Static analysis of multithreaded dynamic programs

A π-calculus based approach

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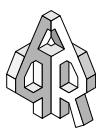

Context

Compositional static analysis

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#define N_EVENT                 5

struct dev_data {
        spinlock_t                      lock;
        atomic_t                        count;
        enum ep0_state                  state;          /* P: lock */
        struct usb_gadgetfs_event       event [N_EVENT];
        unsigned                        ev_next;
        struct fasync_struct            *fasync;
        u8                              current_config;

        /* drivers reading ep0 MUST handle control requests (SETUP)
         * reported that way; else the host will time out.
         */
        unsigned                        usermode_setup : 1,
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                                        setup_abort : 1;
        unsigned                        setup_wLength;

        /* the rest is basically write-once */
        struct usb_config_descriptor    *config, *hs_config;
        struct usb_device_descriptor    *dev;
        struct usb_request              *req;
        struct usb_gadget               *gadget;
        struct list_head                epfiles;
        void                            *buf;
        wait_queue_head_t               wait;
        struct super_block              *sb;
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        /* except this scratch i/o buffer for ep0 */
        u8                              rbuf [256];
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static inline void get_dev (struct dev_data *data)
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        atomic_inc (&data->count);
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static void put_dev (struct dev_data *data)
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        if (likely (!atomic_dec_and_test (&data->count)))
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static struct dev_data *dev_new (void)
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/* other /dev/gadget/$ENDPOINT files represent endpoints */
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Memory leaks ?

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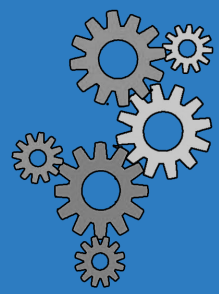

Automatic verification

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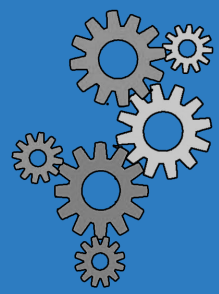

Automatic verification

Static analysis of multithreaded programs

Abstract interpretation [Min, 2012]
Software Model Checking (e.g. : Promela/Spin [Holtzmann, 2005])
Compositional verification (e.g. : Mage [Abramsky et al., 2004])
...

Our approach

π-calculus based abstractions

About π-calculus

A process algebra that is expressive and compositional

Modeling

- Parallelism
- Concurrency
- Recursion
- Higher order functions
- Dynamic creation of resources

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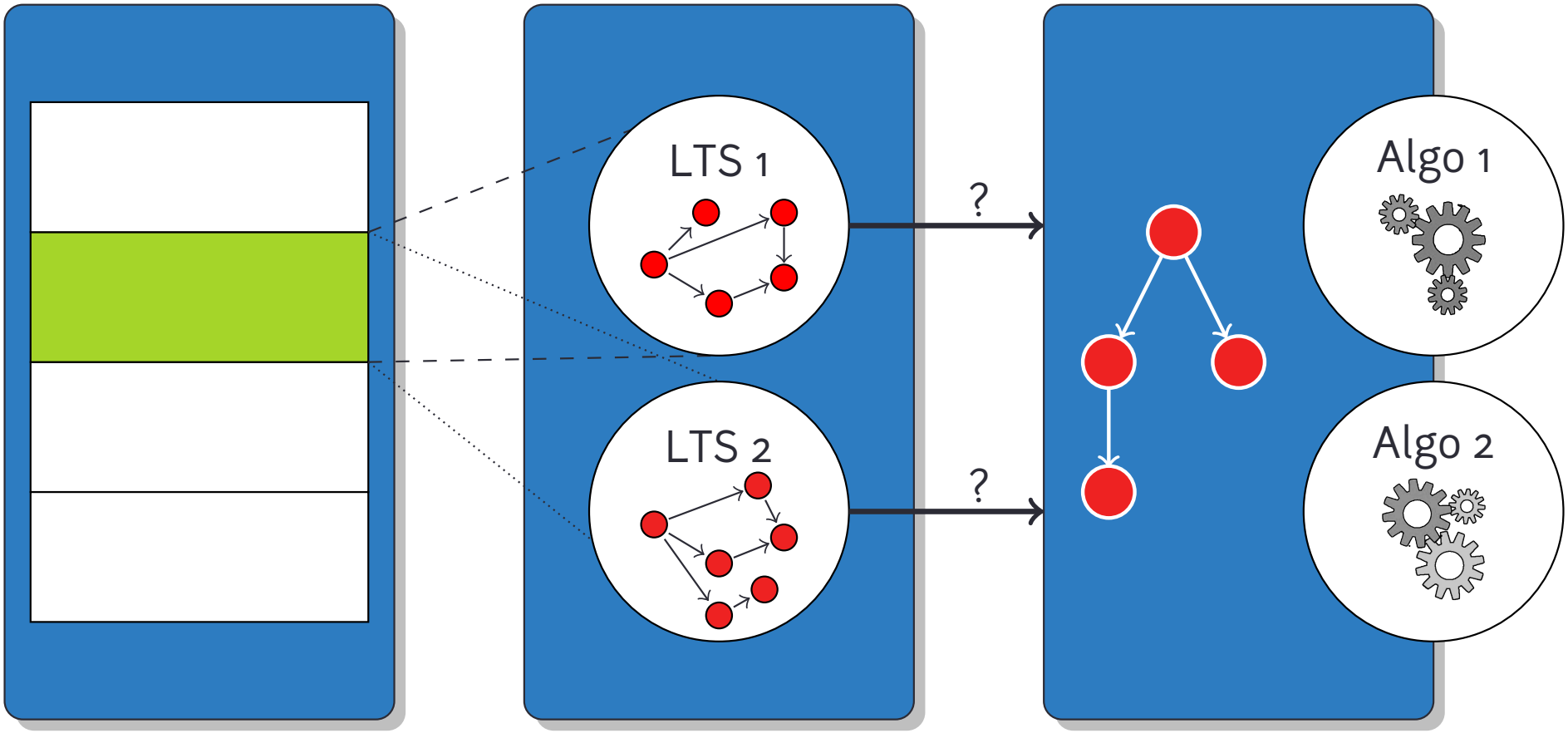
But...

...name creation and name input do not allow to build ground automata (because alpha-conversion)

Our approach

Introducing an intermediate abstraction to deal with dynamic resources



The Omniscent Garbage Collector Framework (OGC)

An algorithmic framework to deal with dynamic resources, in an automatic verification context

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Applications

- Pure names management
- Thread identities attribution
- Memory cells attribution
- Fresh names in programming languages

Future work

Improvements and correctness of OGC algorithms

Extension to a π-calculus with values

Verification of properties related to dynamic resources

- Model checking (with a logic for resources)
- Divergence checking