

Implementing a Prefix Manager ASA

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This document is a quick report on implementing an Autonomic Service Agent (ASA) for prefix management, based on [draft-ietf-anima-prefix-management](#). This is a demonstration ASA, i.e. it does not actually hand out real prefixes to real routers, but it is otherwise intended to be reasonably complete.

It is based on the Python 3 demonstration [prototype of GRASP \(file graspy.pdf\)](#) (read that document first) and inherits its limitations, especially the absence of a real ACP and therefore the absence of security.

The implementation is called `pfxm3` and can be downloaded from <https://github.com/becarpenter/graspy>. You also need `acp.py` and `grasp.py` from the same repository and the Python CBOR module (`pip3 install cbor` should do it).

`Pfxm3` has two operating modes: *master* and *delegator*. When running as a master, it starts by creating two pools of prefixes (for IPv6 and IPv4), and it acts as a source of the `PrefixManager.Params` objective.

An extra feature is the shortest delegated prefix length, a parameter entered by the user. It can be any reasonable length.

When running as a delegator, it starts with an empty prefix pool, it acquires the value of `PrefixManager.Params`, and it delegates IPv6 and IPv4 prefixes (currently all of the same length) to imaginary requesting routers. Both as a master and as a delegator, it seeks prefixes from peer ASAs when the pool is low, and it hands out prefixes to peer ASAs when possible. An extra feature is the delegated prefix length, a parameter entered by the user. It can be any reasonable length.

In theory a network could include any number of masters and any number of delegators, with the only condition being that each master's initial prefix pool is unique. A realistic scenario is to have exactly one master and as many delegators as you like. A scenario with no master is useless.

A defect in the implementation is that the data are kept in volatile storage. If a delegator exits for any reason, all the prefixes it has obtained or delegated are lost. If

a master exits, its entire spare pool is lost. In a real implementation, stable storage for these data is essential.

Pf_{xm3} doesn't implement 'dry run' negotiation realistically. That would mean temporarily marking any prefix handed out in a dry run as reserved, until either the peer obtains it in a live run, or a suitable timeout expires.

The main data structures used are

- The prefix pool, an ordered list of available prefixes. Prefixes are split when a longer prefix is needed than is listed in the pool, and a background garbage collector recombines split prefixes if they are returned to the pool.
- The delegated list, where a delegator stores the prefixes it has given to (imaginary) routers.

The main logic flows and some more details are below.

My conclusions: Apart from figuring out the bit manipulations and eliminating a few fencepost errors, this was quite easy work. I think it shows that the whole mechanism is viable. With stable storage added, and a secure ACP, it should be safe for real world use.

Main thread logic (IPv6 case only; IPv4 is similar) :

Create empty prefix pool (and an associated lock)

Create empty list of delegated prefixes

Ask user whether to act as master

if master:

 Create initial prefix pools

Register ASA with GRASP

Register objectives `PrefixManager` and `PrefixManager.Params`

if master:

 Create value of `PrefixManager.Params`

 Start thread to flood `PrefixManager.Params`

 Start synch listener for `PrefixManager.Params`

Start **main_negotiator** thread for `PrefixManager`

if not master:

 Synchronize (obtain value of) `PrefixManager.Params`

 Start **delegator** thread

Start garbage collector (**compress**) thread for prefix pool

while true:

 if prefix pool is low:

 Calculate wanted prefix length `L`

 Discover peers

 Choose a peer (prefer `good_peer` if available)

`req_negotiate("PrefixManager", peer)`

 if OK:

 if offered prefix length $< L+1$:

 Negotiation succeeded

`good_peer = peer`

 else:

 Fail negotiation

`sleep(10s)`

Main negotiator thread :

While true:

- listen_negotiate("PrefixManager")
- start a separate new negotiator thread

Negotiator thread:

Request prefix length L from pool

if not OK:

- while not OK and $L < 64$:

- $L = L + 1$

- Request prefix length L from pool

if OK:

- Offer prefix length L to peer

- if accepted:

- Negotiation succeeded

- else:

- Fail negotiation

else:

- Fail negotiation

Delegator thread:

while True:

- sleep(at least 1s) # in real world, wait for PD request

- get a /64 from pool

- if OK:

- append it to list # in real world, respond to PD request

- else:

- signal main thread that pool is low

Compress thread:

while True:

- search pool for adjacent prefixes of length L

- if they match at length L-1:

- merge prefixes

- sleep(5s)

Important global variables

```
ppool = []          #prefix pool
                    #The format is an array of tuples, such that
                    # ppool[i] = [plen, prefix] where
                    # plen is the prefix length (1..128) and
                    # prefix is a bytes object of 128 bits

pool_lock           #lock for thread-safe access to pool

delegated = []       #list of delegated prefixes
                    #(same format as ppool)

need = 0             #needed prefixes (counted in /64s)

master = False       #Boolean

good_peer = None     # where we remember a helpful peer ASA

obj1 = grasp.objective("PrefixManager")      #when acting as server
obj2 = grasp.objective("PrefixManager.Params")

want_obj = grasp.objective("PrefixManager") #when acting as client
```

Threads and Functions

Threads:

```
class flooder(threading.Thread):
    """Thread to flood PrefixManager.Params repeatedly"""

class main_negotiator(threading.Thread):
    """Main negotiator"""

class negotiator(threading.Thread):
    """Thread to negotiate PrefixManager as server"""

class delegator(threading.Thread):
    """Thread to delegate prefixes"""

class compress(threading.Thread):
    """Thread to compress pool"""
```

Functions (IPv4 versions are similar, where needed):

```
def endit(snonce, r):
    """Support function for negotiator"""

def make_mask(plen):
    """-> bytes object that is a mask of plen bits"""

def mask_prefix(plen,prefix):
    """-> packed prefix masked to length plen"""

def split_prefix(plen, prefix):
    """-> plen+1, prefix1, plen+1, prefix2"""

def create_pool():
    """makes a prefix pool, called only in master"""

def get_from_pool(plen):
    """-> packed prefix of requested length, or None"""

def insert_pool(plen, prefix):
    """inserts in pool in canonical order"""

def sum_pool():
    """ -> estimate of pool size in /64s"""

def nudge_pool(L):
    """signal need for prefixes of length L"""
```

Diagnostic functions:

```
dump_pool():
    """Print prefix pool"""

def dump_delegates():
    """Print delegated prefixes"""

def dump_some():
    """Print obj_registry and flood cache"""
```