# Chaos for a Fast, Secure, and Predictable Future

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# Software is in Danger!

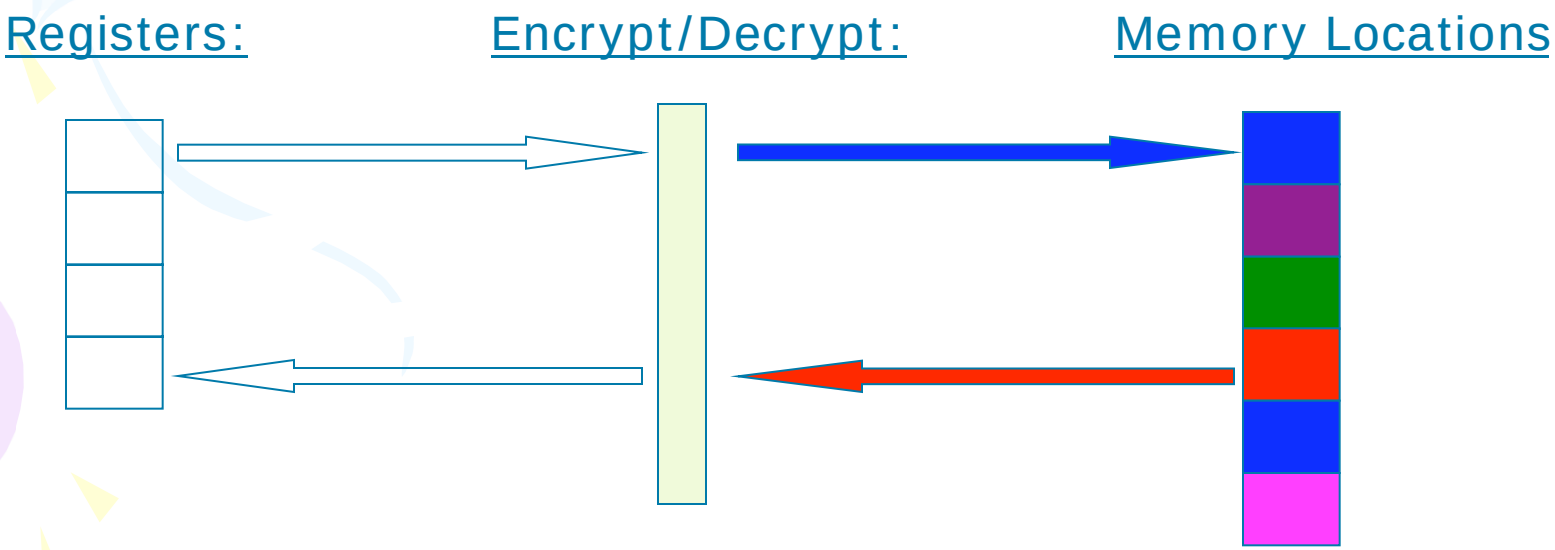
- Attackers exploit code for fun/profit!
- Buffer overflows often violate:
  - Call Graph
  - Points-to Graph
  - Reaching Definitions Analysis
- Other attacks violate:
  - Type Safety
  - Information Flow Policies

# The Secret Life of Run-time Checks

- Attacks thwarted by run-time checks
- Challenges
  - Performance
  - Physical memory usage
  - Virtual address space usage
  - Concurrency Overhead

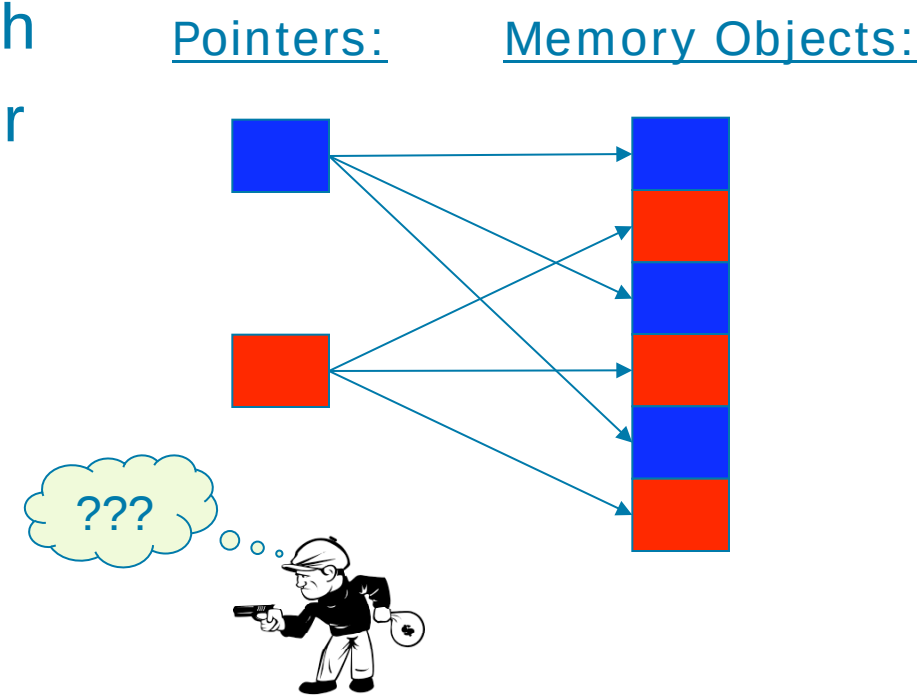
# Predictably Unpredictable!

- Encrypt data between registers and memory
  - Stores encrypt
  - Loads decrypt
- Using a single key is boring and useless!
- Assign keys to stores/loads based on semantic property
- Violations: Predictably unpredictable!



# Points-To Analysis[1,2]

- Input: points-to graph
- Assign distinct key for each points-to set
- Use fast XOR keys
- Stores encrypt
- Loads decrypt

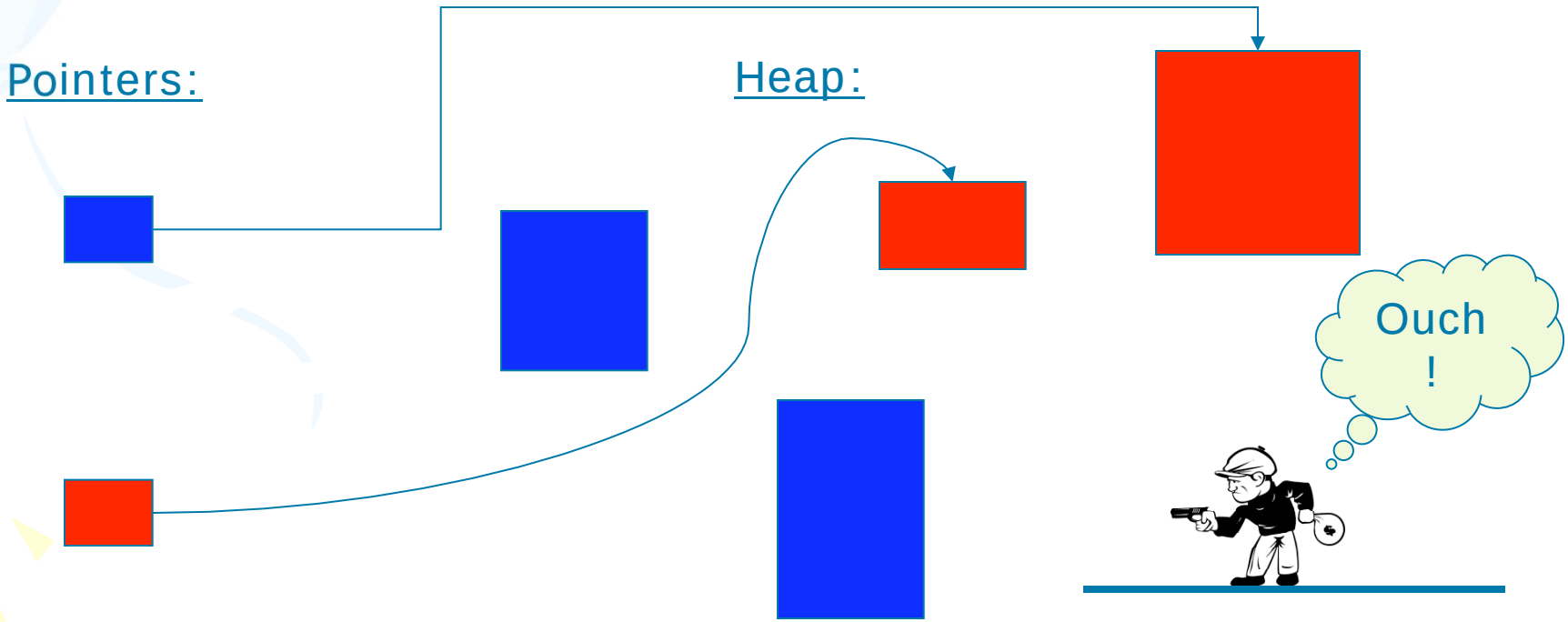



Violation of points-to analysis yields unpredictable result!

1. Bhatkar and Sekar, DIMVA 2008
2. Cadar et. al., TechReport 2008

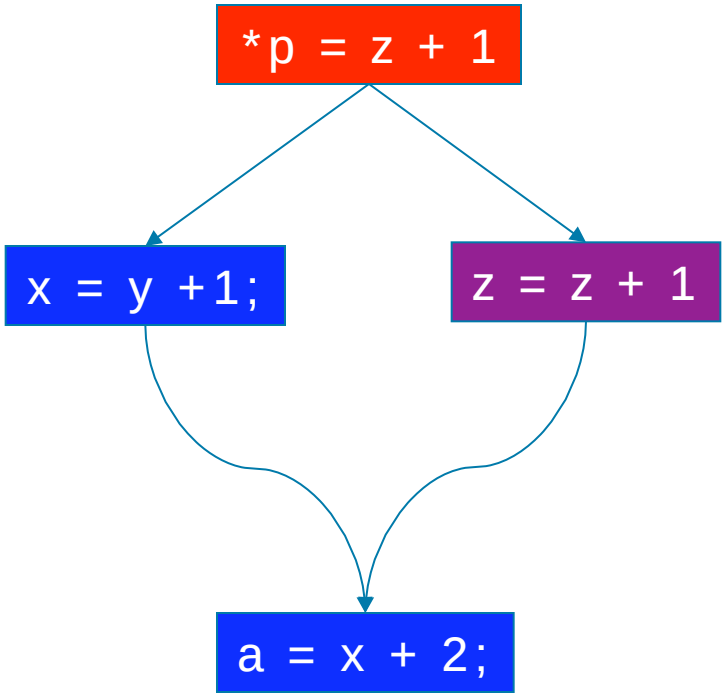
# Secure Information Flow

- Pick crypto keys for high, low information
- Decrypting high information with low key generates unpredictable result



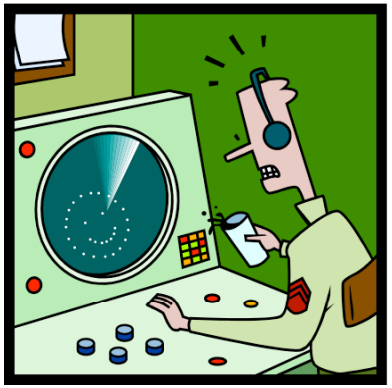
# Reaching Definitions

- Merge sets of overlapping reaching definitions
- Each set gets a unique crypto key
- Violation causes unpredictable behavior



# Challenges

- Buffer overreads[1] can leak key data
- Small values can be brute-forced[1,2]
- XOR encryption not sufficient



1. [Strackx et. al., EuroSec 2009]
2. [Shacham et. al., CCS 2004]

# Parting Thoughts

- Are there semantic safety properties that could be protected using chaos?

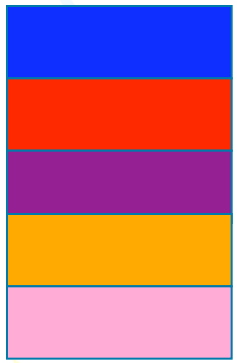
- Control flow integrity
- Type-safety
- Thread-privacy
- Data hiding
- Variable scopes
  - Dangling stack pointers

# Extras!

# Type-Safety

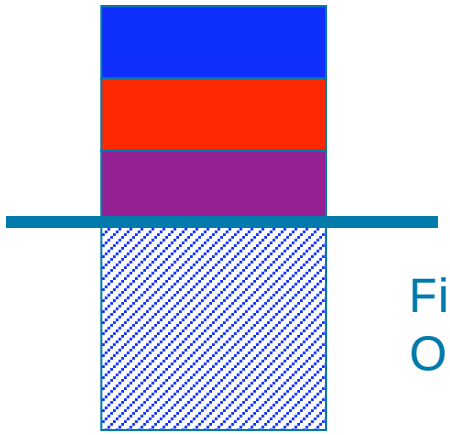
- Create a crypto key for each field
- Create a crypto key for stack
- Type-unsafe accesses generate unpredictable behavior

Subclass with Fields:



Pointers:

Super Class with Fields:



Fields from
Other object