A+P implementations and experiments results

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Outlines

- Implementing and deploy A+P with operators network

- Implementing Non-continuous port allocation flavor of A+P

- UPnP 1.0 efforts with A+P alike approach

- Experiments results of Port/session usages (applicable to general IPv4 sharing context)
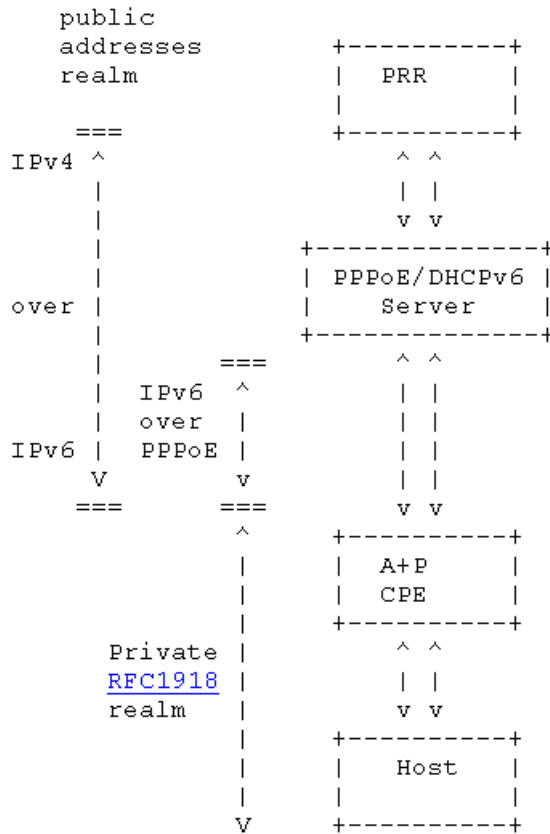
Where are we?

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Implementation Overview

- Network Topology

```
        public
        addresses                +----------+
        realm                    |   PRR    |
                                 |          |
        ===                      +----------+
IPv4   ^                           ^  ^
        |                          |  |
        |                          v  v
        |                       +-------------+
over    |                       | PPPoE/DHCPv6 |
        |                       |    Server    |
        |           ===         +-------------+
        |     IPv6   ^               ^  ^
        |     over   |               |  |
IPv6   |     PPPoE  |               |  |
        V            v               |  |
        ===          ===             v  v
                      ^           +----------+
                      |           |   A+P    |
                      |           |   CPE    |
                      |           +----------+
Private |                          ^  ^
RFC1918 |                          |  |
realm   |                          v  v
        |                       +----------+
        |                       |   Host   |
        V                       |          |
                                +----------+
```

- CPE Parameters

Model	CPU Speed (MHz)	Flash (MB)	RAM (MB)	Wireless NIC	Wireless Standard	Wired Ports
Linksys WRT54GS	200	8	32	Broadcom (integrated)	11g	5

Two flavors of implementations

- Port Range A+P (Continuous port range)
  - Allocates a range of ports per customer

- Scattered Port Sets A+P (Non-Continuous port sets)
  - Validate feasibility of non-continuous ports with A+P approach;
    - one possible solution among others to offer non-continuous port provisioning.

  - Evaluate efforts and investigate possibility of making UPnP 1.0 applications still work with this approach

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Scattered ports sets allocation Targets

- Not sacrifice port randomization compare to Continuous port range allocation

- Evaluate efforts and investigate possibility of making UPnP 1.0 applications still work with A+P approach

How to provision scattered ports?

- Only two parameters
- Subscribers ID pattern

```
|1st |2nd |3rd |4th |5th |6th |7th | 8th|
+----+----+----+----+----+----+----+----+
| 0  | s  | 0  | 0  | s  | 0  | s  | 0  |
+----+----+----+----+----+----+----+----+
|9th |10th|11th|12th|13th|14th|15th|16th|
+----+----+----+----+----+----+----+----+
| s  | 0  | s  | 0  | 0  | 0  | 0  | 0  |
+----+----+----+----+----+----+----+----+
```

- Subscribers ID value

```
|1st |2nd |3rd |4th |5th |6th |7th | 8th|
+----+----+----+----+----+----+----+----+
| 1  | 0  | 1  | 1  | 0  | 1  | 0  | 1  |
+----+----+----+----+----+----+----+----+
|9th |10th|11th|12th|13th|14th|15th|16th|
+----+----+----+----+----+----+----+----+
| 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
+----+----+----+----+----+----+----+----+
```

How to derive CPE IPv6 prefix in Scattered Port Sets context

Formed by stateless PRR:

- Subscribers ID value = Destination port & Subscribers ID pattern;

- Subscribers ID pattern could either be per domain or per address pool, depends on ports allocation policy.

```
|31bits|1bit| 32bits|8bits|16bits  |4bits|1bit|1bit|1bit|1bit| 32bits|
+------+----+-------+-----+------+-----+----+----+----+----+--------+
|AplusP|flag|Public |  EUI64 |SID_  |Reser|flag|flag|flag|flag|Reserved|
|Prefix| 0  |IPv4   |     |Value |-ved | 1  | 2  | 3  | 4  |        |
|      |    |Address|     |      |     |    |    |    |    |        |
+------+----+-------+-----+------+-----+----+----+----+----+--------+
```

Random ephemeral port selection among restricted ports sets for Customer NAT

- ## Why preserve randomness as much as possible ?

  - ### RFC 6056 "Recommendations for Transport-Protocol Port Randomization"

Only one line code needs to be changed on legacy customer NAT!
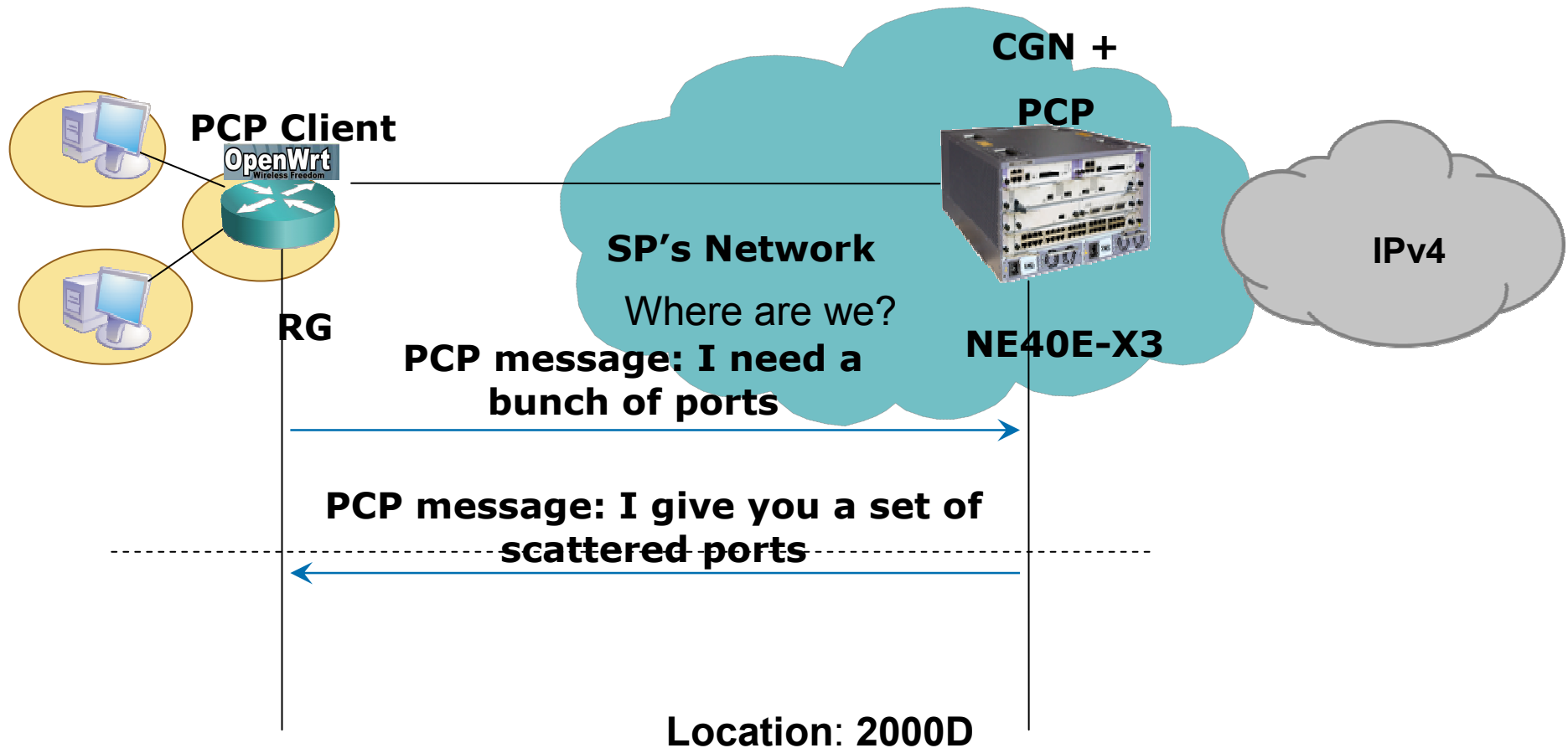
```
do{

    restricted_next_ephemeral = (random()|subscriber_ID_pattern)

                                & subscriber_ID_value;

    if(five-tuple is unique)

    return restricted_next_ephemeral;

}
```

An Implementation of Scattered Port Sets (Demoed in DS-Lite use case)

CGN + PCP

PCP Client

OpenWrt Wireless Freedom

SP's Network
Where are we?

IPv4

RG

NE40E-X3

PCP message: I need a bunch of ports

PCP message: I give you a set of scattered ports

Location: 2000D

Check out website for this demo: http://130.129.48.23:35328/

This website worked based on the live demo during IETF 81, and has been moved to :
http://opensourcev6transtechnologies.weebly.com/ietf-81-pcp-demo-site.html

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UPnP 1.0 extensions experiments

- UPnP 1.0 Actions/parameters extension
  - GetPortRangeLow(), and GetPortRangeHigh ()
  - NewExternal_IPAddress, NewPortRange_Low and NewPortRange High
- UPnP friendly port allocation
  - UPnP 1.0 applications behaviors of asking for an external port
  - Do applications work with UPnP 1.0 friendly port sets allocations method?

UPnP 1.0 applications behaviors of asking for an external port

```
+-------------------+---------------------------------------------+
|  Application      |   Behaviors                                 |
|                   |                                             |
+-------------------+---------------------------------------------+
| Microtorrent v2.2 | call GetSpecificPortMapping by incremental by|
|                   |  1 each time,                               |
| (also known as    |  until find an external port available, and |
|  uTorrent)        |  then call AddPortMapping,or return error    |
|                   |   after five failures                       |
+-------------------+---------------------------------------------+
| Emule v0.50a      | call AddPortMapping, after finding the      |
|                   | external port not available return error    |
|                   |                                             |
+-------------------+---------------------------------------------+
| Azureus v4.6.0.2  | call AddPortMapping, after finding the      |
|                   | external port not available, try the same   |
|                   | port 5 more times by call AddPortMapping,    |
|                   | then return error                           |
|-------------------+---------------------------------------------+
| Shareazav2.2.5.7  | call GetSpecificPortMapping, after finding  |
|                   | the external port not available, return error|
|                   | without issuing AddPortMapping              |
+-------------------+---------------------------------------------+
```

Does it work with UPnP 1.0 friendly port provisioning method?

- If instance a scattered port allocation with port sets interval less than 5
  - Have to design Subscriber ID Pattern 0x02 and,
  - Sharing Ratio: 2 (Assumed to be *not* a practical/efficient sharing ratio in most use cases)
- Only one application among others would be made working
- Only the chances of success have been increased with other applications

```
+-------------------+-------------------------------------------------+
|  Application      |  Does it work with UPnP 1.0 friendly port       |
|                   |  provisioning method?                           |
+-------------------+-------------------------------------------------+
| Microtorrent v2.2 |  Yes                                            |
+-------------------+-------------------------------------------------+
| Emule v0.50a      |  1/5 chance of working                          |
+-------------------+-------------------------------------------------+
| Azureus v4.6.0.2  |  1/5 chance of working                          |
|-------------------+-------------------------------------------------+
| Shareazav2.2.5.7  |   1/5 chance of working                         |
+-------------------+-------------------------------------------------+
```

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Port usages of applications

Application	Test case	Maximum port usage	Duration (seconds)
IE	browsing a news website	20-25	200
	browsing a video website	40-50	337
Firefox	browsing a news website	25-30	240
	browsing a video website	80-90	230
Chrome	browsing a news website	50-60	340
	browsing a video website	80-90	360
Android Chrome	browsing a news website	40-50	300
	browsing a video website	under 10	160
Google Earth	locating a place	30-35	240
Android Google Earth	locating a place	10-15	240
Skype	make a call	under 10	N/A
BitTorrent	downloading a file	200	N/A

Multiplexing sessions on the same source port?

- Common assumption of EIM NAT doesn't multiplex sessions on the same source port
- Test results shows exceptional results for UDP
  - For UDP it might not matter if the NAT is EIM or non-EIM, since hosts (Utorrent,skypes, etc.,) tend to reuse the same internal IP for different remote peers
  - Thanks to Simon Perreault, with whom discussion/conclusion achieved with offline based on the experiments results.
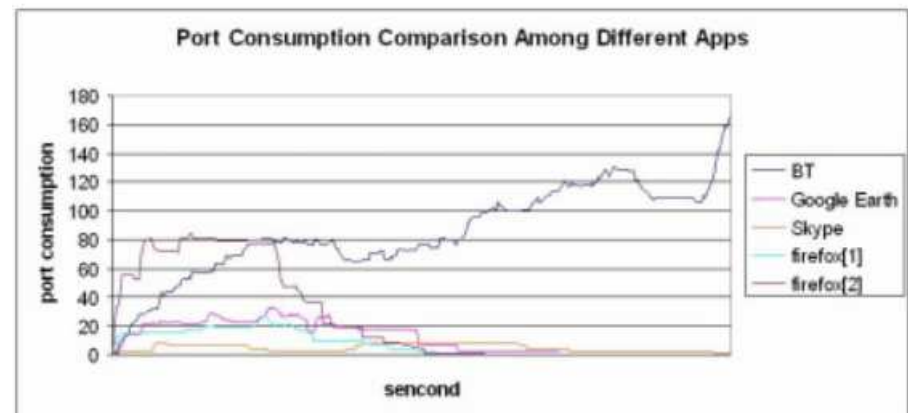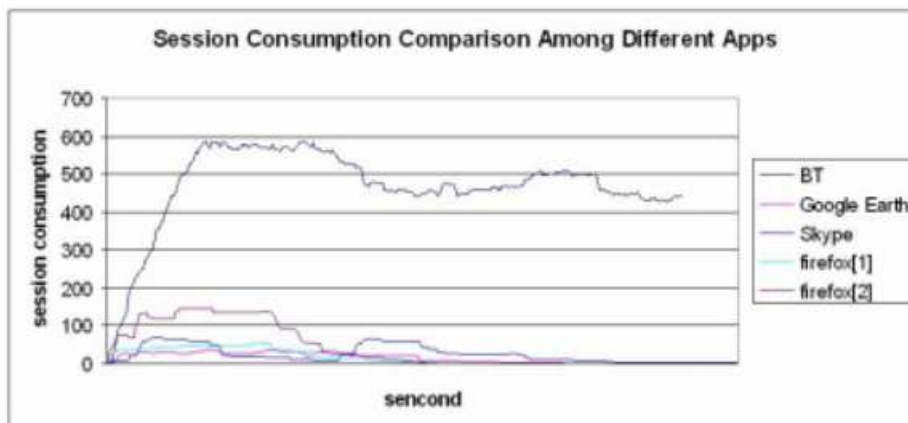
Summary
-What have been learnt?

- A+P is implementable and deployment with operators network

- Non-continuous port allocation is feasible for A+P alike approaches, Besides continuous port allocation.

- Making UPnP 1.0 work with A+P ?
  - Efforts VS. Results
  - Upgrading to UPnP 2.0 sounds a more simpler and reasonable approach

- Port/session usages, applicable to general IPv4 sharing context
  - Typical port usages of applications, thereby offering data for sharing ratio designing
  - UDP applications multiplexes sessions on the same port, which results in that the amount of sessions more than amount of ports no matter EIM NAT or non-EIM NAT
  - To document it in a separated I-D?

Q & A, and next steps?

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'=]):   .)   ( [
 | : :      ' |
  ~~----~~~
```

- Working as a WG item?
- To document port/session usage it in a separated I-D?