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openhead-end

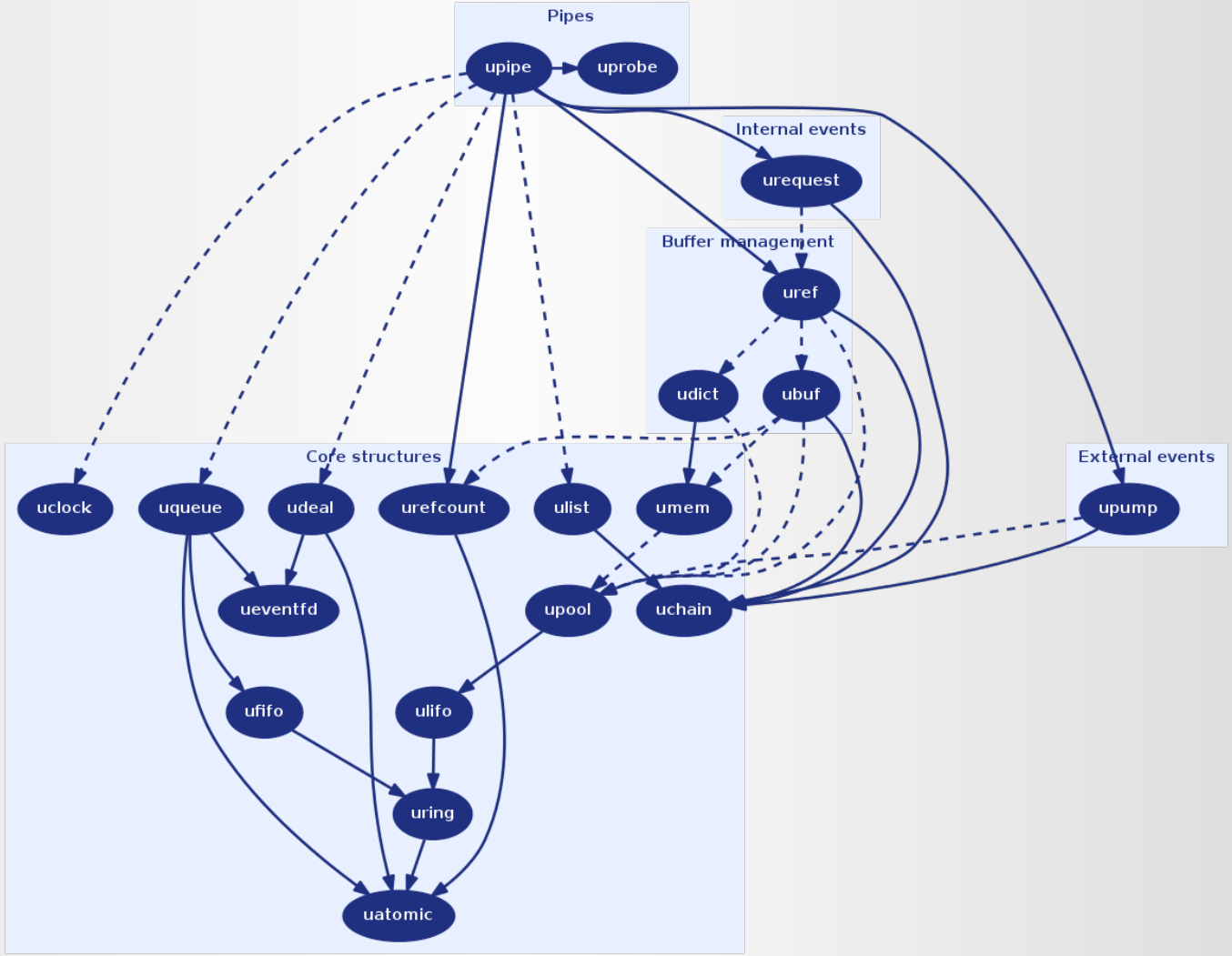
What makes Upipe great for video processing

What is Upipe?

- A young (2012) C multimedia framework
- Initiated by OpenHeadend team
- 3 supporting companies, 7 contributors
- Pre-release 4 just out, plans for 1.0 to be discussed
- Focus on reliability, efficiency and compliance, for broadcast and professional applications
- MIT and LGPL

Upipe main structures

- `struct upipe:` unit of data processing, part of a pipeline
- `struct uprobe:` internal exception catcher, interaction with application
- `struct upump:` external event catcher, event loop
- `struct uclock:` system clock management
- `struct urequest:` inter-pipe negotiation
- `struct uref:` unit of data and metadata
- `struct ubuf:` container of data


Pipes
upipe
uprobe
Internal events
urequest
Buffer management
uref
udict
ubuf
Core structures
uclock
uqueue
udeal
urefcount
ulist
umem
External events
upump
ueventfd
upool
uchain
ufifo
ulifo
uring
uatomic

Advanced buffer management

- Refcounts allow buffer-sharing
  - `struct ubuf *new = ubuf_dup(ubuf);`
- Copy-on-write semantics
  - `ubuf_block_write(ubuf, offset, &size, &buf);`
  - `new = ubuf_block_copy(ubuf_mgr, ubuf, skip, new_size);`
- Zero-copy primitives for data blocks
  - `ubuf_block_append(ubuf1, ubuf2);`
  - `ubuf_block_insert(ubuf1, offset, ubuf2);`
  - `ubuf_block_delete(ubuf, offset, size);`
  - `ubuf_block_resize(ubuf, offset, new_size);`

Arbitrary meta-data attributes

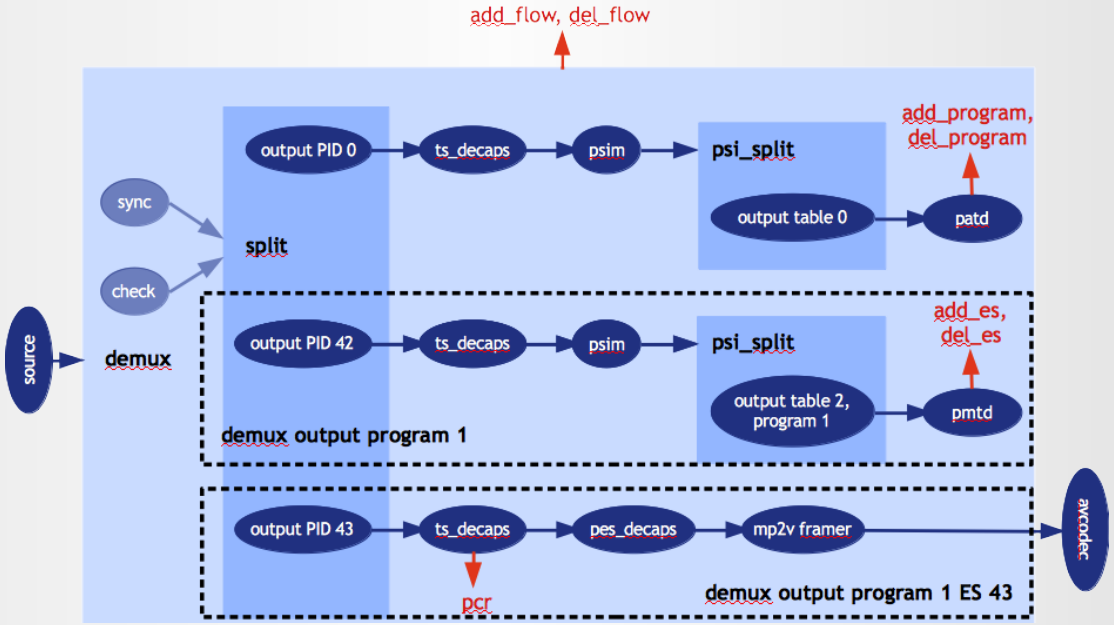
- `struct uref` carried across pipes embeds timestamps & pointers to `ubuf` and attribute dictionary
- Preprocessor macros allow easy attribute declarations:
  - `UREF_ATTR_UNSIGNED(foo, bar, “foo.bar", example of attribute)`
- Accessors to manipulate the attribute:
  - `uref_foo_set_bar(uref, 42);`
  - `uref_foo_get_bar(uref, &uint64_var);`
  - `uref_goo_delete_bar(uref);`
- Implemented with inline buffer (no memory allocation)

Three clock variants

- Packet timestamps are stored in three clock variants:
  - `orig:` original timestamp scaled to 27MHz units
  - `prog:` same scale as `orig` but origin moved to be monotonically increasing, used to encode PTS/DTS
  - `sys:` scale of the system clock `(uclock)`, used to output packets
- Allows to keep a compliant difference between PTSs based on frame rate (eg. 40 ms)
- At the same time skew the system clock to output packets faster or slower to keep up with transmitter

Inner pipes

- Pipes can “embed” other pipes
- Allows for more granularity and flexibility



Event loop

- Upipe's event loop can be exposed to all pipe types via an abstract API (`upump`)
- Allows to have timers in any pipe, for instance event handling (SCTE-35 splicing)
  - ```
    upump = upump_alloc_timer(upump_mgr, callback,
                              opaque, refcount,
                              timeout, repeated);
    ```
- Or to interact with the external world
  - ```
    upump = upump_alloc_fd_read(upump_mgr, callback,
                                opaque, refcount,
                                file_descriptor);
    ```

Dynamic pipeline construction

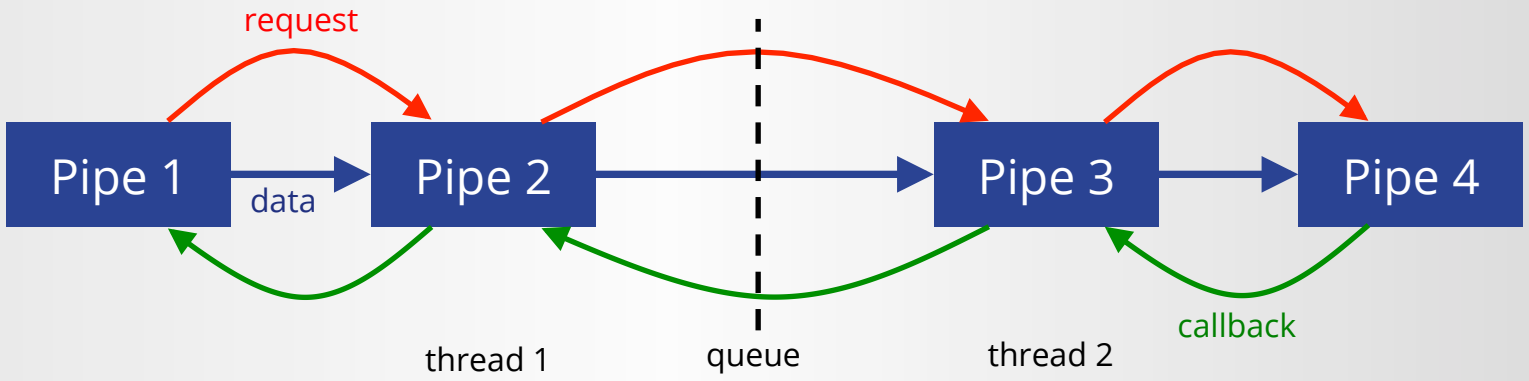
- The `uprobe` API allows the application to receive exceptions from the pipe
- Application can be notified when a pipe needs an output (`UPROBE_NEED_OUTPUT`), or the list of elementary streams of a demux changes (`UPROBE_SPLIT_UPDATE`)
- Useful for dynamic formats such as transport streams

Threading & buffering

- Pipes are low-level — threading is decided by the application
- Queues and workers can move pipelines to threads
  - `local_pipe = upipe_wlin_alloc(remote_thread, local_probe, remote_pipe, remote_probe, input_queue_len, output_queue_len);`
- Local pipe takes the place of the remote pipe in the local thread and can be acted upon
- Lockless FIFOs and LIFOs handle and recycle data structures + eventfd abstraction

Inter-pipe negotiation

- Pipes can register `struct urequest` on their output
- The request is passed from pipe to pipe until handled, the reply flows backwards from callback to callback
- Requests cross threads boundaries via queues and are resent in case of pipeline changes



Available pipes

- `upipe-modules:` pipes for basic manipulation and I/O
- `upipe-ts:` standards-compliant TS demux and mux
- `upipe-framers:` bitstream conversion of common codecs (mp2v, h264, mp2, aac, a52, opus, telx, dvbsub, s302)
- `upipe-av:` avformat demux and mux, avcodec decoder and encoder
- `upipe-swresample, upipe-swscale, upipe-x264, upipe-blackmagic`

Application development

- Currently C API
- Work for LuaJIT bindings under way: https://github.com/nto/lj-upipe
- Transcode example application:
  - `Usage: transcode [-d] [-m <mime>] [-f <format>] [-p <id> -c <codec> [-o <option=value>] ...] ... <source file> <sink file>`
    `-f: output format name`
    `-m: output mime type`
    `-p: add stream with id`
    `-c: stream encoder`
    `-o: encoder option (key=value)`

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Upipe meet-up in BOF room Sunday 14:00