Tekelec EAGLE 5
Integrated Signaling System

Numbering Plan Processor (NPP) Overview

910-5454-001 Revision B

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Patents

This product is covered by one or more of the following U.S. and foreign patents:
U.S. Patent Numbers:
5,732,213; 5,953,404; 6,115,746; 6,167,129; 6,324,183; 6,327,350; 6,456,845; 6,606,379; 6,639,981; 6,647,113; 6,662,017; 6,735,441; 6,745,041; 6,765,990; 6,795,546; 6,819,932; 6,836,477; 6,839,423; 6,885,872; 6,901,262; 6,914,973; 6,940,866; 6,944,184; 6,954,526;6,954,794; 6,959,076; 6,965,592; 6,967,956; 6,968,048; 6,970,542; 6,987,781; 6,987,849; 6,990,089; 6,990,347; 6,993,038; 7,002,988; 7,020,707; 7,031,340; 7,035,239; 7,035,387; 7,043,000; 7,043,001; 7,043,002; 7,046,667; 7,050,456; 7,050,562; 7,054,422; 7,068,773; 7,072,678; 7,075,331; 7,079,524; 7,088,728; 7,092,505; 7,108,468; 7,110,780; 7,113,581; 7,113,781; 7,117,411; 7,123,710; 7,127,057; 7,133,420; 7,136,477; 7,139,388; 7,145,875; 7,146,181; 7,155,206; 7,155,243; 7,155,505; 7,155,512; 7,181,194; 7,190,702; 7,190,772; 7,190,959; 7,197,036; 7,206,394; 7,215,748; 7,219,264; 7,222,192; 7,227,927; 7,231,024; 7,242,695; 7,254,391; 7,260,086; 7,260,207; 7,283,969; 7,286,516; 7,286,647; 7,286,839; 7,295,579; 7,299,050; 7,301,910; 7,304,957; 7,318,091; 7,319,857; 7,327,670
Foreign Patent Numbers:
EP1062792; EP1308054; EP1247378; EP1303994; EP1252788; EP1161819; EP1177660; EP1169829; EP1135905; EP1364520; EP1192758; EP1240772; EP1173969; CA2352246

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Chapter 1

Introduction

Topics:

Chapter 1 provides general Tekelec documentation information.

Numbering Plan Processor (NPP) Overview is an introductory and conceptual document for the EAGLE 5 ISS Numbering Plan Processor. Essential definitions, fundamentals, key terms and phrases, and a basic working knowledge of NPP are provided.

Scope and Audience

What the *Numbering Plan Processor (NPP) Overview* Document Provides

Numbering Plan Processor (NPP) Overview is an introductory and conceptual document for Numbering Plan Processor. Essential definitions, fundamentals, key terms and phrases, and a basic working knowledge of NPP are provided.

What the *Numbering Plan Processor (NPP) Overview* Document Will Not Provide

Numbering Plan Processor (NPP) Overview will not provide the details as to how NPP functions. Except in "examples" scenarios, this *Numbering Plan Processor (NPP) Overview* document will not provide configuration procedures, commands criteria or software parameters, or in-depth explanations of NPP functionality and operation.

Audience

This overview document is intended for EAGLE 5 ISS users who will benefit from an overall understanding of NPP and the concept of NPP relative to EAGLE 5 ISS features. Users of this document are expected to have a working knowledge of telecommunications in general and EAGLE 5 ISS specifically.

Related Publications

For information about additional publications that are related to this document, refer to the *Related Publications* document. The *Related Publications* document is published as a part of the *Release Documentation* and is also published as a separate document on the Tekelec Customer Support Site.

Overview Document Conventions

In order to clearly differentiate between references to objects, actions, literal entries, and user-supplied information, the following conventions are used in this document:

- Menu selections and buttons, if any, are shown in bold, and the steps in a menu path are represented with “>”. For example:

  Select **Edit > STP Connection Configuration** from the menu.

  The **Add** button is not enabled when the **STP Connection Configuration** menu opens.

- Commands and entries, if any, that must be entered exactly as shown in this document are shown in the 10 point Courier bold font. For example:

  Using a text editor (such as Notepad) add the following lines to the AUTOEXEC.BAT file:

  `SETFTRA_HOME="C:\ <download_directory> "`

```
SETJRE_HOME="C:\Program Files\Java\j2re1.4.0_01"
```

- User-specific information, if any, is shown in italics and enclosed in "<>". For example, the name of the folder that is to be used as the download directory is shown as <*download_directory*> in the following command:

  `SETFTRA_HOME="C:\ <`*download_directory*`> "`

Documentation Availability, Packaging, and Updates

Tekelec provides documentation with each system and in accordance with contractual agreements. For General Availability (GA) releases, Tekelec publishes a complete EAGLE 5 ISS documentation set. For Limited Availability (LA) releases, Tekelec may publish a documentation subset tailored to specific feature content or hardware requirements. Documentation Bulletins announce a new or updated release.

The Tekelec EAGLE 5 ISS documentation set is released on an optical disc. This format allows for easy searches through all parts of the documentation set.

The electronic file of each manual is also available from the Tekelec Customer Support site. This site allows for 24-hour access to the most up-to-date documentation.

Printed documentation is available for GA releases on request only and with a lead time of six weeks. The printed documentation set includes pocket guides for commands and alarms. Pocket guides may also be ordered as a set or individually. Exceptions to printed documentation are:

- Hardware or Installation manuals are printed only without the linked attachments found in the electronic version of the manuals.
- The Release Notice is available only on the Customer Support site.

Note:

Customers may print a reasonable number of each manual for their own use.

Documentation is updated when significant changes are made that affect system operation. Updates resulting from Severity 1 and 2 PRs are made to existing manuals. Other changes are included in the documentation for the next scheduled release. Updates are made by re-issuing an electronic file to the customer support site. Customers with printed documentation should contact their Sales Representative for an addendum. Occasionally, changes are communicated first with a Documentation Bulletin to provide customers with an advanced notice of the issue until officially released in the documentation. Documentation bulletins are posted on the Customer Support site and can be viewed per product and release.

Documentation Admonishments

Admonishments are icons and text throughout this manual that alert the reader to assure personal safety, to minimize possible service interruptions, and to warn of the potential for equipment damage.

Table 1: Admonishments

	**DANGER**: (This icon and text indicate the possibility of *personal injury*.)
	**WARNING**: (This icon and text indicate the possibility of *equipment damage*.)
	**CAUTION**: (This icon and text indicate the possibility of *service interruption*.)

Customer Care Center

The Tekelec Customer Care Center offers a point of contact for product and service support through highly trained engineers or service personnel. The Tekelec Customer Care Center is available 24 hours a day, 7 days a week at the following locations:

- Tekelec, USA

  Phone:

  +1 888 367 8552 (US and Canada only)

  +1 919 460 2150 (international)

  Email: *support@tekelec.com*
- Tekelec, Europe

  Phone: +44 1784 467804

  Email:*ecsc@tekelec.com*

When a call is received, a Customer Service Report (CSR) is issued to record the request for service. Each CSR includes an individual tracking number.

After a CSR is issued, the Customer Care Center determines the classification of the trouble. If a critical problem exists, emergency procedures are initiated. If the problem is not critical, information regarding the serial number of the system, COMMON Language Location Identifier (CLLI), initial problem symptoms (includes outputs and messages) is recorded. A primary Customer Care Center engineer is also assigned to work on the CSR and provide a solution to the problem. The CSR is closed when the problem is resolved.

Emergency Response

In the event of a critical service situation, emergency response is offered by the Tekelec Customer Care Center 24 hours a day, 7 days a week. The emergency response provides immediate coverage, automatic escalation, and other features to ensure that the critical situation is resolved as rapidly as possible.

A critical situation is defined as a problem with an EAGLE 5 ISS that severely affects service, traffic, or maintenance capabilities, and requires immediate corrective action. Critical problems affect service and/or system operation resulting in:

- A total system failure that results in loss of all transaction processing capability
- Significant reduction in system capacity or traffic handling capability
- Loss of the system's ability to perform automatic system reconfiguration
- Inability to restart a processor or the system
- Corruption of system databases that requires service affecting corrective actions
- Loss of access for maintenance or recovery operations
- Loss of the system ability to provide any required critical or major trouble notification

Any other problem severely affecting service, capacity/traffic, billing, and maintenance capabilities may be defined as critical by prior discussion and agreement with the Tekelec Customer Care Center.

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To view or download product documentation, log into the Tekelec Customer Support site at:

https://support.tekelec.com/index.asp

1. Log in with your user name and password. (Click on **Need an Account?** if you need to register).
2. Select **EAGLE** from the Product Support menu.
3. Select the release number from the Release menu.
4. Locate the Notices section to view the latest Feature Notice.
5. Locate the Manuals section to view all manuals applicable to this release.

   The documentation is listed in alphabetical order by the manual name. Only the first three manuals display. Click **more…** to see the remaining manuals.
6. Locate the latest revision of the manual name.

   Confirm the release number and last available revision.

   Select the 936-xxxx-x01 part number to download the complete documentation set with all linked files.

   Note: The electronic file for this part number is quite large.
7. To view a manual, double-click the manual name.

8. To download a manual, right-click and select **Save Target As**.

   Note: Customers may print a reasonable number of each manual for their own use.

Chapter 2

NPP Overview

Topics:

This chapter provides the background leading to the introduction of NPP and a description of the overall structure and operation of NPP.

NPP Background

Numbering Plans

Today's telecommunication network is the result of many years of evolution that began with the simplest of networks: a single telephone-to-telephone connection. As the number of telephone service subscribers increased, and thus the number of telephone numbers increased, numbering plans became more complex and administratively heavy.

Numbering plans have historically been hard-wired into the equipment or hard-coded into the software. Changes in numbering plans, depending on the extent of the changes, could result in weeks or even months of person-hours of re-wiring and/or re- coding in the switching equipment, not to mention the need for massive paperwork and record-keeping requirements. In EAGLE 5 ISS as well, all number conditioning parameters for numbering plans were hardcoded in the software by Tekelec. Changes in a telecom company's numbering plan required submission of a feature request to Tekelec to generate script files which then were loaded into the software in the field. Some change requests required months to acccomodate. The need for a way to more efficiently administer and manage numbering plans became obvious.

NPP

NPP is a generic software process used to simplify numbering plan maintenance and admistration. NPP allows operations personnel to learn only one system to be able to provision complex numbering plans and modify digit string manipulation and formatting parameters.

Digit string manipulation common to most features can be organized into three categories:

- digit string filtering
- digit string conditioning
- digit string encoding

To address digit string manipulation needs, NPP provides:

- a consistent, powerful, and flexible interface for number string conditioning and formatting
- a flexible and precise interface for the execution of specific feature logic

The power and flexibility of NPP with the ability to customize feature operation to specific numbering plan requirements enables:

- simple corrective dialing
- number conditioning
- operator-specific code deletion and insertion
- flexible arrangement of numbering plan tokens

NPP Operation

EAGLE 5 ISS features and services invoke Numbering Plan Processor (NPP) to process an incoming digit string, apply specific behaviors programmed by the administrator, and to produce an outgoing digit string in the desired (conditioned) format.

NPP provides a numbering plan administration and maintenance capability. Criteria prescribed by the administrator for numbering plan processing must be specificed in order for digit string conditioning and formatting to take place. For an incoming digit string that does not match pre-set conditioning and formatting criteria, NPP will allow the original incoming digit string to pass the digits through the system without processing.

NPP is a rules-based engine providing the ability to specify:

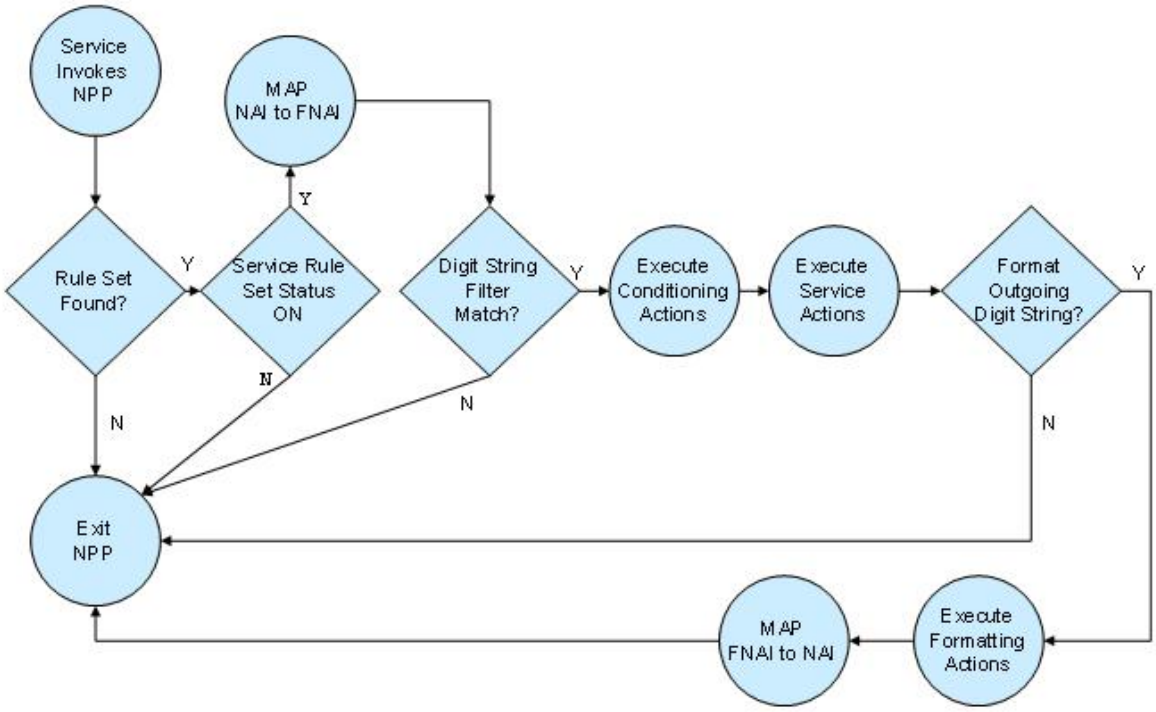
- **action sets** (consisting of conditioning actions for the digit string, service actions for feature-specific logic, and digit string formatting)
- **filters** (to classify a digit string based on NAI, digit string, and length of digit string)
- **rules** (to filter, resulting in an action set)
- **a rule set** (a set of rules)

Sequentially, the high-level call-flow for an incoming/outgoing number is:

1. NPP **receives the incoming message** as an incoming digit string
2. NPP **recognizes the NAI** then selects a rule based on the incoming digit string and filter NAI (FNAI) value
3. NPP **executes conditioning actions** to extract digits from the digit string to be used for service and formatting actions
4. NPP **produces an outgoing digit string** to continue to its destination

Figure 1: NPP Operation Overview on page 9 shows the high level events of NPP operation and their order of occurrence.

Figure 1: NPP Operation Overview



NPP Functional Requirements

NPP Hardware

NPP processing activity is invoked by EAGLE Provisioning Applciation Processor (EPAP) -based features that use service module cards.

NPP Software

There are no specific software requirements or pre-requisites for NPP.

Chapter 3

Action Sets

Topics:

This chapter describes the basics of an action set and the relationship between its components.

NPP allows for customized EAGLE 5 ISS digit string processing behaviors in the form of action sets.

Action Sets

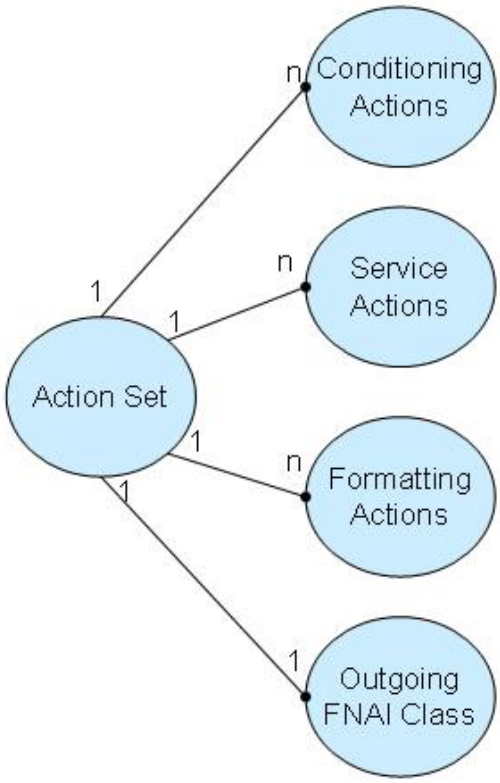
Numbering Plan Processor (NPP) allows customized EAGLE 5 ISS behavior to be provisioned as an action set. Up to 1024 actions sets are supported by an EAGLE 5 ISS.

An action set consists of three subsets of actions and an outgoing FNAI class (listed below in order of execution):

- **Conditioning actions** (CAs; up to 12 per action set), determine how a digit string is manipulated prior to applying services.
- **Service actions** (SAs; up to 8 per action set), determine what EAGLE 5 ISS behavior to apply to a digit string.
- **Formatting actions** (FAs; up to 12 per action set), determine how the outgoing digit string is formatted and applied after service action execution.
- **Outgoing FNAI class** (outgoing FNAI or OFNAI, one per action set), setting communicates the NAI of the outgoing digit string to calling services. Each action set contains an outgoing FNAI class that is communicated to the calling service.

Figure 2: Action and Action Set Relationship on page 12 shows the relationship between actions and action sets.

Figure 2: Action and Action Set Relationship



Examples of simple NPP action sets can be where number portability processing is needed on:

- Properly formatted NATL calls
- Messages with unknown NAI with a national escape code of 1 + 10 digits

All other calls are not subject to processing.

The actions for the examples are shown in *Table 2: Action Set Actions Scenarios* on page 13:

Table 2: Action Set Actions Scenarios

FNAI	FPFX	FDL	Conditioning Actions	Service Actions	Format	Outgoing NAI
NATL	*	*	Add default country code	Number portability	RN+DN	NATL
Unknown	1	11	Delete matched prefix, add default country code	Number portability	RN+DN	Incoming

Conditioning Actions

Conditioning actions (CAs) determine how a digit string is manipulated (processed) prior to applying services. The behavior of CAs does not differ between services; however, each service defines which CAs it supports.

The primary purpose of CAs is to identify digit strings that represent subscriber numbers in international format (international format is defined as (refer to *Table 3: Generic and Specific Conditioning Actions* on page 14 for definitions) "CC = AC = SN" or "CC + DN" or "ZN"). A CA extracts digits from the incoming digit string and sends the digit string to the next action set. NPP allows up to twelve CAs per action set. NPP executes CAs associated with an action set in the order provisioned. *Table 3: Generic and Specific Conditioning Actions* on page 14 lists CAs and their purpose.

CAs deal with extracting and adding digits to the digit string:

- CAs act on the beginning digits of the current digit string. Certain actions can occur more than once in an action set.
- CAs prepare the digit string for database lookup, which requires international number format.

Table 3: Generic and Specific Conditioning Actions

CA	Purpose
IGN[1...10]	ignore/delete 1 to 10 digits
FPFX	define the filter prefix
PFXA[1...8], PFXB[1...8] ... PFXF[1...8]	define up to six different prefixes (A... F) of 1 to 8 digits in length
CC[1...3]	define the next 1 to 3 digits as the country code
CCDEF	insert the default country code
AC[1...8]	define the next 1 to 8 digits as the area code
SN[1-15]	define the next 1 to 15 digits as the subscriber number
SNx	define the remainder of the digits as the subscriber number
DN[1...15]	define the next 1 to 15 digits as the directory number (AC+SN)
DNx	define the remainder of the digits as the directory number
ZNx	define the remainder of the digits as the internationally-formatted dialed number (ZN); useful when dealing with non-dial plan codes
ACLAC	specific, used by Prepaid IDP Query Relay feature to get the area code from the location

CA	Purpose
	area code (LAC) of the location area information (LAI) parameter

Conditioning Action Execution

Numbering Plan Processor (NPP) provides Conditioning actions (CAs) to ignore or assign digit strings to known variables. Conditioning action execution is the process that extracts digits from incoming messages. The process starts at the beginning of the digit string and progresses to the end of the string. Numbering plan data is stored in international format in the RTDB in Eagle Provisioning Application Processor (EPAP) and the EAGLE 5 ISS service module cards. When the incoming digit strings are extracted, the digit string is conditioned into international format so that database lookup can be performed.

The variables that are assigned digit strings are available as formatting actions. At a minimum, one of the following sets of formatting actions must be populated:

- internationally formatted dialed number (ZN), consisting of the country code (CC), area code (AC) and subscriber number (SN)
- country code (CC) + dialed number (DN), consisting of the area code (AC) and subscriber number (SN)
- country code (CC) + area code (AC) + subscriber number (SN)

Storing all other digit strings is optional.

Conditioning action execution also allows populating formatting actions to be used during formatting action execution. For example, a service wants to condition the incoming digits ‘b9090c509192252645’ with filter NAI (FNAI) class international (INTL). In this example, the NPP filter used to isolate the digit string is specified as

- filter prefix = 'b' (FPFX = ‘b’)
- filter digit length = 18 (FDL = 18)
- filter NAI = international (FNAI = INTL)
- ‘50’ is required as the country code
- ‘919’ as the area code
- ‘2252645' as the subscriber number

Because the outgoing digit string will contain the ‘9090’ prefix, the digits to use for the ‘9090’ prefix must be specified: the CC, the AC and the SN, while skipping the ‘c’ digit.

Conditioning Action Examples

Examples of simple to more complex scenarios:

- EXAMPLE: Standard national calls all receive the same handling where NAI=NATL, digits XXXXXXXXXX
  - filter NAI = national (FNAI = NATL)

  - filter prefix = wildcard (FPFX = *)
  - filter digit length = wildcard (FDL = *)
  - To condition this number to international format, the country code must be prefixed. The conditioning action (CA) for this is country code default (CCDEF)
  - If CCDEF = 55 (for example), and the digit string is 87654321, then the digit string will become 5587654321

- EXAMPLE: International calls with international escape code where NAI = international (INTL), digits 011 + XXXXXXXXXXX
  - FNAI = INTL
  - FPFX = 011
  - FDL = *
  - It is common that international calls need only to "escape" any service processing. In these cases, no CAs are required.

- EXAMPLE: Collect calls with operator code, area code follows the operator code, NAI=Unknown, digits 'b' + AC + 9090 + XXXXXXXX
  - FNAI = UNKNOWN
  - FPFX = b (or FPFX = b339090 or FPFX = b349090, etc. -- there are many options for this configuration)
  - FDL = 15
  - If the digit string is b33909087654321, FPFX = b339090 is matched. To achieve standard international format, "b" and "9090" must be stripped, area code "33 must be placed next to directory number "87654321", and the country code must be prefixed. The conditioniong actions for this are:

Table 4: Conditioning Actions for Collect Calls with Operator Code

Conditioning Action...	Consisting of Tokens...	Resulting Digit String
		[incoming digit string = b33909087654321]
IGN1	[no token, just ignore first digit]	33909087654321
AC2	A =33	909087654321
PFXA4	AC=33, PFXA=9090	87654321
SNZ	AC=33, PFXA=9090, SN=87654321	
CCDEF	AC=33, PFXA=9090, SN=87654321, CC=55	

Service Actions

Service actions (SAs) determine the EAGLE 5 ISS behavior to apply to a digit string. Service action behavior is determined by the feature that invokes NPP. For example, if all digit strings of a certain

type require a number portability check, NPP provides a number portability SA that can be associated with an action set. Service actions are executed in the order in which they are provisioned. NPP allows up to eight SAs to be associated with a single action set.

Service Actions Examples

Standard national calls all receive the same handling:

- NAI=NATL XXXXXXXXXX
- If number portability service is needed here, then the service action may simply be CdPNNP.

International calls with international escape code:

- NAI=INTL 011+XXXXXXXXXXX
- This call just wants to escape any service processing. There is no service action in this rule.

Collect Calls with operator code, area code in-between:

- NAI=Unknown 'b'+AC+9090+XXXXXXX

Formatting Actions Examples

The effects of formatting actions on digit strings is shown in *Table 5: FA Example 1* on page 18, *Table 6: FA Example 2* on page 18, *Table 7: FA Example 3* on page 19, and *Table 8: FA Example 4* on page 19. The examples include assumptions for required conditioning actions (CA) and service actions (SA)

Table 5: FA Example 1

Example 1: Standard national calls all receive the same handling		
Assumptions: • **NAI=NATL XXXXXXXXXX** • **To condition this number to international format, the country code must be prefixed, CA1=CCDEF** • **Example digit string is 87654321 before conditioning action** • **Example digit string after conditioning action (CA1) is 559192252645** • **Assume the example requires number portability service and the service action (SA) is simply CdPNNP** • **Assume the example requires just prefixing the routing number (RN) returned from the numbering plan (NP) database and outgoing digit string should be sent in NATL format** • **Assume the rounting number (RN) that was returned from the RTDB is "7777"** • **The resulting outgoing format is RN, DN**		
Formatting action set = {FA1=RN, FA2=DN}		
Formatting Action	**==>**	**Resulting Outgoing Digit String**
Begin	==>	
RN	==>	7777
DN	==>	7777559192252645

Table 6: FA Example 2

Example 2: International calls with international escape code		
Assumptions: • **NAI=INTL 011+XXXXXXXXXXXX** • **Assume the original number is 449192252645.** • **Assusme this call just needs to escape any service processing so only minimum conditioning actions (CA) are required (ZNx)** • **Since this call needs to escape any service processing, there are no service actions (SA) required.** • **Since this call just needs to escape any service processing, the outgoing format is the original number (ORIG).**		
Formatting action set = {FA1=ORIG}		
Formatting Action	**==>**	**Resulting Outgoing Digit String**
Begin	==>	
ORIG	==>	011449192252645

Table 7: FA Example 3

Example 3: Collect calls with operator code, area code in-between		

Assumptions:
• **NAI=Unknown 'b' + AC + 9090 + XXXXXXXX**
• **Assume the digit string is b33909087654321**
• **If the desired outgoing format is to replace the 'b' with a 'd', and to insert the number portability RN after the '9090'**
  • **'9090' put in PFX4**
  • **The NPRelay service action updated the RN token**
  • **Assume DLM1 is provisioned as 'd'**
  • **Assume the RN is "5555"**
• **In this case, the desired outgoing format is**
  • **DLMA**
  • **AC**
  • **PFX4**
  • **RN**
  • **SN**		

Formatting action set = {FA1=DLMA, FA2=AC, FA3=PFX3, FA4=RN, FA5=SN}		
Formatting Action	**==>**	**Resulting Outgoing Digit String**
Begin	==>	
DLMA	==>	d
AC	==>	d33
PFX4	==>	d339090
RN	==>	d3390905555
SN	==>	d339090555587654321

Table 8: FA Example 4

Generic Example		
Assumptions: • **Variables (formatting actions): PFXA = c, PFXB = b, DN = 669192252645, RN = 1234567890**		
Formatting action set = {FA1=PFXA, FA2=RN, FA3=PFXB, FA4=DN}		
Action	**==>**	**Resulting Outgoing Digit String**
Begin	==>	

Generic Example		
Assumptions: • **Variables (formatting actions): PFXA = c, PFXB = b, DN = 669192252645, RN = 1234567890**		
Formatting action set = {FA1=PFXA, FA2=RN, FA3=PFXB, FA4=DN}		
Action	**==>**	**Resulting Outgoing Digit String**
PFXA	==>	c
RN	==>	c1234567890
PFXB	==>	c1234567890b
DN	==>	c1234567890b669192252645

Service Action Precedence

Multiple service actions (SAs) can be associated with a Numbering Plan Processor (NPP) action set. In order to provide a systematic method for service action provisioning and execution, SA precedence value is assigned. Each service defines the order in which SAs are allowed to be executed. SA execution order then will follow the defined SA precedence value.

SA precedence is represented by a number between 0 and 100. Higher precedence SAs are always executed before lower precedence SAs; provisioning of a lower precedence SA ahead of higher precedence SA is prevented. SAs can be defined with equal precedence. NPP executes SAs of equal precedence in the order provisioned.

Table 9: Service Action Precedence Example on page 20 shows an example set of SAs and their precedence values. During Enhanced Operation, Administration, and Maintenance (EOAM).

Table 9: Service Action Precedence Example

Service Action	Precedence	Notes
SA1	100	Always executed first regardless of provisioning order
SA2	50	Always executed after SA1 and prior to SA4. SA2 and SA3 execution order dependent on the order provisioned.
SA3	50	Always executed after SA1 and prior to SA4. SA2 and SA3 execution order dependent on the order provisioned.
SA4	10	Always executed last.

Given the SA precedence values defined in *Table 9: Service Action Precedence Example* on page 20, the SA sets defined in *Table 10: Valid Service Action Sets Example* on page 21 are allowed and the SA sets defined in *Table 11: Invalid Service Action Sets Example* on page 22 are prevented.

Table 10: Valid Service Action Sets Example

Service Action Set	Validity	Notes
SA1	Valid	Single service actions always execute in the correct order [100]
SA2	Valid	Single service actions always execute in the correct order [50]
SA3	Valid	Single service actions always execute in the correct order [50]
SA4	Valid	Single service actions always execute in the correct order [10]
SA1, SA2	Valid	Service actions executed in order of precedence [100, 50]
SA1, SA3	Valid	Service actions executed in order of precedence [100, 50]
SA1, SA4	Valid	Service actions executed in order of precedence [100, 10]
SA1, SA2, SA3	Valid	Service actions executed in order of precedence [100,50,50] – actions of equal precedence execute in the order provisioned (SA2 then SA3).
SA1, SA2, SA4	Valid	Service actions executed in order of precedence [100,50, 10]
SA1, SA3, SA2	Valid	Service actions executed in order of precedence [100,50,50] – actions of equal precedence execute in the order provisioned (SA3 then SA2).
SA1, SA3, SA4	Valid	Service actions executed in order of precedence [100,50,10]
SA1, SA2, SA3, SA4	Valid	Service actions executed in order of precedence [100,50,50,10] – actions of equal precedence execute in the order provisioned (SA2 then SA3).
SA1, SA3, SA2, SA4	Valid	Service actions executed in order of precedence [100,50,50,10] – actions of equal

Service Action Set	Validity	Notes
		precedence execute in the order provisioned (SA3 then SA2)
SA2, SA3	Valid	Service actions executed in order of precedence [50,50] – actions of equal precedence execute in the order provisioned (SA2 then SA3)
SA2, SA3, SA4	Valid	Service actions executed in order of precedence [50,50, 10] – actions of equal precedence execute in the order provisioned (SA2 then SA3)
SA2, SA4	Valid	Service actions executed in order of precedence [50,10]
SA3, SA2	Valid	Service actions executed in order of precedence [50,50] – actions of equal precedence execute in the order provisioned (SA3 then SA2).
SA3, SA2, SA4	Valid	Service actions executed in order of precedence [50,50,10] – actions of equal precedence execute in the order provisioned (SA3 then SA2)
SA3, SA4	Valid	Execution follows SA precedence in decreasing order [50, 10]

Table 11: Invalid Service Action Sets Example

Service Action Set	Validity	Notes
SA4, SA1	Invalid	violated service action precedence (10 < 100)
SA4, SA2	Invalid	violated service action precedence (10 < 50)
SA4, SA3	Invalid	violated service action precedence (10 < 50)
SA2, SA1	Invalid	violated service action precedence (50 < 100)
SA3, SA1	Invalid	violated service action precedence (50 < 100)

Service Action Set	Validity	Notes
SA1, SA4, SA2	Invalid	violated service action precedence (10 < 50)
SA1, SA4, SA3	Invalid	violated service action precedence (10 < 50)

Formatting Actions

Formatting actions (FAs) are applied after service action execution and determine how the outgoing digit string is formatted. The digits associated with an FA are made available during conditioning action execution and service action execution.

NPP allows up to twelve FAs to be associated with a single action set. The outgoing digit string is constructed by inserting digits associated with each FA. FAs are executed in the order provisioned.

To provision formatting action parameters, at least one of the following conditioning actions must be provisioned:

- CC + AC + SN or
- CC + DN or
- ZN

Service actions might have to be provisioned as well as conditioning actions, depending on the particular formatting action.

The parameters of an outgoing digit string are in the form of tokens. If tokens are empty, they are skipped. Valid tokens are listed in *Table 12: Formatting Actions: Valid Tokens* on page 23.

Table 12: Formatting Actions: Valid Tokens

Token	Definition
SN	Subscriber Number (DN + AC)
DN	Directory Number (AC + SN)
ZN	(defined during conditioning action provisioning)
AC	Area Code
RN	Routing Number
SP	Service Provider
CC	Country Code
FPFX	Filter PreFiX
PFX[A...F]	Prefixes [defined during conditioning action provisioning]

Token	Definition
DLM[A...C]	[service defined] Delimiters
ORIG	Original incoming digit string
GRN	Generic routing number
VMID	Voicemail identifier

Outgoing FNAI Class

Each action set must contain an outgoing FNAI (OFNAI) setting that communicates the NAI of the outgoing digit string to calling applications. NPP will map the specified OFNAI class to a service-specific NAI value using the FNAI mapping facility described in section *Filter Nature of Address Indicator (FNAI) Class* on page 26 .

EAGLE 5 ISS prevents provisioning an NPP Rule with a non-supported OFNAI class value. For example, if a NPP service has NAI1=NONE, any rule containing an OFNAI class value cannot be provisioned.

Chapter 4

Filters and Rules

Topics:

This chapter provides a high level description of NPP filters and rules.

When NPP is called to process an incoming digit string by an EAGLE 5 ISS feature or service, an NPP rule will determine what is involved in the processing.

Filters

Numbering Plan Processor (NPP) uses a filter to classify a digit string based on the three components of an NPP filter:

- a nature of address indicator (NAI) class, where NPP allows both standard and user-defined NAIs (a filter NAI is an FNAI)
- the leading digit string or prefix (a filter prefix, FPFX), using longest match logic
- the length of the digit string (filter digit length, FDL)

The combination of an FNAI, FDL and FPFX constitute an NPP filter. When the digit string matches the defined filter, the digit string is processed by NPP. If the digit string does not match, the digit string exits the NPP as it originally entered.

NPP filters can be provisioned that ignore the FPFX or FDL, or both, by specifying wildcard characters for the FPFX and FDL values (see section *Searching NPP Rules with Wildcard Values* on page 32 for more information about wildcard values).

For NPP filter examples and scenarios, see *Filter Examples* on page 28.

Filter Nature of Address Indicator (FNAI) Class

Many EAGLE 5 ISS protocols infer digit string formatting based on a protocol-specific Nature of Address Indicator (NAI) value. Numbering Plan Processor (NPP) uses this same concept to help isolate digit strings. NPP defines NPP-specific FNAI classes to which services can map service-specific NAI values.

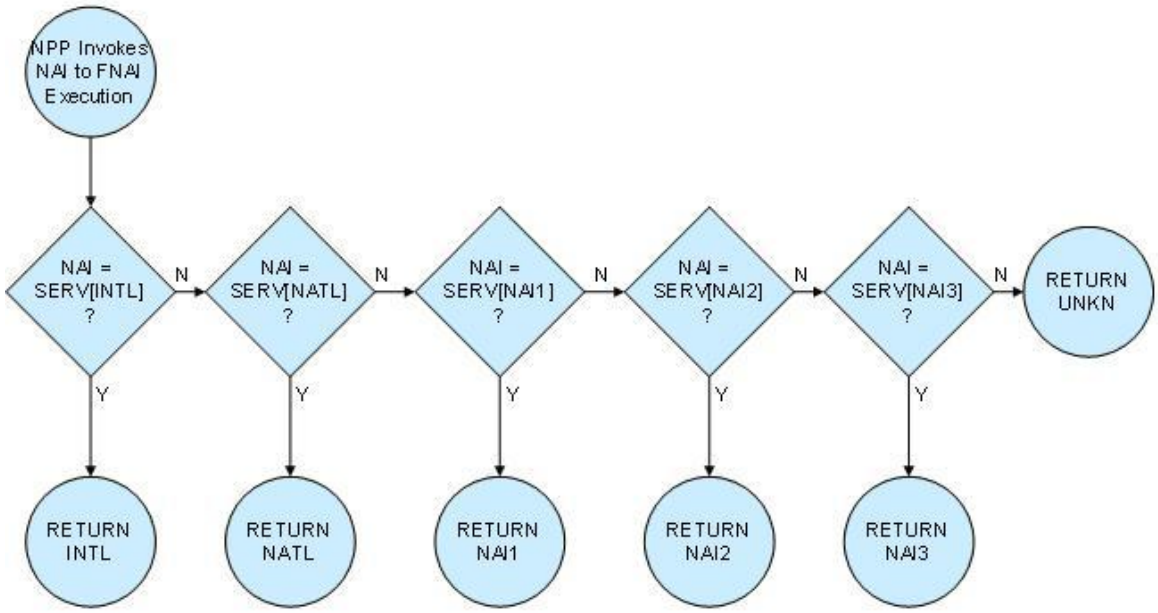
NPP supports six different FNAI classes:

- NATL (national)
- INTL (international)
- NAI1 (generic1)
- NAI2 (generic2)
- NAI3 (generic3)
- UNKN

Services that invoke NPP processing provide an NAI value along with the incoming digit string. NPP is responsible for mapping the service-specific NAI value to an appropriate NPP FNAI class value.

The execution of the NAI to FNAI class algorithm is described in *Figure 3: NAI to FNAI Mapping Algorithm* on page 26. Any NAI value not mapped to an FNAI class is interpreted as UNKN (Unknown). If support is not needed for an FNAI class, provision the FNAI class to “NONE”. Provisioning an FNAI class to or from “NONE” can be done only if the service’s service rule set is empty.

Figure 3: NAI to FNAI Mapping Algorithm



Filter Prefix

Many EAGLE 5 ISS features search for matching digit patterns at the beginning of digit strings to determine if processing is required. NPP provides this function with filter prefixes (FPFX). An FPFX is a hexadecimal string of digits located at the beginning of a digit string. An FPFX can be simply an asterisk ("*"), a letter (such as "d"), or a series of digits (such as "919", "060", or "9090"). For example, for incoming digit string, 00152558776925, the filter prefix (FPFX) is 001. Once the FPFX parameter is defined and provisioned in NPP, the leading incoming digit patterns must match the FPFX filter for further NPP processing.

Filter Digit Length

Numbering Plan Processor (NPP) provides digit string isolation based on the incoming length of the digit string. The NPP filter digit length (FDL) specifies the number of digits that the incoming digit string must have to match the filter.

Filter Examples

Table 13: NPP Filter Examples

Filter Nature of Address Indicator (FNAI) Class	Filter Prefix (FPFX)	Filter Digit Length (FDL)
INTL	'9090'	8
INTL	'060'	12
NATL	*	8
INTL	'd'	*
INTL	*	*
NAI1	'919'	*
UNKN	*	*

Some possible NPP Filter scenarios are:

- All standard national calls receive the same handling where NAI=NATL, digits XXXXXXXXXX
  - FNAI = NATL
  - FPFX = *
  - FDL = *
- International calls with international escape code where NAI=INTL, digits 011+XXXXXXXXXXX
  - FNAI = INTL
  - FPFX = 011
  - FDL = *
- Collect calls with operator code, area code following the operator code, NAI=Unknown, digits 'b'+AC+9090+XXXXXXXX
  - FNAI = UNKNOWN
  - FPFX = b (or FPFX = b339090 or FPFX=b349090, etc. -- there are many options for this configuration)
  - FDL = 15

Rules

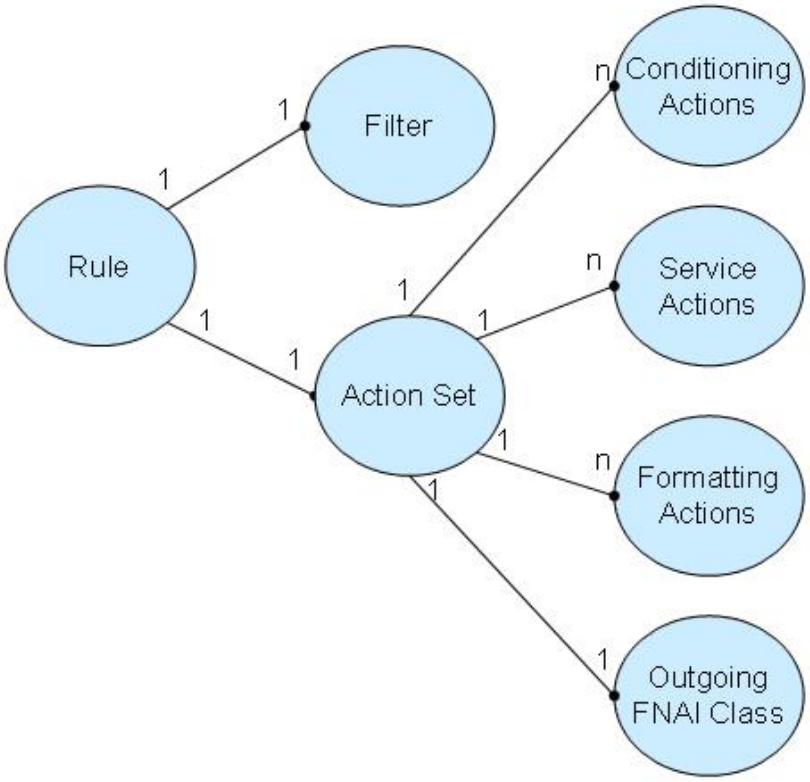
Defining and combining a filter and an action set results in the creation of a rule. A set of rules is called a service rule set. A simple table representation of rule definition is shown in *Table 14: Rule Definition Criteria* on page 29

Table 14: Rule Definition Criteria

Rule Definition						
Filters			Action Set			
Filter NAI	Filter Prefix	Fiter Digit Length	Conditioning Action	Service Action	Formatting Action	Outgoing FNAI Class
(fnai)	(fpfx)	(fdl)	(ca)	(sa)	(fa)	(ofnai)

An NPP rule specifies the message type through the filter and the behavior to apply to each message through the action set. The relationships between rules, filters, action sets, and actions is depicted in *Figure 4: Rule, Filter, and Action Set Relationship* on page 29.

Figure 4: Rule, Filter, and Action Set Relationship



Validating Conditioning Action Sets

During NPP rule provisioning, NPP verifies that appropriate CAs are provisioned against an NPP rule. For rules with a wildcard value for FDL, the associated CA set must contain a ZNX, DNX or

SNX set. For rules with specific FDL values (non-wildcard) the associated CA set must process the entire number of digits (either ignored by IGN or otherwise).

For example, if the NPP rule consisted of FPFX='0123', FNAI=INTL and FDL=16, the associated CA set would need to process all 16 digits of the incoming digit string for conditioning action execution to be considered successful. Alternatively, if the NPP rule consisted of a wildcard value for FDL, the associated CA set would have to contain ZNX, DNX or SNX for conditioning action execution to be considered successful.

Services and Service Rule Sets

A Numbering Plan Processor (NPP) service is an EAGLE Provisioning Application Processor EPAP)-based feature, such as Prepaid IDP Relay Query (IDP Relay).

An NPP service rule set is a collection of rules that are associated with an NPP service. NPP supports up to 4096 rules per service rule set. The maximum number of NPP rules per EAGLE 5 ISS is 8192.

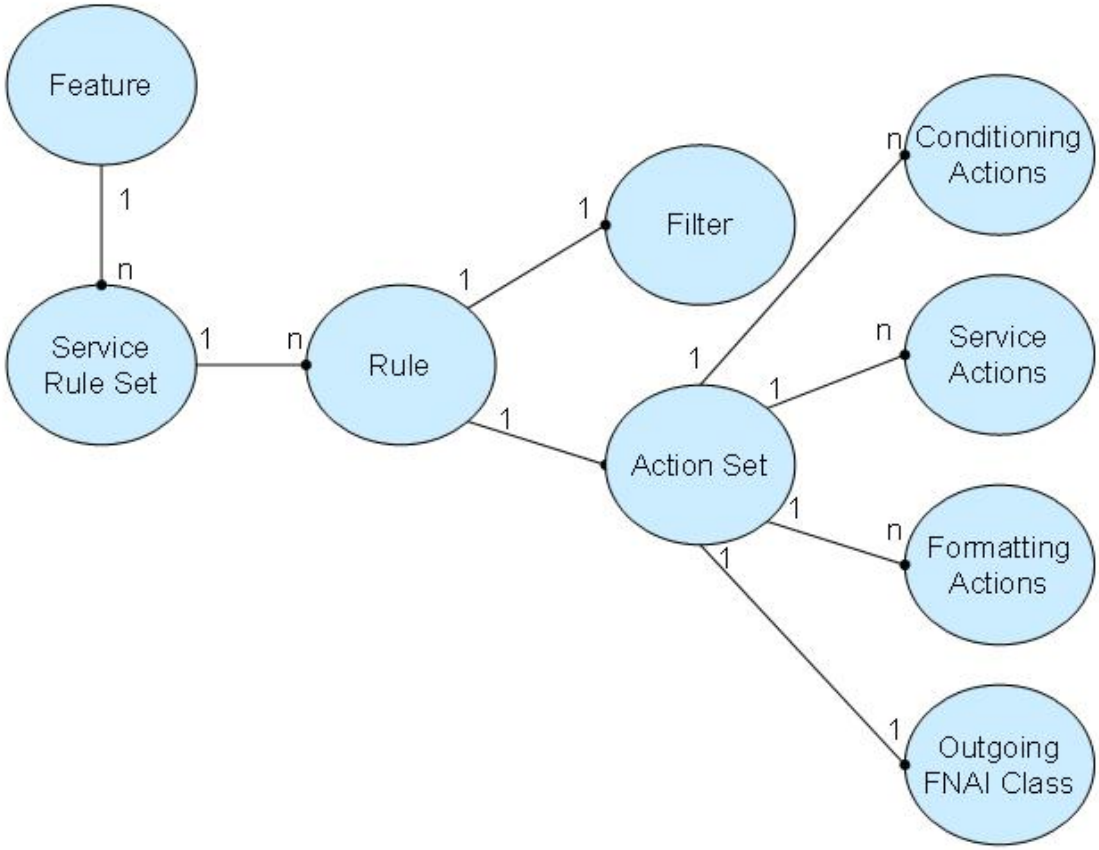
A simple example of a service rule set is shown in *Table 15: Service Rule Set Example* on page 30

Table 15: Service Rule Set Example

:srvn = NPPT		
:fnai = NATL	:fnai = INTL	:fnai = UNKN
:fpfx = 060	:fpfx = *	:fpfx = *
:fdl = 10	:fdl = 15	:fdl = *
:asn = ACTSET1	:asn = ACTSET2	:asn = ACTSET3

The relationship between features, NPP services, and action sets is shown in *Figure 5: Service Rule Set and Rule Relationship* on page 30.

Figure 5: Service Rule Set and Rule Relationship



Searching NPP Rules

NPP applies a best-fit matching algorithm when filtering incoming messages. The filter-matching algorithm first considers FNAI, then FPFX, then FDL when searching for a rule match. The presence of wildcard values for FPFX and FDL requires the search algorithm to traverse the rule set at most four times.

Table 16: Best Fit Match Search Order on page 31 specifies the order in which the matching algorithm searches for a matching rule.

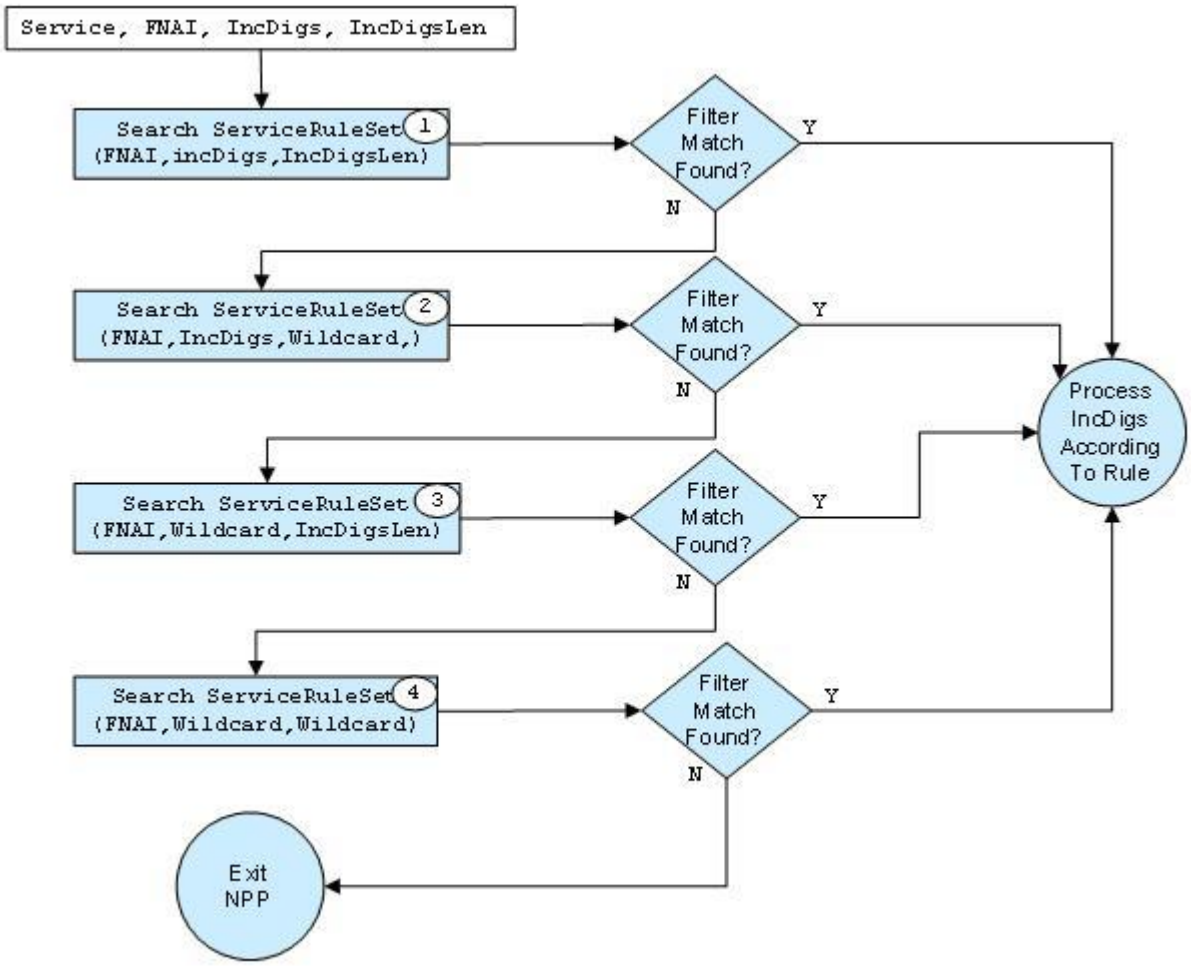
Table 16: Best Fit Match Search Order

Search Order	FNAI [NATL, INTL, UNKN, NA1...3]	FPFX	FDL
1	Specific	Specific	Specific
2	Specific	Specific	Wildcard
3	Specific	Wildcard	Specific

Search Order	FNAI [NATL, INTL, UNKN, NA1...3]	FPFX	FDL
4	Specific	Wildcard	Wildcard

Figure 6: Filter Search on page 32 describes the filter search algorithm.

Figure 6: Filter Search



Searching NPP Rules with Wildcard Values

As *Table 17: NPP Filter Search Example -- 1 of 2* on page 33 and *Table 18: NPP Filter Search Example -- 2 of 2* on page 33 show, there are three search cases where wildcard values are used. In each case the search algorithm considers only NPP rules that have the wildcard value specified for the filter criteria. For example, if no specific match is found (case 1 of 2) NPP then searches the NPP rules that have FDL=*. When searching with wildcard values for FDL or FDFX, NPP considers

only the NPP rules that are specifically provisioned with wildcard values. NPP rules with specific values for FDL or FPFX, are not considered during wildcard searches: only the NPP rules specifically provisioned with the wildcard values are searched.

Table 17: NPP Filter Search Example -- 1 of 2 on page 33 and *Table 18: NPP Filter Search Example -- 2 of 2* on page 33 illustrate different filter selection scenarios.

Table 17: NPP Filter Search Example -- 1 of 2

Provisioned Rules	FNAI	FPFX	FDIGLEN	NOTES
1	INTL	abc	16	Specific, Specific, Specific
2	INTL	abc123	16	Specific, Specific, Specific
3	INTL	abc12	*	Specific, Specific, Wildcard
4	INTL	*	16	Specific, Wildcard, Specific
5	UNKN	*	*	Specific, Wildcard, Wildcard

Table 18: NPP Filter Search Example -- 2 of 2

Example	Incoming FNAI	Incoming Digit String	Incoming DIGLEN	Rule Selected
1	INTL	abcdef12345678901	16	1
2	INTL	abc123def12345678	16	2
3	INTL	abc2345678901def	16	1
4	INTL	abc1234567890	13	3
5	INTL	0123456789abcdef	16	4
6	INTL	1234567890abcde	15	5

Multiple Services

An NPP service is used by EAGLE 5 ISS EPAP-based features such as IDP Query Relay, to process digit strings according to that feature's service rule set. NPP supports multiple services at the same time; each with a separate service rule set.

Table 19: Sample NPP Configuration on page 34 illustrates a sample NPP configuration containing service rule sets.

Table 19: Sample NPP Configuration

		Rule					
	Filter	Action Set					
Service Rule Set	**NAI**	**FPFX**	**FDL**	**CA**	**SA**	**FA**	**OFNAI CLASS**
NPPT	NATL	060	8	IGN2, CCDEF DN12	RTDBTRN	CC, RN, DN	INTL
NPPT	NATL	*	*	NONE	NONE	ORIG	NATL
NPPT	INTL	*	*	NONE	RTDBTRNSP	ORIG	INTL
IDPRCLD	UNKN	9090	12	FPFX, CCDEF DN8	SA1	RN, DN	NATL
IDPRCDPN	UNKN	*	*	NONE	NONE	ORIG	UNKN

Chapter 5

Test Service

Topics:

This chapter describes the NPP Test Service at a high level and gives examples of its application.

NPP Test (NPPT) Service

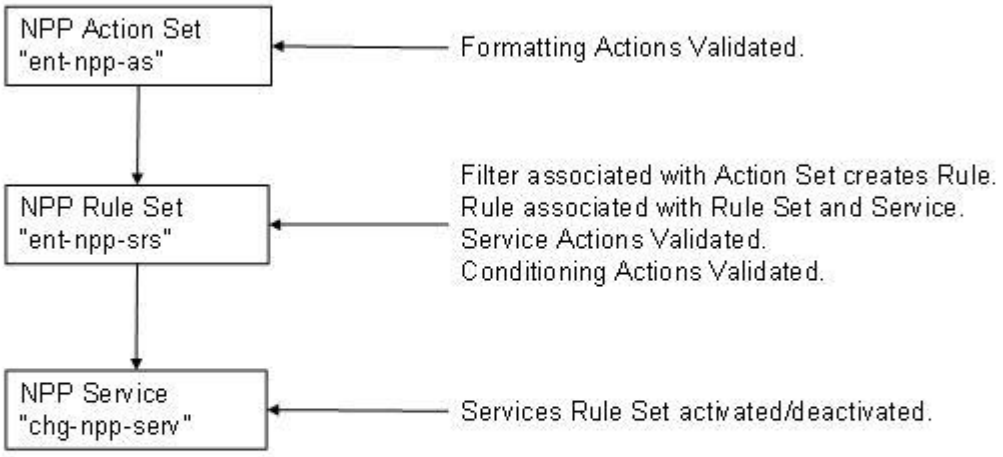
EAGLE 5 ISS features can have feature-specific test commands for NPP functions. NPPT Service is an EAGLE 5 ISS EPAP-based function that utilizes NPP and allows provisioning of NPP action sets and rules associated with the NPPT Service rule set. NPPT service allows an adminstrator to validate NPPT service rule sets by injecting test messages through an interface. The test messages provide the ability to experiment with and validate NPP rules and action sets without affecting live traffic.

NPPT Service produces EAGLE 5 ISS terminal output that describes the following:

- the service
- the rule within the service rule set that NPP selected as a match (if any)
- the conditioning actions executed (if any)
- the service actions executed (if any)
- the formatting actions executed (if any)
- the original digit string
- the conditioned digit string
- the outgoing digit string
- the continuation indicators from each executed service action
- the formatting indicators from each executed service action

The provisioning order required by NPP is shown in *Figure 7: NPP Provisioning Order* on page 36

Figure 7: NPP Provisioning Order



NPP Test Rule Set Example

The example test rule set is defined with three filters pointing to the same action set as shown in *Figure 8: Example NPP Test Rule Set: Service Rule Set* on page 37. There are two action sets defined, referred to from the rules specified in *Figure 9: Example NPP Test Rule Set: Action Set* on page 38.

Figure 8: Example NPP Test Rule Set: Service Rule Set

```
> rtrv-npp-srs

Command Accepted - Processing
   oper 22-05-23 03:51:10 EST  UNKNOWN ??.?.?-60.13.0
   rtrv-npp-srs
   Command entered at terminal #5.

 oper 22-05-23 03:51:10 EST  UNKNOWN ??.?.?-60.13.0
   SRVC      FPFX          FDIGLEN  FNAI    ASN
   ------------------------------------------------
   nppt      02919         12       intl    set1
   nppt      03919         12       intl    set1
   nppt      444           13       ntl     set2
```

Figure 9: Example NPP Test Rule Set: Action Set

```
> rtrv-npp-as
Command Accepted - Processing

   oper 22-05-23 03:53:06 EST  UNKNOWN ??.?.?-60.13.0
   rtrv-npp-as
   Command entered at terminal #5.

   oper 22-05-23 03:53:06 EST  UNKNOWN ??.?.?-60.13.0
   ASN       CA       SA       FA       OFNAI  REFS
   ------------------------------------------------
   set1      ccdef    rtdbtsp  sp       inc    2
             ign2              cc
             ac3               ac
             sn7               sn

   set2      pfxa3    rtdbtsp  sp       inc    1
             ccdef              pfxa
             dn10               cc
                                dn
```

NPP Test (NPPT) Provisioning Example

The following example for a given numbering plan shows the difference between provisioning for incoming calls starting with ‘9090’ and those that start with ‘060’.

SCENARIO 1: PREFIX ‘9090'

DESCRIPTION: Incoming digit strings contain a country code (CC), an area code (AC) and a subscriber number (SN). Incoming digit strings beginning with '9090' will have FNAI class set to international and filter digit length set to 16 digits.

RULES TO APPLY:

- Provision an action set that conditions the incoming digits, applies the service action RTDBTRN, and formats the outgoing digits according to an international format.
- Provision an NPP rule with FPFX='9090', FDL=16 and FNAI=INTL.

SCENARIO 2: PREFIX '060'

DESCRIPTION: Incoming digit string contains an area code (AC) and a subscriber number (SN). Incoming digit strings starting with '060' will have FNAI class set to national and filter digit length set to 16 digits.

RULES TO APPLY:

- Provision an action set that conditions the incoming digits, applies the service action RTDBTRNSP, and formats the outgoing digits by pre-pending the RN or the SP to the original digits.
- Provision an NPP rule with FPFX='060', FDL=13 and FNAI=NATL.

THE NPP PROVISIONING PROCESS::

1. Provision the NPP action sets
   - Provision for the '9090' scenario:
     ent-npp-as:asn=lkuprelease:ca1=IGN4:ca2=CC2:ca3=DN10:sa1=RTDBTRN:
     fa1=CC:fa2=RN:fa3=DN:ofnai=INTL
   - Provision for the '060' scenario:
     ent-npp-as:asn=lkuprelay:ca1=CCDEF:ca2=IGN3:ca3=DN7:sa1=RTDBTRNSP:
     fa1=RN:fa2=SP:fa3=ORIG:ofnai=NATL
2. Provision the NPP rules
   - The '9090' scenario: oent-npp-srs:srvn=nppt:fnai=INTL:fpfx=9090:fdiglen=16:asn=lkuprelease
   - The '060' scenario: oent-npp-srs:srvn=nppt:fnai=NATL:fpfx=060:fdiglen=13:asn=lkuprelay
3. Provision the NPP service state
   - In these examples, it is the same for both
   - chg-npp-serv:srvn=nppt:intl=7:natl=5:nai1=12:nai2=13:nai3=14
   - chg-npp-serv:srvn=nppt:status=ON
4. Send an NPP test message for each scenario

User Interface Commands

Table 20: User Interface Commands on page 40 contains descriptions for the User Interface (UI) commands for NPP. For the complete list of EAGLE 5 ISS commands, refer to the *EAGLE 5 ISS Commands Manual*.

Table 20: User Interface Commands

Command	Command Type	Description
ent/chg-npp-as	action set	Enter or change an NPP action set
dlt-npp-as	action sett	Delete an NPP action set
rtrv-npp-as	action set	Display an NPP action set
ent/chg-npp-srs	service rule set	Create or change an NPP rule set
dlt-npp-srs	service rule set	Delete a rule from an NPP rule set
rtrv-npp-srs	service rule set	Display an NPP rule set
chg-npp-serv	service	Change service state and/or NAI-to-FNAI class mappings
rtrv-npp-serv	service	Display all NPP service's status, NAI-to-FNAI class mappings and service action precedence
tst-npp-msg	test	Send an NPP test message

Glossary

C

CA	Conditioning Action CAs indicate what digit conditioning actions to execute when processing a digit string.
CLLI	Common Language Location Identifier
CSR	Customer Service Request

D

DN	Directory number A DN can refer to any mobile or wireline subscriber number, and can include MSISDN, MDN, MIN, or the wireline Dialed Number.

E

EOAM	Enhanced Operation, Administration, and Maintenance The application used by the GPSM-II card for enhanced OAM functions.
EPAP	EAGLE Provisioning Application Processor

F

FA	Formatting Action FAs determine how the outgoing digit string is formatted
FNAI	Filter Nature of Address Indicator Class values depicted as mnemonics for specifying a filter, represented by an enumerated type

F

	as NATL, INTL, NAI1, NAI2, NAI3, UNKN.
FPFX	Filter Prefix

I

INTL	FNAI class International
ISS	Integrated Signaling System

L

LAC	Location Area Code
LAI	Location Area Information

N

NAI	Nature of Address Indicator
NAI1	FNAI class Generic 1
NAI2	FNAI class Generic 2
NAI3	FNAI class Generic 3
NATL	FNAI class National
NPP	Numbering Plan Processor Provides the flexible service application behavior that satisfies the needs of customers resident in complex signaling networks. It is used for number conditioning, RTDB lookup, and outgoing number formatting.

N

NPPT	NPP Test A service that allows provisioning of NPP Action Sets and Rules associated with the NPP Service Rule set.

S

SA	Service Action Indicates what service-specific behaviors to execute when processing a digit string.
STP	Signal Transfer Point

U

UNKN	FNAI class Unknown

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