Massively distributed intrusions detection : goals, challenges and possible solutions.

SEC2 2015, Lille

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Plan

Plan

Intrusion detection is hard in a cloud context

Cloud specific issues

- Complex and dynamic network architectures
- Sensible data

Attacks can avoid standard security solutions

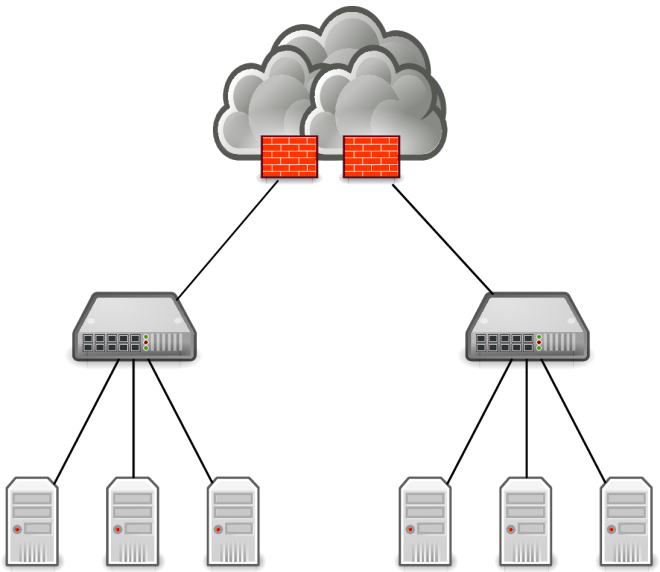
- by trying to lead the attack from inside the network [1]
- by spliting the attack using several hosts, network routes [4]

Bandwith and computing power is cheap to rent : Cloud As A Weapon [1]

D. Bryan and M. Anderson. *Cloud computing, a weapon of mass destruction*, DEFCON 2010

- Thunderclap
- Less than a few dollars to put a host down
- Instead of infecting host to create a botnet, just rent them !

Usual security solutions tends be located at the edge of the network



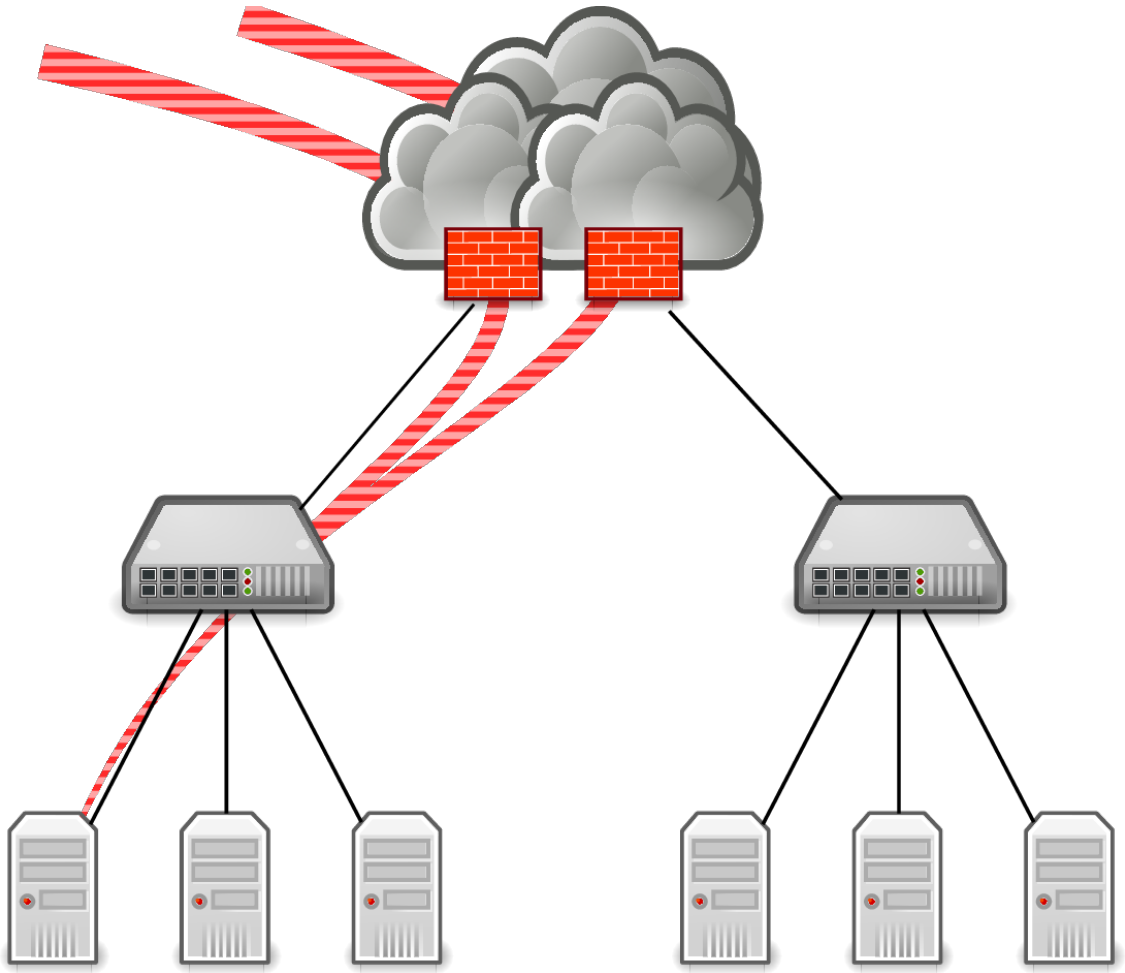
Firewalls

- usually located at the connection between data center and ISP
- filters network packet based on security rules

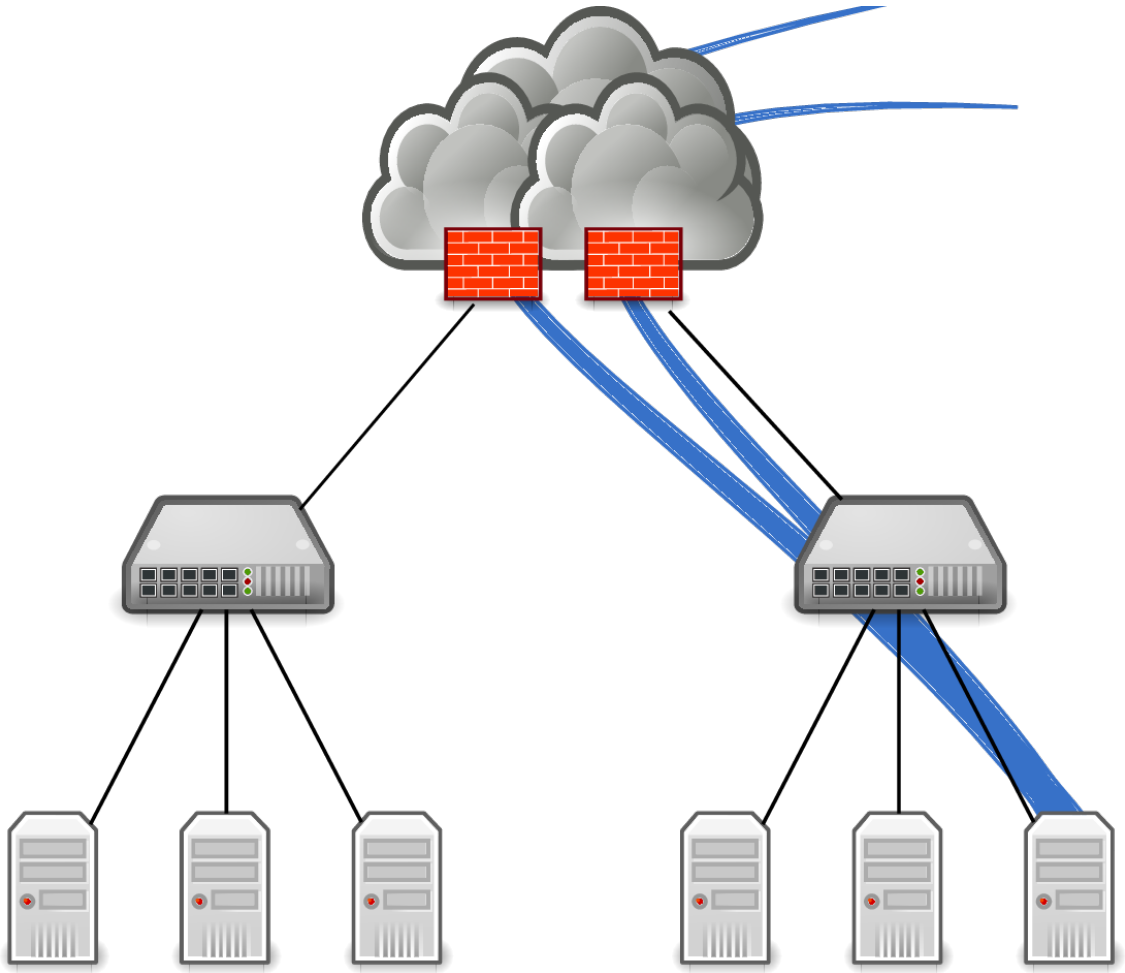
Intrusion Detection Systems (IDS)

- monitors the network (NIDS) or the operating system (HIDS)
- passive system : its goal is to raise alerts
- pattern matching or behavior analysis

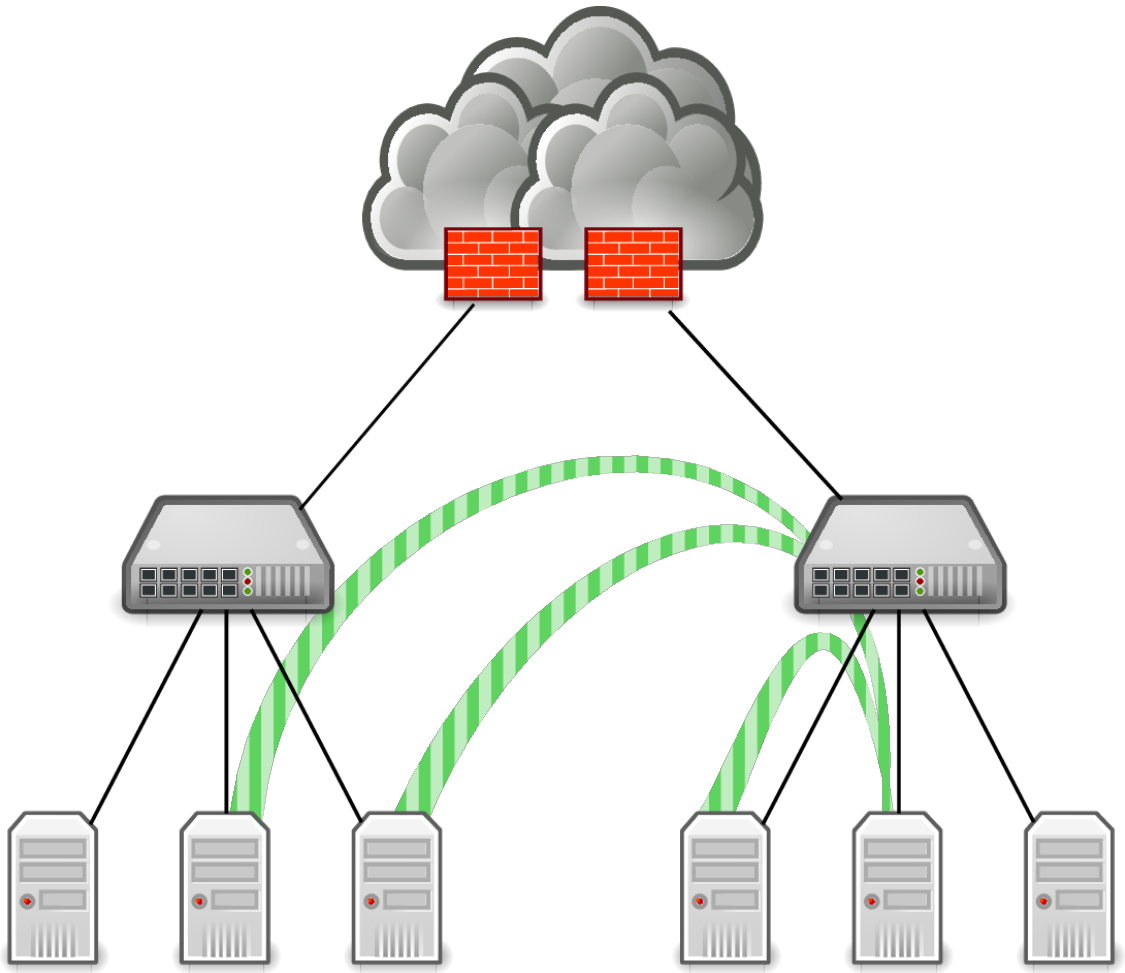
Attacks can come from outside



Attacks can be performed from inside



Attacks can stay inside



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One solution may be distributed, collaborative IDS

Push IDS inside the infrastructure

- More probes means more information
- More information means better detection (or at least, may lead to)

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Why not almost everywhere ?

- Firewalls
- Switches
- Network cards/link
- Hypervisors

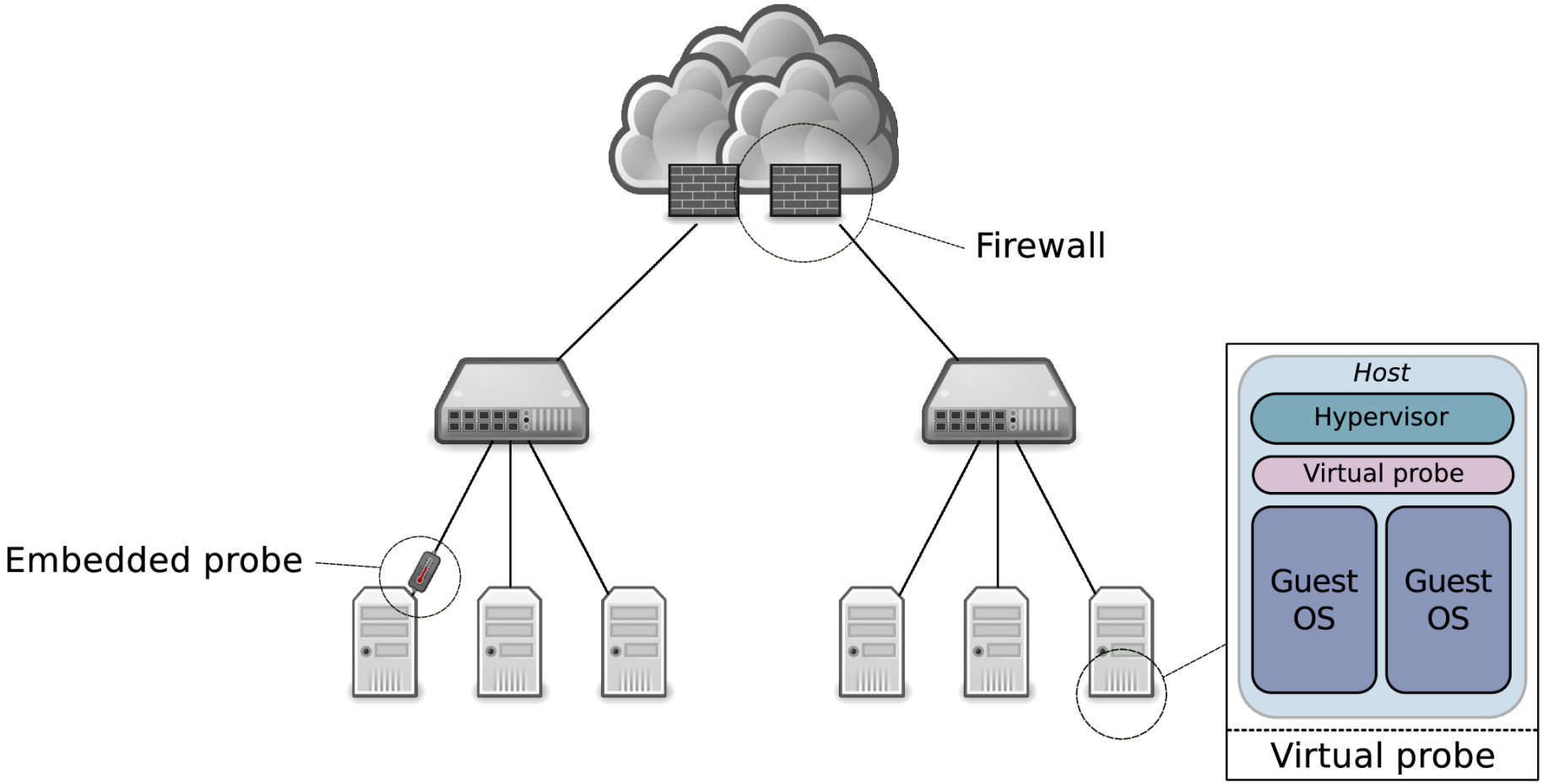
Plan

DISCUS is our proposal to deploy IDS everywhere [3]

Main ideas

- Put IDS probes as close to monitoring targets as possible
- Probes can be software or hardware
  - Embedded : cheap , but not very powerful, and hard to program
  - FPGA : very good power/cost ratio , but hard to create
  - Kernel or userspace software (snort, standalone software, kernel module) : can achieve high performance but need powerful hardware (high cost)

Let's put probes everywhere



Creating software for the probes is not that easy

Issues

- Heterogeneous targets $\rightarrow$ lots of expertise
- Collaboration is hard
- Deployment is hard

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Use of a Domain Specific Language (DSL)

- Focus on detection logic, not implementation details
- Use compile tools to handle heterogeneity and deployment

DSL focus on specific logic

- Not as expressive as generic purpose languages

DSL focus on specific logic

- Not as expressive as generic purpose languages
  - Limit development errors
  - Ensure strong properties on generated software
  - Allow better automatic optimisation

Event syntax

```
on my_event_name(args_list)
    [where condition]
    [...]
    action_list
    [...];
```

Actions

- Raise another event (now or later)
- Raise an alert
- Handle tables' structure

Filtering HTTP packets

```
on tcp_packet(..., int16 dst_port, ...)
    where dst_port == 80
    raise http_packet(...);
```

Tables : a structure to share data

- Distributed database of contextual data
- Table entries are aggregates of primary types
- Provides a way to collaborate

Declaration of a table

```
table tcp_connection {
    ipaddr src,dst;
    int16 p_src,p_dst;
    enum tcp_connection_state state;
    time last_pkt;
    (...)
};
```

Removing entries and purging tables

```
remove entry from tcp_connection when
    entry.state == TCP_CLOSED;

on purge tcp_connection select entry where
    entry.last_pkt + 3600 < now;
```

Using tables in events : updating last packet timestamp

```
on tcp_packet(ipaddr src, ipaddr dst, ...)

        update entry.last_pkt = now
```

Using tables in events : updating last packet timestamp

```
on tcp_packet(ipaddr src, ipaddr dst, ...)

    for first entry in tcp_connection with
            entry.src == src
            and entry.dst == dst
            and (...)

        update entry.last_pkt = now
```

Using tables in events : updating last packet timestamp

```
on tcp_packet(ipaddr src, ipaddr dst, ...)

    for first entry in tcp_connection with
            entry.src == src
            and entry.dst == dst
            and (...)

        update entry.last_pkt = now

    ifnone
        insert into tcp_connection {
            src = src;
            dst = dst;
            state = TCP_INIT;
            last_pkt = now;
            (...)
        };
```

Use case : detecting SYN Flood attacks

A basic DoS attack : SYN Flood [2]

- Opening a lot of TCP connections
- Initiating the handshake but not finishing it
- Memory congestion

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Detection

- Count number of partially opened TCP connections per client
- Alert when the number reaches a fixed threshold (50)

Table

```
table dos_attempt {
    ipaddr src;
    int16 count;
    time last_attempt;
};


remove entry from dos_attempt
    when entry.count > 50;

on purge dos_attempt select entry
    where entry.last_attempt + 3600 < now;
```

Finding partially opened TCP connections

```
on tcp_packet(ipaddr src, ..., int9 flags, ...)
    where flags == tcp_flags.SYN
    raise check_dos_attempt(src, dst,
        src_port, dst_port) in 50 ms;
```

Finding partially opened TCP connections

```
on tcp_packet(ipaddr src, ..., int9 flags, ...)
    where flags == tcp_flags.SYN
    raise check_dos_attempt(src, dst,
        src_port, dst_port) in 50 ms;

on check_dos_attempt(ipaddr src, ..., int16 dst_port)
    for first entry in tcp_connections with
            entry.src == src and (...)
            and entry.connection_state != OPENED
        raise dos_attempt(src);
```

Dealing with DOS attempts

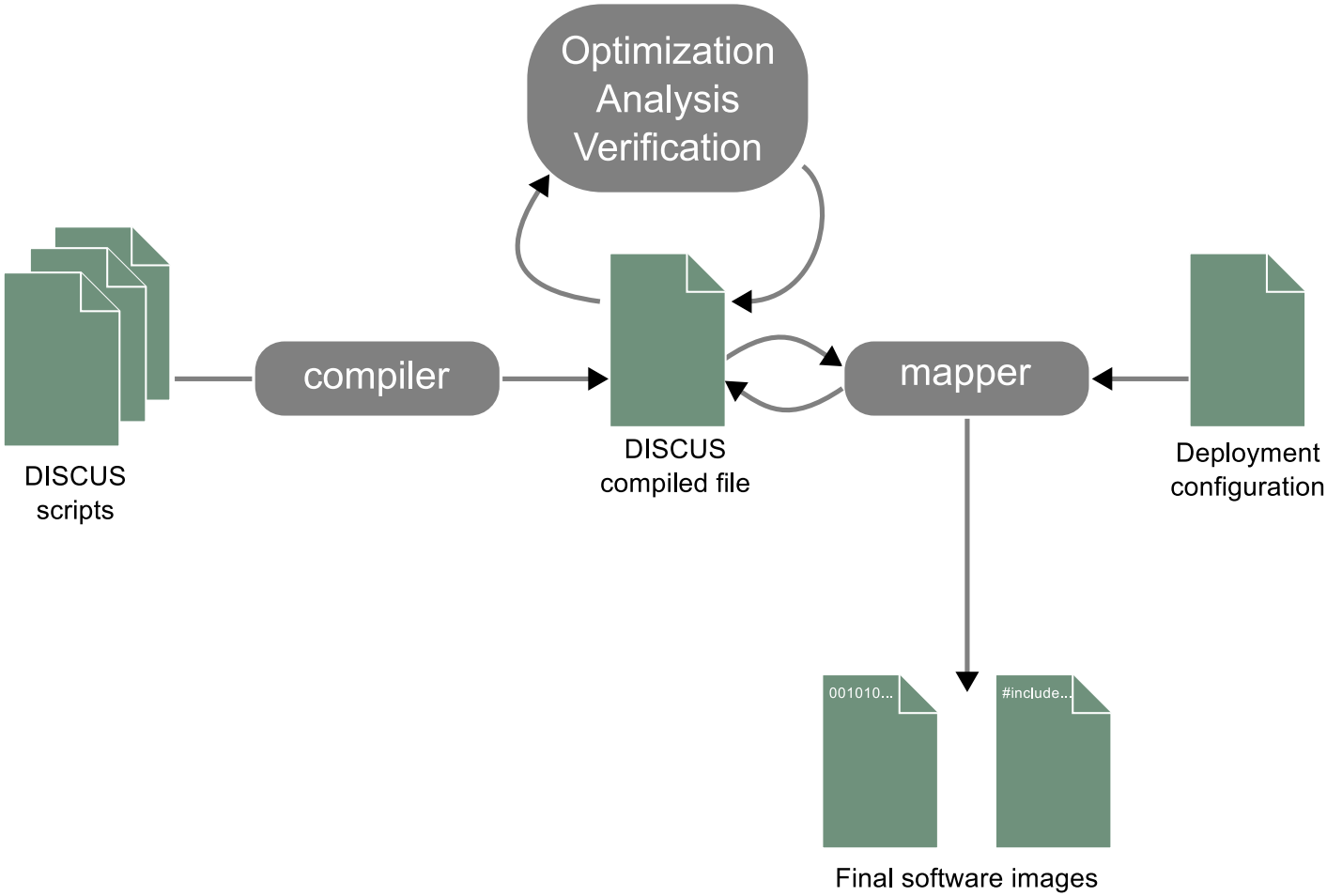
```
on dos_attempt(ipaddr src)
    for first entry in dos_attempt with
            entry.src == src
        update entry.count += 1
        update entry.last_attempt = now
        raise check_threshold(src)
    ifnone
        insert into dos_attempt {
            (...)
        };
```

Dealing with DOS attempts

```
on dos_attempt(ipaddr src)
    for first entry in dos_attempt with
            entry.src == src
        update entry.count += 1
        update entry.last_attempt = now
        raise check_threshold(src)
    ifnone
        insert into dos_attempt {
            (...)
        };

on check_threshold(ipaddr src)
    for first entry in dos_attempt with
            entry.src == src
            and entry.count >= 50
        alert("Some message");
```

DISCUS development process



Plan

What's done

- Compiler, optimizer
- Targets : embedded micro-controller, linux user space (libpcap), Snort scripts
- Automatic snort to discus translation : 98% of snort rules can be converted to DISCUS script
  - remaining 2% involves C code (snort modules)
- Simple data handling/sharing

Next steps

Enhanced data handling/sharing

- Efficient
- Secure
- Adapted to heterogeneous targets

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More targets !

- FPGA !
  - High performance, quite low cost
  - Integrates IDS in switches
- Network cards firmwares

Next steps

Dynamic reconfiguration

- Redefine security rules
- Without stopping monitoring

More domains

- Industrial Control System Security
  - No more standard IP networks
  - Real time guaranties ?
- Securing IoT
  - Tiny IDS in every Thing

Questions ?

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[1] D. N. M. Bryan et M. Anderson. *Cloud Computing, a Weapon of Mass Destruction ?* 2010. url : https://www.defcon.org/html/links/dc-archives/dc-18-archive.html.

[2] Ramana Rao Kompella. « On Scalable Attack Detection in the Network ». In : 2004.

[3] D. Riquet, G. Grimaud et M. Hauspie. « DISCUS : A massively distributed IDS architecture using a DSL-based configuration ». In : *Proceedings of the 2014 International Conference on Information Science, Electronics and Electrical Engineering (ISEEE'2014)*. Sapporo City, Hokkaido, Japan, 2014.

[4] D. Riquet, G. Grimaud et M. Hauspie. « Large-scale coordinated attacks : Impact on the cloud security ». In : *Proceedings of The Second International Workshop on Mobile Commerce, Cloud Computing, Network and Communication Security 2012 (MCNCS*