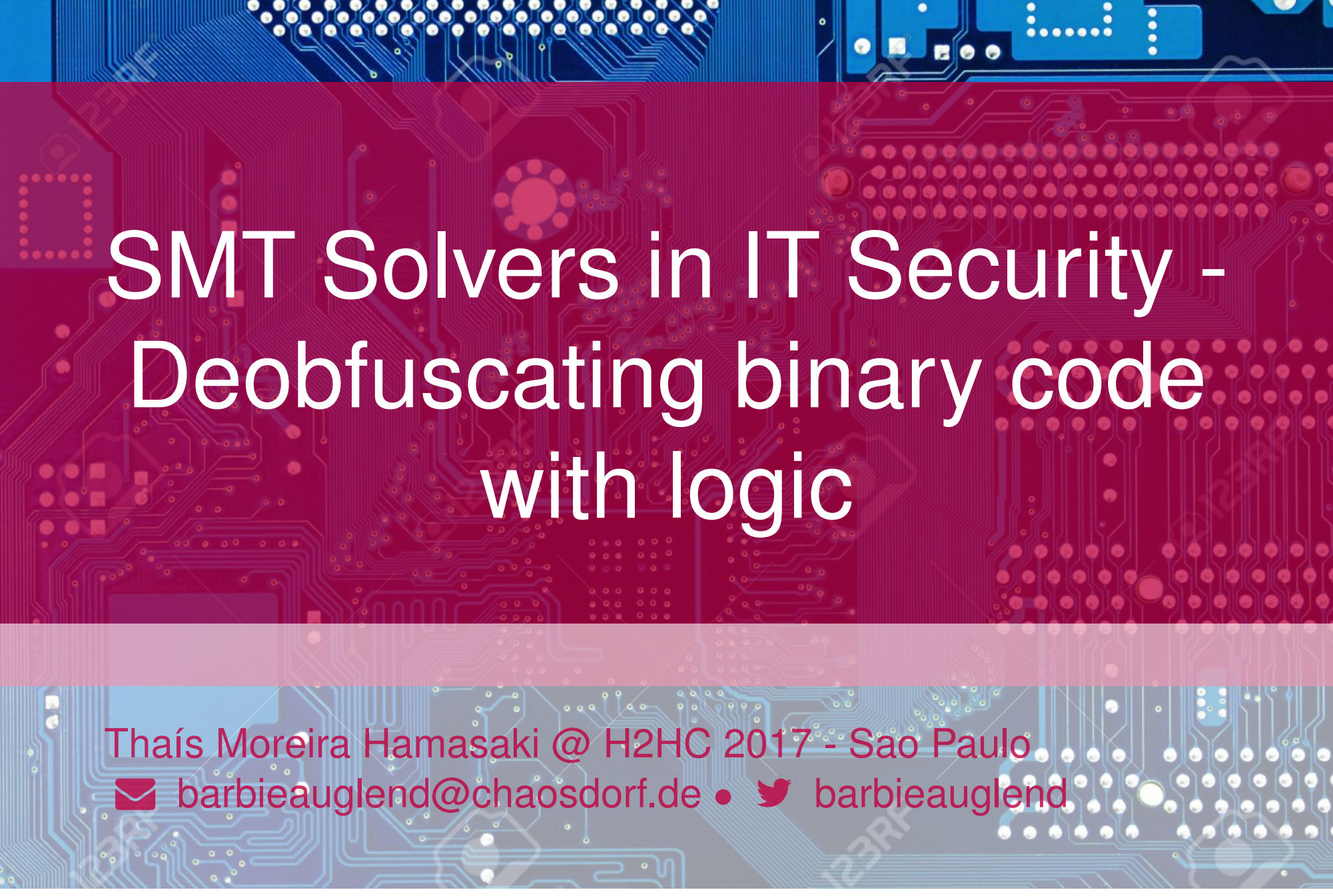
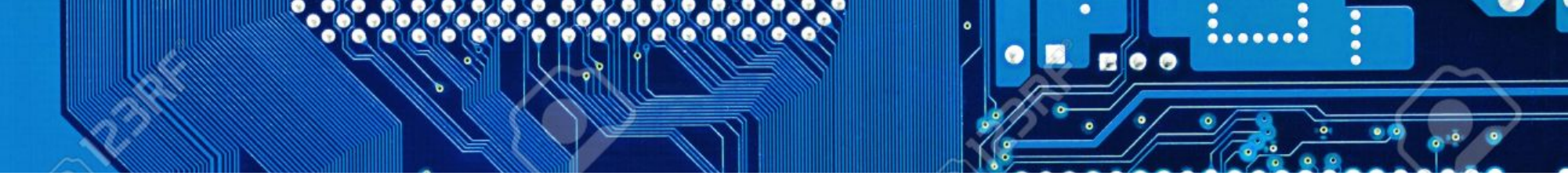


SMT Solvers in IT Security - Deobfuscating binary code with logic

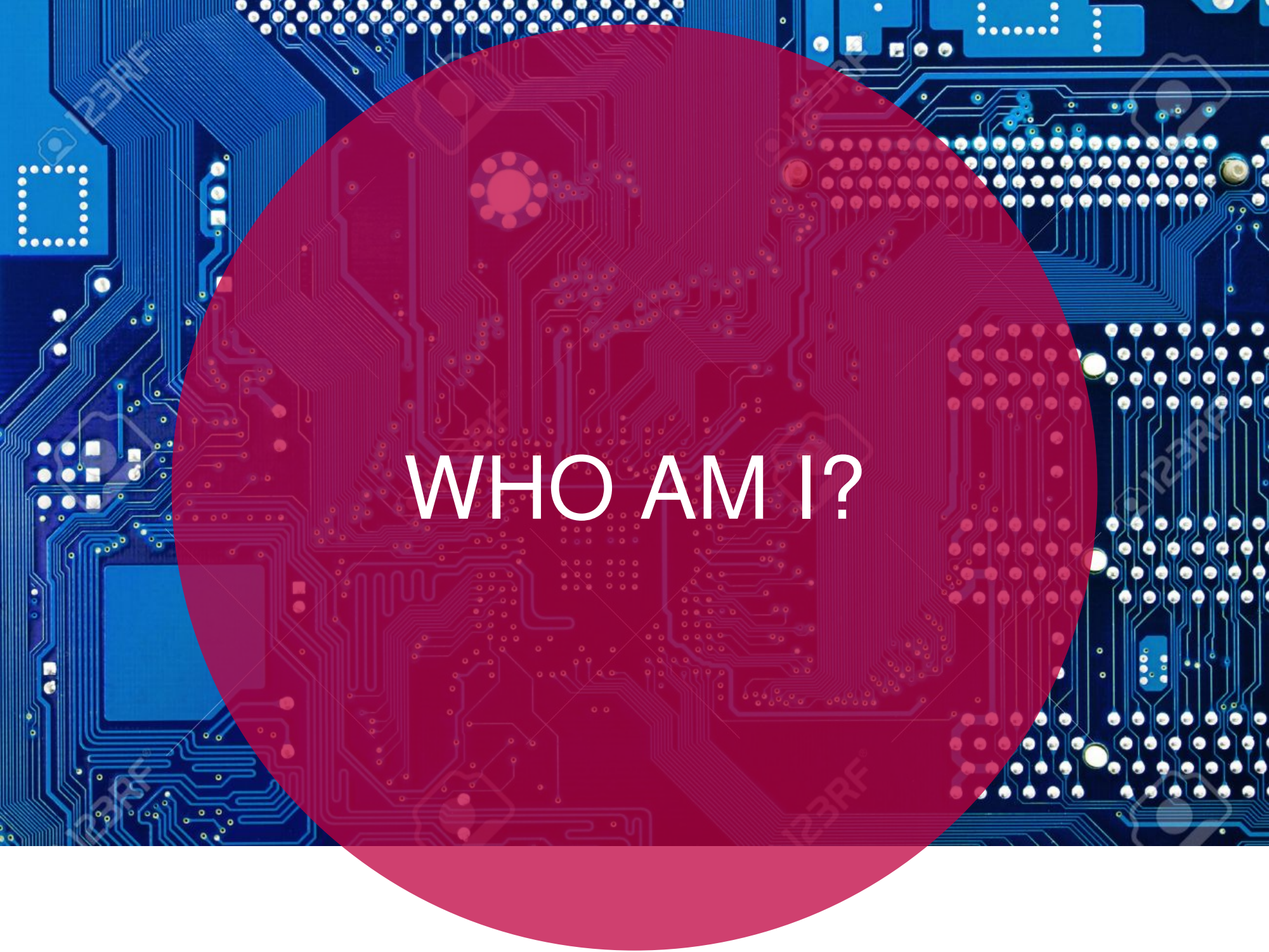
Thaís Moreira Hamasaki @ H2HC 2017 - Sao Paulo

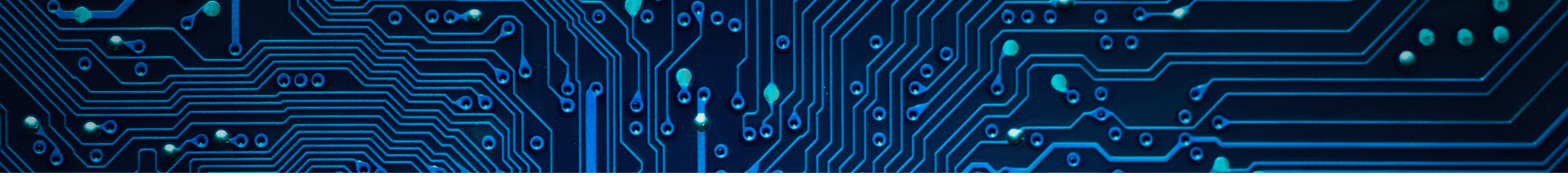
barbieauglend@chaosdorf.de • barbieauglend



DISCLAIMER

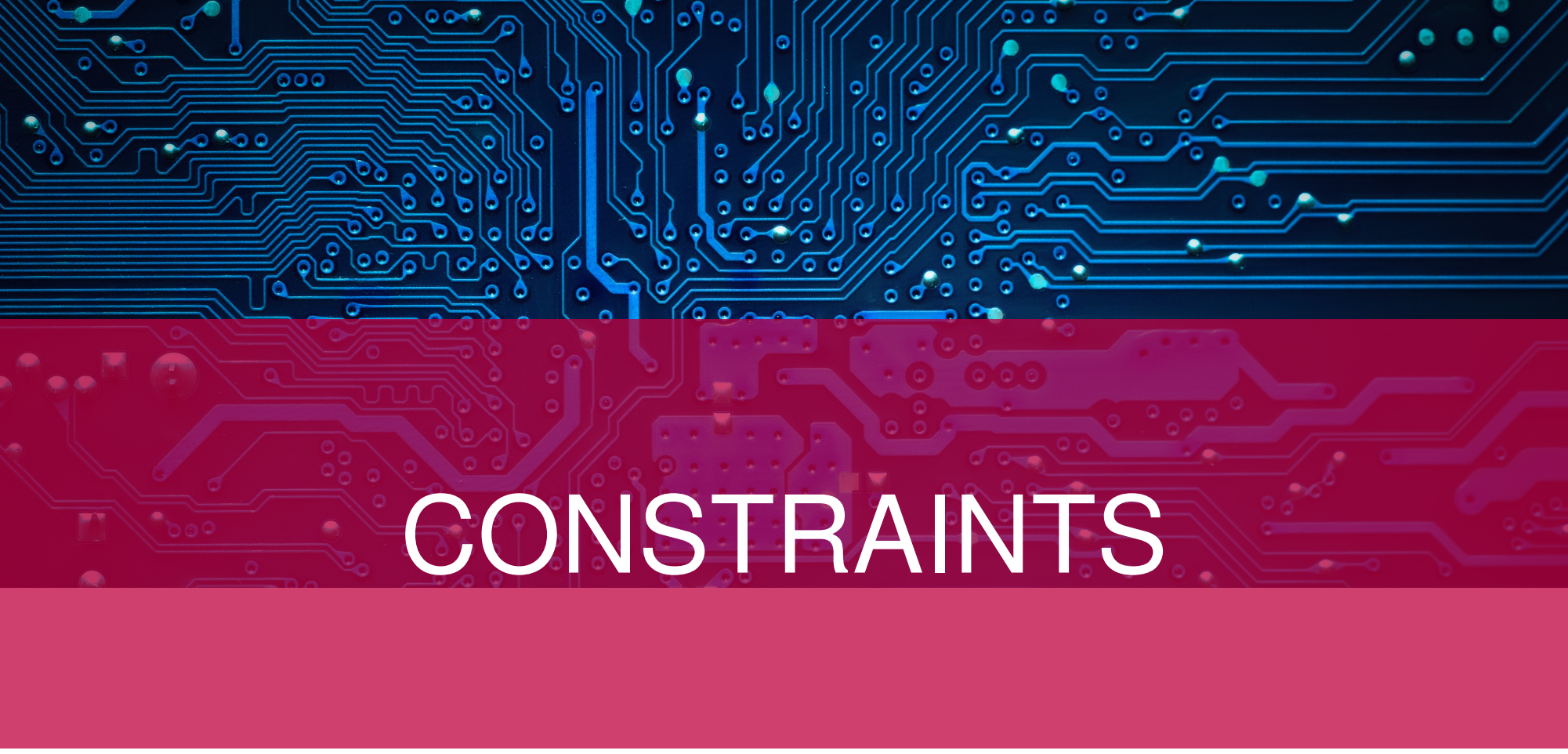
This research was accomplished by Thaís Moreira Hamasaki in her personal capacity. The opinions and views expressed in this talk and article are the author's own and do not necessarily reflect the official policy or view of her employer.


WHO AM I?

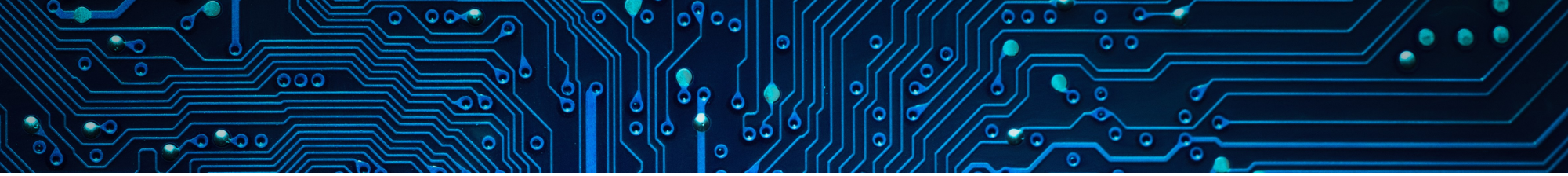


Overview:

- Introduction to Constraint Logic Programming
- Applications of CLP in IT Security
- Binary Obfuscation
- Malware deobfuscation using CLP

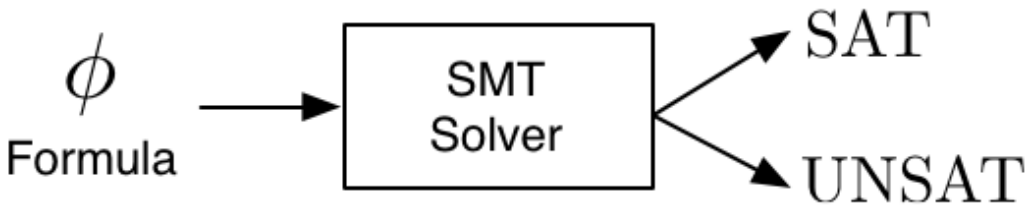


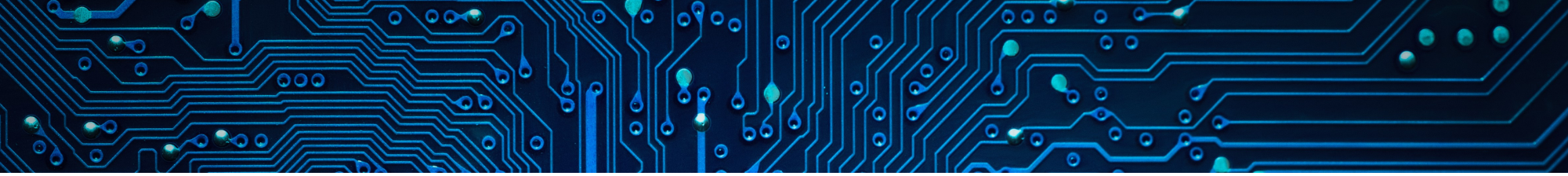
CONSTRAINTS



”Constraint programming represents one of the closest approaches computer science has yet made to the Holy Grail of programming: the user states the problem, the computer solves it.”

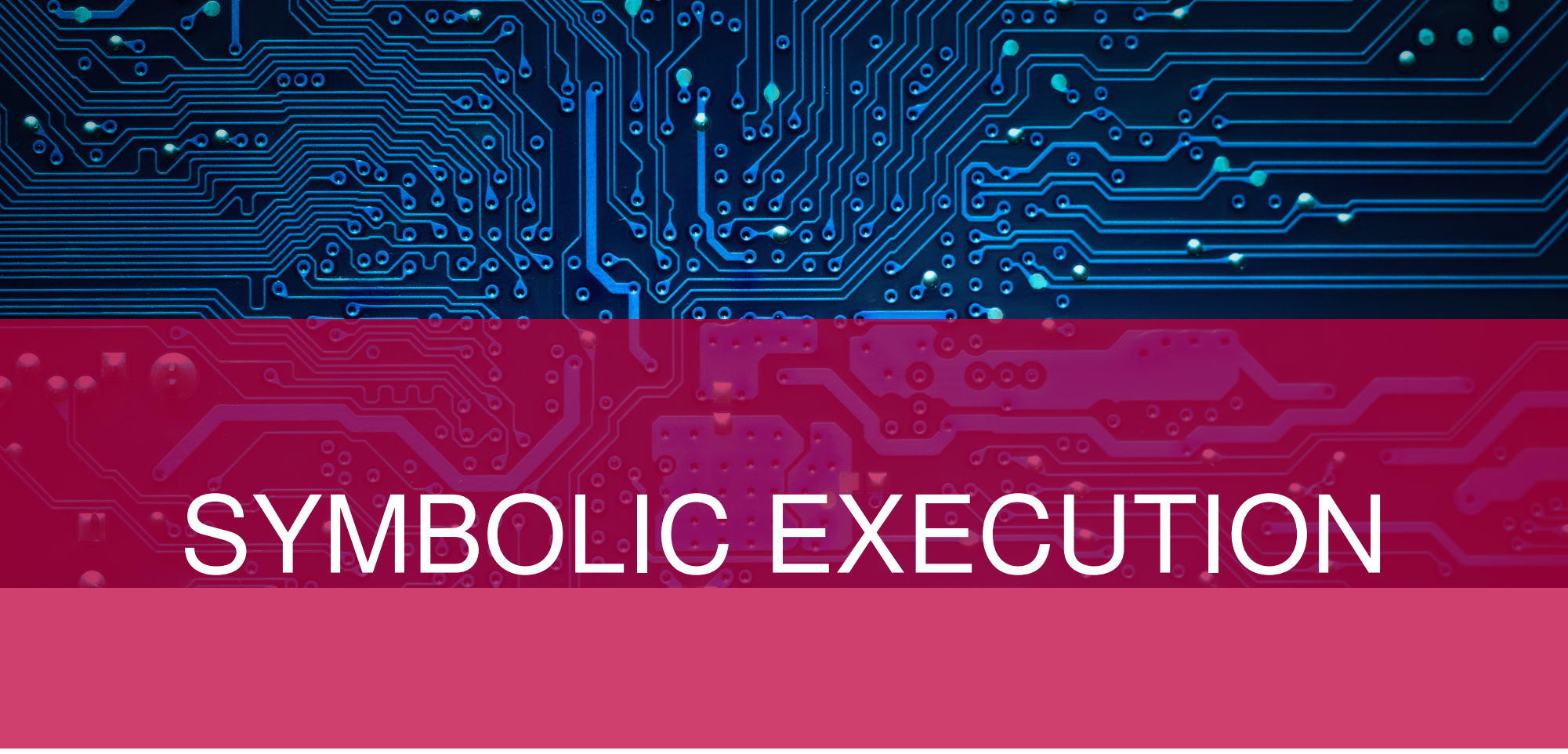
Eugene C. Freuder, Constraints, April 1997


ϕ
Formula
SMT
Solver
SAT
UNSAT

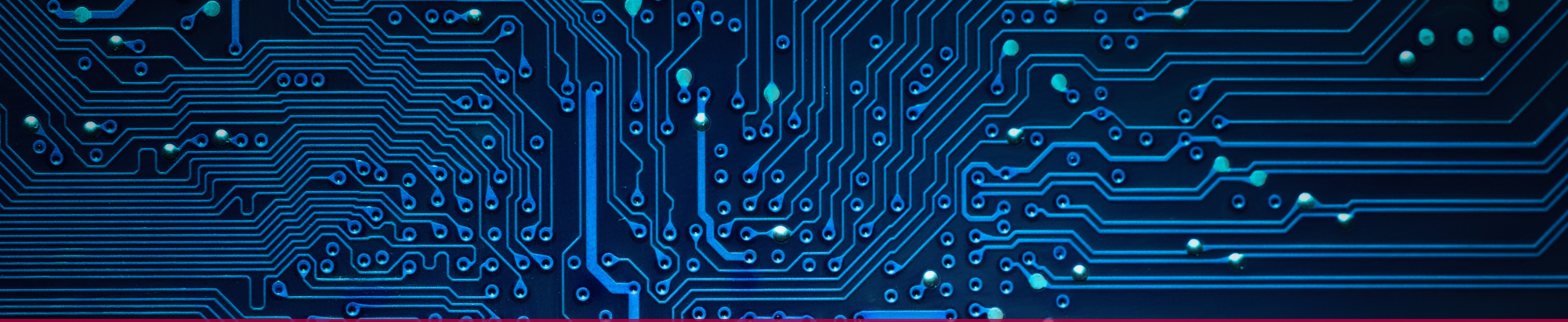


Automated Theorem Proving

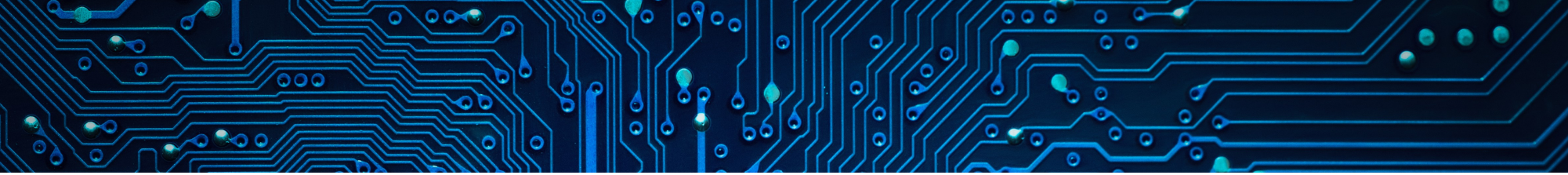
- Hardware and Software $\rightarrow$ Large-scale verification
- Languages specification and Computing proof obligations



SYMBOLIC EXECUTION

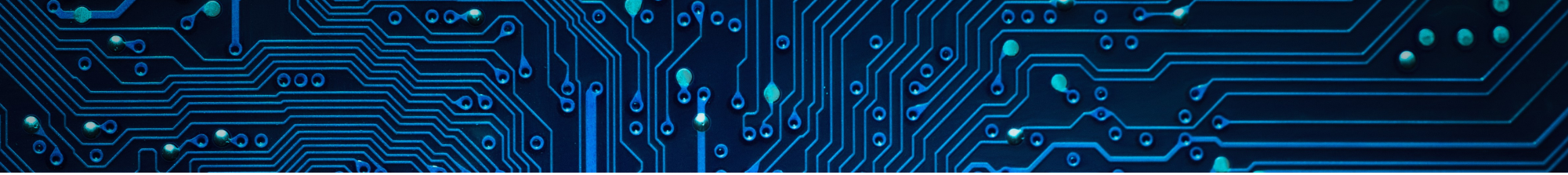


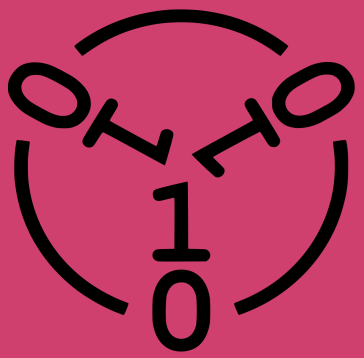
APPLICATIONS



Bug Hunting

- Fuzzing
- Verification
- Analysis



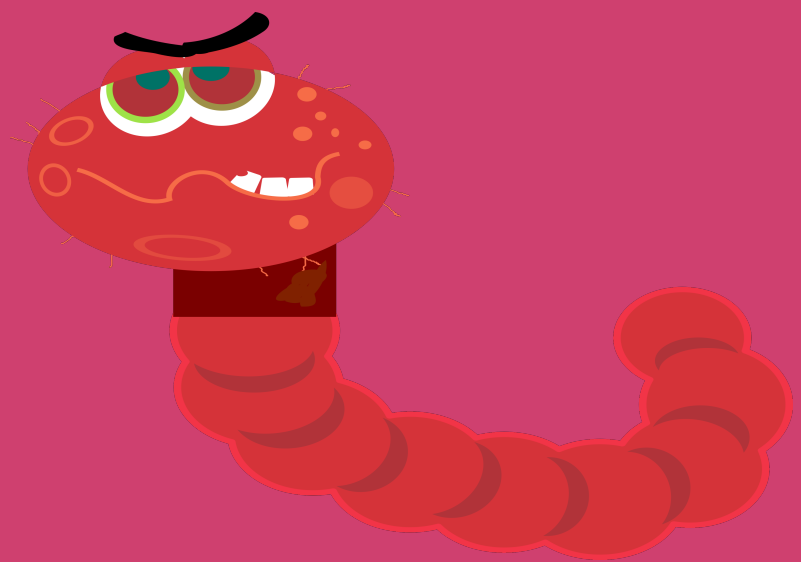


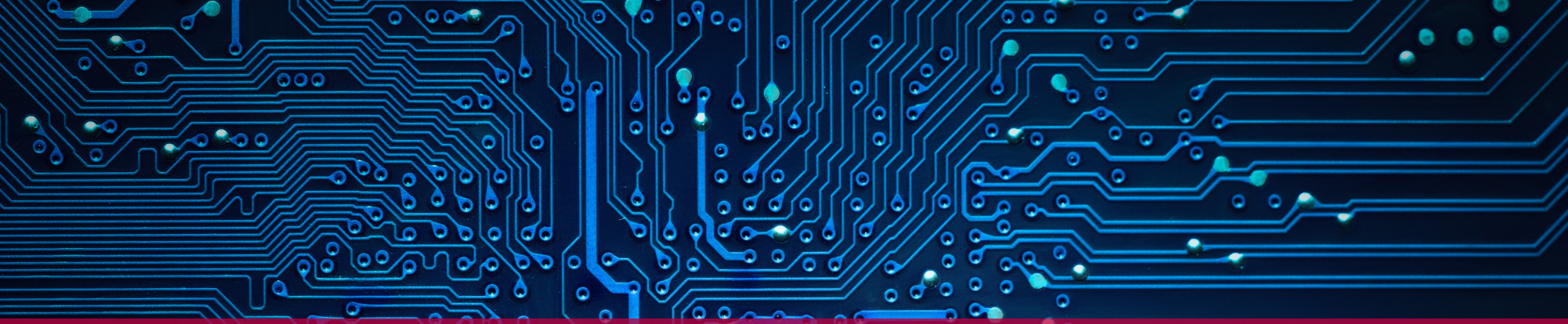
Exploit Generation

- Automatic Exploit Generation
- Proof of Concept
- Automatic Payload Generation

Malware Analysis

- Obfuscation
- Garbage-code elimination
- Compilation
- Packing
- Anti-debugging
- Crypto analysis

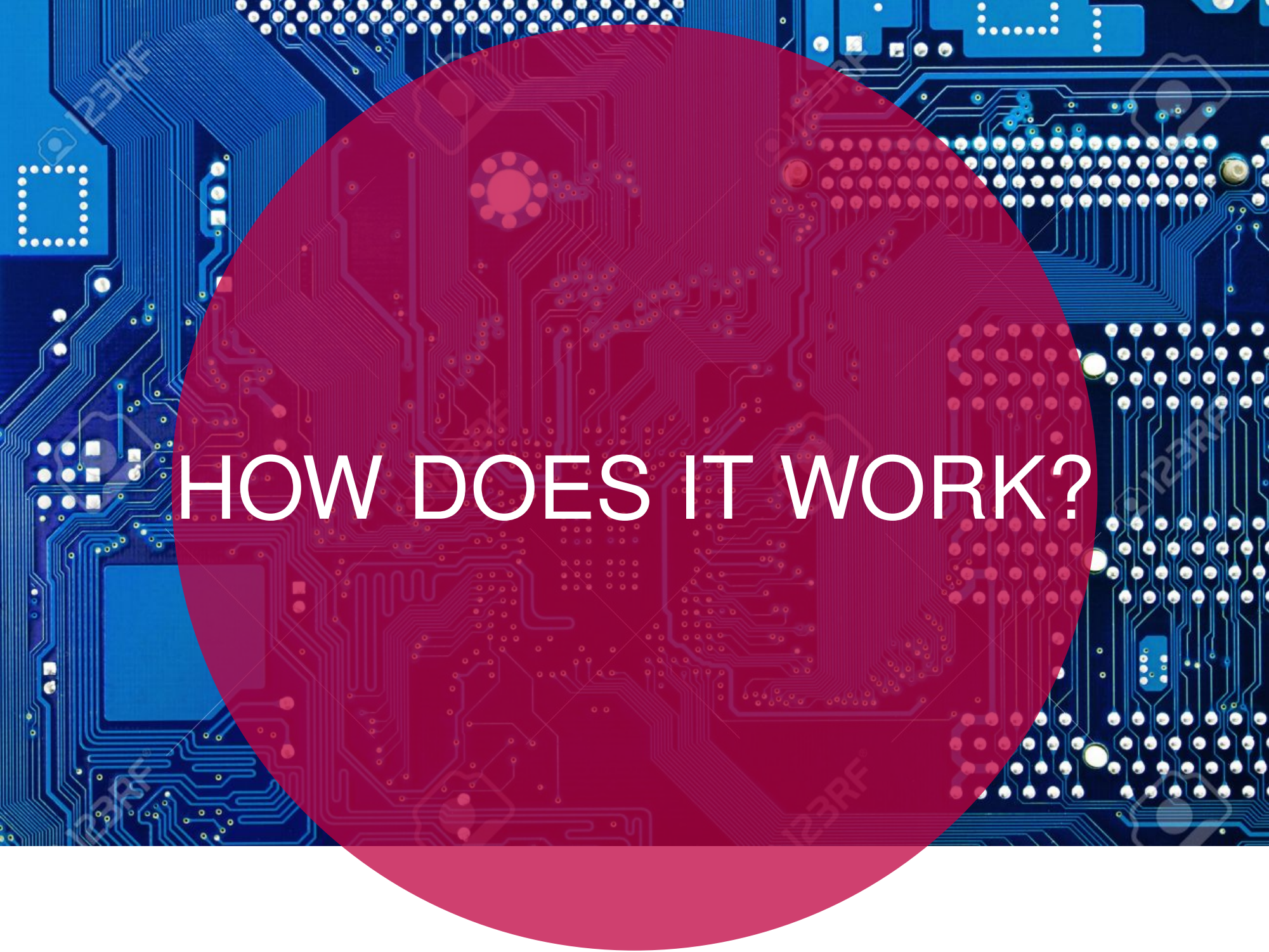




BINARY OBFUSCATION

Malware Obfuscation

SW Property Protection


HOW DOES IT WORK?

- Compiled
- Packed
- Obfuscated
- Anti-debugging

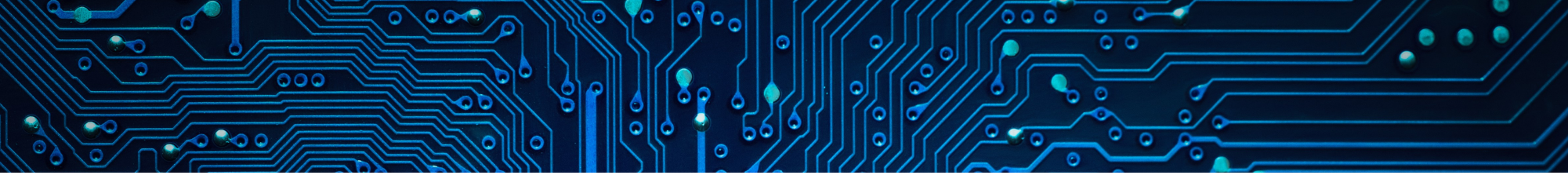
Garbage Code

- Unnecessary instructions
- Jumps that are never taken

The exclusive or operation

Packers

- UPX, NSIS
- self implemented



Malware Analysis

- Practical: Techniques to thwart analysis
- Theoretical: Rice's Theorem

Rice's Theorem

Theorem

Let L be a subset of Strings representing Turing machines, where

1. If M_1 and M_2 recognize the same language, then either $\langle M_1 \rangle, \langle M_2 \rangle \in L$ or $\langle M_1 \rangle, \langle M_2 \rangle \notin L$.
2. $\exists\ M_1, M_2$ s.t $\langle M_1 \rangle \in L$ and $\langle M_2 \rangle \notin L$.

Then L is undecidable.

```
1  x = input();
2  x = x + 7;
3
4  if (x > 0)
5  y = input();
6  else
7  y = 11;
8
9  if (x > 2)
10 if (y == 42)
11 throw
     Exception()
```

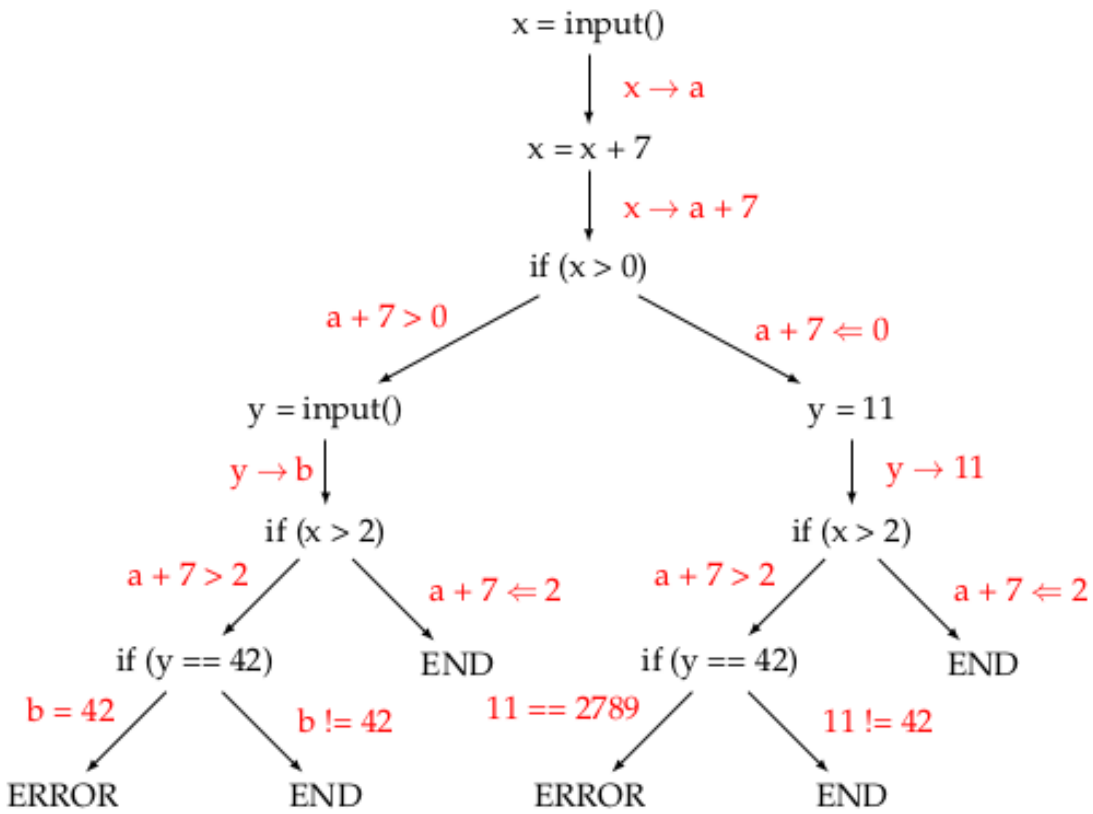
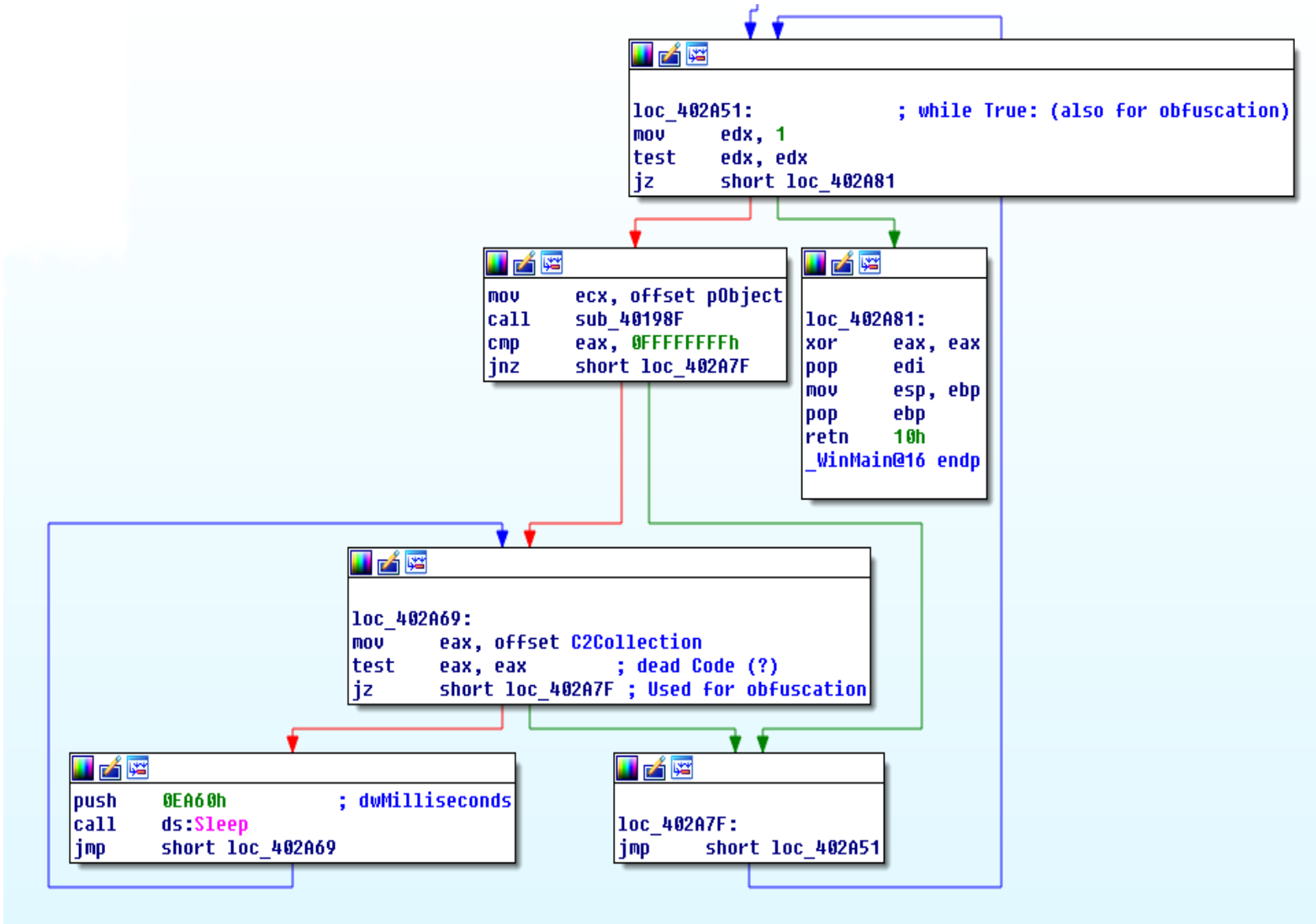
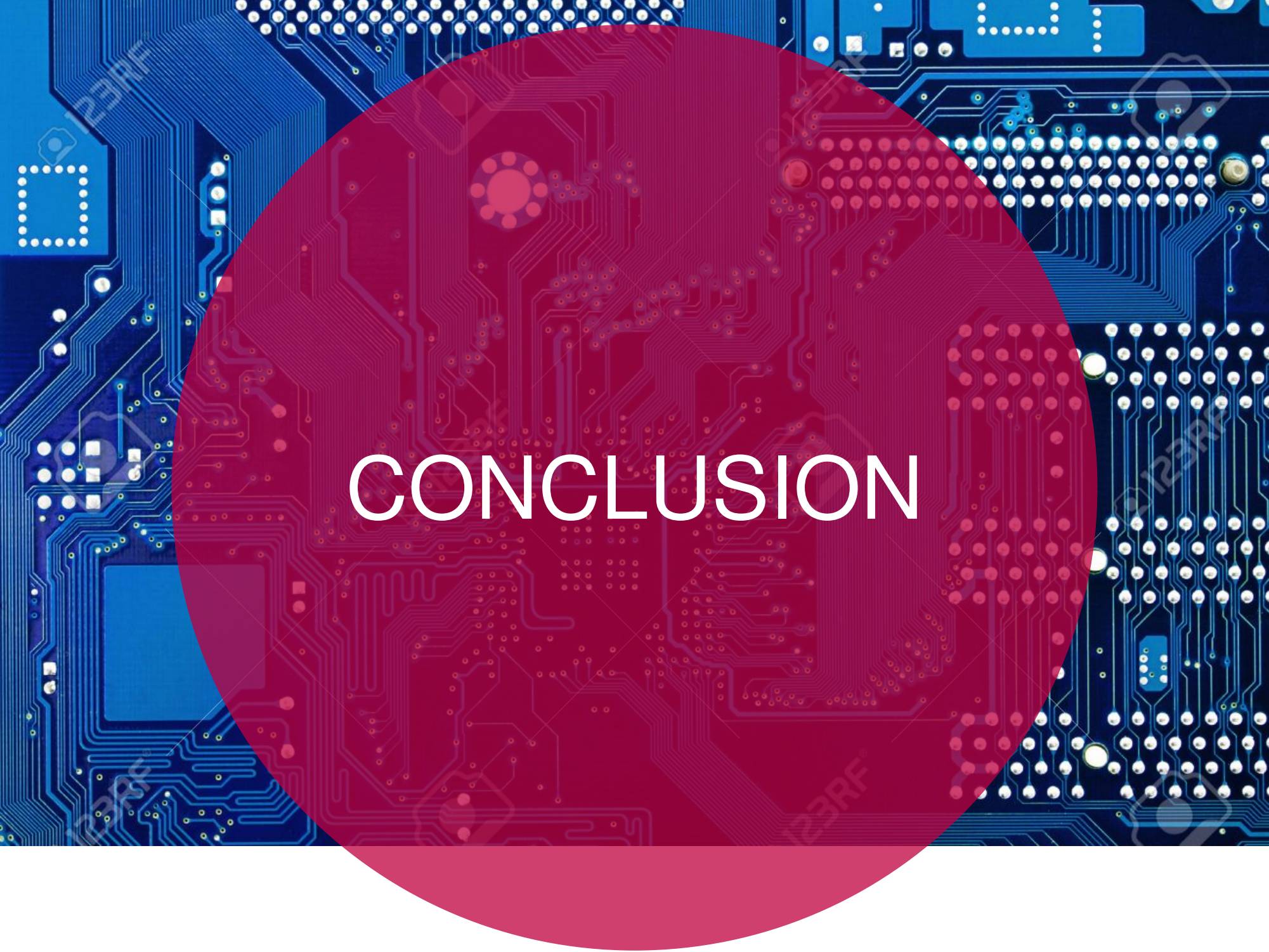


Figure 8: *Example of symbolic execution for simple program*

- Symbols as arguments
  $\Rightarrow$ **any** feasible path
- Program states
  - Symbolic values for memory locations
  - Path conditions


loc_402A51: ; while True: (also for obfuscation)
mov edx, 1
test edx, edx
jz short loc_402A81
mov ecx, offset pObject
call sub_40198F
cmp eax, 0FFFFFFFFh
jnz short loc_402A7F
loc_402A81:
xor eax, eax
pop edi
mov esp, ebp
pop ebp
retn 10h
_WinMain@16 endp
loc_402A69:
mov eax, offset C2Collection
test eax, eax ; dead Code (?)
jz short loc_402A7F ; Used for obfuscation
push 0EA60h ; dwMilliseconds
call ds:Sleep
jmp short loc_402A69
loc_402A7F:
jmp short loc_402A51


CONCLUSION


THANK YOU!