2	Node UP	24
3.4	Configure ASDNS	25
3.4.1	Main Scenario	25

Prepared (also subject responsible if other)		No.	
ECIAMAO		51/155 17-AVA 901 16 Uen	
Approved	Checked	Date	
		2017-11-7	PD1

3.5	Process Report & AS Alarms	26
3.5.1	Main Scenario	26
3.5.2	Alternative Scenarios	27
3.5.2.1	Report UP	27
3.5.2.2	Report DOWN	28
3.5.2.3	Report Timeout	29
3.5.2.4	Report Error	30
3.6	Query Resolve	30
3.6.1	Main Scenario	31
3.6.2	Alternative Scenarios	31
3.6.2.1	Match Querying Address Fail	31
3.6.2.2	Select Site Fail	32
4	Operational Conditions	33
4.1	Configurable Parameters	33
4.1.1	Configurable Parameters for ASDNS	33
4.1.1.1	ASDNS Site	33
4.1.1.2	ASDNS Policy	34
4.1.1.3	ASDNS Record	35
4.1.1.4	ASDNS_PERCENT_DIFF	35
4.1.1.5	Update ASDNS Server	36
4.1.2	Configurable Parameters for Monitor	36
4.1.2.1	Monitor	36
4.1.2.2	Monitor Method	36
4.1.2.3	Monitor Resource	37
4.1.2.4	Update Monitor	38
4.1.3	Configurable Monitor Scripts	38
4.1.3.1	Ping	38
4.1.3.2	SNMP	39
4.2	Commands and User Procedures	47
4.3	Charging	47
4.4	Characteristics	47
5	Statement of Compliance	47
6	Miscellaneous	47
7	Terminology	47
8	References	47

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

1 Introduction

1.1 Document History

Rev	Date	Sign.	Comment
A	2015-01-29	ECIAMAO	<ul style="list-style-type: none">Replaces 5/155 17-AVA 901 16 Uen B due to IPWorks 15B updates.
C	2017-03-23	EJIAHLU	<ul style="list-style-type: none">Update for revision number to C (Because of the sharp B was not displayed correctly, so the revision is upgraded to C.)
D	2017-11-07	ECIAMAO	<ul style="list-style-type: none">Update the section 4.1.3.2.

1.2 Purpose

The purpose of this document is to give a high level description of the IPWorks ASDNS functions.

1.3 Scope

The scope of this document is to describe the IPWorks ASDNS functions on a high level.

ASDNS functions can be divided into two main groups: monitoring and resolving. Monitoring is used to determine the state/load of a resource and report it back to DNS servers. Resolving is used by a DNS server to interpret report received from monitoring and response query with a filtering and ordering answer.

Although resolving is tightly related to the component DNS server, DNS server function is not covered. Other related components CLI and Element Servers are also not covered.

1.4 Document Structure

The main chapters are organized as follows:

Chapter 1: describes the document base information.

Chapter 2: briefly describes use cases.

Chapter 3: gives the detailed sequence diagram description of ASDNS functions.

Chapter 4: describes the ASDNS configurable parameters of operational conditions.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

2 Survey of Included Functions

2.1 Overview

ActiveSelect DNS will enable the DNS server to provide optimized responses to DNS(A, AAAA) queries. ActiveSelect DNS is not a standard DNS or BIND feature but it will be designed to interoperate with non-ActiveSelect DNS solutions. ActiveSelect DNS will be a feature of the IPWorks DNS server (BIND 9).

High level functions of AS Monitor and AS DNS are shown by below Use Case diagrams in figure 2-1 and figure 2-2 respectively.

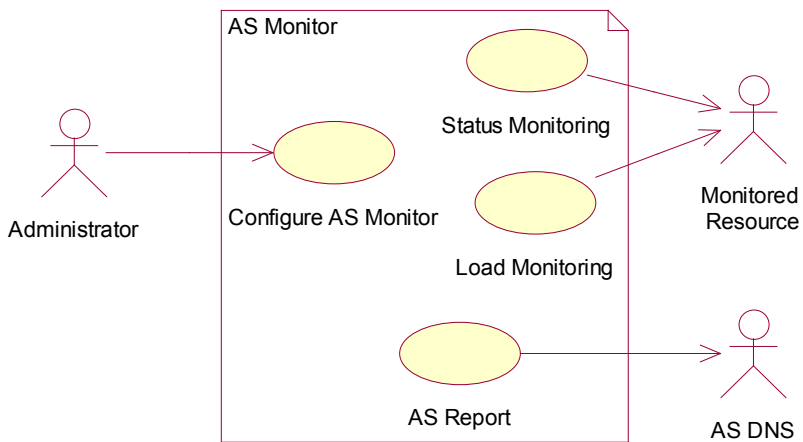
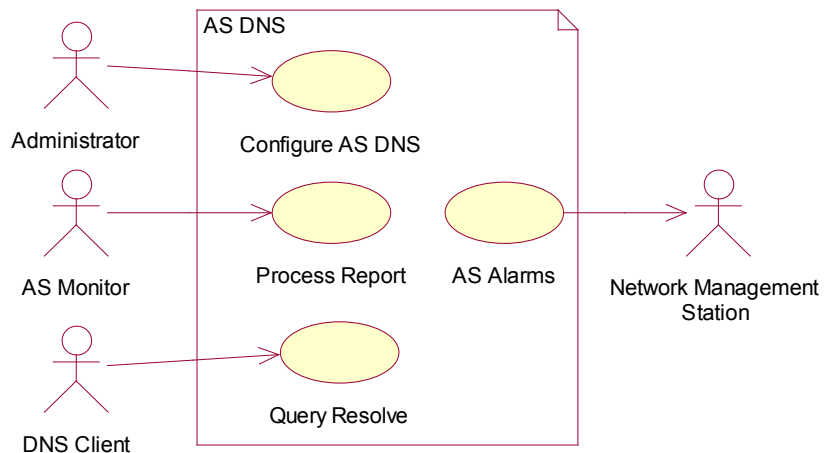


Figure 2-1 AS Monitor Function Overview



Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Figure 2-2 AS DNS Function Overview

The ActiveSelect functionality is described as follows.

1. Monitoring: AS monitor collects status/load information from nodes using external simple scripts such as PING/SNMP queries, or more complex techniques to determine the status/load of a node.
2. Reporting: collected node status/load information is reported to ASDNS server by AS monitor.
3. Processing Report: ASDNS server processes reports, and updates status/load information for related logical site and nodes in it.
4. Resolving: filtering and ordering use collected status/load information to resolve a client query. Records will be filtered from an answer that do not meet criteria such as geographical proximity or availability and records may be ordered according to the load of the corresponding nodes in a selected logical site.

a. Filtering

Records will be filtered in two ways: the first is based on the status of the node, and the second is based on the address of the client issuing the query.

If the IP address is reachable the node will be considered UP, otherwise it will be considered DOWN. Addresses of nodes that are DOWN are excluded from responses.

The IP address of issuing query is used to determine which addresses to be included in the response. For this case, the configuration will define domain name resources that includes logical sites for client address ranges. The address of a querying client will be matched with an address range and the response will only include addresses in a logical site that are defined for that range.

b. Load Balancing by Ordering

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Load values collected from monitoring may be used to implement load balancing among application resources (nodes) by ordering records in a response. After querying address matches to a client source range in a prefer policy, sites selection will give more preference to more lightly loaded site in the selected prefer policy, and node selection will give more preference to more lightly loaded node in the selected site. Thus, addresses of application resources (nodes) with a lower load value will be placed higher with higher possibility in the answer. Successive queries may receive a different order of addresses in the answer. Consequently, load balancing will work with DNS resolvers that use the first address listed in the DNS response.

5. Optimized Response: ASDNS server response to the client with an optimized answer.

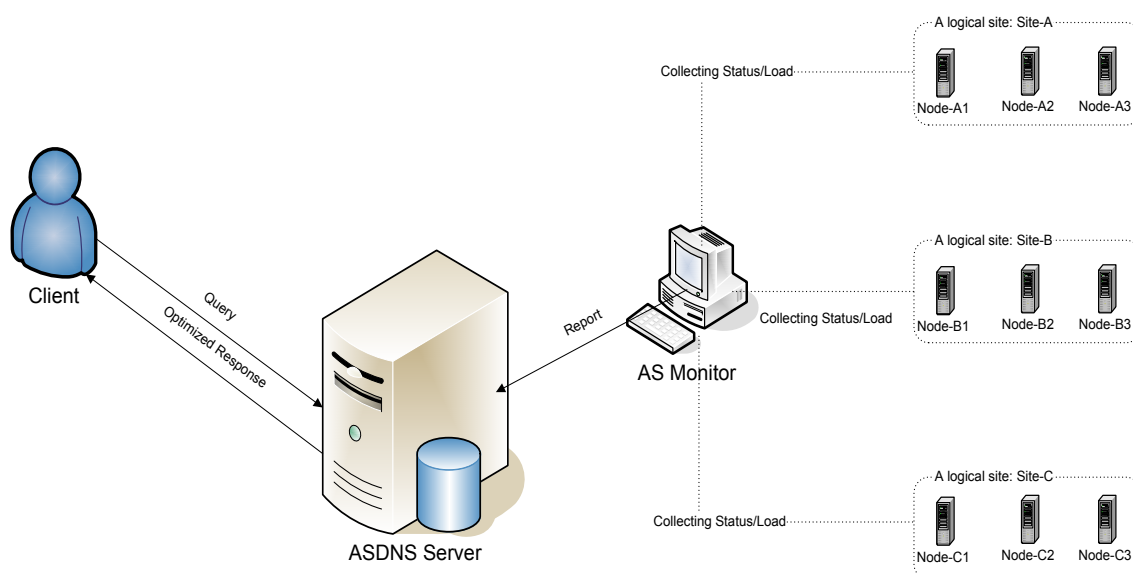


Figure 2-3 Topology Diagram for ASDNS

For example, figure 2-3 gives three logical sites “Site-A, Site-B, Site-C”:

- Each logical site contains several nodes “Node-A1, Node-A2, Node-A3”, “Node-B1, Node-B2, Node-B3”, and “Node-C1, Node-C2, Node-C3” respectively.
- Assume that a domain name resource “sh.example.com” is associated to two prefer policies “Policy-1” and “Policy-2”, which correspond to “IP-Range-1 Site-B Site-A” and “IP-Range-2 Site-C” respectively.
- “IP-Range-1 Site-B Site-A” consists of an ordered sites “Site-B Site-A” and a client address range “IP-Range-1”.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

4. "IP-Range-2 Site-C" consists of a ordered sites "Site-C" and a client address range "IP-Range-2".

5. After a client in address "IP-Client" issues a query to dnsname "sh.example.com", AS DNS server will match address "IP-Client" to client address ranges "IP-Range-1" and "IP-Range-2" in turn. If "IP-Range-1" is matched to "IP-Client", and then resolving will be based on logical sites "Site-B Site-A" in "Policy-1".

2.2 List of Actors

2.2.1 Actor:Administrator

The administrator using the IPWorks system configures AS monitor and AS DNS configuration parameters.

2.2.2 Actor:Monitored Resource

Monitored resource is a node or application resource whose status or load is collected by AS monitor.

2.2.3 Actor:AS DNS

AS DNS is a dns server that will receive and process resources' status/load report from AS monitor.

2.2.4 Actor:AS Monitor

AS Monitor is a independent process that will report status or load of monitored resources to AS DNS.

2.2.5 Actor:DNS Client

DNS Client is a user that issues DNS query to AS DNS.

2.2.6 Actor:Network Management Station

Network Management Station will receive node up and node down alarms.

2.3 List of Sub-Functions

2.3.1 Configure AS Monitor

It is used to configure AS Monitor configuration parameters.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

2.3.2 Status Monitoring

It is used to periodically execute external scripts to collect a resource status, and the interval of executing external scripts is configurable (refer to parameter "interval" in Section 4.1.2). A resource is associated with a IP address and a configurable dnsname, and its status is defined as UP (available) or DOWN (unavailable), and the status will be directly acquired from a external script.

2.3.3 Load Monitoring

It is used to periodically execute external scripts to collect a resource load, and the interval of executing external scripts is also configurable (refer to parameter "interval" in Section 4.1.2). The load definition depends on users, it can be a value "cpu idle time" or "load average" or a value that is caculated from a user predefined load model, and the load value will also be directly acquired from a external script.

2.3.4 AS Report

It is used to caculate status or load according to configued parameters dependent resources, and periodically report them to DNS server. The interval of report to DNS server is fixed as 5s.

2.3.4.1 Status

A resource status acquired from the external script will be reported as its status. A resource is configurable with one or more dependent/prerequisite resources. That means a resource status might be determined by dependent resources. If any of the dependent resources are unavailable, then this resource will also be reported as unavailable.

2.3.4.2 Load

A resource load acquired from the external script will be calculated as "be_load" and "fe_load".

be_load is calculated to affect the site congestion and fe_load is calculated to affect the node load.

be_load is calculated as following:

$$be_load = 1/w$$

"fe_load" is a load factor to change node load, which is calculated according to w(m_load) and node load p(node selected possibility) as follows.

$$fe_load = (5 - e^{\frac{\sqrt{5}}{2}w}) \times (3 + \frac{1}{e^p}) \times 0.0274 + 0.69$$

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

When w is very high, fe_load will be less than 1 and thus the node load will decline. On the other hand, when w is very low, fe_load will be higher than 1 and thus the node load will increase.

When p is high, fe_load will decrease, it will make p lower. When p is low, fe_load will become larger, it will make p higher. So that node selected possibilities can reach a balance more promptly.

The range of w is $[0, 1]$

The range of p is $[0, 1]$

The range of fe_load is $[0.87, 1.13]$

Thus, to a underloaded node, its node load will become higher. In reverse, to a overload node, its node load will become lower.

A load calculation example is in figure 2-4.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

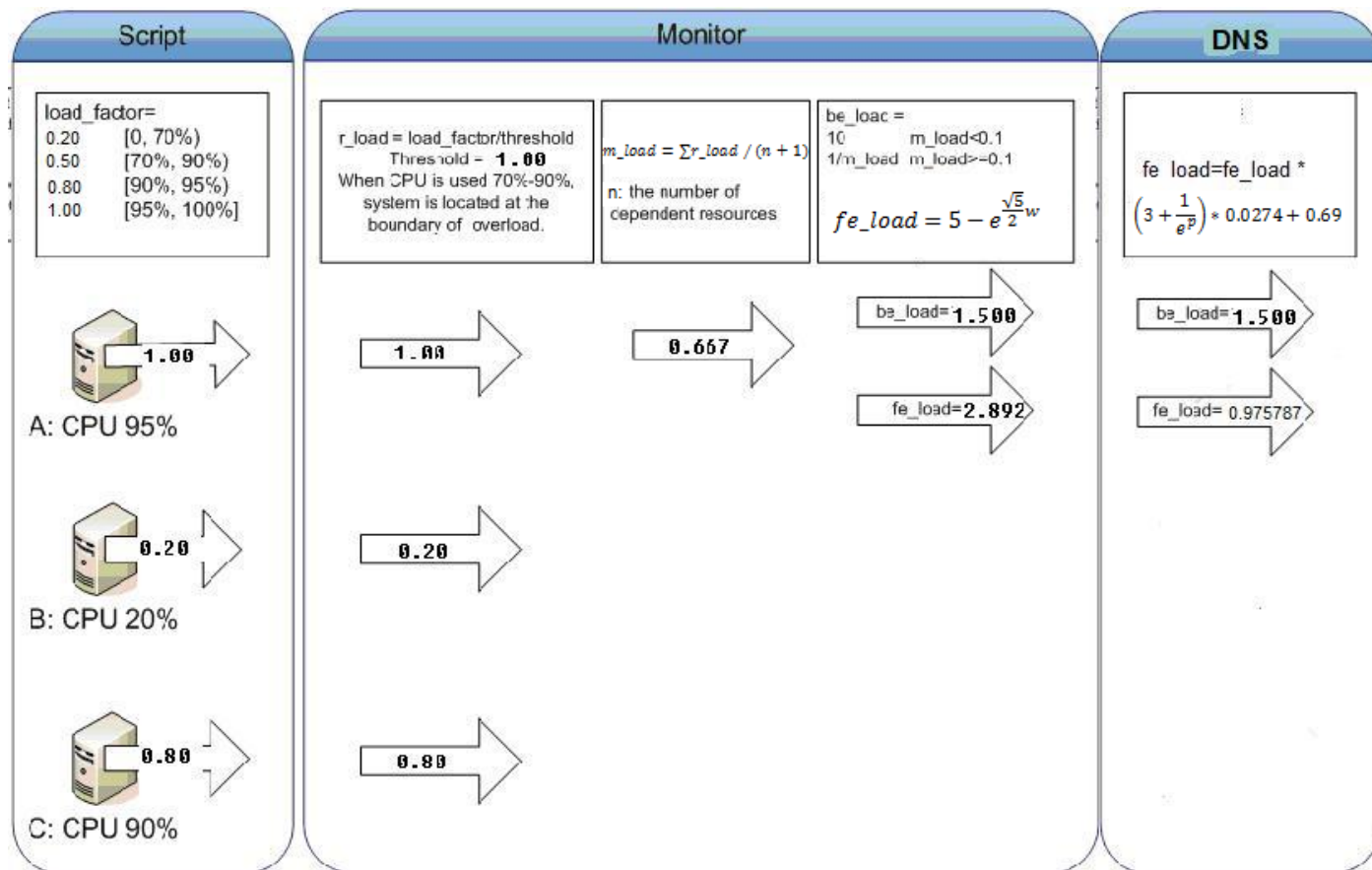


Figure 2-4 Load Calculation in Monitor

In the example, assume that there are three monitored resources A, B and C, and resource A has dependent/prerequisite resources B and C. The procedure is described as follows.

- 1) Load values "load_factor" of resource A, B, C acquired from a external script are 1.00, 0.20, 0.80.
- 2) The relative mean load r_load of resource A, B, C are caculated as 1.00 0.20, 0.80.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

- 3) The mean load “m_load” of resource A is a mean of the sum of relative loads of A and its dependent resources B and C, the caculated value is 0.667.
- 4) Lastly be_load of resouce A are caculated as 1.00658 and temporary fe_load will be calculated as 2.892, which will be reported to AS DNS server. Ultimate fe_load will be calculated with the possibility. E.g. the possibility of resouce A is 50%, the fe_load will be 0.97.

2.3.5 Configure AS DNS

It is used to configure active selection related configuration parameters in DNS server.

2.3.6 Process Report

When receiving a report from monitor, DNS server will update related status/load information, and load includes node load and site load. A update timer periodically check whether there is no any report for available nodes in a fixed time (for example 40s). The interval for the update timer is fixed as 30s.

2.3.6.1 Status Update

Logically, a site consists of a list of nodes. When DNS server receives up/dwon status report about a node every time, it will update the reported node status and corresponding site status.

If node status is reported UP (available) from one monitor, the node status will be updated as up, and corresponding site is updated as up, too. If node status is transferred from down to up, then sends a node up alarm.

If node status is reported DOWN (unavailable) from all monitors, the node status will be updated as down, and corresponding site is updated as down when there are no up nodes in its list. If node status is transferred from up to down, then sends a node down alarm.

if node status is up, but in a certain interval (for example 40s), there are no any report about the node, then node status and corresponding site statue should be set as down, and a node down alarm also should be send out.

2.3.6.2 Node Load Update

Every 5s DNS server will update the node load for all nodes with status UP in a same logical site using the latest fe_load. When DNS server receives load report from a node every time, a new fe_load will be calculated. The final caculated fraction value will be used to implement “Node Selection Possibility” - select node in resolving.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Figure 2-5 shows a example for node load update. At a certain time, assume that node_load value for node A, B, and C in a site are 0.333333 respectively. Reports from A, B, and C will be processed one by one. Every report will result in a new normalized node_load vaule, which will be used to calculate fraction for implementing "Node Selection Possibility".

- 1) After receiving A's report from monitor, where fe_load is 0.8878, node_load values of node A are caculated as 0.292974, and node B and C still have initial values 0.333333.
- 2) Then node_load values of node A, B and C are normalized as 0.305296, 0.347352, 0.347352 respectively.
- 3) Lastly, fraction will be calculated as 0.000000, 0.305296, 0.652648 for node A, B and C. Three intervals [0.000000, 0.305296], [0.305296, 0.652648], and [0.652648, 1.000000] represents the possibility value 0.305296, 0.343752, 0.343752 for selecting A, B, and C respectively. These possibility values are just the value of normalized node_load values.
- 4) After receiving reports of node B and C, fraction value are evaluated again similar to node A. When starting to process report of node B, the initial possibility values are result of A's report. When starting to process report of node C, the initial possibility values are result of B's report.

Prepared (also subject responsible if other)		No.	
ECIAMAO		51/155 17-AVA 901 16 Uen	
Approved	Checked	Date	
		2017-11-7	PD1

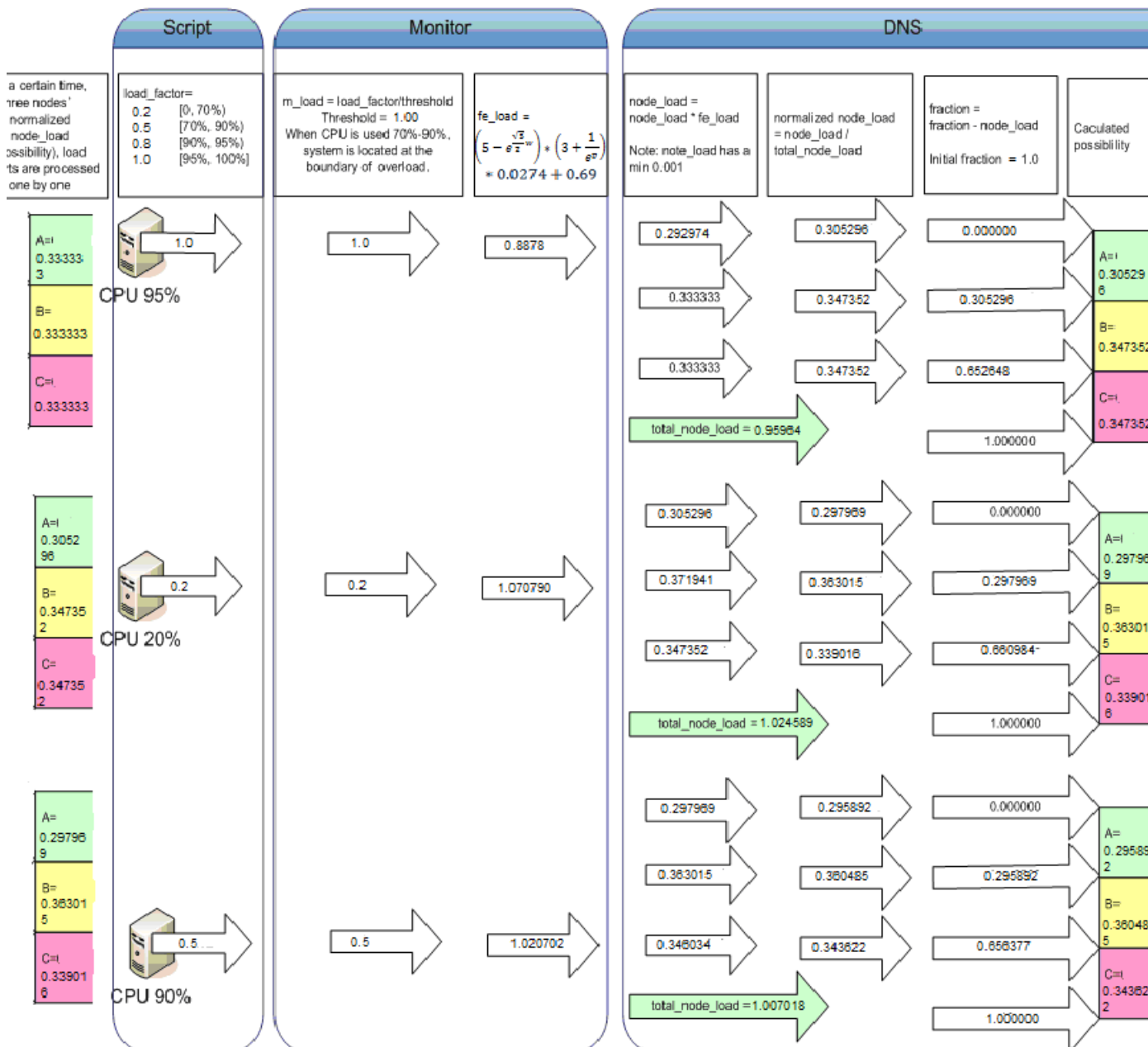


Figure 2-5 Node Load Update

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

2.3.6.3 Grouping Function

Consider this scenario, there are 3 nodes configured in one site. One node start with low load, the other two nodes start with similar high traffic load and. When the 1st node catches up with the other two nodes, its node_load is much higher than the node_load of the other two, and it will take long for them to become equal. The result is its traffic load will surpass the other two nodes and they will reach complete balance after a while. Figure 2-6 shows how traffic load and node_load changes in this scenario.

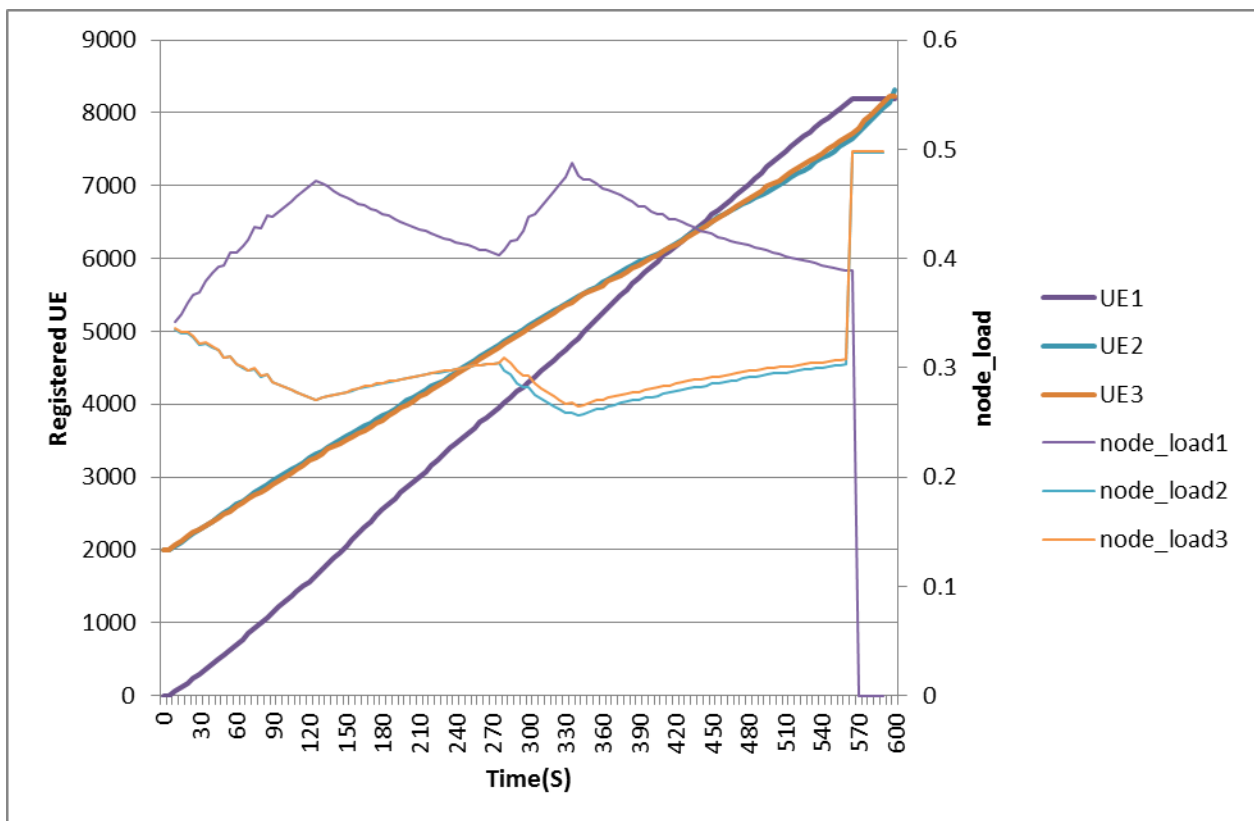


Figure 2-6 Grouping Function Disabled

Grouping Function is introduced to solve this problem, this function is an optional function and it provides more accurate load balance control.

After the node load update for one node, if Grouping function is enabled, it will go below procedure:

- 1) The grouping function uses the extra percent value got from monitor script and ASDNS_PERCENT_DIFF to determine whether there are nodes have the similar load as below formula shows.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Percent_of_current_node – Percent_of_other_node <= ASDNS_PERCENT_DIFF

If yes, these nodes will form a group. After compare with all other nodes in one site, possibilities(node_load) of the nodes in one group will be set to equal value (Their average).

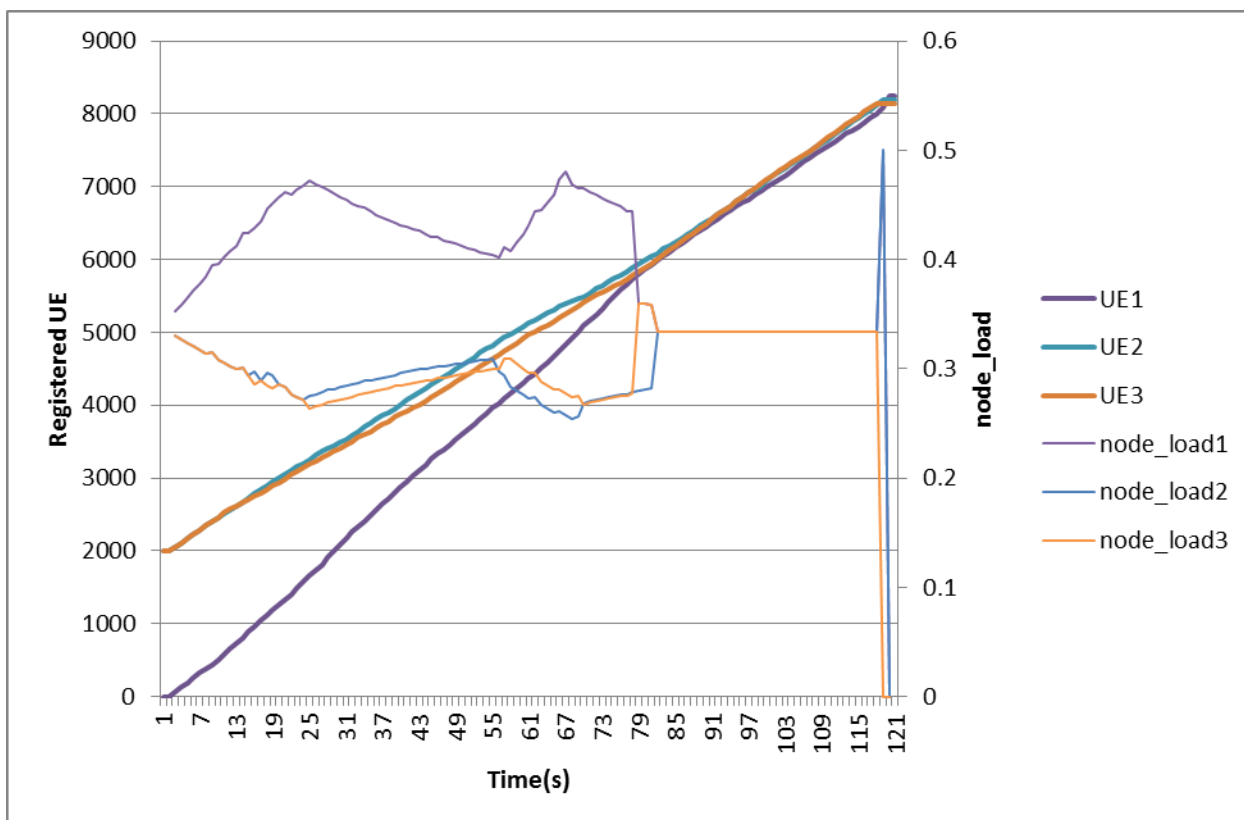
2) ASDNS_PERCENT_DIFF defines whether enable or disable the grouping function and defines its value. The value can be integer -1 ~ 5.

-1(default) Disable
0~5 Enable

3) Percent value is the percentage of node's load, it is a integer from 0 to 100. The way to calculate percent value is different regarding different usage scenario.

In the predefined monitor script snmpmonitor_percent, percent value is (Number of Error query)/(Number of Total query). For SBC in IMS, percent value could be (Number of Current Registered user)/(Number of Max user capacity).

Figure 2-7 shows how traffic load and node_load changes when this function is enabled.



Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Figure 2-6 Grouping Function Enabled

This function can only be applied when the type of MonitorMethod is load. And the recommended monitor interval is equal or less than 15s.

2.3.6.4 Site Load Update

Logically, a resource configured as Active Selection consists of a list of sites. After DNS server updates a node load, it will update the related site congestion and site load for all sites in a resource. Site congestion will be used to select site firstly; if no selected site, site_load will be used to calculate fraction for implementing "Site Possibility Selection".

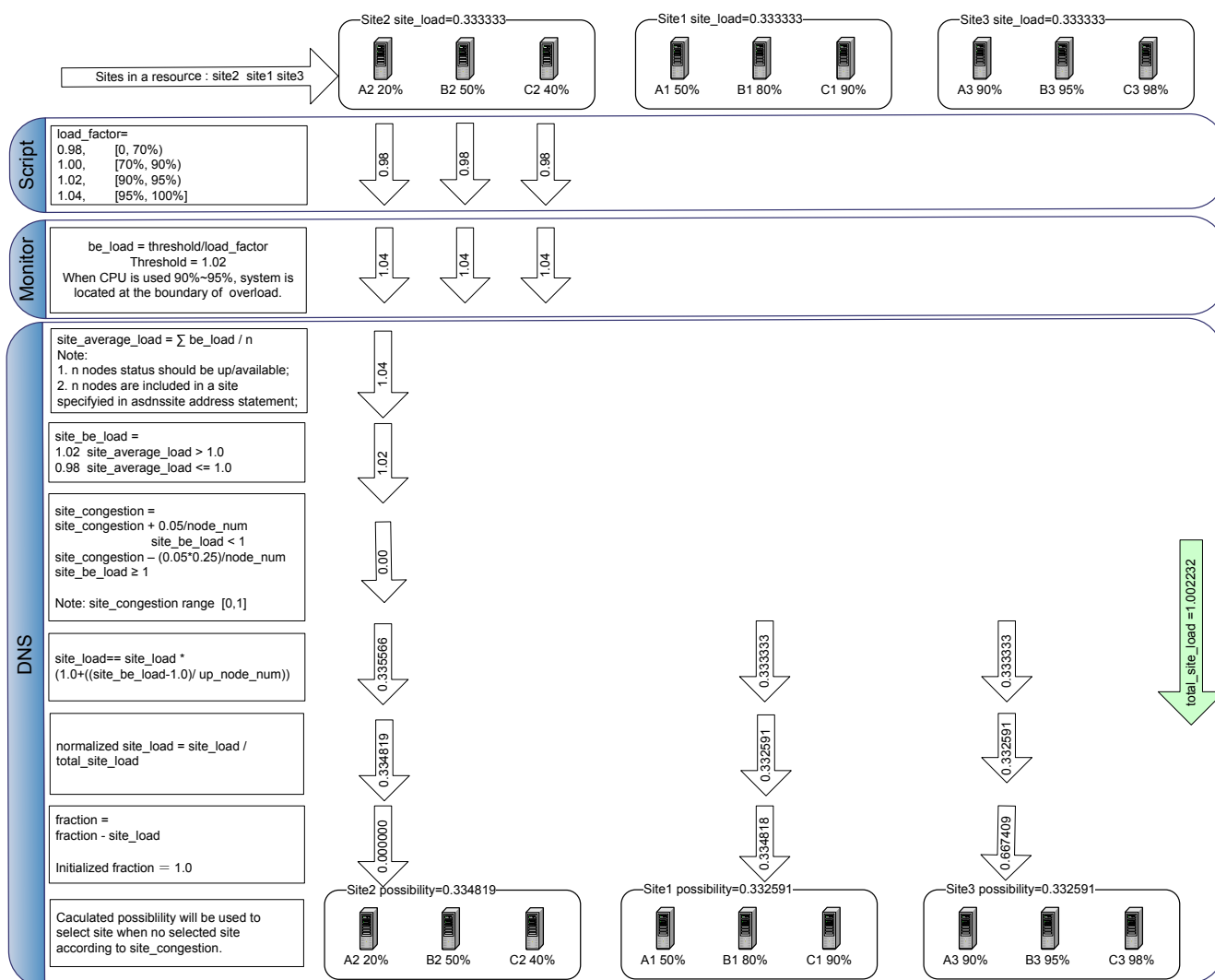


Figure 2-8 Site Load Update

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Figure 2-8 shows a example process of site load update. At a certain time, assume that site_load values of site2 and site1 and site3 are 0.333333 respectively. The be_load values for three nodes in site2 are 1.04. Three sites site1, site2, and site3 is in a prefer, and only the prefer is included in the resource. Report from A2 of site2 is processed as follows.

- 1) According to A2's report from monitor, site_average_load value for site2 is calculated as 1.04;
- 2) Calculate site_congestion levels and site_load value as 0.000000 and 0.335566.
- 3) Normalize site_load across three sites: site2, site1 and site3. The nomalized results are 0.334819, 0.332591, 0.332591.
- 4) Final fractions are calculated as 0.000000, 0.334818, 0.667409. Three intervals [0.000000, 0.334818], [0.334818, 0.667409], and [0.667409, 1.000000] represents the possibility value 0.334819, 0.332591, 0.332591 for selecting site2, site1, and site3 respectively. These possibility values are just the value of normalized site_load values.

2.3.7 AS Alarms

When receiving node down/up notification from Process Report function, it will send node down or node up alarms to Network Management Station through SNMP Agent.

2.3.8 Query Resolve

DNS server will use updated status and caculated possibility to select site and node for respond DNS client appropriately when a query is made for a dnsname resource.

Figure 2-9 shows a example process of site and node selection. At a certain time, assume site_congestion values of site2 and site1 and site3 are 0.5, 0.2, 0.8 respectively, and site_load values are 0.2, 0.7, 0.1 respectively. The node_load values of node A2, B2, C2 in site2 are 0.3, 0.2, 0.5; node A1, B1, C1 in site1 are 0.4, 0.3, 0.6 (Node B1 is down.); node A3, B3, C3 in site3 are 0.8, 0.1, 0.1 respectively. When client issues a query for a dnsname resource that is related to logical sites site3, site2, and site1, the following selection shows resolving procedure.

- 1) Select the first site satified with the condition site_congestion <= rand_num. Here random number is 0.40 and site_congestion of site2, site1, site3 are 0.5, 0.2, 0.8, so site1 are selected.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

- 2) If random number is 0.90, then no satisfied site according to site_congestion, so continue to select site according to site_load. site1 has a maximum site_load value 0.7, and it means that site1 can be selected with a possibility 70%. Assume that site1 are selected.
- 3) Then select node in site1 according to node_load. Node B1 is down, so select node among A1 and C1. Node C1 has a maximum node_load value 0.6, and it means that node C1 can be selected with a possibility 60%. So the fraction_A1=[0, 0.4], fraction_C1=[0.4, 1]. A random number ranging in [0, 1] will be generated, The fraction the number belongs to will determine which node will be selected. Assume that node C1 are selected.
- 4) Address corresponding to the selected node C1 will be placed at the first item in the answer, and address corresponding to down node B1 will be filtered. The final sequence in the response will be C1, A1.

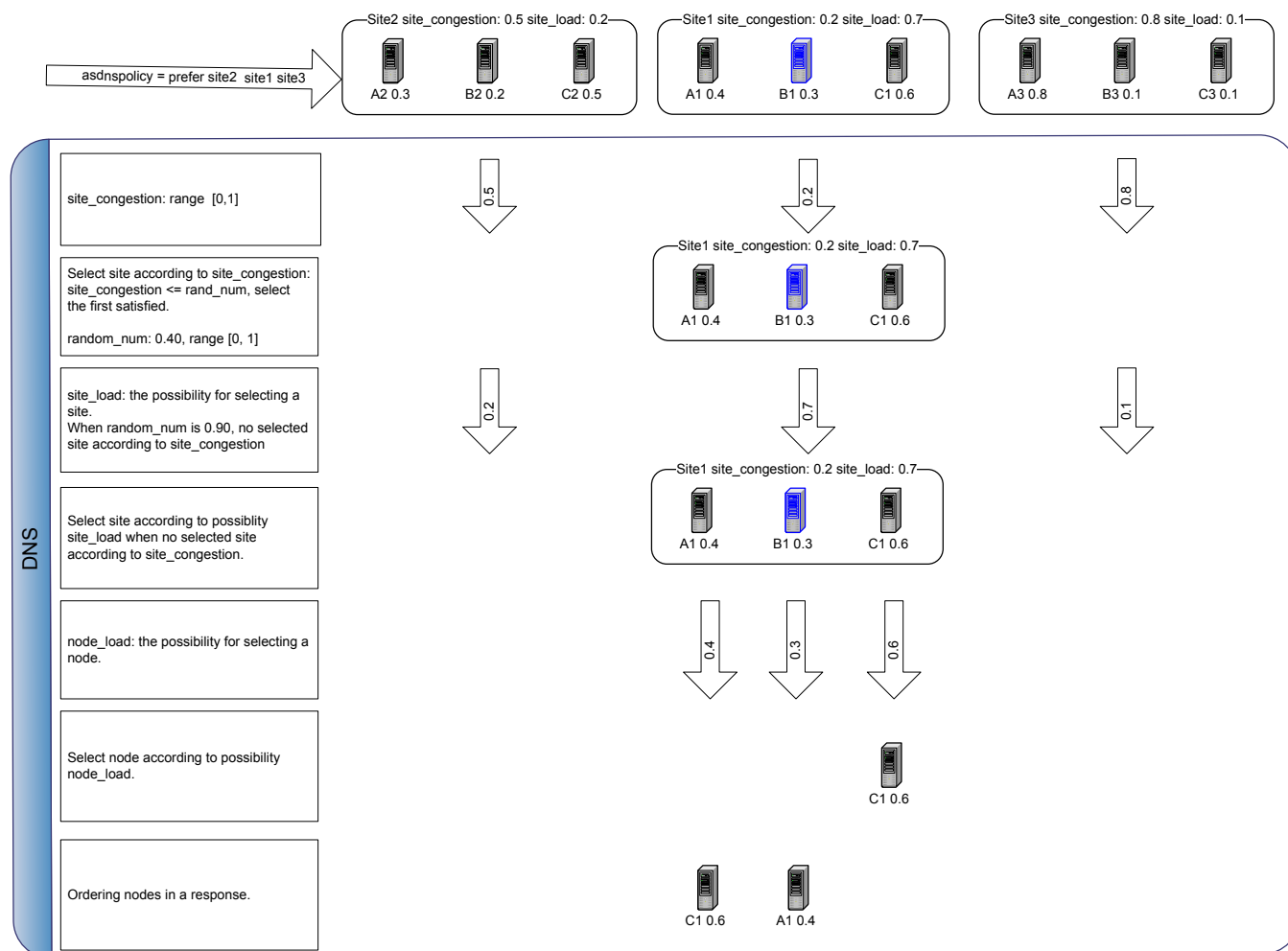


Figure 2-9 Site and Node Selection for Query Resolve

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

3 Detailed Description

3.1 Configure AS Monitor

3.1.1 Main Scenario

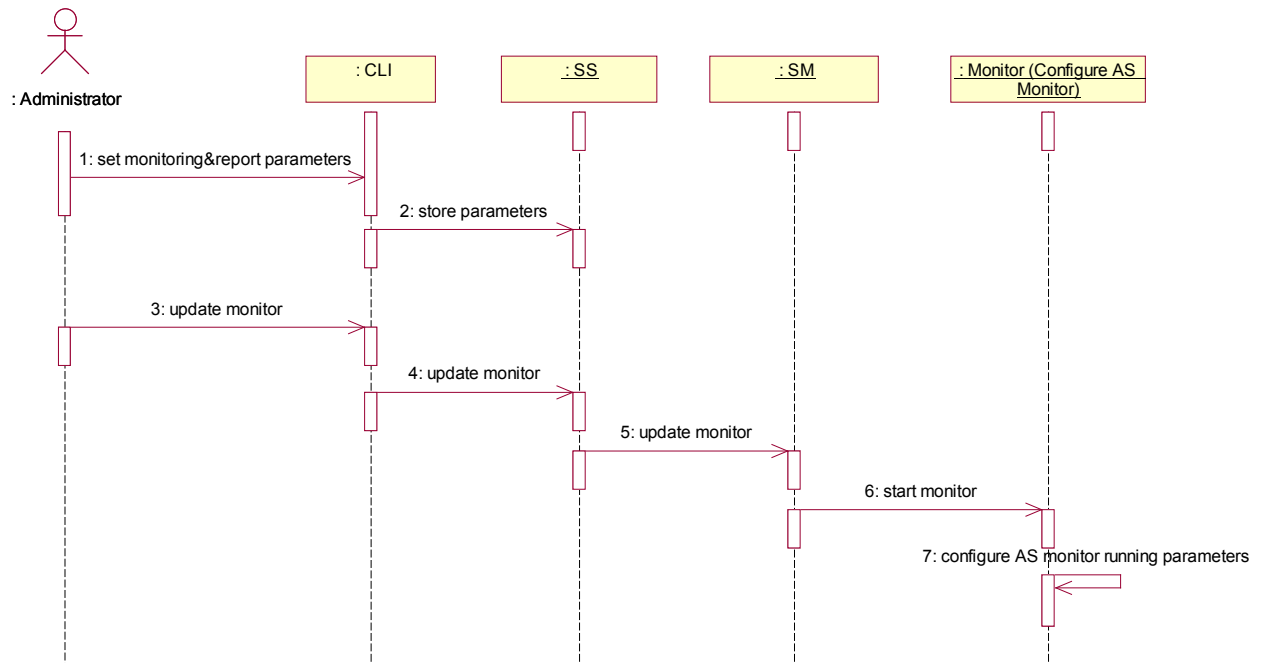


Figure 3-1 Configure AS Monitor

1. Administrator sets monitoring&report parameters through CLI;
2. SS stores the parameters into DB;
3. Administrator issues update monitor command to CLI;
4. CLI issues update monitor command to SS;
5. SS issues update monitor command to SM, and then SM updates monitor configure file asdnsmon.conf;
6. SM starts monitor;
7. Configure AS Monitor function configures AS monitor running parameters.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

3.2 Status Monitoring & Load Monitoring

The precondition is that monitor has been started.

3.2.1 Main Scenario

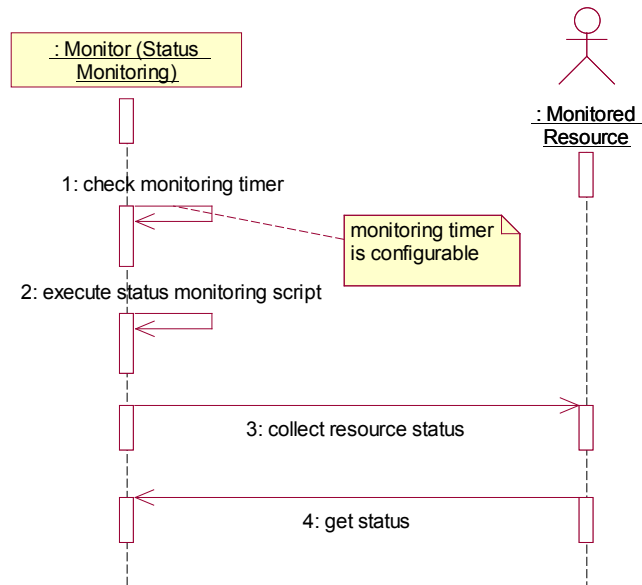


Figure 3-2 Status Monitoring

1. Status Monitoring checks whether or not monitoring timer expire;
2. When monitoring timer is expired, Status Monitoring according to configured monitoring parameters, such as monitored resource IP address, external monitor script and its input parameters, executes status monitoring script;

Owing to monitor type is specified as “status” and Status Monitoring function uses status monitoring script, only UP/DOWN status are monitored;
3. Status Monitoring function collects resource status from monitored resources.
4. Status Monitoring function gets status.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

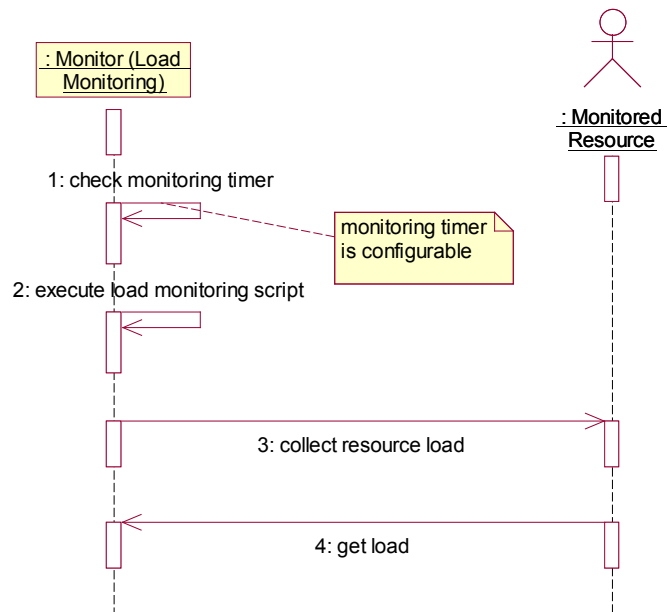


Figure 3-3 Load Monitoring

1. Load Monitoring checks whether or not monitoring timer expire;
2. When monitoring timer is expired, Load Monitoring according to configured monitoring parameters, such as monitored resource IP address, external monitor script and its input parameters, executes load monitoring script;

Owing to monitor type is specified as “load” and Load Monitoring function uses load monitoring script, in addition to load is monitored, according to whether or not there is returned load after executing load monitoring script, status can also be monitored.

3. Load Monitoring function collects load from monitored resources.
4. Load Monitoring function gets load.

3.3 AS Report

The precondition is that monitor has been started.

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Approved	Checked	Date 2017-11-7	PD1

3.3.1 Main Scenario

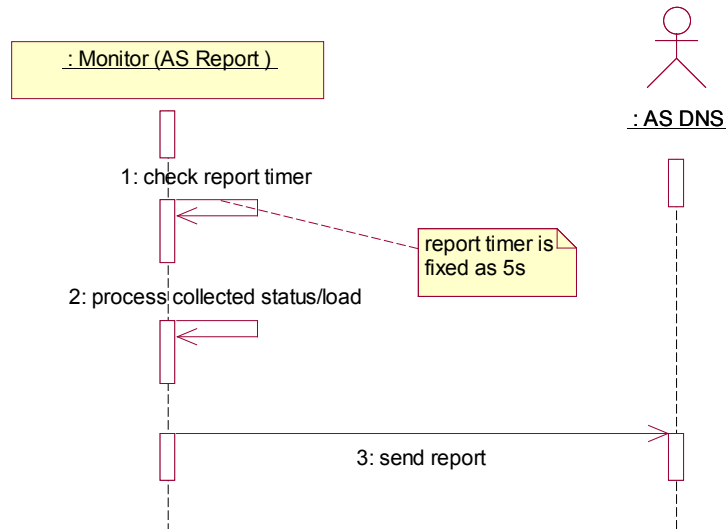


Figure 3-4 Report

1. AS Report function checks whether or not report timer expire;
2. When report timer is expired, according to configured report parameters, such as dependent/prerequisite resources, threshold, AS Report function processes collected status/load;
3. According to configured report parameters, such as DNS server and TSigkey, AS Report function sends report to AS DNS server.

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Approved	Checked	Date 2017-11-7	PD1

3.3.2 Alternative Scenarios

3.3.2.1 Node DOWN

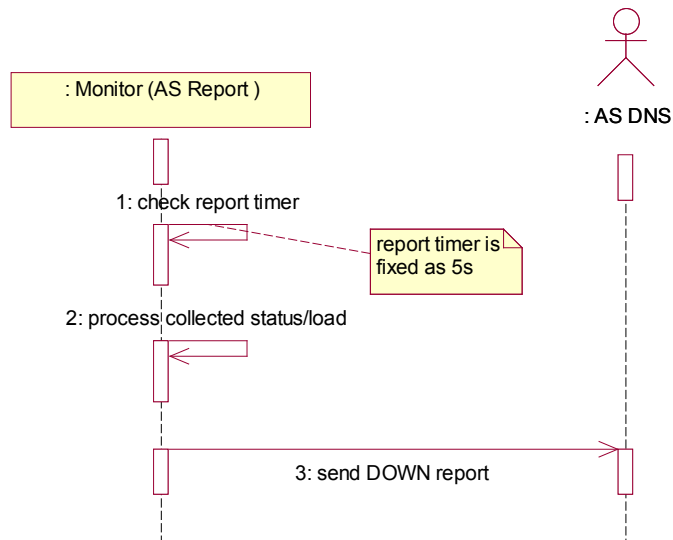


Figure 3-5 Node DOWN

1. AS Report function checks whether or not report timer expire;
2. When report timer is expired, according to configured report parameters, such as dependent/prerequisite resources, threshold, AS Report function processes collected status/load;
3. According to configured report parameters, such as DNS server and TSigkey, if current status of monitored resource is DOWN and previous status is UP (initial default status can be seen as UP), AS Report function reports status DOWN information to AS DNS server.

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Approved	Checked	Date 2017-11-7	PD1

3.3.2.2 Node UP

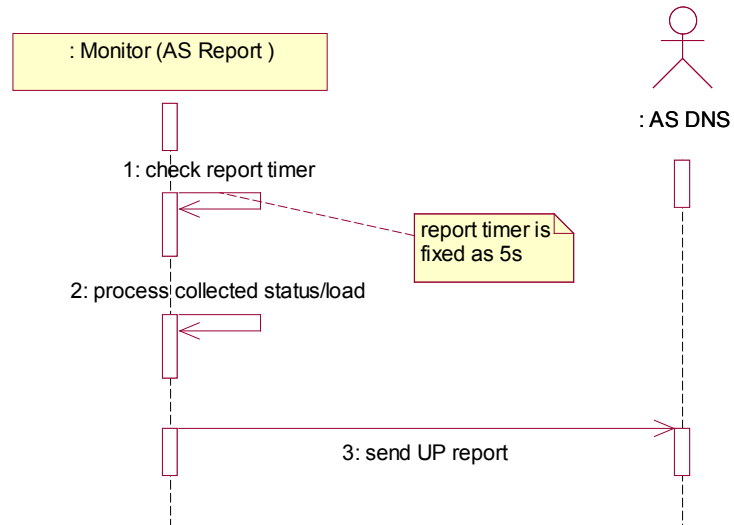


Figure 3-6 Node UP

1. AS Report function checks whether or not report timer expire;
2. When report timer is expired, according to configured report parameters, such as dependent/prerequisite resources, threshold, AS Report function processes collected status/load;
3. According to configured report parameters, such as DNS server and TSigkey, if current status of monitored resource is UP and previous status is DOWN (initial default status can be seen as UP), AS Report function reports status UP information to AS DNS server.

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Approved	Checked	Date 2017-11-7	PD1

3.4 Configure ASDNS

3.4.1 Main Scenario

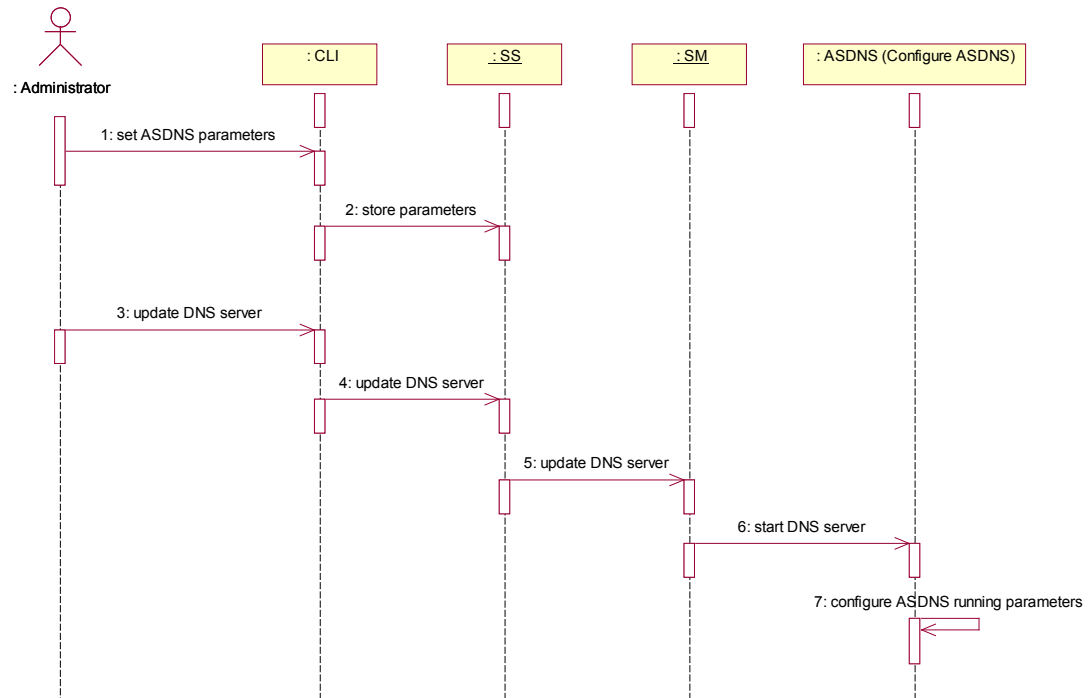


Figure 3-7 Configure ASDNS

1. Administrator sets Active Selection related parameters through CLI;
2. SS stores the parameters into DB;
3. Administrator issues update DNS server command to CLI;
4. CLI issues update DNS server command to SS;
5. SS issues update DNS server command to SM, and then SM updates ASDNS configure file asdns.conf;
6. SM starts DNS server;
7. Configure ASDNS function configures AS DNS server running parameters.

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Approved	Checked	Date 2017-11-7	PD1

3.5 Process Report & AS Alarms

The precondition is that DNS server has been started.

3.5.1 Main Scenario

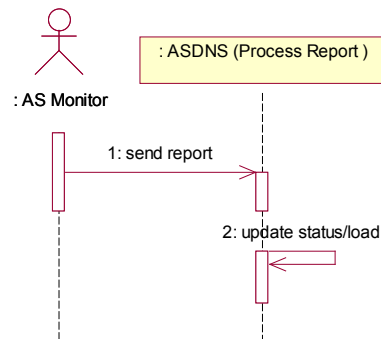


Figure 3-8 Process Report

1. AS Monitor sends report to ASDNS server and triggers Process Report;
2. ASDNS server updates related sites and nodes status/load;

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Approved	Checked	Date 2017-11-7	PD1

3.5.2 Alternative Scenarios

3.5.2.1 Report UP

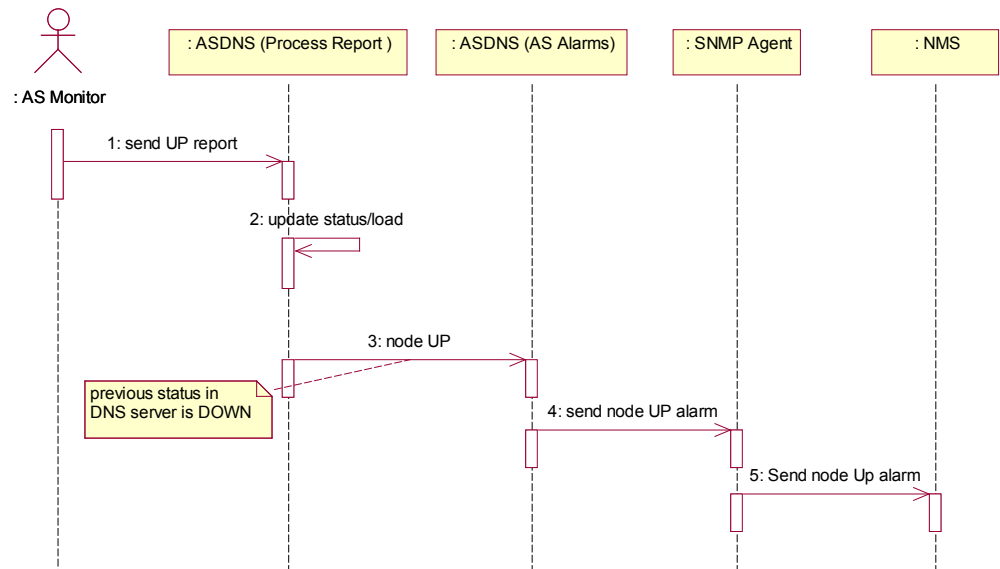


Figure 3-9 Report UP

1. AS Monitor sends UP report to ASDNS server and triggers Process Report function;
2. ASDNS server updates related sites and nodes status/load;
3. If the previous node status is DOWN, Process Report function notifies AS Alarms function node UP;
4. AS Alarms function communicates with SNMP agent to send node UP alarm;
5. SNMP agent sends node UP alarm to NMS;

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Approved	Checked	Date 2017-11-7	PD1

3.5.2.2 Report DOWN

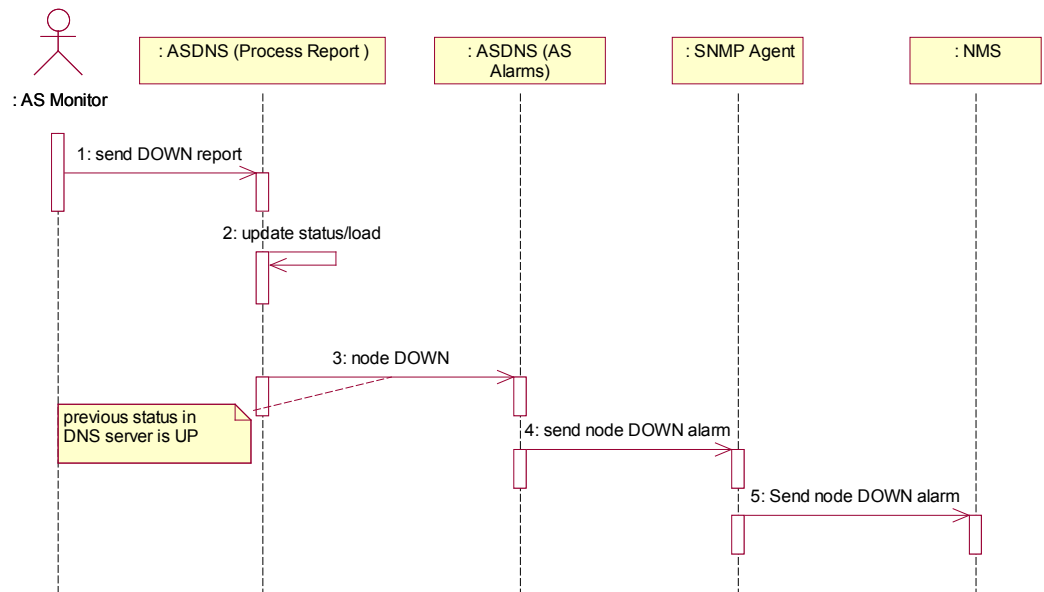


Figure 3-10 Report DOWN

1. AS Monitor sends DOWN report to ASDNS server and triggers Process Report function;
2. ASDNS server updates related sites and nodes status/load;
3. If the previous node status is UP, Process Report function notifies AS Alarms function node DOWN;
4. AS Alarms function communicates with SNMP agent to send node DOWN alarm;
5. SNMP agent sends node DOWN alarm to NMS;

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Approved	Checked	Date 2017-11-7	PD1

3.5.2.3 Report Timeout

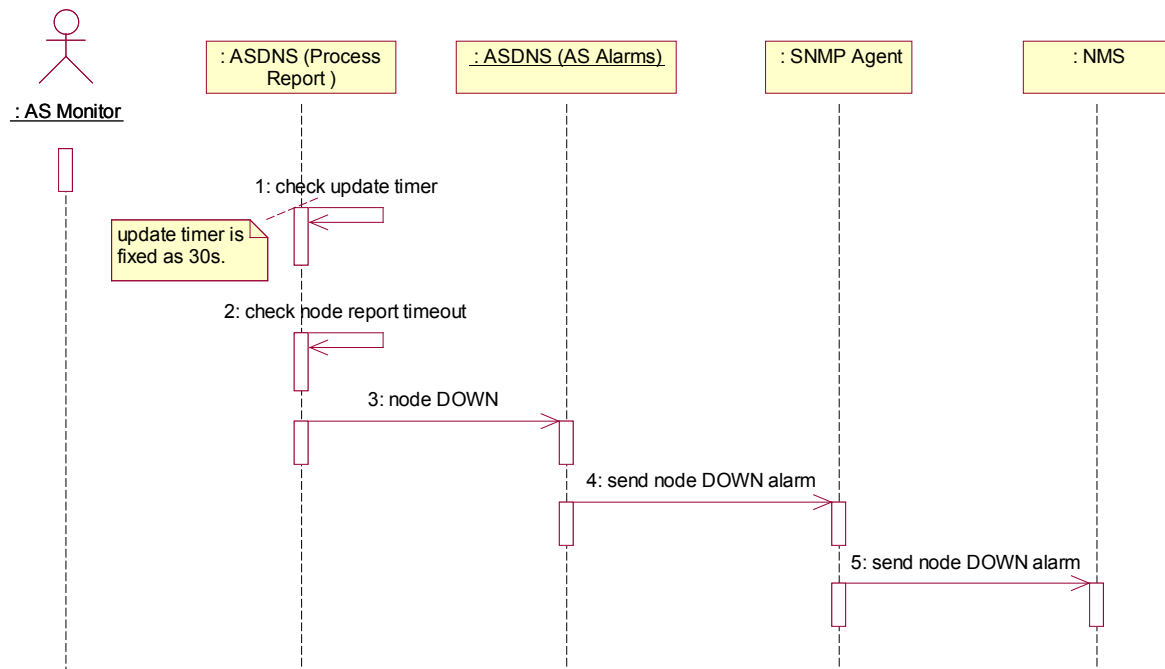


Figure 3-11 Report Timeout

1. Process Report function checks whether or not update timer expire;
2. When update timer is expired, Process Report function checks all nodes one by one, and confirms whether report for a node is timeout in a specified interval (40s);
3. If it is timeout for some nodes, Process Report function assumes that the nodes are down and notifies AS Alarms function node timeout DOWN;
4. AS Alarms function communicates with SNMP agent to send node down;
5. SNMP agent sends node down alarm to NMS;

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Approved	Checked	Date 2017-11-7	PD1

3.5.2.4 Report Error

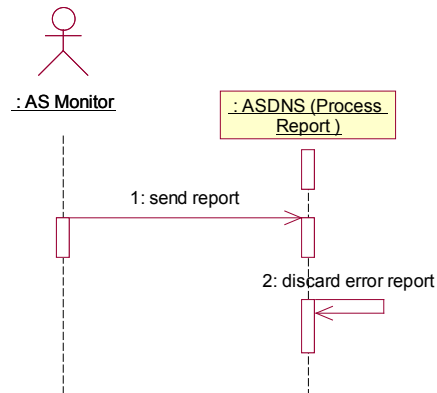


Figure 3-12 Report Error

1. AS Monitor sends report to Process Report function in ASDNS server;
2. If there is no configured AS DNS record for related report, or TSIGkey is not allowed by DNS server, discard the error report;

3.6 Query Resolve

The precondition is that DNS server has been started.

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Approved	Checked	Date 2017-11-7	PD1

3.6.1 Main Scenario

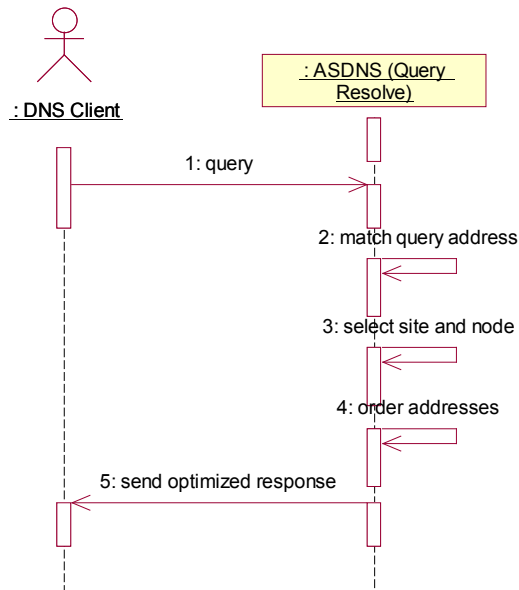


Figure 3-13 Resolving

1. DNS Client issues dnsname query request to DNS server;
2. Query Resolve function matches the address of the querying client to an address range of one of prefers configured for the dnsname resource;
3. Query Resolve function selects a site in logical sites of selected prefer, and then select a node in the selected site.
4. Query Resolve function orders the addresses. The address corresponding to the selected node will be placed at the first in the answer, and other addresses corresponding to unselected nodes in the selected site are placed subsequently.
5. Sends optimized response to DNS client;

3.6.2 Alternative Scenarios

3.6.2.1 Match Querying Address Fail

1. DNS Client issues dnsname query request to DNS server;
2. Query Resolve function can not match the address of the querying client to an address range of one of prefers configured for the dnsname resource;

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

3. Sends DNS response to DNS client, that means respond like a DNS server;

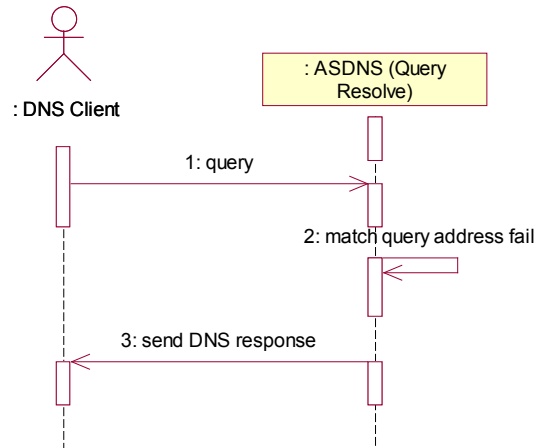


Figure 3-14 Match Querying Address Fail

3.6.2.2 Select Site Fail

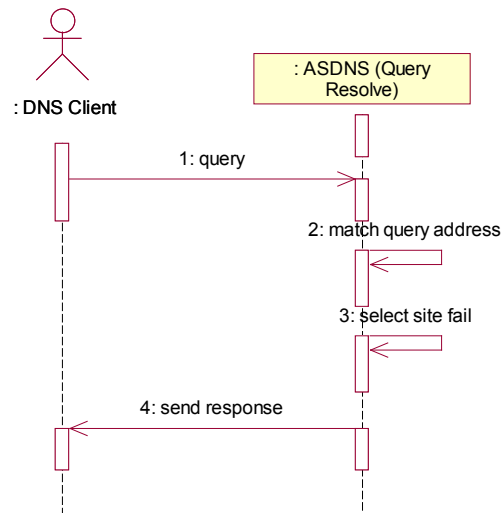


Figure 3-15 Select Site Fail

1. DNS Client issues dnsname query request to DNS server;
2. Query Resolve function matches the address of the querying client to an address range of one of prefers configured for the dnsname resource;

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

3. Query Resolve function can not select a site in logical sites of selected prefer.

4. Sends response to DNS client according to the following failure strategy (default failure strategy is “default”):

none - response no any records;

site - response all matched records in all sites in the selected prefer;

default - response as a DNS server;

4 Operational Conditions

4.1 Configurable Parameters

In CLI, ASDNS and Monitor related parameters can be configured through commands `create`, `modify`, `delete`, and `update`.

Command `create` is used to create the new ASDNS related objects (asdns site, asdns policy, and asdns record) or create the new Monitor related objects (monitor, monitor method, and monitor resource) with specified parameters.

Command `modify` is used to modify the created ASDNS related objects (asdns site, asdns policy, and asdns record) or modify the created Monitor related objects (monitor, monitor method, and monitor resource) with specified parameters.

Command `delete` is used to delete the created ASDNS related objects (asdns site, asdns policy, and asdns record) or delete the created Monitor related objects (monitor, monitor method, and monitor resource).

Command `update` is used to update the ASDNS server or Monitor with new Active Selection configuration information.

4.1.1 Configurable Parameters for ASDNS

ASDNS related parameters can be configured for asdns site, asdns policy, and asdns record through commands `create`, `modify`, `delete`, and `update`.

4.1.1.1 ASDNS Site

```
create asdnssite -set name=<site_name>;address=<node1_ip,[node2_ip, ...]>;returncount=<count>;
```

```
modify asdnssite <site_name> -set address=<node1_ip,[node2_ip, ...]>;returncount=<count>;
```

```
delete asdnssite <site_name>;
```

Asdns site related parameters:

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

- name: the name of the site. The commands operate a site with name <site_name>.
- address: define the IP addresses for a collection of nodes to be considered in a logical site. Here, a logical site may group a list of IP addresses <node1_ip, node2-ip, ...>.
- returncount: When addresses from a site are being returned in response to a resolver query, this indicates that the maximum number of addresses <count> may be returned.

4.1.1.2 ASDNS Policy

```
create asdnspolicy -set name=<policy_name>;prefer="[<source-range>] prefer <site1> [<site2> ...] [<failure-strategy>]";
```

```
modify asdnspolicy -set name=<policy_name>;prefer="[<source-range>] prefer <site1> [<site2> ...] [<failure-strategy>]";
```

```
delete asdnspolicy <policy_name>;
```

Asdns policy related parameters:

- name: the name of the asdns policy. The commands operate a policy with name <policy_name>.
- prefer: it defines the site preferences for a policy, and the syntax is: [<source-range>] prefer <site1> [<site2> ...] [<failure-strategy>]. A <source-range> is used to match client query address. If it matches, then the sites site1 and site2 are checked in the order specified by the prefer statement until a available site is found. <failure-strategy> indicates that if all of the addresses associated with the sites in a prefer are reported as down, one of three optional keywords (site, none or default) may be used to specify what behavior will occur.
- Site: the resource records for all sites in the list will be returned.
- none: no resource records will be returned.
- default: all matching resource records in the zone (including the ones not in the preferred sites) will be returned.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

4.1.1.3 ASDNS Record

```
create asdnsrecord -set dnsname=<dns-name>;policy=<policy-name>;tsigkey=<tsig-key-name>;alternatednsname=<alternative-dns-name>;
```

```
create asdnsrecord -set dnsname=<dns-name>;policy=<policy-name>;tsigkey=<tsig-key-name>;alternatednsname=<alternative-dns-name>;
```

```
delete asdnsrecord <dns-name>;
```

Asdns record related parameters:

- **dnsname:** The domain name of a resource for which ASDNS function is enabled and queries will be filtered and balanced. The commands operate a record with <dns_name>.
- **tsigkey:** a TSIG key will be used by the DNS server to validate the signature on reports received from the monitor. Here it is set as <tsig-key-name>.
- **alternatednsname:** Alternate dns name that will be considered to be aliase of dnsname <dns-name>. <alternative-dns-name> is a alias of <dns-name>.
- **policy:** the policy that will be used to resolve asdns record. Here, a policy name <policy-name> is set.

4.1.1.4 ASDNS_PERCENT_DIFF

ASDNS_PERCENT_DIFF defines whether to enable or disable the grouping function and defines its value.

The value is use to determine whether two nodes can be form a group. If the difference of the percent value of two nodes is less than ASDNS_PERCENT_DIFF as formula below shown, this means these two nodes have the same level of load, then they can be put into a group. In a group, possibilities of the nodes will be set to the same value.

$$\text{Percent_of_current_node} - \text{Percent_of_other_node} \leq \text{ASDNS_PERCENT_DIFF}$$

The value can be integer -1 ~ 5.

-1(default) Disable

0~5 Enable

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

4.1.1.5 Update ASDNS Server

```
update dnsserver <server-name>;
```

Command `update` is used to update DNS server with new Active Selection configuration information, which include the above `asdns` site, `asdns` policy, and `asdns` record. The updated DNS server has name `<server-name>`.

4.1.2 Configurable Parameters for Monitor

Monitor related parameters can be configured for monitor, monitor method, and monitor resource record through commands `create`, `modify`, `delete`, and `update`.

4.1.2.1 Monitor

```
create monitor -set name=<monitor-name>;address=<host-ip>;
```

```
modify monitor <monitor-name> -set address=<host-ip>;
```

```
delete monitor <monitor-name>;
```

Monitor related parameters:

- **name:** the name of the created monitor. The commands operate a monitor with name `<monitor-name>`.
- **address:** the address where monitor runs. The monitor `<monitor-name>` runs on host `<host-ip>`.

4.1.2.2 Monitor Method

```
create monitormethod -set name=<method-name>;filename=<external-script-name>;interval=<time-interval>;argument=<arg1,arg2,...>;threshold=<overload-threshold>;type=<script-type>;
```

```
modify monitormethod <method-name> -set filename=<external-script-name>;interval=<time-interval>;argument=<arg1,arg2,...>;threshold=<overload-threshold>;type=<script-type>;
```

```
delete monitormethod <method-name>;
```

Monitor method related parameters:

- **name:** the name of the monitor method. The commands operate a monitor method with name `<method-name>`;
- **filename:** The file name of the script that is used to perform monitoring. In the examples, a external script file name is `<external-script-name>`.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

- **Interval:** specify frequency, how often the monitoring script runs in order to collect status/load information. In the example, script `<external-script-name>` will periodically execute according to interval `<time-interval>`.
- **argument:** defines value(s) that should be passed to the script as command line parameters. In the example, the argument `<arg1, arg2, ...>` will be passed to the script `<external-script-name>` when executing.
- **threshold:** specifies a overload threshold for a monitored resource. Here the threshold is `<overload-threshold>`.
- **type:** the type of monitoring script that is executed by a monitor, for example, `<script-type>` may be set as status or load.

4.1.2.3 Monitor Resource

```
create monitorresource -set name=<resource-name>;monitor=<monitor-name>;method=<method-name>;address=<monitored-target-ip>;dnsname=<dns-name>;prerequisite=<dependent-resource-name>;port=<port-number>;reportcontact=<dns-server-contact>;
```

```
modify monitorresource <resource-name> -set monitor=<monitor-name>;method=<method-name>;address=<monitored-target-ip>;dnsname=<dns-name>;prerequisite=<dependent-resource-name>;port=<port-number>;reportcontact=<dns-server-contact>;
```

```
delete monitorresource <resource-name>;
```

Monitor resource related parameters:

- **name:** the name of the created resource. The commands operate a monitored resource with name `<resource-name>`.
- **address:** specify the target resource IP address to be monitored. Here the monitored resource has IP `<monitored-target-ip>`.
- **dnsname:** The domain name correspond to address of the monitored resource. It allows the monitor to differentiate between two resources with the same address. Here it is set as `<dns-name>`.
- **prerequisite:** specifies a list of dependent resources. Here it is another created monitor resource with name `<dependent-resource-name>`.

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

- port: The TCP/IP port that should be used to monitor the resource. Here it is <port-number>.
- reportcontact: specify which dns server(s) should receive the monitoring information, and what TSIG key should be used to sign messages. Here report contact is specified as <dns-server-contact>.

4.1.2.4 Update Monitor

update monitor <monitor-name>;

Command `update` is used to update Monitor with new Active Selection configuration information, which include the above monitor, monitor method, and monitor resource. The updated monitor has name <monitor-name>.

4.1.3 Configurable Monitor Scripts

Monitor scripts are configured for monitor to obtain load or status information that will be sent to DNS server.

The user may create customized scripts. They can utilize any available values to derive the load and status information. If successful, the script must write the appropriate value as a single line of ASCII text to its standard output and return an exit status of 0. If unsuccessful, the script must write any error text (describing the failure) to standard output and return a non-zero exit status. Different failures should be distinguished with different error text written to standard output and different (non-zero) exit status values.

Sample scripts are provided with the ActiveSelect DNS Monitor that may be used or customized to satisfy user requirements.

4.1.3.1 Ping

A example Ping script “pingmonitor” can be used to get the status of an monitored resource with a specified IP address. A UNIX shell script which uses the Ping utility is showed as follows. Through CLI, two arguments “address” and “timeout” can be configured. When script “pingmonitor” is called, the two configured arguments will be passed to the following \$1 and \$2 respectively, and unix command “ping \$1 \$2” will be executed, and then “exit \$?” will return a status value (0 for UP/available or any other non-negative value for DOWN/unavailable) upon exit.

This Ping scripts example shows users how to use other scritps to implement status monitoring, if successful, the script must return an exit status of 0, and if unsuccessful, the script must return a non-zero exit status.

```
#!/bin/sh
```

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

USAGE="usage: pingmonitor <address> [timeout]"

if [\$1]

then

ping \$1 \$2

else

echo \$USAGE

fi

exit \$?

4.1.3.2 SNMP

IPWorks provides a set of utilities to obtain SNMP values from a manageable object.

- snmpget
- snmpgetnext
- snmpbulkget
- snmptable
- snmpwalk

The script may obtain a value or set of values using an object OID or, having configured a MIB, using an SNMP name.

4.1.3.2.1 SNMP Returning with Load Value

A example SNMP script "snmpmonitor" can be used to get the status and load of an monitored resource with a specified IP address. Assume that a statistic file on a monitored resource stores four variable values, which correspond to four different OID (see Table 4.1).

Table 4.1 SNMP Mibs OID

Variable	OID
ipworksASDTQueryRequests	1.3.6.1.4.1.193.113.2.1.1.2.1.0
ipworksASDTQueryFailures	1.3.6.1.4.1.193.113.2.1.1.2.2.0
ipworksASDTQueryValue1	1.3.6.1.4.1.193.113.2.1.1.2.3.0
ipworksASDTQueryValue2	1.3.6.1.4.1.193.113.2.1.1.2.4.0

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

Through CLI, a argument “address” can be configured. When script “snmpmonitor” is called, the one configured argument will be passed to the following \$1. The algorithm through which snmpmonitor obtains the monitored resources’ status and load as follows.

- 1) Through snmp command “snmpget”, obtain value of ipworksASDTQueryValue2 corresponding to OID 1.3.6.1.4.1.193.113.2.1.1.2.4.0;
- 2) If (ipworksASDTQueryValue2 != 0) return exit status 1;
- 3) Through snmp command “snmpget”, obtain value of ipworksASDTQueryValue1 corresponding to OID 1.3.6.1.4.1.193.113.2.1.1.2.3.0;
- 4) If (ipworksASDTQueryValue1 >= 70%) LOADF = 1.0; echo LOADF to its standard output and return an exit status 0;
- 5) Through snmp command “snmpget”, obtain value of ipworksASDTQueryRequests and ipworksASDTQueryFailures corresponding to OID 1.3.6.1.4.1.193.113.2.1.1.2.1.0 and OID 1.3.6.1.4.1.193.113.2.1.1.2.2.0 respectively;

if (ipworksASDTQueryFailures < (ipworksASDTQueryRequests * 0.05))
LOADF = 0.2;

else if (ipworksASDTQueryFailures < (ipworksASDTQueryRequests * 0.10)) LOADF = 0.4;

else LOADF = 0.6;
- 6) Echo LOADF to its standard output and return an exit status 0; LOADF will be used as monitored resource load, which will be used to calculate fe_load and be_load;

A UNIX shell script which uses the snmpget utility to show users how to implement load monitoring is as follows. This SNMP scripts example shows users how to use other scripts to implement load monitoring, if successful, the script must write the appropriate load value to its standard output and return an exit status of 0, and if unsuccessful, the script must return a non-zero exit status.

```
#!/bin/sh
```

```
if [ $1 ]
```

```
then
```


Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

```
HOST=$1

else

    exit 1

fi

# If status is not UP, return down

STAT_RS=`snmpget -v 1 -c public ${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.4.0`

STAT_RC=$?

if [ ${STAT_RC} -ne 0 ]

then

    exit 1

fi

STAT_V=`echo ${STAT_RS} | sed s?..??`

if [ ${STAT_V} -ne 0 ]

then

    exit 1

fi

# If CPU utilization is >= 70%, load factor will indicate overloaded.

CPU_RS=`snmpget -v 1 -c public ${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.3.0`

CPU_RC=$?

if [ ${CPU_RC} -ne 0 ]

then

    exit 1

fi

CPU_V=`echo ${CPU_RS} | sed s?..??`

if [ ${CPU_V} -ge 70 ]

then

    LOADF=1.0

else

    REQ_RS=`snmpget -v 1 -c public ${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.1.0`
```

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

```
REQ_RC=$?

ERR_RS=`snmpget -v 1 -c public ${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.2.0`

ERR_RC=$?

if [ ${REQ_RC} -ne 0 -o ${ERR_RC} -ne 0 ]

then

    exit 1

else

    REQ_V=`echo ${REQ_RS} | sed s?..??`

    ERR_V=`echo ${ERR_RS} | sed s?..??`

fi

# Compute load factor as follows:

# Under-utilized: Failures < 5% of Requests

# Normal load: 5% of Requests < Failures < 10% of Requests

# Congested: 10% of Requests < Failures

NORMF=`expr ${REQ_V} / 20`

OVERF=`expr ${REQ_V} / 10`

if [ ${ERR_V} -lt ${NORMF} ]

then

    LOADF=0.2

elif [ ${ERR_V} -lt ${OVERF} ]

then

    LOADF=0.4

else

    LOADF=0.6

fi

fi

echo ${LOADF}

exit 0
```

Prepared (also subject responsible if other) ECIAMAO		No. 51/155 17-AVA 901 16 Uen	
Approved	Checked	Date 2017-11-7	PD1

4.1.3.2.2 SNMP Returning with Load and Percent Value

This predefined script is used in Grouping function is enabled. It is based on SNMP script described in 4.1.3.2.1.

It adds a new return value percent.

- 1) If (ipworksASDTQueryValue1 >= 70%) PERCENT = 100; echo PERCENT with LOADF to its standard output and return an exit status 0;
- 2) Through snmp command "snmpget", obtain value of ipworksASDTQueryRequests and ipworksASDTQueryFailures corresponding to OID 1.3.6.1.4.1.193.113.2.1.1.2.1.0 and OID 1.3.6.1.4.1.193.113.2.1.1.2.2.0 respectively;

PERCENT = ipworksASDTQueryFailures / ipworksASDTQueryRequests

And transform it to integer.

- 3) Echo PERCENT with LOADF to its standard output and return an exit status 0; LOADF will be used as monitored resource load, which will be used to calculate fe_load and be_load; PERCENT will be used in grouping function if it is enabled and it will determine if nodes in one site have similar traffic load.

A UNIX shell script which uses the snmpget utility to show users how to implement load monitoring is as follows. This SNMP scripts example shows users how to use other scripts to implement load monitoring, if successful, the script must write the appropriate load value and percent value to its standard output and return an exit status of 0, and if unsuccessful, the script must return a non-zero exit status.

```
#!/bin/sh
```

```
# -----
```

```
#
```

```
# COPYRIGHT Telefonaktiebolaget L M Ericsson 2002-2013
```

```
#
```

```
# The copyright of the computer program herein is the property of
```

```
# Telefonaktiebolaget L M Ericsson, Sweden. The program may be
```

```
# used and/or copied only with the written permission from
```

```
# Telefonaktiebolaget L M Ericsson or in the accordance with the
```

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Approved	Checked	Date 2017-11-7	PD1

terms and conditions stipulated in the agreement/contract under

w hich the program has been supplied.

#

#

Module Description:

Retrieve SNMP values and determine status and load factor.

#

Status 0 means resource is UP, 1 means resource is DOWN.

The load factor returned assumes that the Monitor threshold is 1;

< 1 means resource is underloaded, > 1 means resource is overloaded,

1 is normal.

if [\$1]

then

HOST=\$1

else

exit 1

fi

If status is not UP, return down

STAT_RS=`snmpget -v 1 -c public \${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.4.0`

STAT_RC=\$?

if [\${STAT_RC} -ne 0]

then

exit 1

fi

STAT_V=`echo \${STAT_RS} | sed s?..??`

if [\${STAT_V} -ne 0]

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Approved	Checked	Date 2017-11-7	PD1

then

exit 1

fi

If CPU utilization is >= 70%, load factor will indicate overloaded.

CPU_RS=`snmpget -v 1 -c public \${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.3.0`

CPU_RC=\$?

if [\${CPU_RC} -ne 0]

then

exit 1

fi

CPU_V=`echo \${CPU_RS} | sed s?.*?.??`

if [\${CPU_V} -ge 70]

then

LOADF=1.0

PERCENT=100

else

REQ_RS=`snmpget -v 1 -c public \${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.1.0`

REQ_RC=\$?

ERR_RS=`snmpget -v 1 -c public \${HOST} 1.3.6.1.4.1.193.113.2.1.1.2.2.0`

ERR_RC=\$?

if [\${REQ_RC} -ne 0 -o \${ERR_RC} -ne 0]

then

exit 1

else

REQ_V=`echo \${REQ_RS} | sed s?.*?.??`

ERR_V=`echo \${ERR_RS} | sed s?.*?.??`

fi

Compute load factor as follows:

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Approved	Checked	Date 2017-11-7	PD1

Under-utilized: Failures < 5% of Requests

Normal load: 5% of Requests < Failures < 10% of Requests

Congested: 10% of Requests < Failures

NORMF=`expr \${REQ_V} / 20`

OVERF=`expr \${REQ_V} / 10`

PERCENT=`expr \${ERR_V} * 100 / \${REQ_V}`

if [\${ERR_V} -lt \${NORMF}]

then

LOADF=0.2

elif [\${ERR_V} -lt \${OVERF}]

then

LOADF=0.4

else

LOADF=0.6

fi

fi

echo \${LOADF},\${PERCENT}

exit 0

4.1.3.2.3 SNMP Monitoring ePDG Nodes

IPWorks provides the function of monitoring ePDG nodes status and load, which help balance the load of the ePDG nodes.

The epdgmonitor script uses snmpwalk to query the ePDG Route Processor (RP) periodically. ePDG RP collects the information of each ePDG node, and returns them to ASDNS as query result. If the corresponding ePDG node is down or its load exceeds the predefined threshold, ASDNS notifies DNS to drop these nodes in DNS responses sent to UEs.

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Approved	Checked	Date 2017-11-7	PD1

For more information on how to configure epdgmonitor in CLI and how to configure the script for monitoring ePDG node, refer to Section **Creating MonitorMethod with the EpdgMonitor Script** and Section **Monitoring ePDG Node** in *Configure DNS and ENUM*, Reference [5].

Note: : In this function, it only supports to send query message to SNMP server with version 2c.

4.2 Commands and User Procedures

Refer to Section 4.1.

4.3 Charging

-

4.4 Characteristics

-

5 Statement of Compliance

No applicable standard exists for ASDNS.

6 Miscellaneous

-

7 Terminology

ASDNS	Active Selection DNS
CLI	Command Line Interface
DNS	Domain Name Space
MIB	Management Information Base
OID	Object Identifier
SM	Server Manager
SNMP	Simple Network Management Protocol
SS	Storage Server

8 References

[1] "DNS and BIND" by Paul Albitz and Cricket Liu, O'Reilly ISBN: 0-596-00158-4

[2] <http://www.isc.org/products/BIND>

[3] "DNS Deployment-Considerations" EUD/D/DNS AD01:004

[4] <http://www.ietf.org/rfc/rfc1035.txt?number=1035>

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Approved	Checked	Date 2017-11-7	PD1

[5] Configure DNS and ENUM, 7/1543-AVA 901 33/2 Uen