Dereference Under the Influence (DUI)
You Can't Afford It

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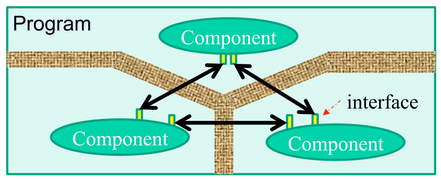
Problem Introduction

- Security-critical components are often protected using isolation mechanisms
  - Interactions via API interfaces



- Attackers can affect the protected component by input to interfaces
  - Data values
  - Memory addresses
- We call memory dereference affected by attackers *Dereference Under the Influence (DUI)*.

DUI Detector: An automatic tool to detect DUI

binary

input

Execution State Collection

- Executed instructions log
  - Raw instruction
  - Instruction operands
  - Memory states
- Module loading/unloading log
  - Tracking memory page permission
- Dynamic taint tracking
  - Fine-grained taint source tracking
  - 1-level table lookup

Instruction Shortlisting

- Write DUI detection
  - Memory writing instruction
  - Tainted source operand register
  - Tainted writing address

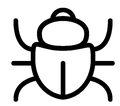
```
mov   %eax, (%esi)
```

- Read DUI detection
  - Memory read instruction
  - Tainted read address
  - Result is used at sinks

```
mov    (%esi), %eax
……
sink(%eax)
```

Access Behavior Analysis

- Trace formula generation
  - Data-flow constraints
  - Control-flow constraints
  - Memory permission
  - Data life-cycle
- Attacker's capability estimation
  - Build queries on memory
    - Bit-pattern
    - Range
  - Solve the query using solver
- DUI filtering



vulnerability

severity

Types of DUI

- **Write DUI**: memory writing operation

```
v1 = API_recv();
v2 = API_recv();
array[v1] = v2;
```

memory corruption

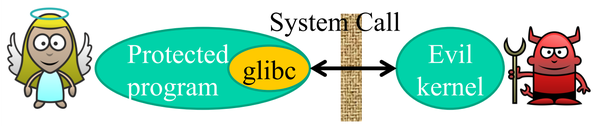
- **Read DUI**: memory read operation

```
v1 = API_recv();
data = *(base+v1);
API_send(data);
```

information leakage

* API_recv() receives data from outside
* API_send() sends data to outside

DUI in glibc



brk system call

Setup the heap region:

```
addr1 = brk(arg1)
addr2 = brk(arg2)
*(addr1 + 4) = addr2 - addr1
```

Corresponding inst.:

```
mov %eax, 0x4(%edx)
…
mov %eax, 0x4(%edi)
```

Detected DUIs

condition (brk1 %8 == 0 && brk2 > brk1)

```
address = brk1 + 0x2718 ;
data = (brk2 - brk1 - 0 x2718) | 0x1;
```

condition (brk1 %8 != 0 && brk1 < brk2 && brk2< brk3)

`address` : dependent on brk1 ;
`data` : dependent on brk1 and brk2 ;

condition (brk1 %8 != 0 && brk1 < brk2 && brk2 > brk3)

`address` : dependent on brk1 ;
`data` : dependent on brk1 and brk3 ;

mmap2 system call

Map files or devices into memory

Related inst. :

```
mov   %eax, 0x1ac(%edi)
```

Conclusion

- Attackers can influence memory operations of isolated components through inputs to their public interfaces.
- We present DUI Detector, an automatic tool to detect dereference under the influence (DUI) through memory access patterns in execution traces.

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Some pictures courtesy of http://icons8.com/