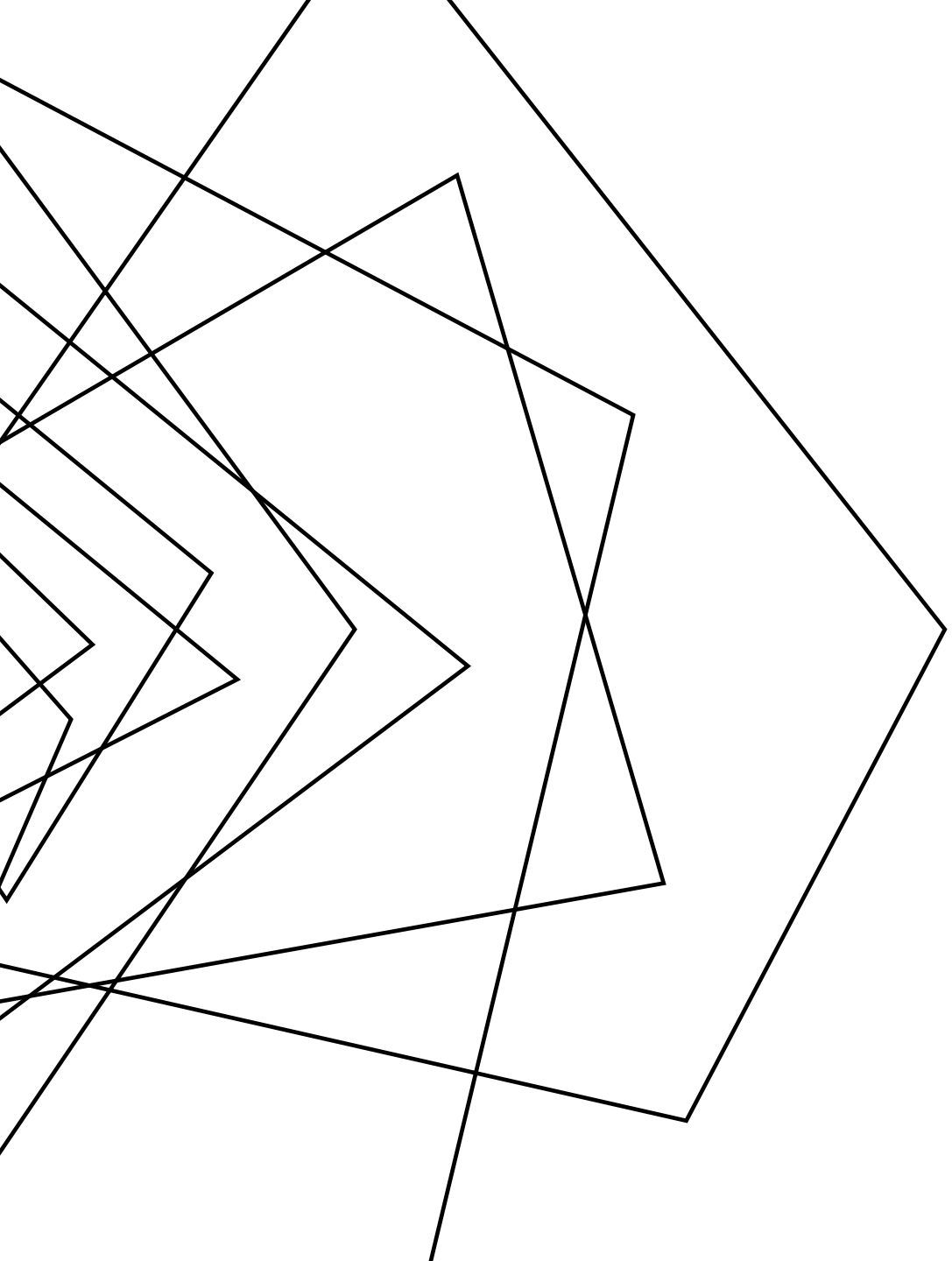
EXERCISE #14

PRACTICAL INFOFLOW REVIEW

Write your name and answer the following on a piece of paper

Provide an instance of a program with an implicit information flow from a confidential source to a sink

ADMINISTRIVIA AND ANNOUNCEMENTS



CLASS PROGRESS

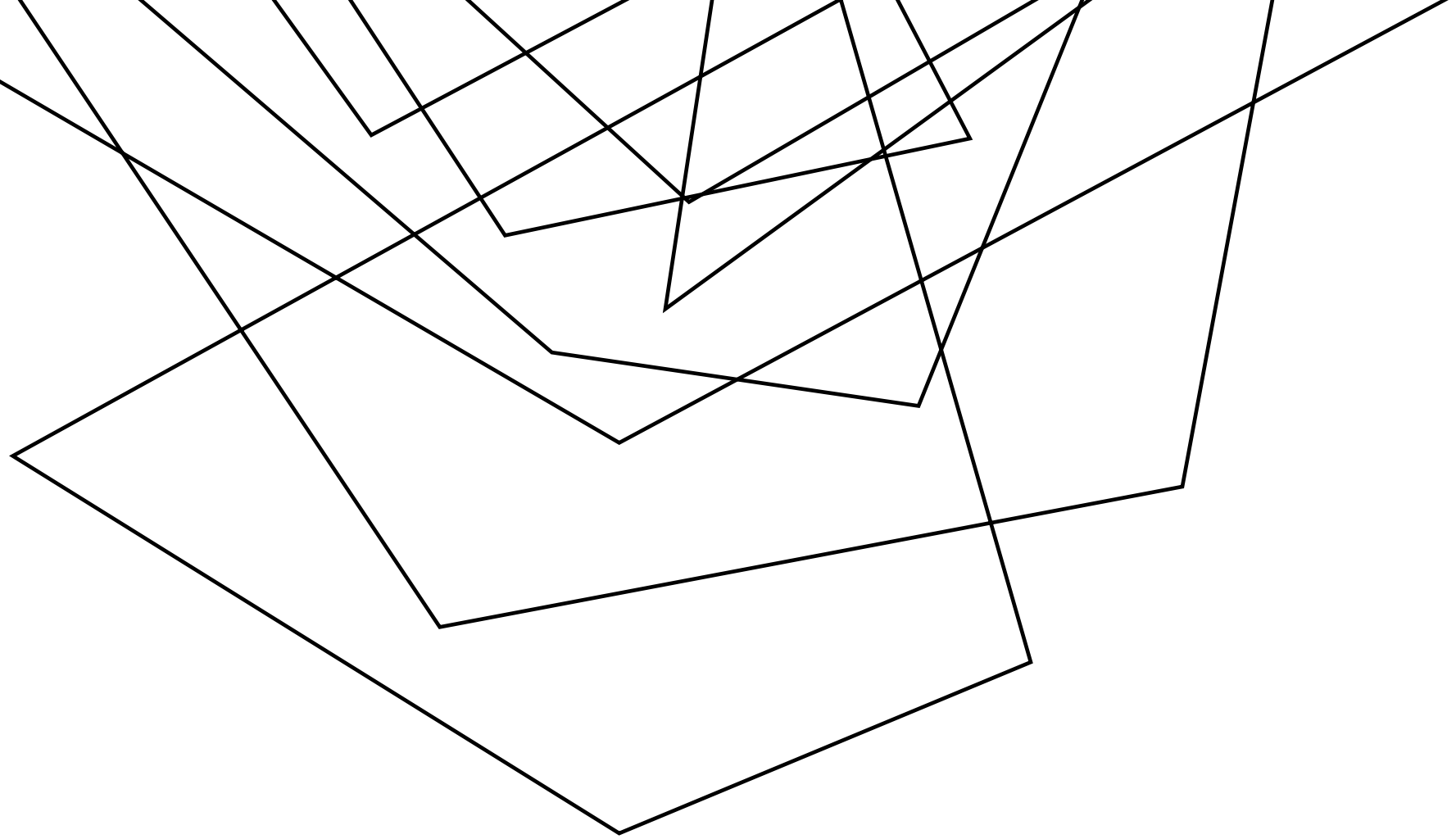
SHOWING SOME APPLICATIONS OF STATIC DATAFLOW

LAST TIME: DATAFLOW DEPLOYMENT

REVIEW: LAST LECTURE

USING DATAFLOW IN PRACTICAL CONTEXTS

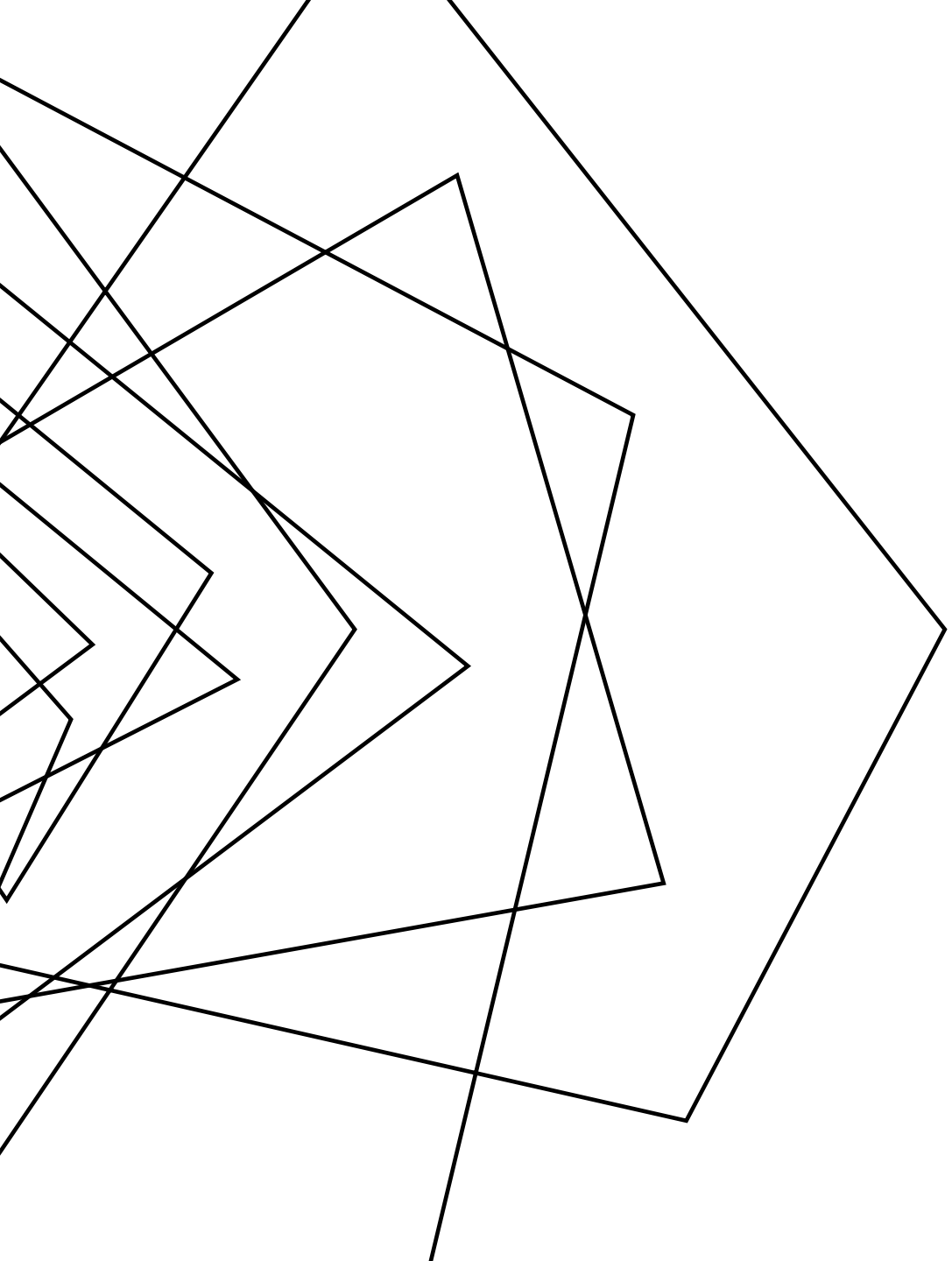
- Ex. - Looking for initialized variables



SIDE CHANNELS

EECS 677: Software Security Evaluation

Drew Davidson

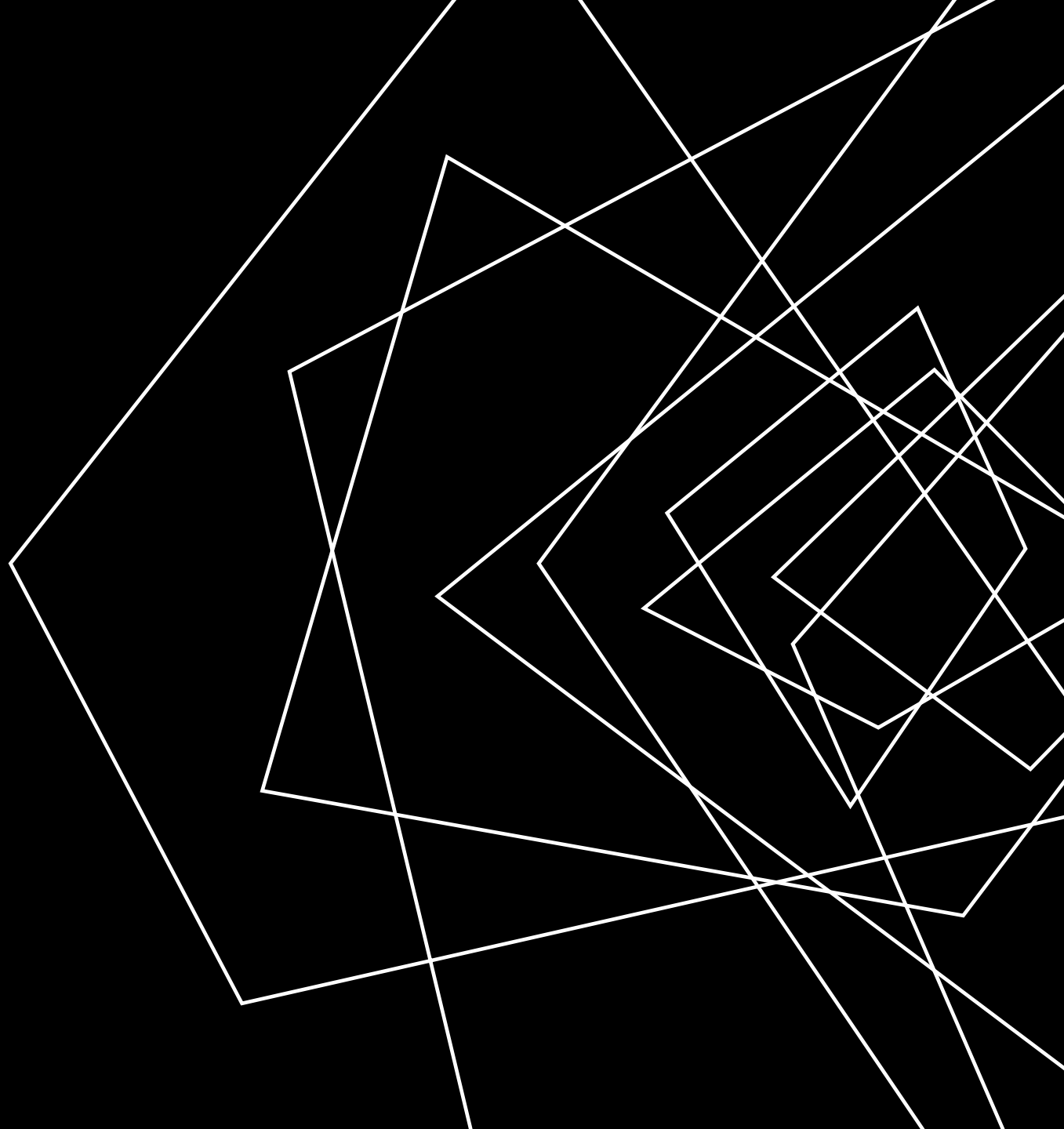


OVERVIEW

CONTEMPLATE OTHER WAYS THAT SNEAKY DATA FLOWS CAN OCCUR

LECTURE OUTLINE

- Threat Models
- Side Channels - Overview
- Timing
- A dataflow approach



THINKING ABOUT ATTACKS

THREAT MODELS

There's no such thing as "Absolute Security"

- It's always possible to come up with SOME (potentially wacky) scenario where the adversary can subvert a system

Consider the various attack classes

- **Denial of Service:** Availability is compromised
- **Exfiltration:** Confidentiality policy is compromised
- **Compromise:** Integrity policy is compromised

A FRAMEWORK FOR ASSUMPTIONS

THREAT MODELS

A THREAT MODEL IS COMPOSED OF:

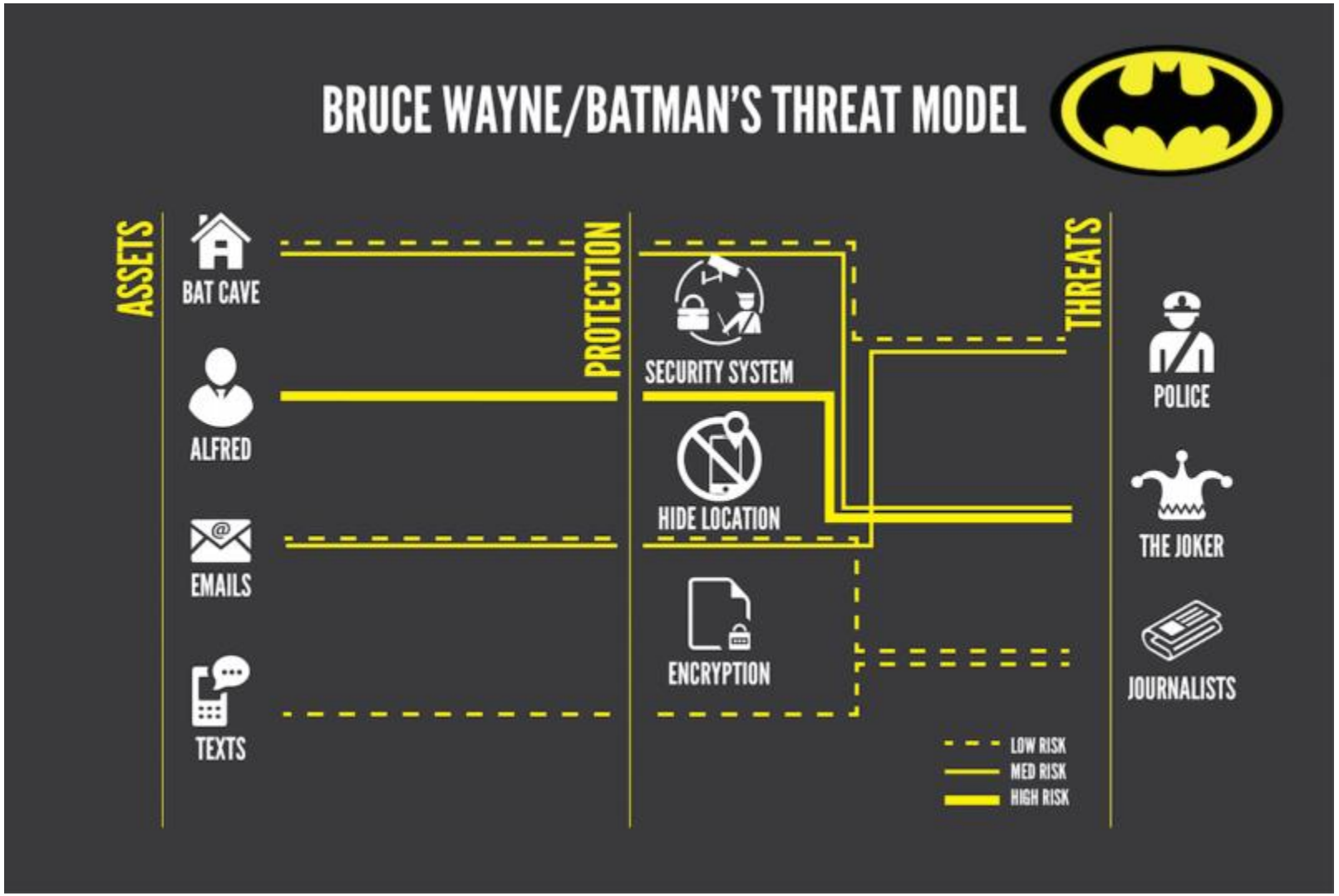
- **Adversary Goals:** What is the adversary attempting to do?
- **Adversary Capabilities:** What resources can the adversary bring to bear to accomplish their goals?

SECURITY MEANS PREVENTING GOALS FROM BEING ACCOMPLISHED, DESPITE CAPABILITIES

- **Defender Capabilities:** What resources MUST be brought to bear to defeat the threat model?

THINKING ABOUT ATTACKS

THREAT MODELS



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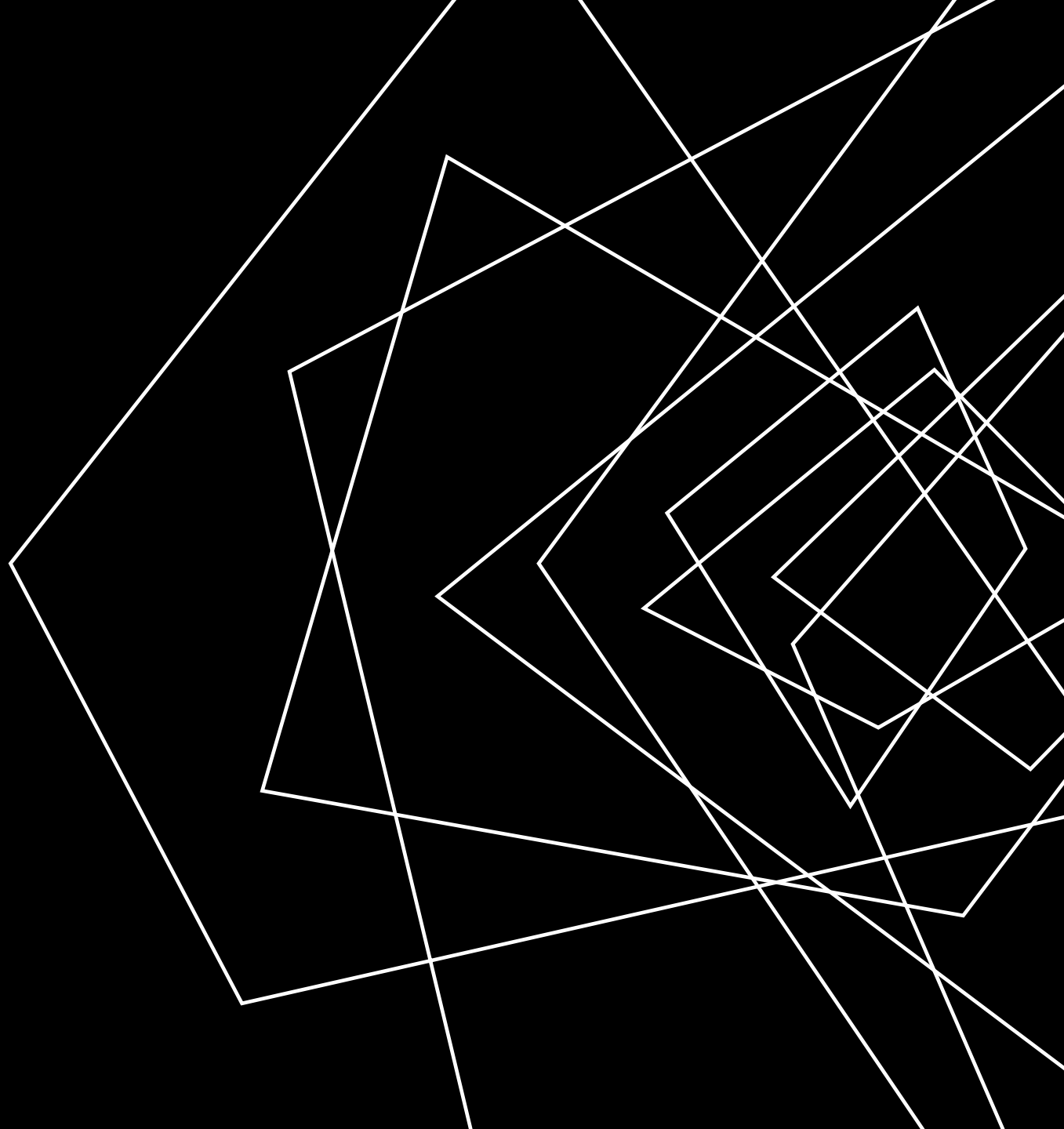

THE BASIC IDEA OF SIDE CHANNELS

Abstraction is a key principle of Computer Science!

As a programmer, you shouldn't need to know underlying details

As a security expert, these details might end up being important!

The way a program accomplishes its tasks are important, especially from a security aspect

- How long does it take for the program to do X ?
- How hot does it make the processor when X happens?
- How much power does it draw when X happens?

SIDE CHANNELS – THE BIG IDEA

SIDE CHANNELS - INSTANCES

COMPUTATION MAY HAVE EFFECTS OUTSIDE OF PROGRAM SEMANTICS

Some operations (internally) take longer based on aspects of the data

TEMPEST

SIDE CHANNELS – HISTORY

Electromagnetic Leakage of keys

- **WWII:** Bell Telephone discovers electromagnetic leakage in one-time pad teleprinters, detectable at 100-ft radius
- **1951:** CIA rediscovers leakage, detectable at 200-ft radius
- **1964:** TEMPEST shielding protocol established

TEMPEST

SIDE CHANNELS – HISTORY

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VAN ECK PHREAKING

SIDE CHANNELS – HISTORY

Electromagnetic Leakage of Monitors

- Pick up the monitor's electromagnetic emanations that differ depending on how the screen lights up
- Originally determined for CRT (1985), also discovered for LCD monitors (2004)

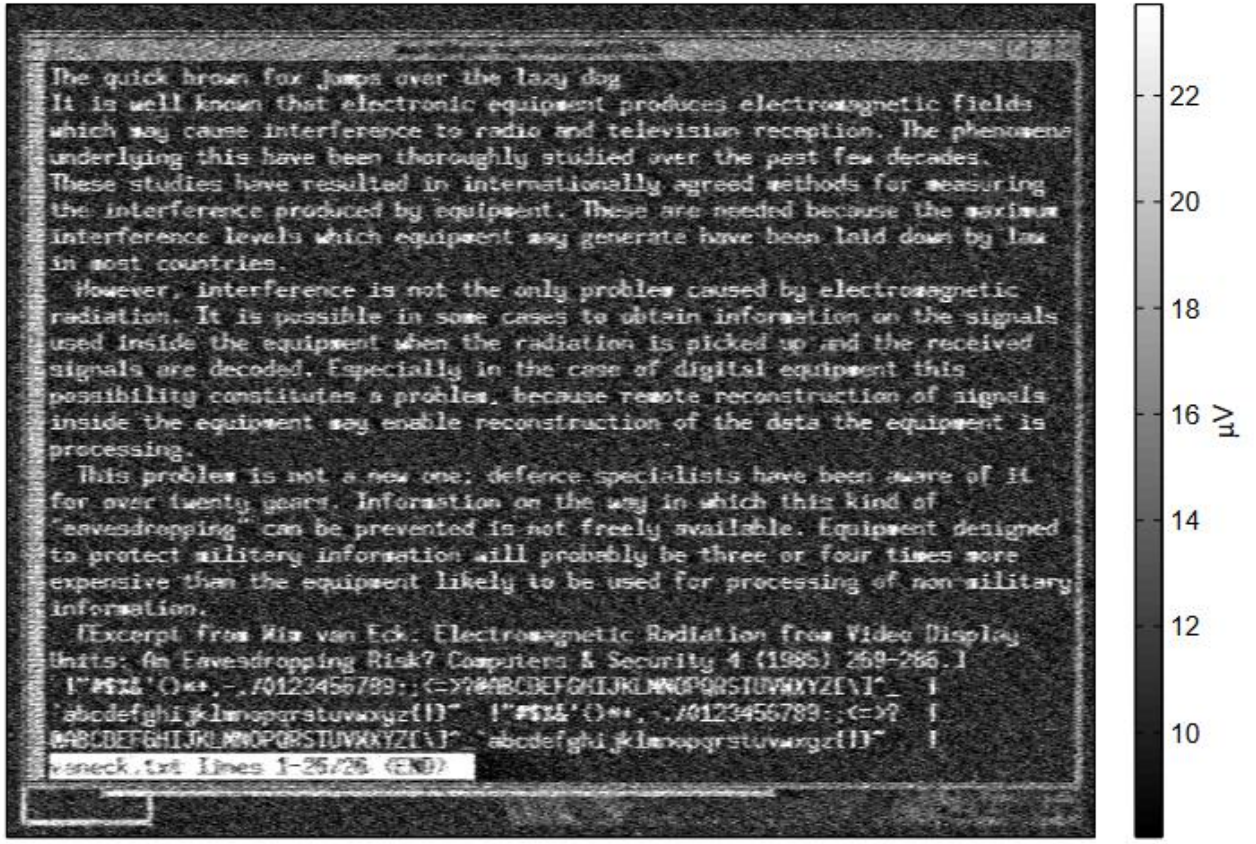

Fig. 3. Text signal received from a 440CDX laptop at 10 m distance through two intermediate offices (3 plasterboard walls).

SIDE CHANNELS – PARTIAL CREDIT

EVEN "HINTS" ABOUT SECRET DATA CAN BE PROBLEMATIC

Assume you're trying to guess a password

– knowing even 1 character massively reduces the search space

– knowing the length of the password reduces the search space

COVERT CHANNELS
SIDE CHANNELS

Sometimes a Program Wants to Leak data

Exfiltration !

LECTURE OUTLINE

- Threat Models
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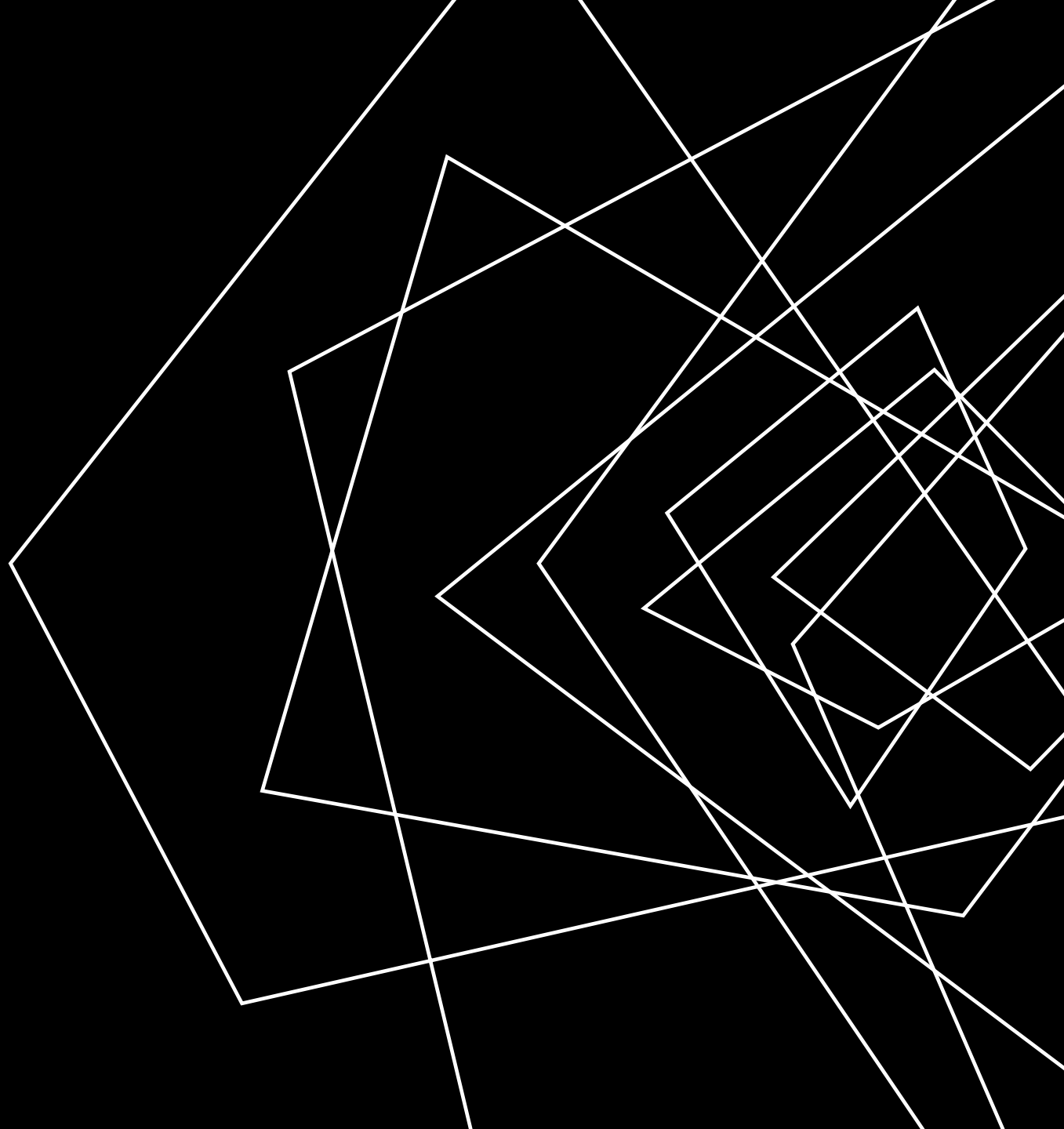
- Timing
- A dataflow approach



TIMING SIDE CHANNELS

SIDE CHANNELS - INSTANCES

SOME COMPUTATIONS TAKE LONGER THAN OTHERS

Some operations (internally) take longer based on aspects of the data

```
bool checkPW(const char * given){
  const char * expected = “12345”;
  int len = min(5, strlen(given));
  for (int i = 0; i < len, i++){
    if (given[i] != expected[i]){
      return false;
    }
  }
  return true;
}
```

TIMING SIDE CHANNELS

SIDE CHANNELS - INSTANCES

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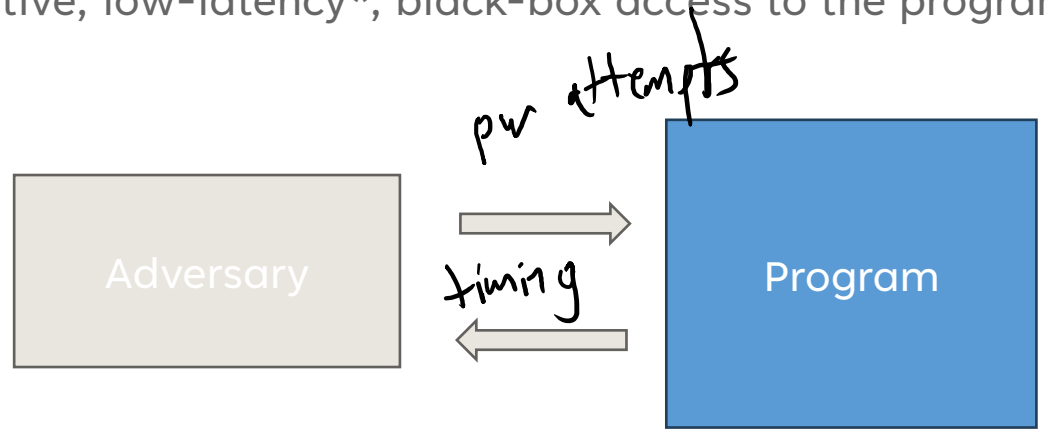
THREAT MODEL

Interactive, low-latency*, black-box access to the program, precise timer



*: May be overcome with more samples

TIMING SIDE CHANNELS - FIX

SIDE CHANNELS - INSTANCES

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    if (given[i] != expected[i]){
      return false;
    }
  }
  return true;
}
```

bool ok = true;

~~return false;~~ ok = false;

ok

~~true~~

TIMING SIDE CHANNELS – FIX

SIDE CHANNELS – INSTANCES

Limitations of Uniform Execution

- Necessarily slow down your computation to the worst case
- May require some pretty precise understanding of timing
- May not always be obvious what the worst-case even is

LECTURE OUTLINE

- Threat Models
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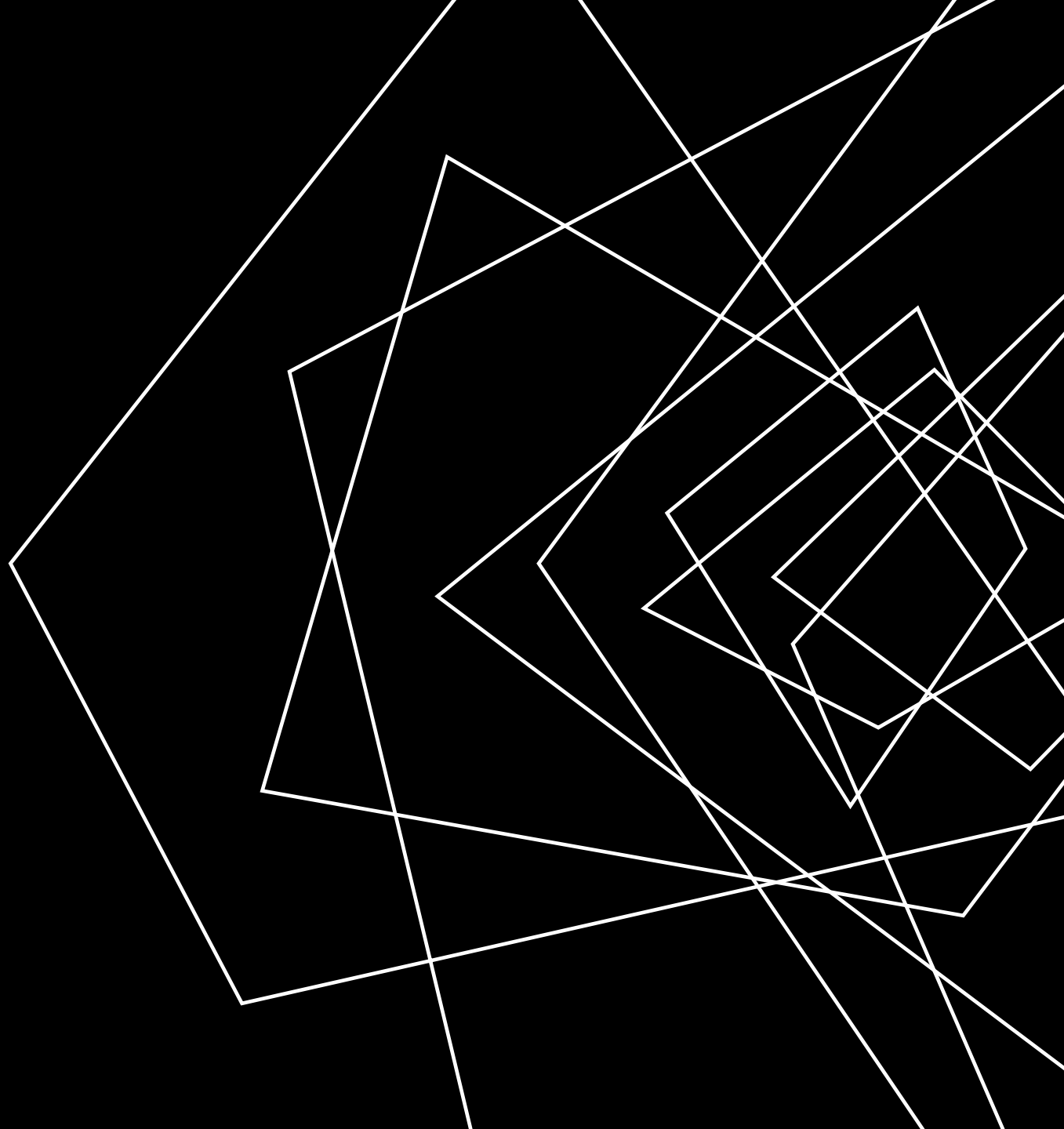
- Instances
- A dataflow approach



TIMING SIDE CHANNELS – FIX

SIDE CHANNELS - INSTANCES

CAN WE FIX THIS ISSUE WITH OUR DATAFLOW APPROACH?

- Instruction transformers: how much time that instruction takes
- Block composition: the sum total of instruction times
- Merge operation: some sort of check that all paths are of comparable time?

WRAP-UP