TAPS-related topics from the NEAT project

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TAPS WG - IETF 98
Chicago- USA
28 March 2017
Introduction on NEAT

- NEAT project has been ongoing since **March 2015**

- NEAT library builds a **TAPS-like prototype system**
  - Protocol- and platform-independent
  - Open source, BSD Licensed (3 clause), implemented in C
  - Currently supports FreeBSD, Linux (Ubuntu), Mac OSX, and NetBSD
  - Event-based (using callbacks), libuv-based
  - Most core components are in place but still work-in-progress

- The NEAT API was first presented at IETF 95 (**Buenos Aires**)

- NEAT User API based on [draft-ietf-taps-transports-usage](https://tools.ietf.org/html/draft-ietf-taps-transports-usage) and NEAT internal use-cases
Key Features

- API properties
- NEAT Policy system
- Simpler/flexible coding with the NEAT User API
- Application feedback (Happy Apps)
Application properties in NEAT

- NEAT gives users a chance to control as much as they want, yet allow automatization

- It uses a key/value-based property system in JSON format
  - They can have different types and metadata attached to them, e.g. precedence
  - can set multiple/all properties with one API call

```c
neat_set_property(ctx, flow, properties);
```

- Properties are given "precedence" -- e.g. 1=desired; 2=required
  1) Desired: try and fallback if unsuccessful
  2) Required: fail if unsuccessful

```json
{
    "transport": [
        {
            "value": "SCTP",
            "precedence": 1
        },
        {
            "value": "TCP",
            "precedence": 1
        }
    ]
}
```
Key Features

- API properties

- **NEAT Policy system**

- Simpler/flexible coding with the NEAT User API

- Application feedback (Happy Apps)
NEAT Policy System (#1)

NEAT’s selection of protocols and parameterization is based on:

① Configured policies (PIB lookup)
② Tested capabilities (Happy Eyeballs)
③ Known and learned capabilities (CIB lookup)

NEAT Policy components and their interactions
NEAT Policy System (#2)

- **NEAT** provides a flexible way for defining policies; also allows for creation of profiles depending on the networking scenario.

- **Policies**: based on NEAT properties with priorities among themselves, in JSON format; set by the user, system administrator or developer.

- **Profiles**: are policies applied before CIB lookup; match (high-level) property in the request is replaced with the associated profile (low-level) properties.

- Policies and profiles are stored in Policy Information Base (PIB)

```json
{
    "name": "Low latency",
    "match": {
        "low_latency": {
            "precedence": 1,
            "value": true
        }
    },
    "properties": {
        "interface_latency": {
            "precedence": 2,
            "value": [0, 40]
        },
        "is_wired": {
            "precedence": 1,
            "value": true
        }
    }
}
```

An example of profile
Key Features

- API properties
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Simpler/flexible coding with the NEAT User API

- **Built in NEAT:** many common network programming tasks like address resolution, buffer management, encryption, connection establishment and handling

- Address resolution and connection establishment with a *single* function call

  ```c
  neat_open(ctx, flow, "bsd10.fh-muenster.de", 80, NULL, 0);
  ```

- **Example #1:** Establishing a listening socket *(42 SLoC with NEAT API vs 59 SLoC with socket API)*

- **Example #2:** we ported Nghttp2 (a HTTP/2 implementation) web server/client and a few other smaller http/https-based clients to use NEAT
  - Interoperable with TCP
  - Can benefit from using SCTP

  ~20% reduction in code lines
Key Features

- API properties
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Application feedback (Happy Apps) (#1)

- **Happy Apps**: offers selection mechanisms when the underlying transport protocol does not provide the signals required -- e.g. QoS fallback with UDP(-Lite)

- **Network QoS**: often limited to controlled network environment due to lack of *high-level API*

- **Key challenge**: how to express service requirements, while still enabling policy to influence choice and providing flexibility when the network is unable to directly satisfy the requirements

- **With NEAT**: can use user requirements, policy, and dynamic info collected from other connections to drive an appropriate DSCP code-point
Example: we developed **neat-streamer** based on Gstreamer (pipeline-based media library for audio/video)
Major updates since IETF 95 (#1)

- **Multi-streaming**: transparent use of SCTP multi-streaming (compile-time option)

- **Flow-level priority**: API support for flow group (local) priorities to leverage:
  - Coupled-CC with TCP based on `draft-welzl-tcpccc-00`
  - Stream scheduling with SCTP (`WiP`)

- **“transport protocol” HE mechanism**: improvements in the code
  - Including investigation of transport HE’s cost *(presented in TAPS, IETF 96)*
  - Uses priorities among “candidate transport solutions” with a fixed delay
  - NEAT transport-level HE is explained in `draft-grinnemo-taps-he-02`
Major updates since IETF 95 (#2)

- Datagram support for the API (UDP, UDP-Lite)
- Support for SCTP, SCTP/UDP (both in kernel and userland)
- Server-side support (listening on multiple protocols)
- Multi-homing support (with STCP)
- Multipath support (with MPTCP) (unmerged)
- Security (TLS/TCP; DTLS/UDP and ongoing work on DTLS/SCTP)
- Lots of improvements, debuggings and coding optimizations!

neat
NEAT EU project: https://www.neat-project.org
Github Repository: https://github.com/NEAT-project/neat
API documentation and tutorial: http://neat.readthedocs.io/en/latest

Also to appear in IEEE Communications Magazine, June 2017


Comments, feedback, patches, test results, suggestions on target apps are welcome!

Q&A

neat
1. Request to open flow & pass application requirements
2. Query PM about feasible transport candidates based on destination domain name
3. PM determines available transport candidates that fulfil policy (PIB) and cached information (CIB)
4. Return ranked list of feasible transport candidates as pre-filter for address resolution
5. Resolve addresses
6. Query PM about feasible transport candidates for resolved destination address
7. PM builds candidates, assigning priorities based on PIB/CIB matches
8. Return ranked list of feasible transport candidates for flow establishment
9. Do Happy Eyeballs with candidates, according to specified priorities
10. Return handle to selected transport solution
11. Cache results from Happy Eyeballs in the CIB

static char *properties = 
{"transport": {"value": "reliable", "precedence": 2}};

int main(void) {
    struct neat_ctx *ctx;
    struct neat_flow *flow;
    struct neat_flow_operations ops;

    ctx = neat_init_ctx();
    flow = neat_new_flow(ctx);
    memset(&ops, 0, sizeof(ops));
    ops.on_connected = on_connected;
    neat_set_operations(ctx, flow, &ops);
    neat_set_property(ctx, flow, properties);
    neat_open(ctx, flow, "bsd10.fh-muenster.de", 5000, NULL, 0);
    neat_start_event_loop(ctx, NEAT_RUN_DEFAULT);
    neat_free_ctx(ctx);
    return EXIT_SUCCESS;
}
A Simple Client using the NEAT API (#2)

static neat_error_code on_connected(struct neat_flow_operations *ops) {
  ops->on_writable = on_writable;
  ops->on_all_written = on_all_written;
  neat_set_operations(ops->ctx, ops->flow, ops);
  return NEAT_OK;
}

static neat_error_code on_writable(struct neat_flow_operations *ops) {
  neat_write(ops->ctx, ops->flow, "Hi!", 3, NULL, 0);
  return NEAT_OK;
}

static neat_error_code on_all_written(struct neat_flow_operations *ops) {
  ops->on_readable = on_readable;
  ops->on_writable = NULL;
  neat_set_operations(ops->ctx, ops->flow, ops);
  return NEAT_OK;
}
static neat_error_code on_readable(struct neat_flow_operations *ops) {
    uint32_t bytes_read = 0;
    char buffer[32];

    if (neat_read(ops->ctx, ops->flow, buffer, 31,
            &bytes_read, NULL, 0) == NEAT_OK) {
        buffer[bytes_read] = 0;
        fprintf(stdout, "Read %u bytes:\n%s", bytes_read, buffer);
    }
    neat_close(ops->ctx, ops->flow);
    neat_stop_event_loop(ops->ctx);

    return NEAT_OK;
}