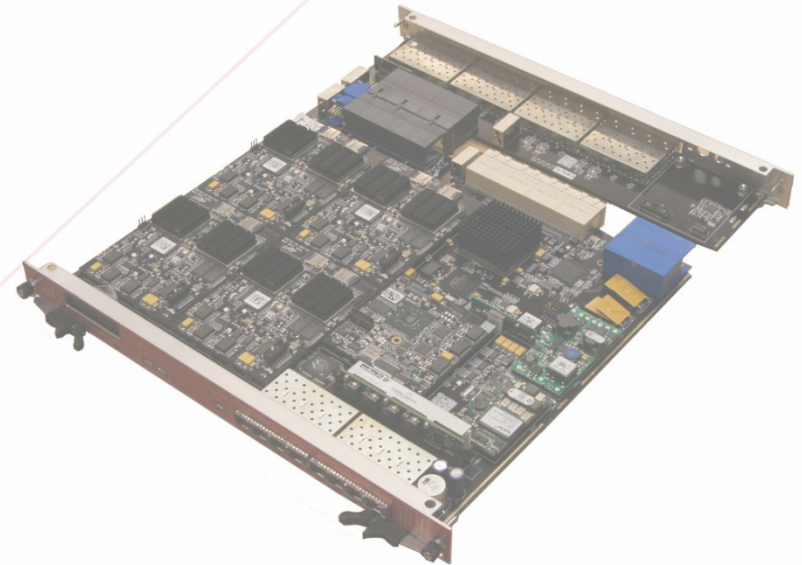## PseudoArp Exercise

This exercise will introduce the use of one of the provided DSL clients. A mapping will be created that maps IP address in a shelf to MAC address. We are doing this so that the next exercise has a database to work with.

Objectives:

- Construct a C++ class and compile it rather than a set of C routines as in the Hello World example.

- Introduce a DSL client.

- Introduce the concept of the BSI

- Construct a Pseudo ARP table for use in a later exercise

The Address Resolution Protocol (ARP) is used to resolve network layer addresses (IP address) to link layer addresses (MAC addresses). This exercise creates a "Pseudo ARP" database for use with the next exercise (Pseudo UDP). The methodology is to do the following:

- Loop over all RCEs in the crate by slot, bay and RCE (2 slots * 4 bays * 2 RCEs == 16)

- Ask each RCE for its IP and Ethernet information via the DSL client class `service::atca::Client`.

- Store this information in a small key-value-table.

| 1 | In your downloaded copy of `workshop_examples` (expanded in the previous exercise), change directory to `arp_example` and take a look at the `PseudoArp.hh` include file. |

```
bash> cd workshop_examples/arp_example
bash> less PseudoArp.hh
```

2 Here's the class definition for `PseudoArp`

```
#include <inttypes.h>
#include "kvt/Kvt.h"

namespace examples {
  class PseudoARP {
  public:
    PseudoARP();
    ~PseudoARP();
  public:
    uint64_t lookup(uint32_t);
  public:
    int refresh();
  private:
    KvTable _table;
  };
}
```

Notes and Comments

- The `lookup()` function takes an IPV4 address (in network byte order) as an argument and returns the MAC address associated with it.

- `refresh()` is the function which constructs the mapping between IPV4 and MAC.

- `KvTable` is a very lightweight key-value table provided with the RPT core. `KvTable` objects can only store 32 bit values, so they tend to have a pretty low memory footprint.

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Now, open `PseudoArp.cc`. The lookup function reads:

```
uint64_t PseudoARP::lookup(uint32_t ip)
{
  uint32_t reduced;
  KvtKey key = Hash64_32(0, ip);
  if ((reduced=(uint32_t)KvtLookup(key,_table))
      == 0) {
    // not found
    return 0;
  }
  return _unreduce(reduced);
}
```

Notes

- If the underlying lookup returns zero, this means that the IP address isn't in the table.

- `KvTable` can only store 32 bit objects. Since MAC addresses are 48 bits long, we must do something to make the address that length.

- `PseudoArp` uses knowledge that the MAC address space for RCEs is allocated with the first two bytes as `08:00`. `_unreduce()` adds these two bytes back.

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The next important function is refresh. The first part of the function fetches the shelf name from the BSI:

```
Bsi bsi = LookupBsi();
if (!bsi) {    // error state, deal with it.
  return rc;
}
uint32_t addr;
char
buffer[BSI_GROUP_NAME_SIZE*sizeof(unsigned)];
shelf = BsiReadGroup(bsi, buffer);
```

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5	The last part of refresh calls `_populate_loop()`. This function loops over slots, bays and elements and calls a `lookup` on each element in the shelf to get its IP info. Here we show the first part of the loop.	**Notes**

```
service::atca::Client client;
service::atca::Address addr(shelf,
    slot+1, bay, rce);
service::dsl::Location* loc =
    client.lookup(addr);
if (!loc) continue;
```

- `service::atca::Client` is tbe DSL client used by `atca_dump` and `atca_ip` to resolve the shelf/slot/bay/element space to IP space.

- When `service::atca::Client::lookup()` is called, the class sends a broadcast out asking for a match If a response is received, that information is returned. If not, it retries (up to 5 times) and then times out, and lookup returns NULL.

6	The second part of the loop extracts the MAC address and IP address from the info returned by `client.lookup()`, chops off the known bytes from the MAC address and saves the info to the table.	**Notes**

```
uint32_t ipaddr  = loc->layer3.addr();
uint64_t mac     = loc->layer2;
KvtKey key = Hash64_32(0, ipaddr);
KvtValue value = (KvtValue)_reduce(mac);
// If the insert goes bad, return error
if (0 == KvtInsert(key, value, table))
    return -1;
++count;
```

- `count` is used here as an error check. If nothing is found by the end of `_populate_loop()`, then an error is declared.

7	The last part of `PseudoArp.cc` that is important is at the end, by `lnk_prelude`. (PRINT statements are removed for brevity.)	**Notes**

```
examples::PseudoARP*
    common_pseudoarp_instance = 0;
// "Install" this object
extern "C" const int lnk_options = LNK_INSTALL;

extern "C" int lnk_prelude(void *arg, void *elf)
```

- A common `PseudoArp` instance is created in `lnk_prelude`. This is used by code which uses the library.

- Notice the `lnk_options` constant. When set to LNK_INSTALL, the library is not simply loaded into memory, it is installed

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```
{
  common_pseudoarp_instance =
      new examples::PseudoARP();
  return 0;
}
```

into a load table.

- Do this either when multiple pieces of code will use the library, or when a task is going to be run over and over again and the library should only be loaded once (per boot cycle)

---

8   In `arp_task.cc`, `Task_Start()` looks up the MAC address of this node from the table, and prints the result.

---

9   Build the code with `build.sh`. Then run it with:

```
[/] run examples:arp_test.exe
```

Check the output via `syslog` and notice that your RCE's IP address is printed.

Notes

- If one or more of the RCEs in the shelf are absent, the task will take seconds (or minutes) to run. If all are there, the task will finish quickly

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