PV204: THREAT MODELING

TRIAL RUN

AGENDA

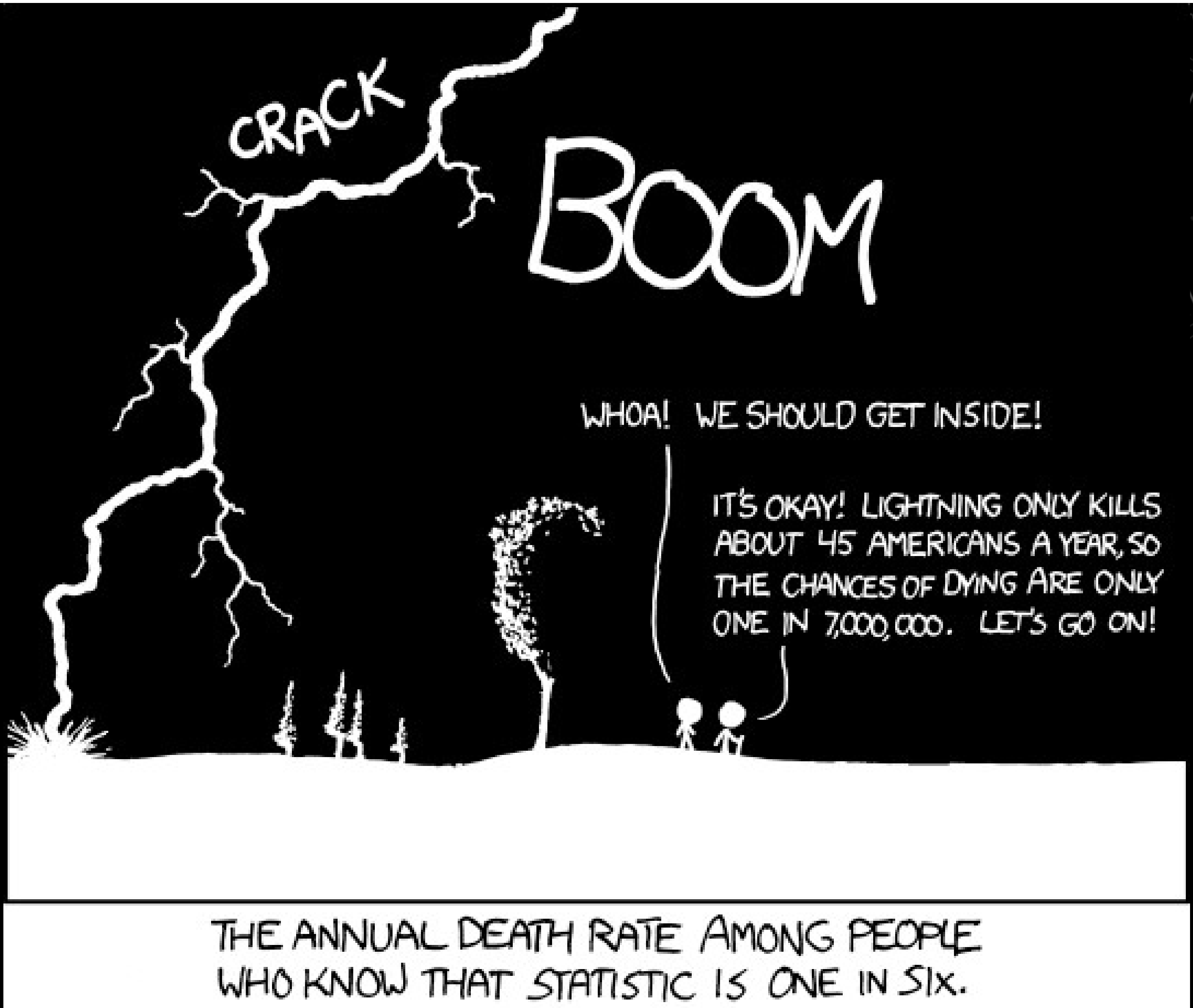
Threat Modeling

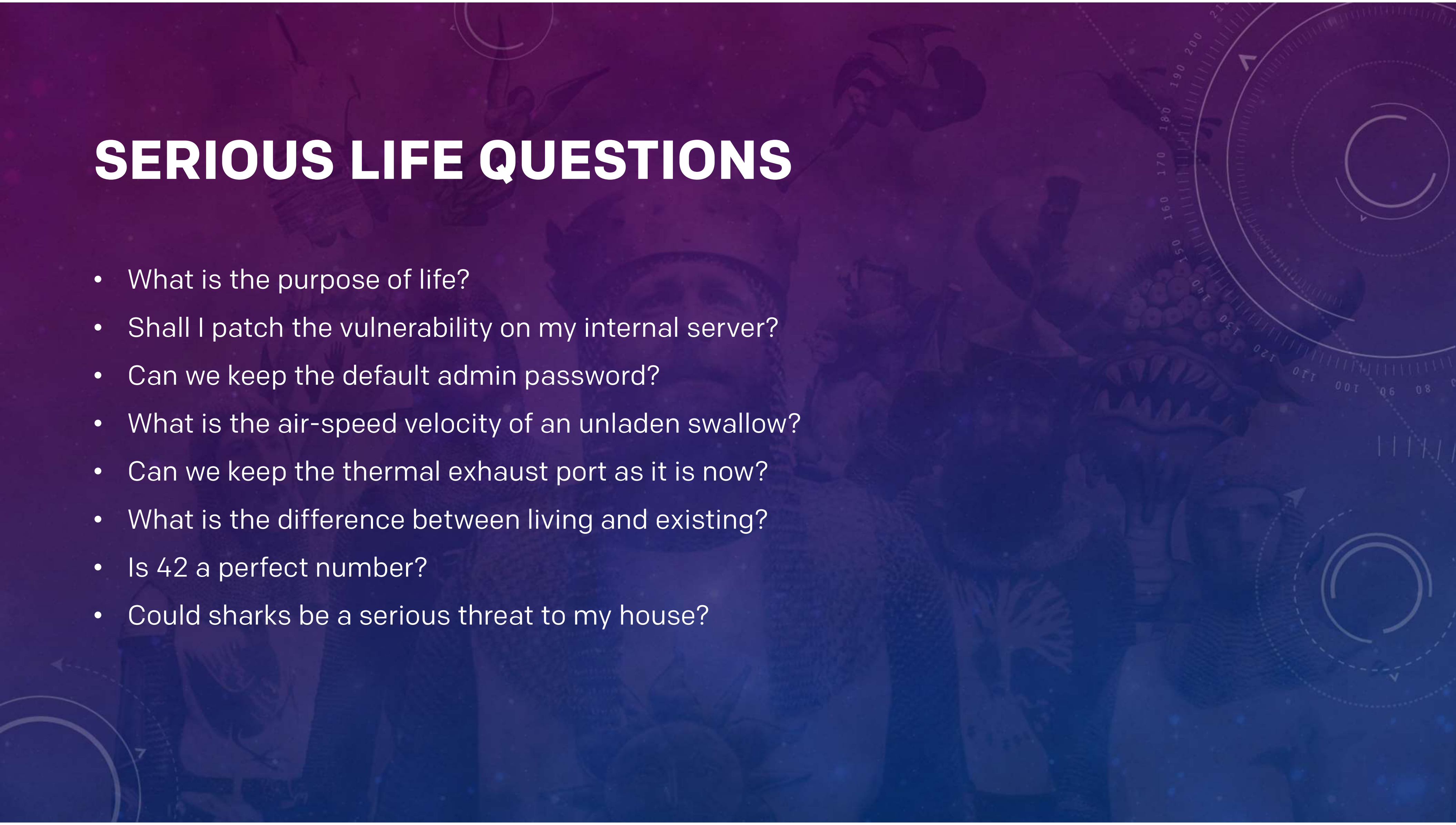
Term definitions

Examples!

Attack Trees, STRIDE, Security Cards

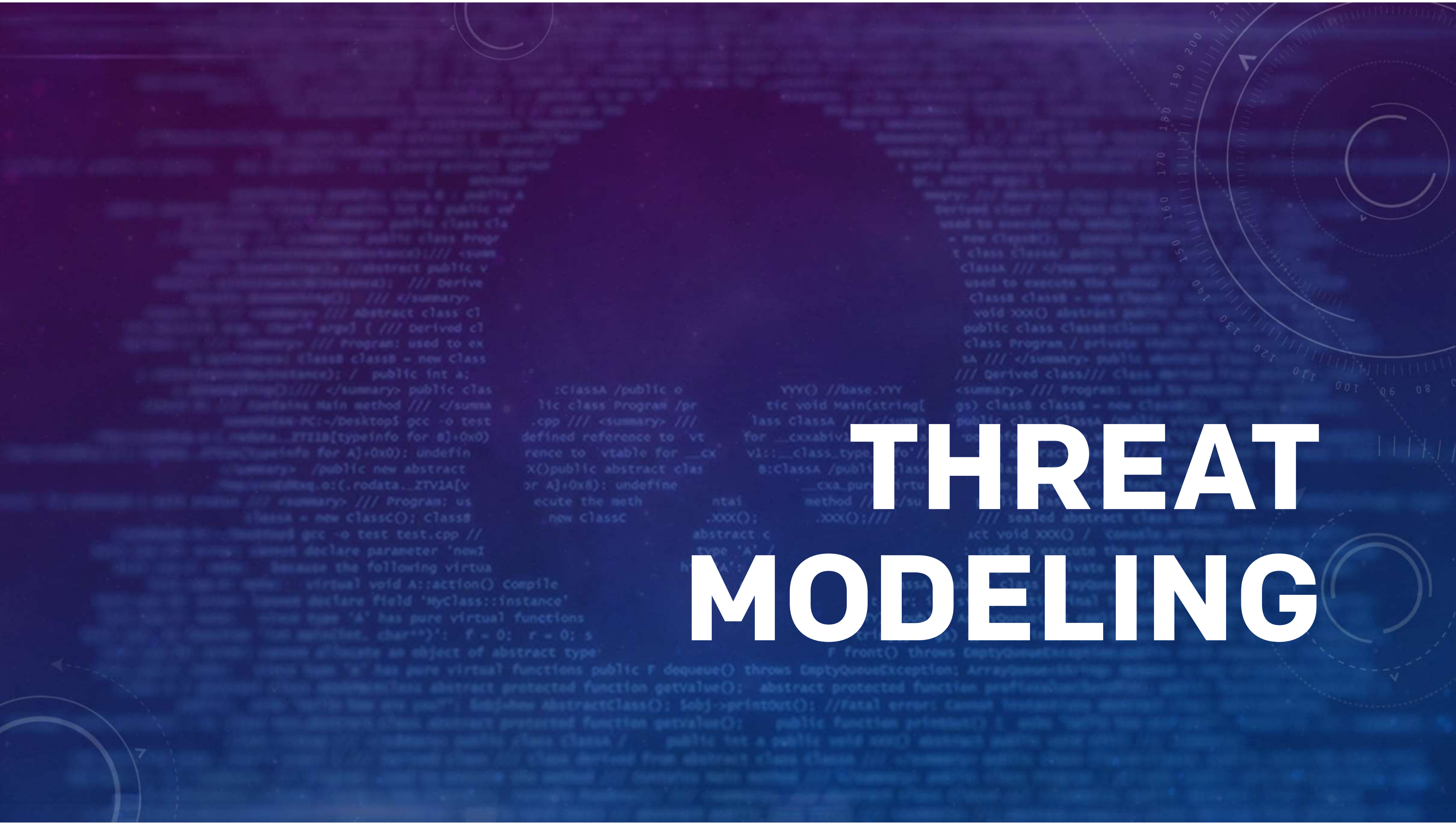
Practical Threat Modeling


CRACK
BOOM
WHOA! WE SHOULD GET INSIDE!
IT'S OKAY! LIGHTNING ONLY KILLS ABOUT 45 AMERICANS A YEAR, SO THE CHANCES OF DYING ARE ONLY ONE IN 7,000,000. LET'S GO ON!
THE ANNUAL DEATH RATE AMONG PEOPLE WHO KNOW THAT STATISTIC IS ONE IN SIX.



SERIOUS LIFE QUESTIONS

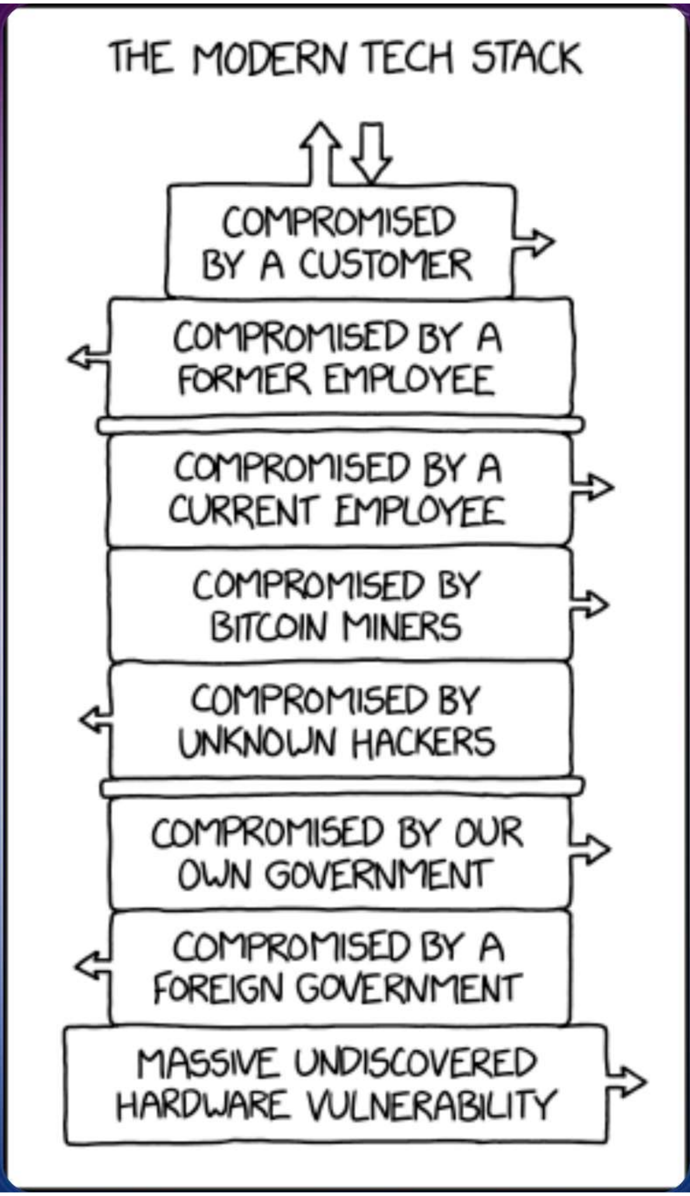
- What is the purpose of life?
- Shall I patch the vulnerability on my internal server?
- Can we keep the default admin password?
- What is the air-speed velocity of an unladen swallow?
- Can we keep the thermal exhaust port as it is now?
- What is the difference between living and existing?
- Is 42 a perfect number?
- Could sharks be a serious threat to my house?



THREAT MODELING

THE MODERN TECH STACK

XKCD 2166


THE MODERN TECH STACK
COMPROMISED BY A CUSTOMER
COMPROMISED BY A FORMER EMPLOYEE
COMPROMISED BY A CURRENT EMPLOYEE
COMPROMISED BY BITCOIN MINERS
COMPROMISED BY UNKNOWN HACKERS
COMPROMISED BY OUR OWN GOVERNMENT
COMPROMISED BY A FOREIGN GOVERNMENT
MASSIVE UNDISCOVERED HARDWARE VULNERABILITY

TERM DEFINITIONS

Asset

An asset is what we’re trying to protect.

Vulnerability

A weakness or gap in our protection efforts.

Threat

What we’re trying to protect against.

Risk

Risk is the intersection of assets, threats, and vulnerabilities.

DEFINITION: THREAT MODELING

Threat modeling is a process by which potential threats can be identified, enumerated and prioritized, all from a **hypothetical attacker's point of view**.

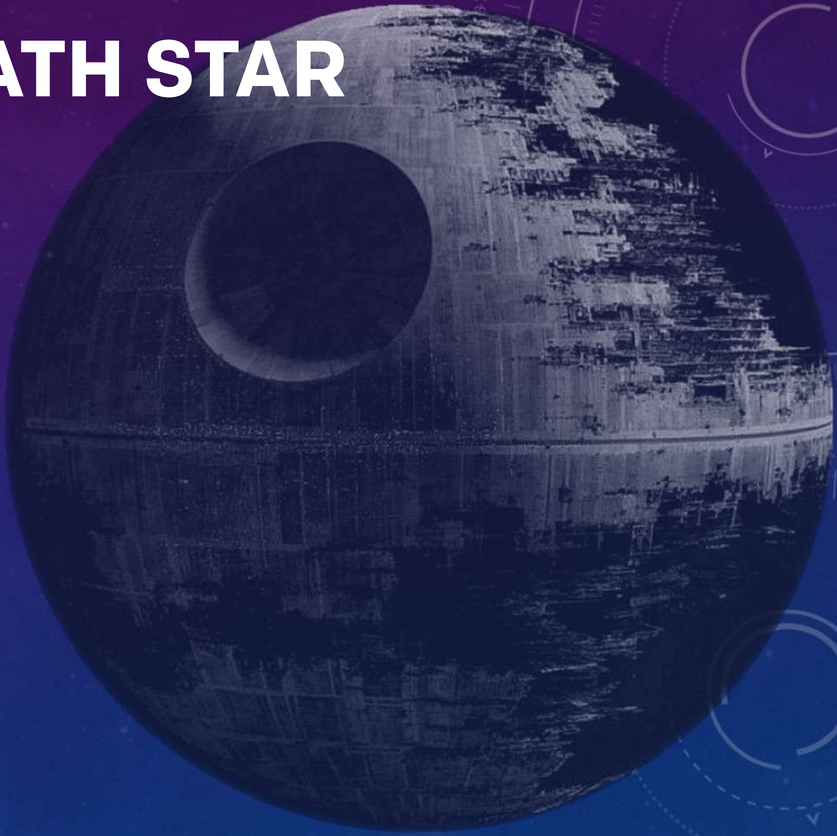
(aka "analyzing risky designs")

PRIMARY COMPONENTS

- Assets
- Personas/Attackers
    - Not just people, it could be other disasters as well
- Methods/Attack Vectors
    - Impacts
    - Likelihood
- Mitigation/Countermeasuers

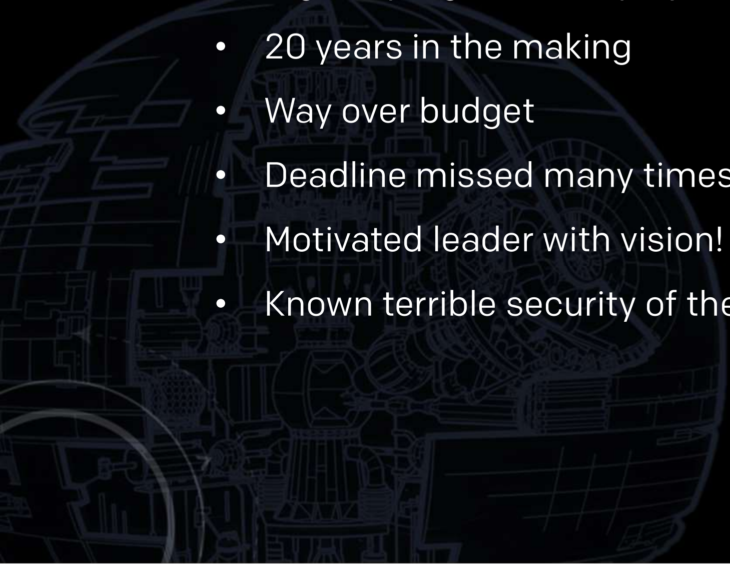
THREAT MODELING THE DEATH STAR

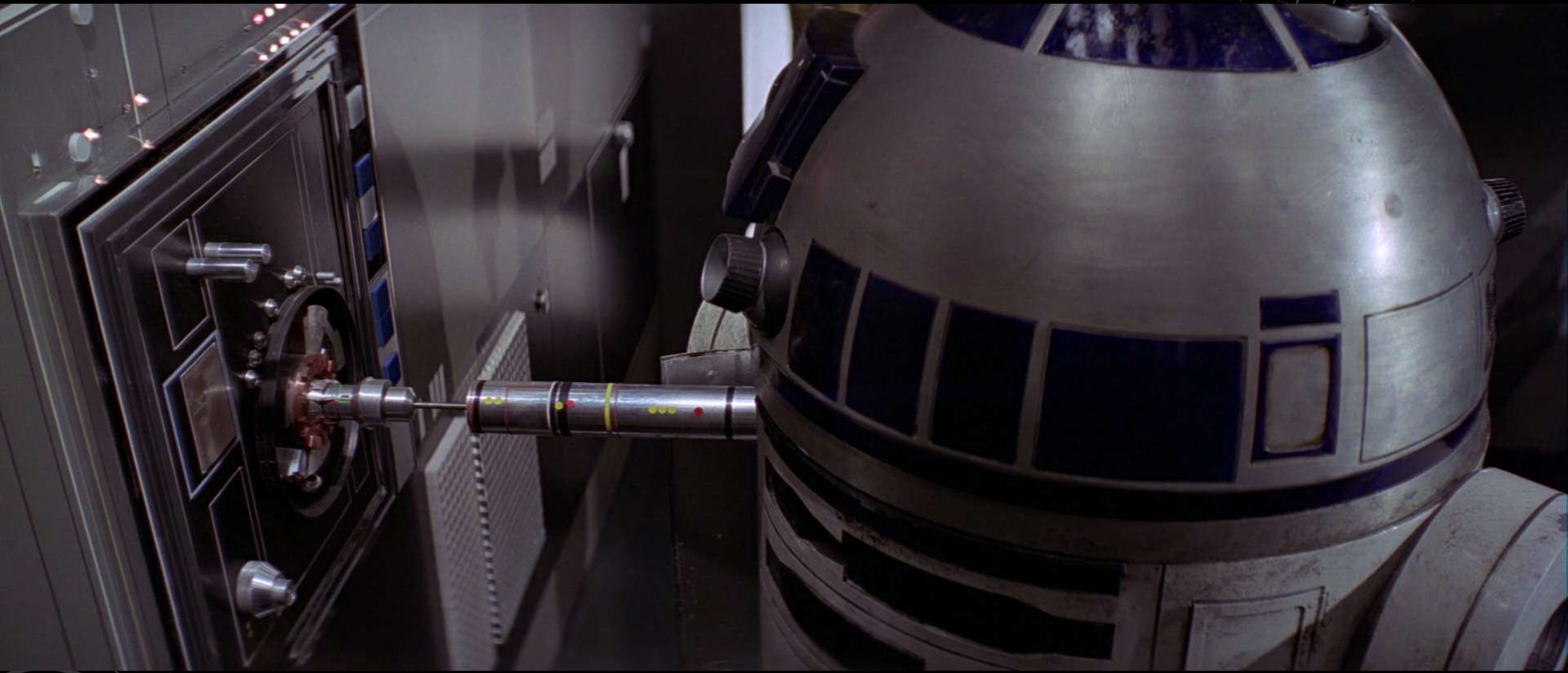
- Credit: **Threat Modeling the Death Star**; Mario Areias; PyCon 2019

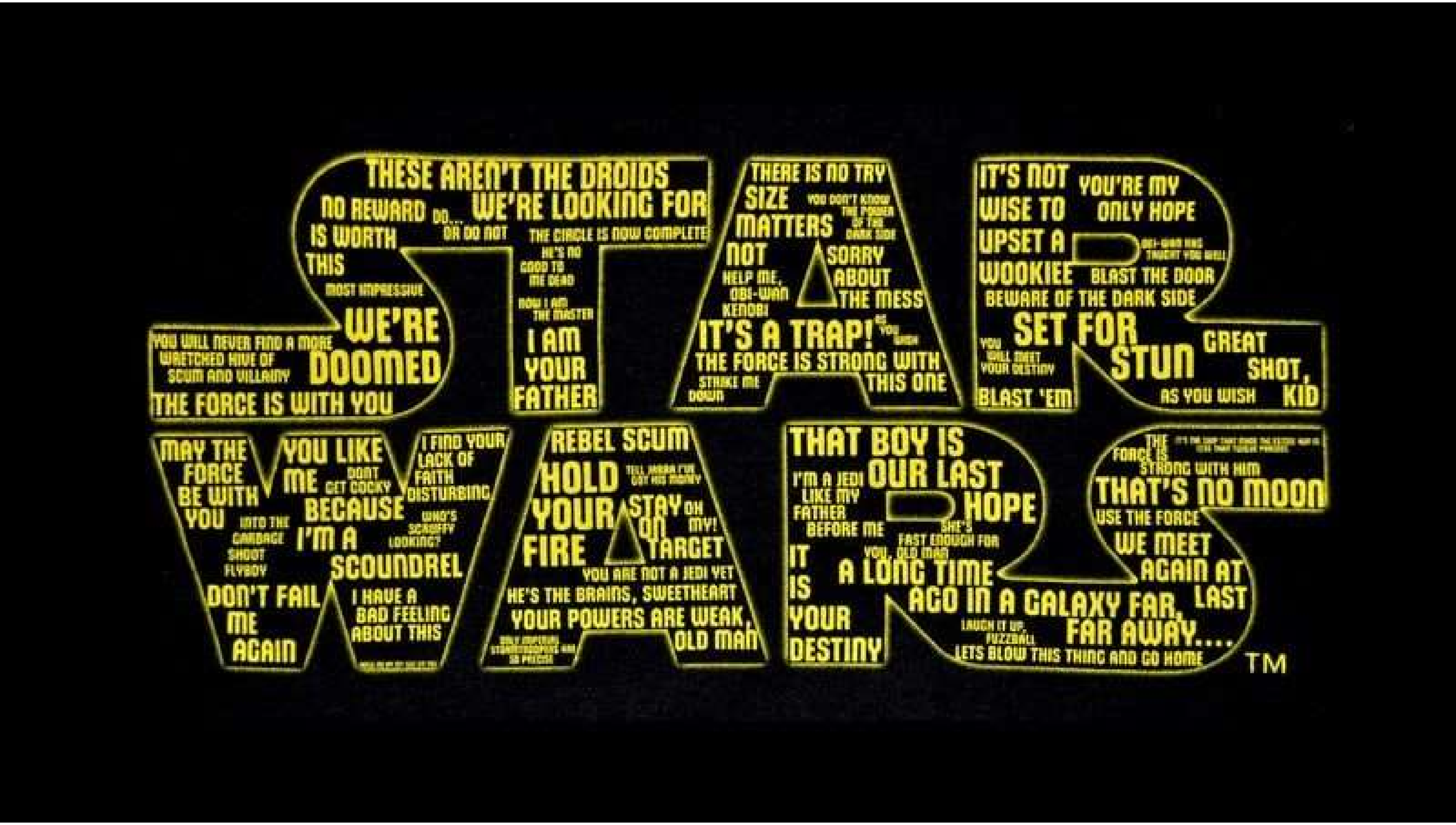


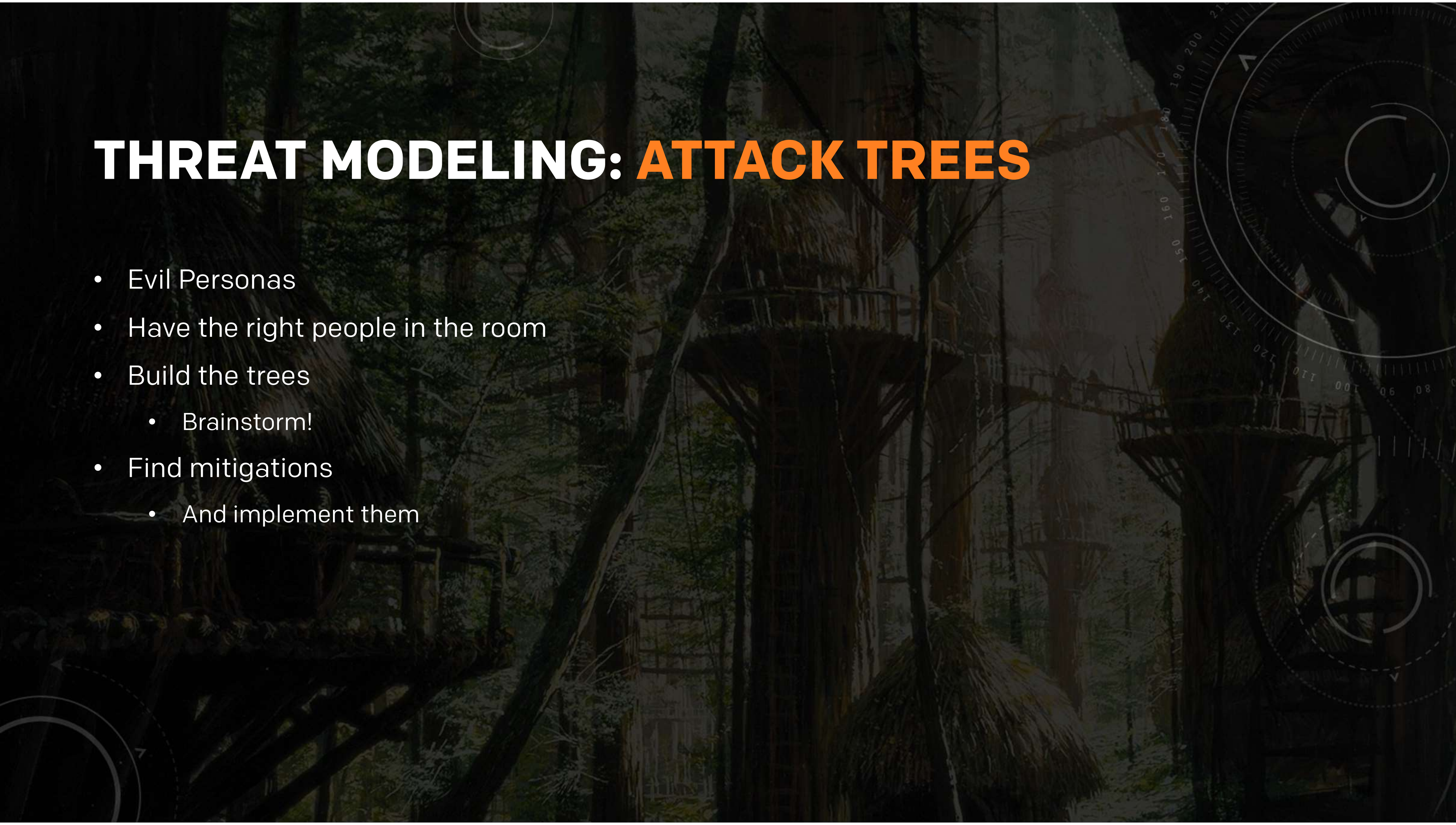
YOUR MISSION

- Goal: The Death Star
- Stakeholder: Galactic Empire
- Project status
    - Big, very big waterfall project
    - 20 years in the making
    - Way over budget
    - Deadline missed many times
    - Motivated leader with vision!
    - Known terrible security of the past projects






THESE AREN'T THE DROIDS
WE'RE LOOKING FOR
NO REWARD
IS WORTH
THIS
DO...
OR DO NOT
THE CIRCLE IS NOW COMPLETE
HE'S NO
GOOD TO
ME DEAD
NOW I AM
THE MASTER
I AM
YOUR
FATHER
MOST IMPRESSIVE
WE'RE
DOOMED
YOU WILL NEVER FIND A MORE
WRETCHED HIVE OF
SCUM AND VILLAINY
THE FORCE IS WITH YOU
THERE IS NO TRY
SIZE
MATTERS
NOT
YOU DON'T KNOW
THE POWER
OF THE
DARK SIDE
SORRY
ABOUT
THE MESS
HELP ME,
OBI-WAN
KENOBI
IT'S A TRAP!
AS
YOU
WISH
THE FORCE IS STRONG WITH
THIS ONE
STRIKE ME
DOWN
IT'S NOT
WISE TO
UPSET A
WOOKIEE
YOU'RE MY
ONLY HOPE
OBI-WAN HAS
TAUGHT YOU WELL
BLAST THE DOOR
BEWARE OF THE DARK SIDE
YOU
WILL MEET
YOUR DESTINY
SET FOR
STUN
GREAT
SHOT,
KID
AS YOU WISH
BLAST 'EM
MAY THE
FORCE
BE WITH
YOU
YOU LIKE
ME
DONT
GET COCKY
BECAUSE
I'M A
SCOUNDREL
INTO THE
GARBAGE
SHOOT
FLYBOY
I FIND YOUR
LACK OF
FAITH
DISTURBING
WHO'S
SCRUFFY
LOOKING?
DON'T FAIL
ME
AGAIN
I HAVE A
BAD FEELING
ABOUT THIS
REBEL SCUM
HOLD
YOUR
FIRE
TELL JABBA I'VE
GOT HIS MONEY
STAY
ON
TARGET
OH
MY!
YOU ARE NOT A JEDI YET
HE'S THE BRAINS, SWEETHEART
YOUR POWERS ARE WEAK,
OLD MAN
ONLY IMPERIAL
STORMTROOPERS ARE
SO PRECISE
THAT BOY IS
OUR LAST
HOPE
I'M A JEDI
LIKE MY
FATHER
BEFORE ME
SHE'S
FAST ENOUGH FOR
YOU, OLD MAN
IT
IS
YOUR
DESTINY
A LONG TIME
AGO IN A GALAXY FAR,
FAR AWAY....
LAUGH IT UP,
FUZZBALL
LETS BLOW THIS THING AND GO HOME
THE
FORCE IS
STRONG WITH HIM
THAT'S NO MOON
USE THE FORCE
WE MEET
AGAIN AT
LAST
TM



THREAT MODELING: ATTACK TREES

- Evil Personas
- Have the right people in the room
- Build the trees
  - Brainstorm!
- Find mitigations
  - And implement them

PERSONAS

POTENTIAL ATTACKERS

SCRIPT KIDDIES

Expertise

▰▰

Resources

▰▰▰

Organization

▰

BOUNTY HUNTERS

Expertise

▰▰▰▰▰

Resources

▰▰▰

Organization

▰▰

JEDI

Expertise

🟥🟥🟥🟥🟥🟥🟥

Resources

🟦🟦🟦

Organization

🟦🟦

INSIDER THREAT

Expertise

▰▰▰▰

Resources

▰▰▰

Organization

▰▰▰▰

NATION STATE

Expertise

Resources

Organization

RIGHT PEOPLE IN THE ROOM

LET'S DO SOME ANALYSIS!

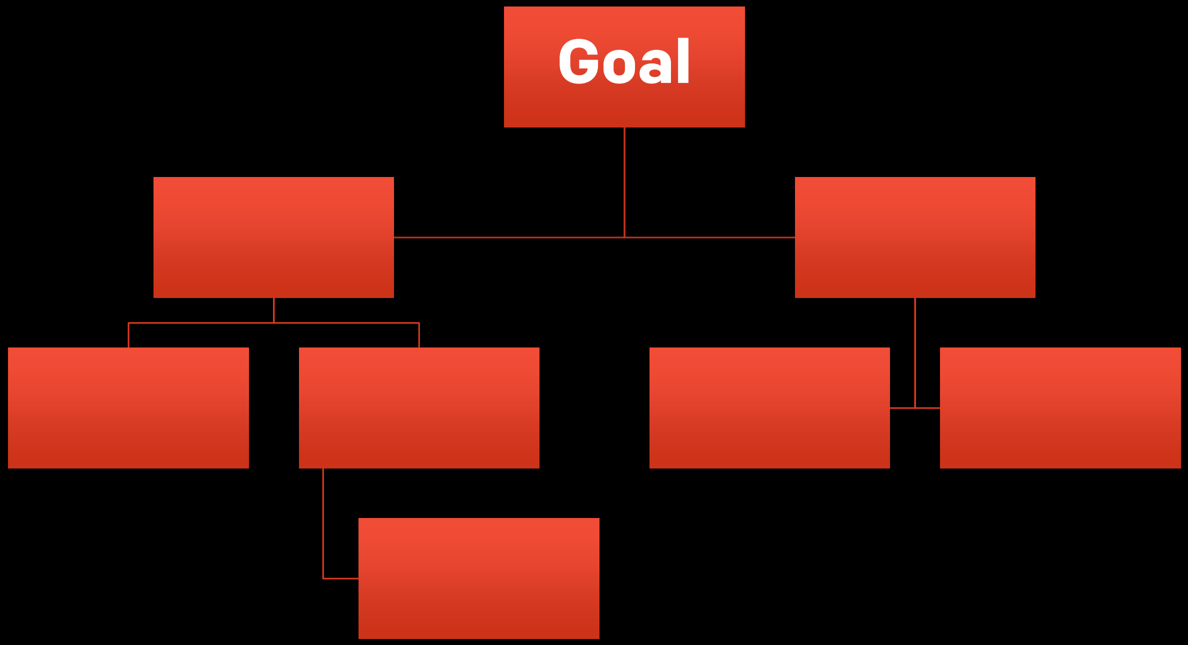
OUR TEAM

- Engineers
- Architects
- You, as a lead security architect!

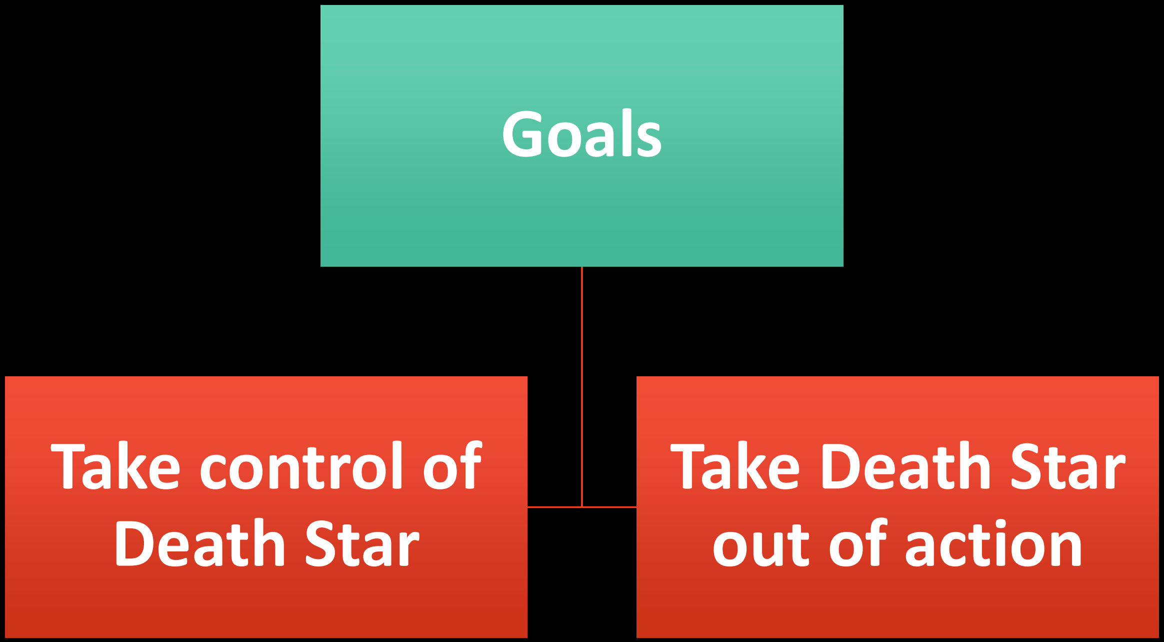
ATTACK VECTORS

GOALS, METHODS

THREAT MODELING: ATTACK TREES



THREAT MODELING: ATTACK TREES

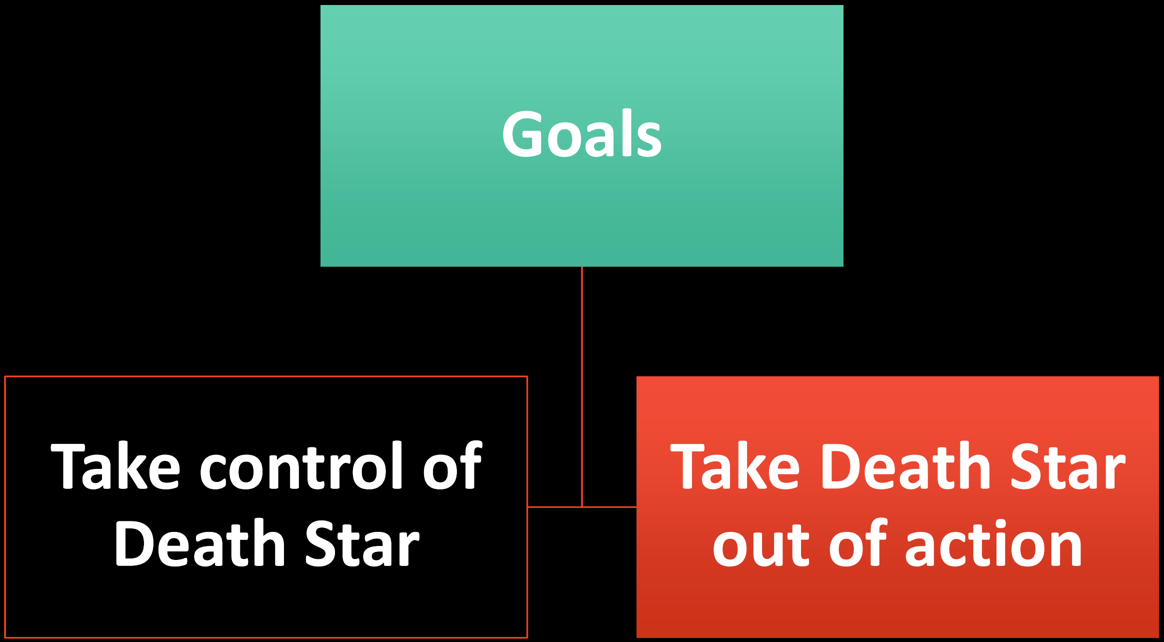


Goals

Take control of Death Star

Take Death Star out of action

THREAT MODELING: ATTACK TREES



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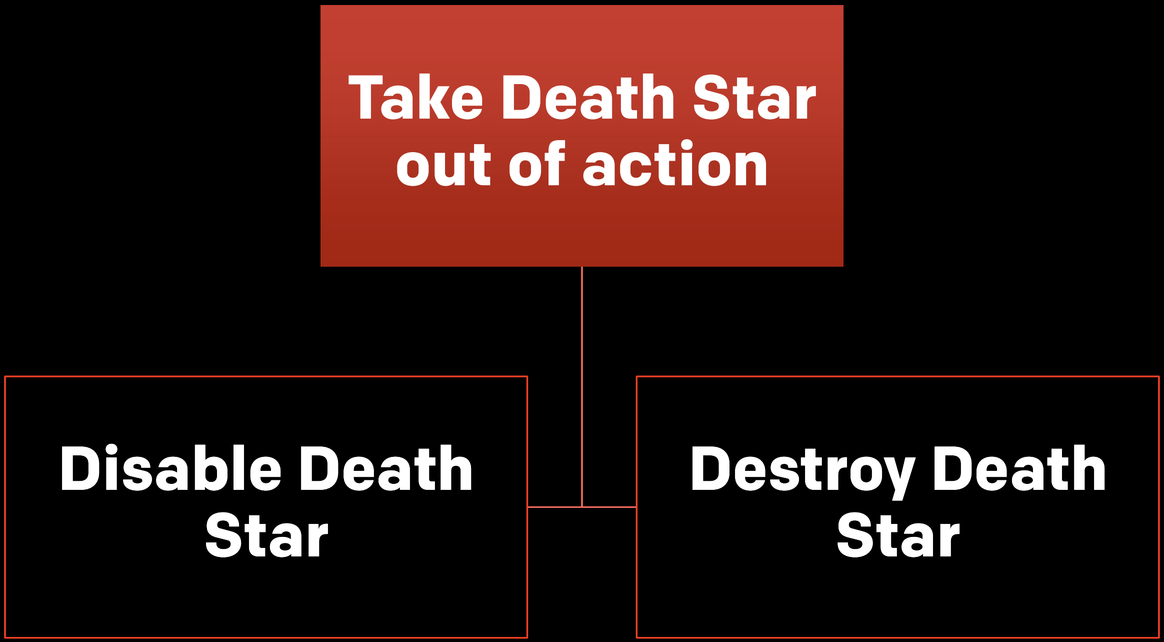
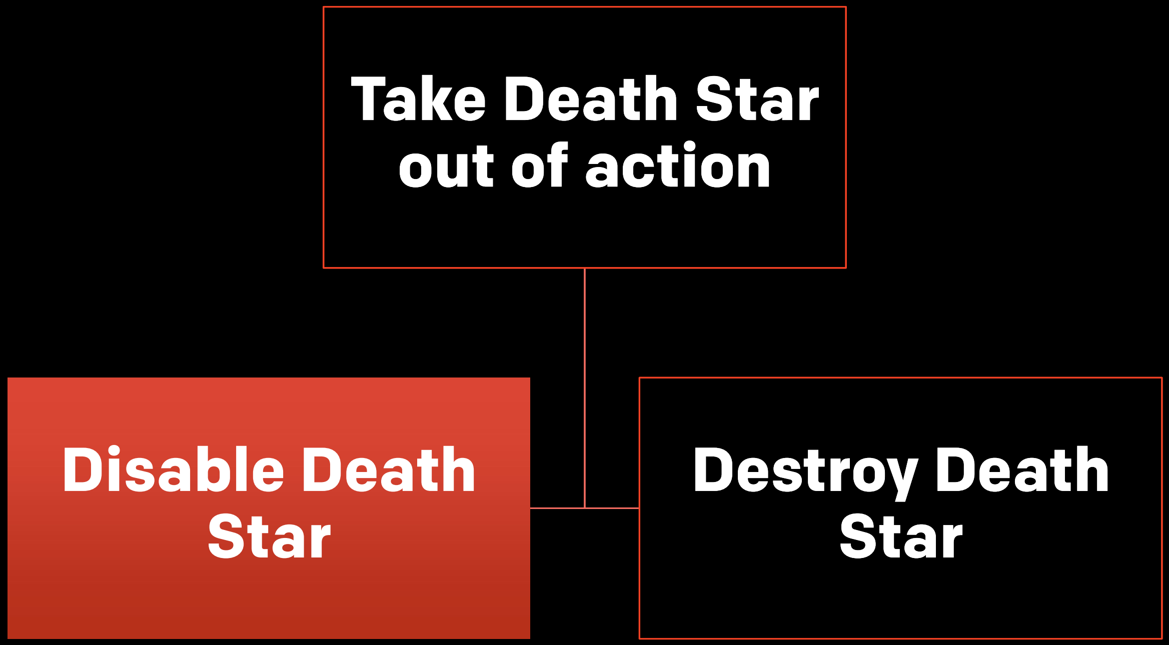


Take Death Star out of action

Disable Death Star

Destroy Death Star

THREAT MODELING: ATTACK TREES

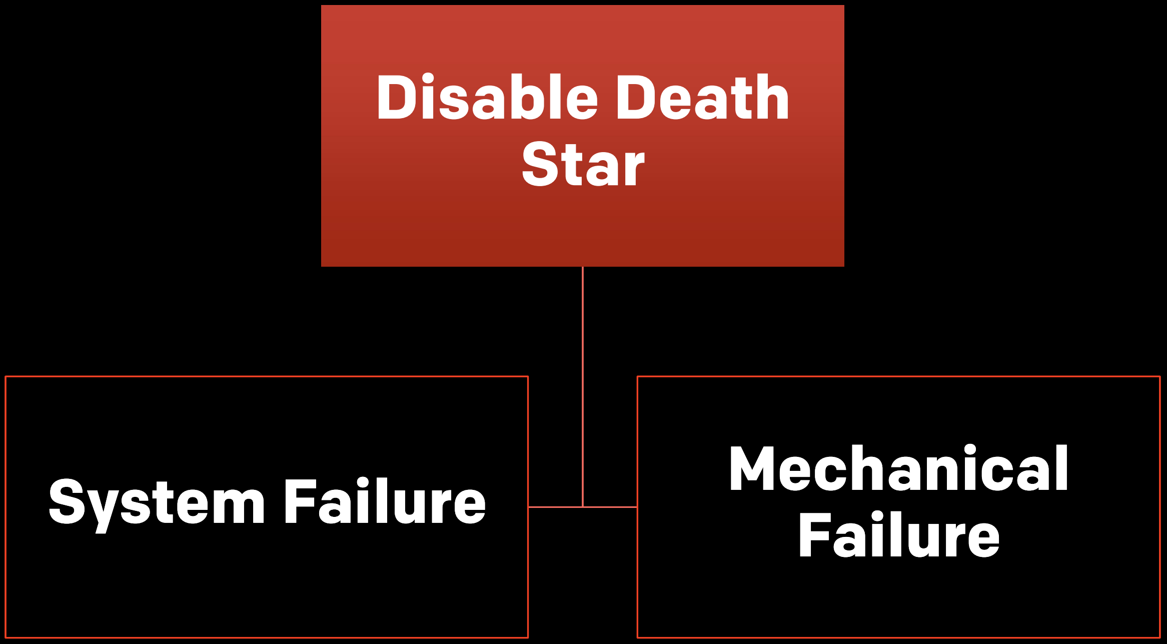


Take Death Star out of action

Disable Death Star

Destroy Death Star

THREAT MODELING: ATTACK TREES

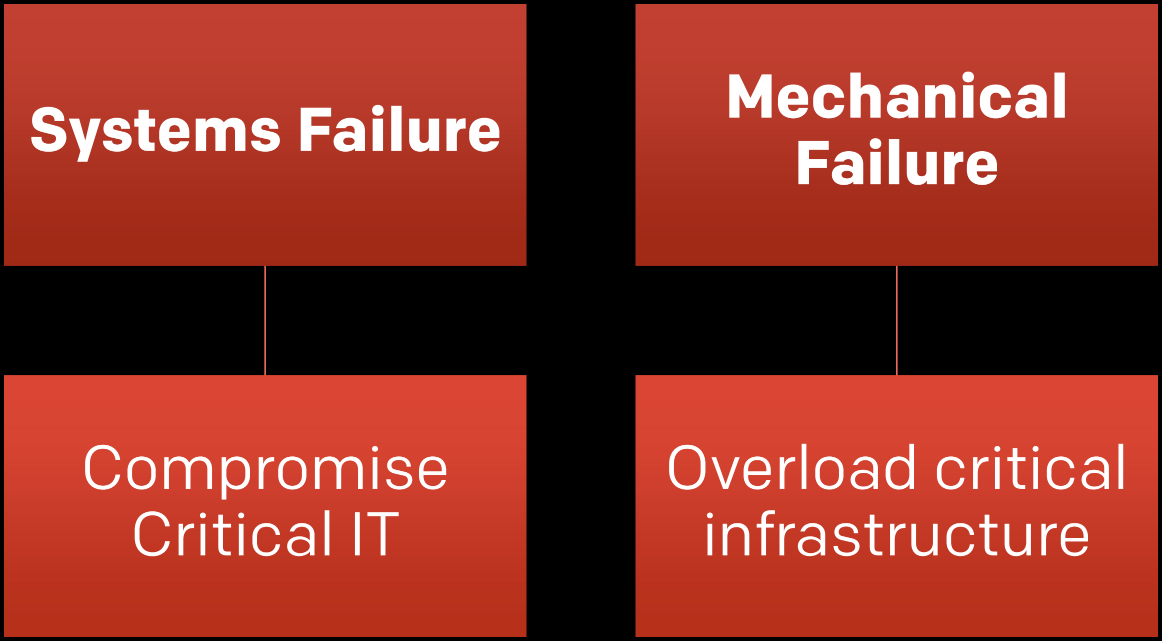


Disable Death Star

System Failure

Mechanical Failure

THREAT MODELING: ATTACK TREES



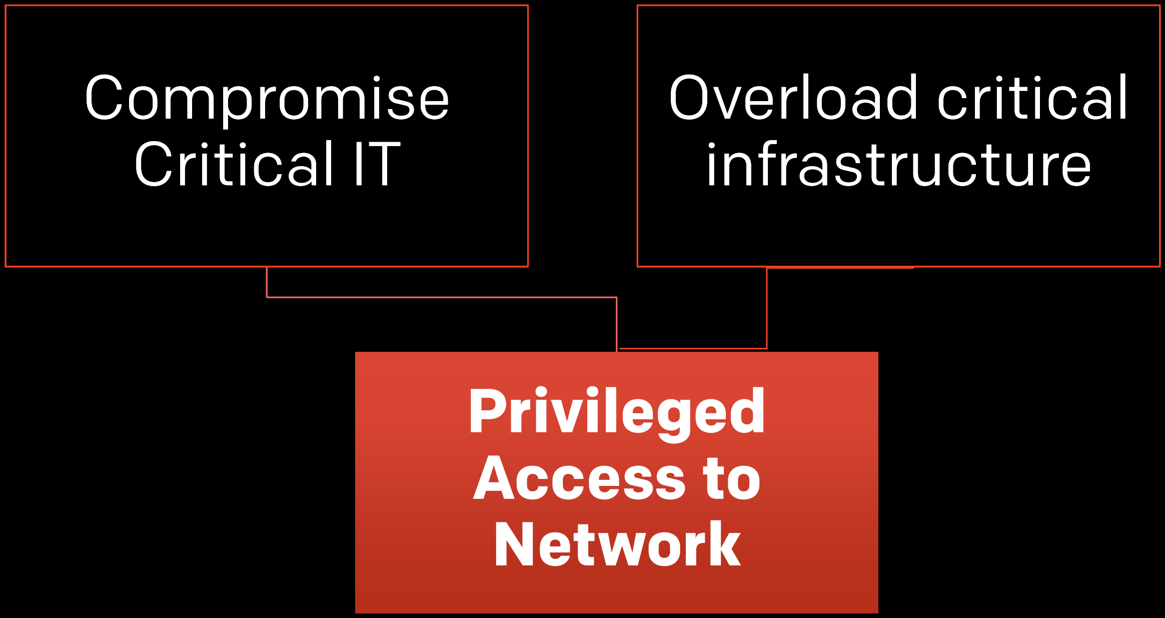
Systems Failure

Compromise Critical IT

Mechanical Failure

Overload critical infrastructure

THREAT MODELING: ATTACK TREES

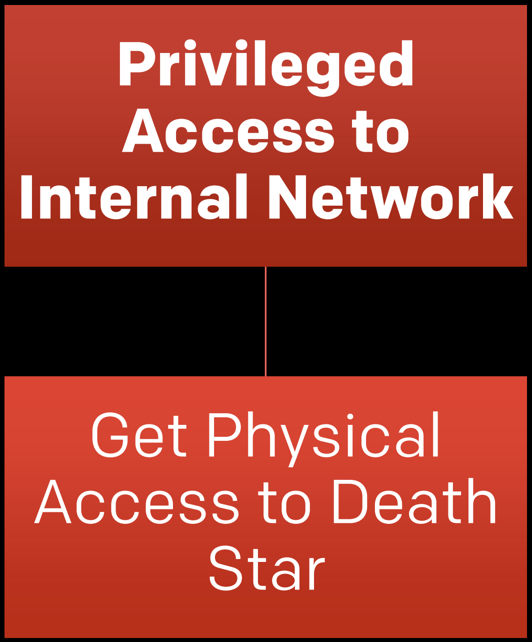


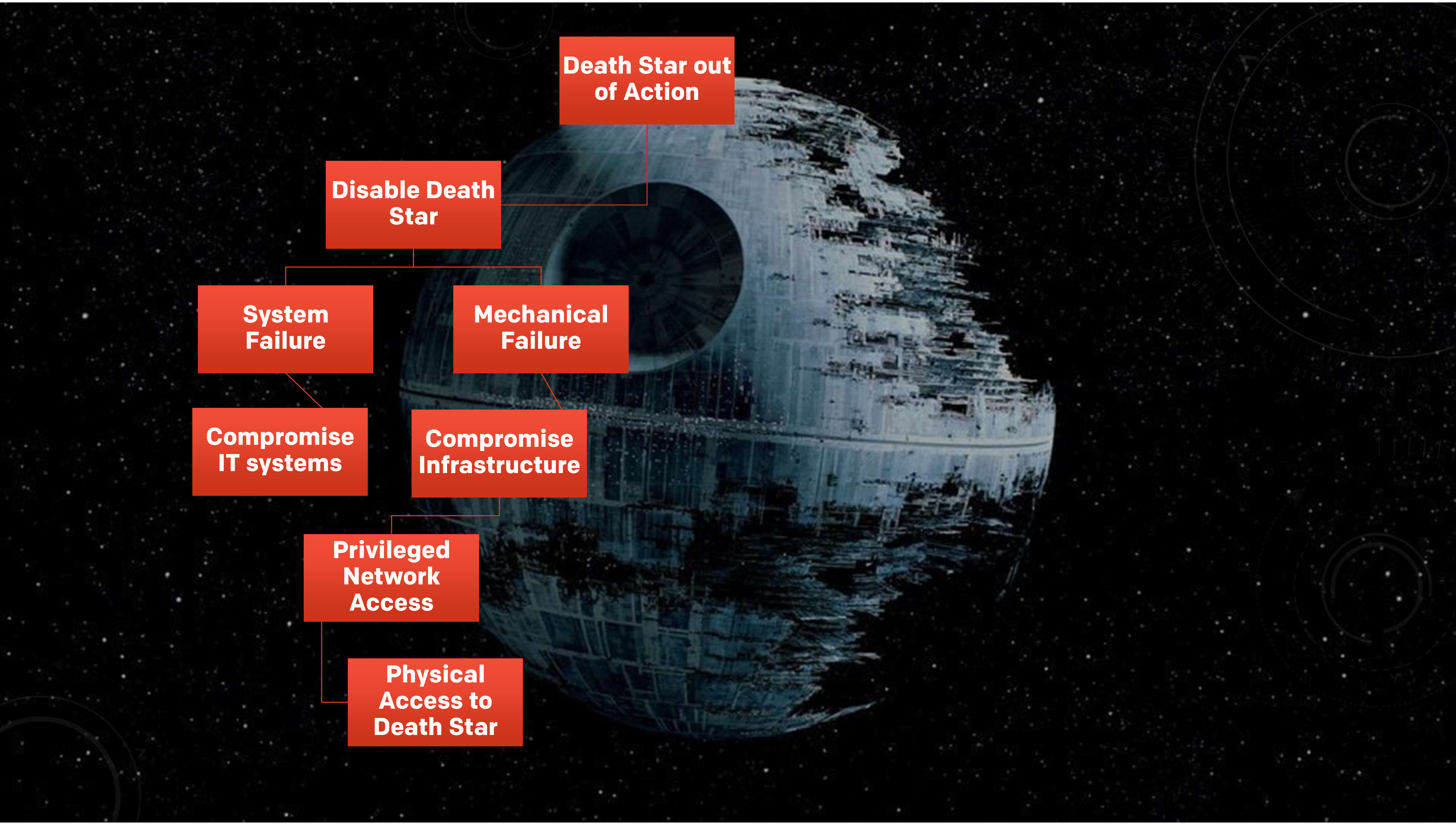
Compromise Critical IT

Overload critical infrastructure

Privileged Access to Network

THREAT MODELING: ATTACK TREES


Privileged Access to Internal Network
Get Physical Access to Death Star



Death Star out of Action

Disable Death Star

System Failure

Mechanical Failure

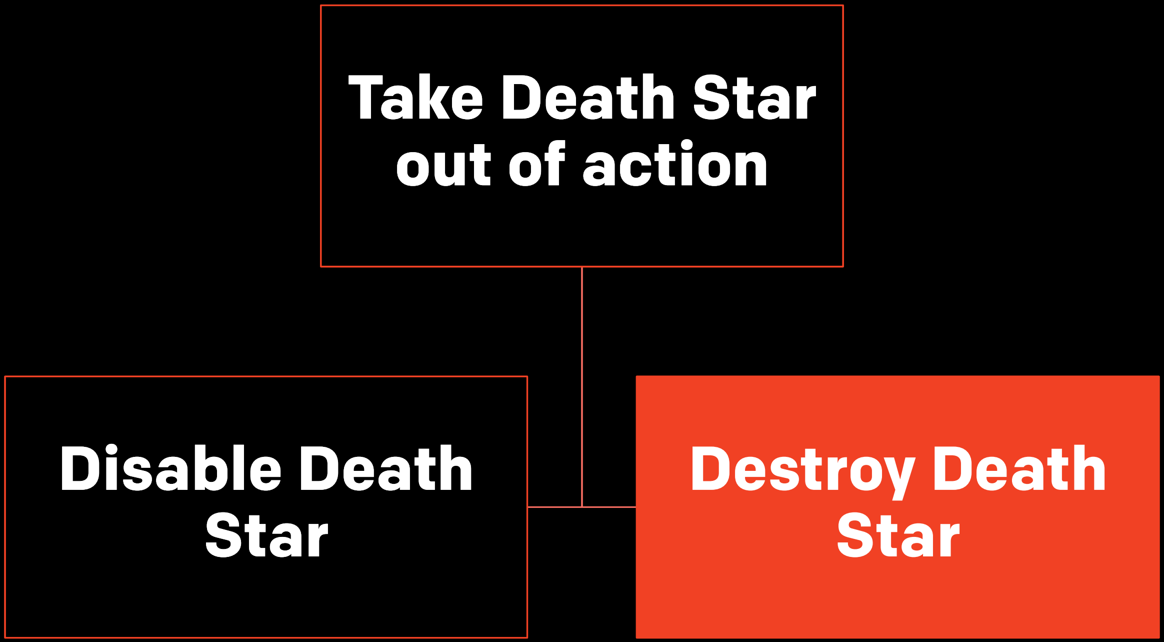
Compromise IT systems

Compromise Infrastructure

Privileged Network Access

Physical Access to Death Star

THREAT MODELING: ATTACK TREES

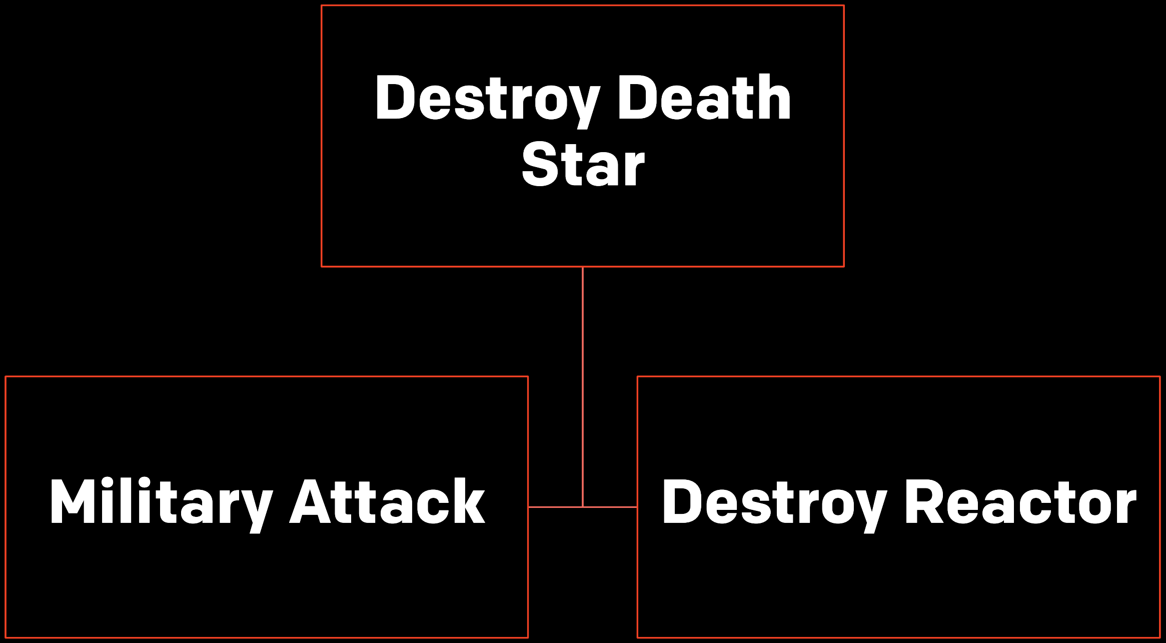


Take Death Star out of action

Disable Death Star

Destroy Death Star

THREAT MODELING: ATTACK TREES

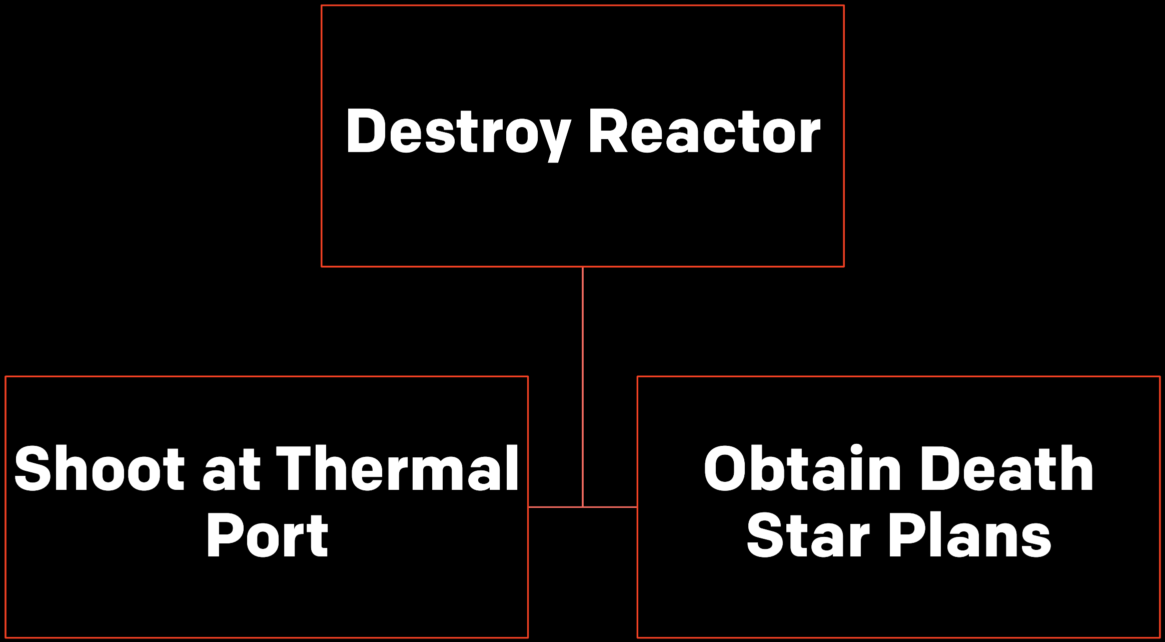


Destroy Death Star

Military Attack

Destroy Reactor

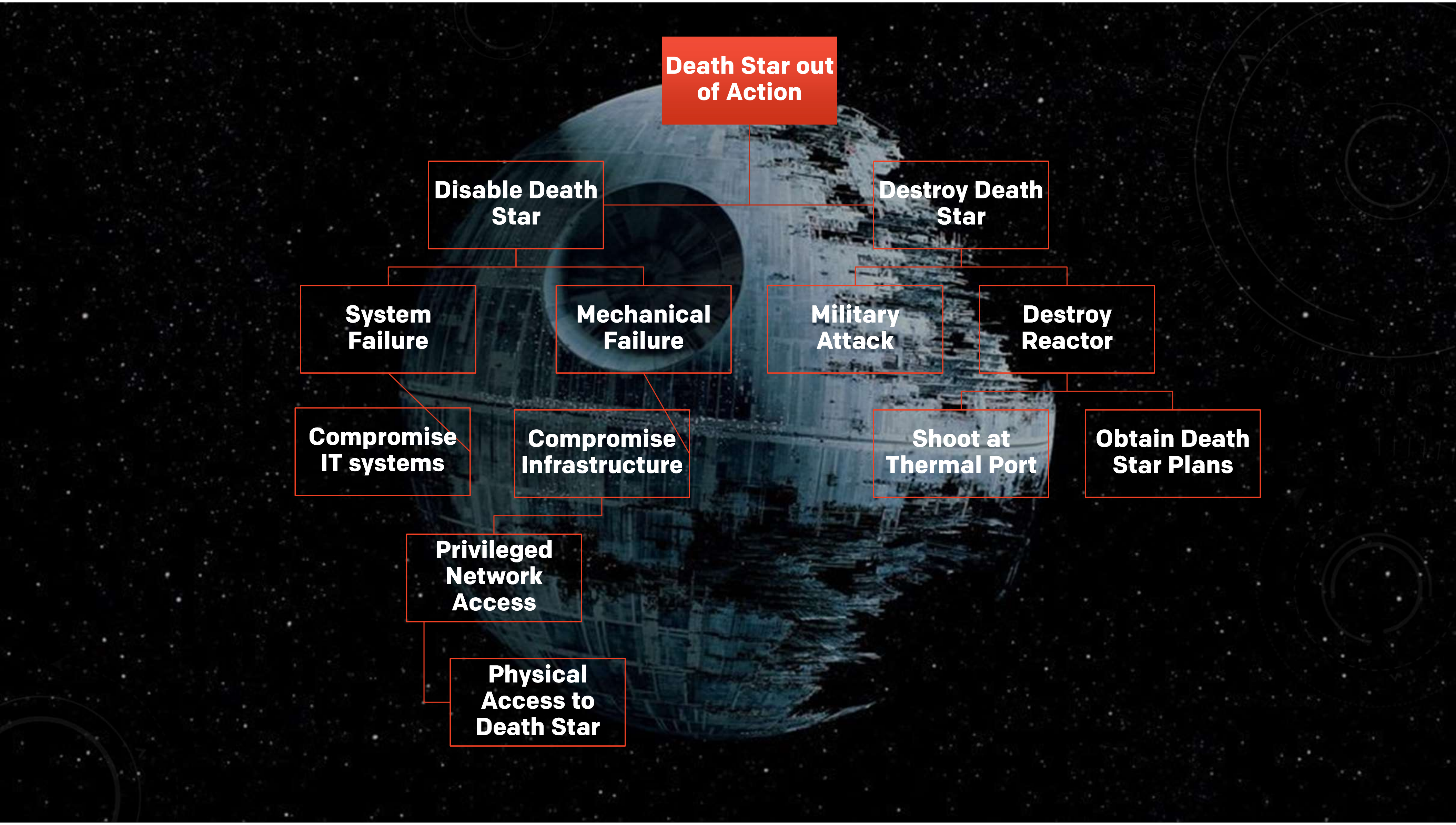
THREAT MODELING: ATTACK TREES



Destroy Reactor

Shoot at Thermal Port

Obtain Death Star Plans



Death Star out of Action

Disable Death Star

System Failure

Compromise IT systems

Mechanical Failure

Compromise Infrastructure

Privileged Network Access

Physical Access to Death Star

Destroy Death Star

Military Attack

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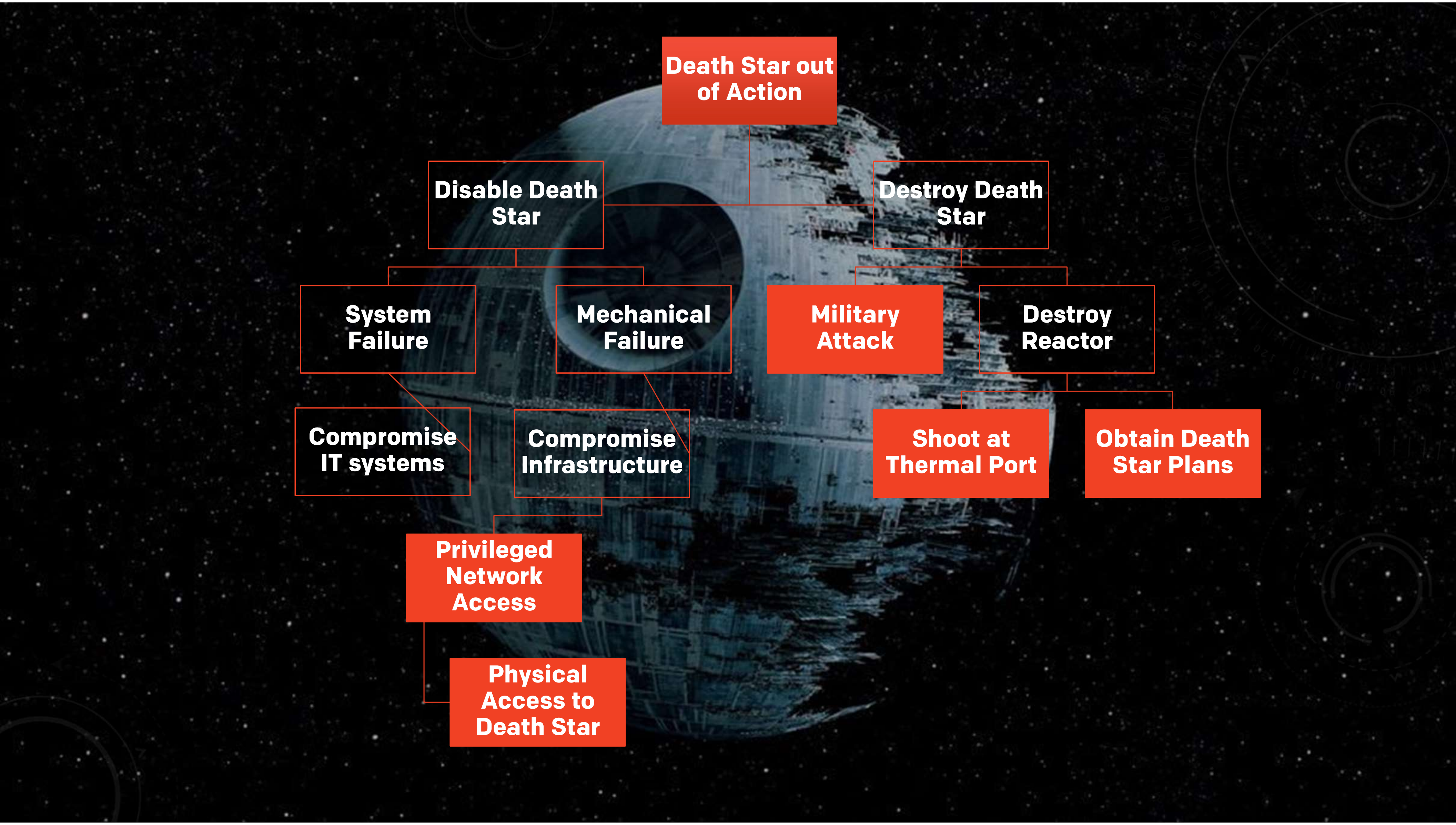
Obtain Death Star Plans



Death Star out of Action

Disable Death Star

System Failure

Compromise IT systems

Mechanical Failure

Compromise Infrastructure

Privileged Network Access

Physical Access to Death Star

Destroy Death Star

Military Attack

Destroy Reactor

Shoot at Thermal Port

Obtain Death Star Plans

MITIGATION STRATEGIES

MINIMIZE THE RISKS

PRIVILEGED ACCESS TO NETWORK

Impact: **CRITICAL**

Likelihood: **MEDIUM**

Mitigation strategies

- Better authentication / authorization
- Defense in Depth
- Pen Testing the Systems
- …

▷ Likelihood: **LOW**

MILITARY ATTACK

Impact: **CRITICAL**

Likelihood: **HIGH**

Mitigation strategies

- Incident Response procedures
- Star Destroyers "On Call"
- Monitor Rebellion Activities
- …

ALERT
Sir, are you absolutely sure? It does mean changing the bulb.

MILITARY ATTACK

Impact: **CRITICAL**

Likelihood: **HIGH**

Mitigation strategies

Incident Response procedures

Star Destroyers "On Call"

Monitor Rebellion Activities

…

➤

Impact: **HIGH**

Likelihood: **MEDIUM**

SHOOT AT THERMAL PORT

Impact: **CRITICAL**

Likelihood: **LOW**

Mitigation strategies

Move Death Star plans to Imperial Security complex.

JOB WELL DONE!

LET’S DEPLOY THAT THING

FORENSIC ANALYSIS

WHAT HAPPENED?

NEW PERSONA?

Another Jedi in the story!

Support from a Bounty Hunter!

Princess Leia’s brother!

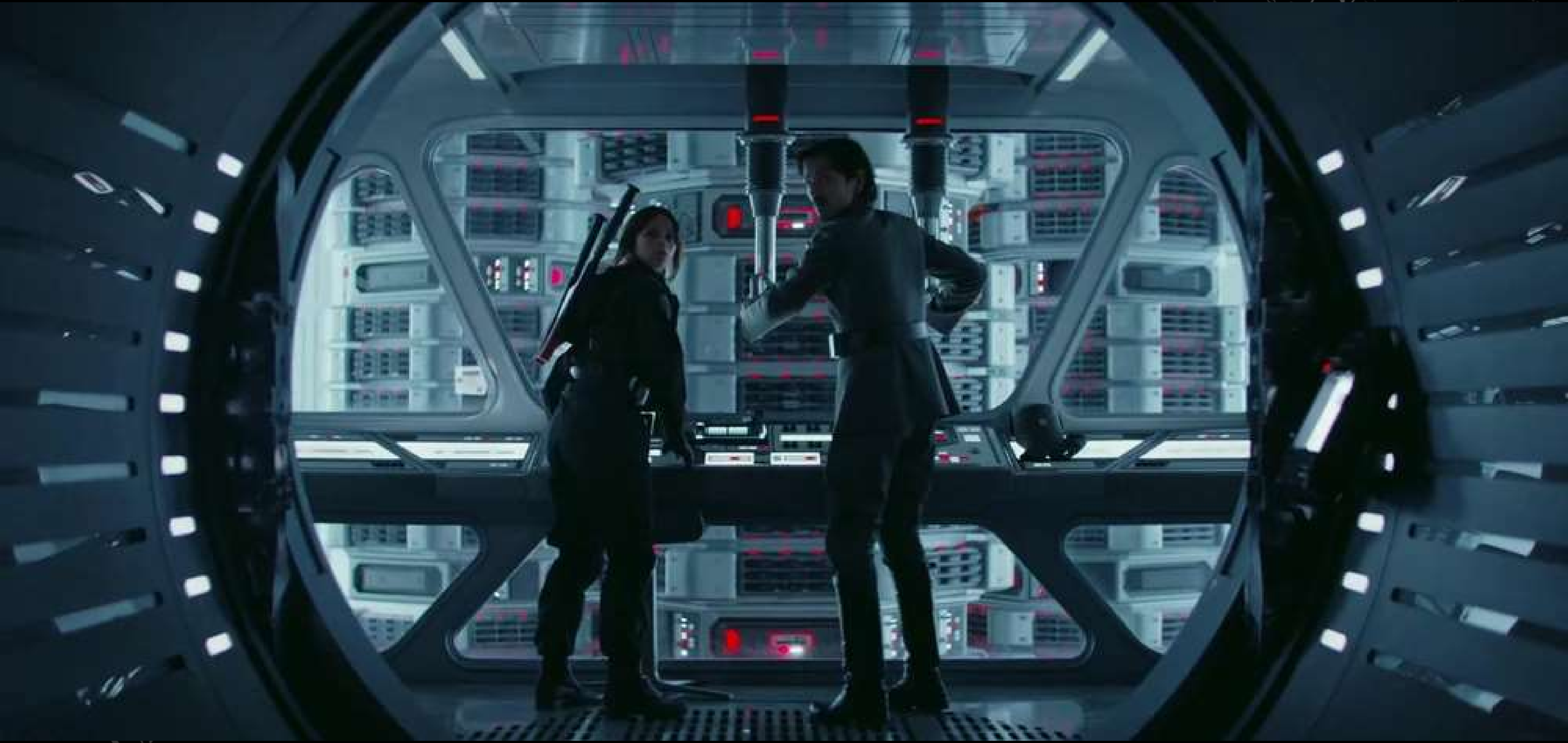
Son of a.. your boss!

DESIGN FLAWS

Insufficent design reviews!

A vital flaw in design

Introduced by an insider



THREAT MODEL EARLY AND OFTEN

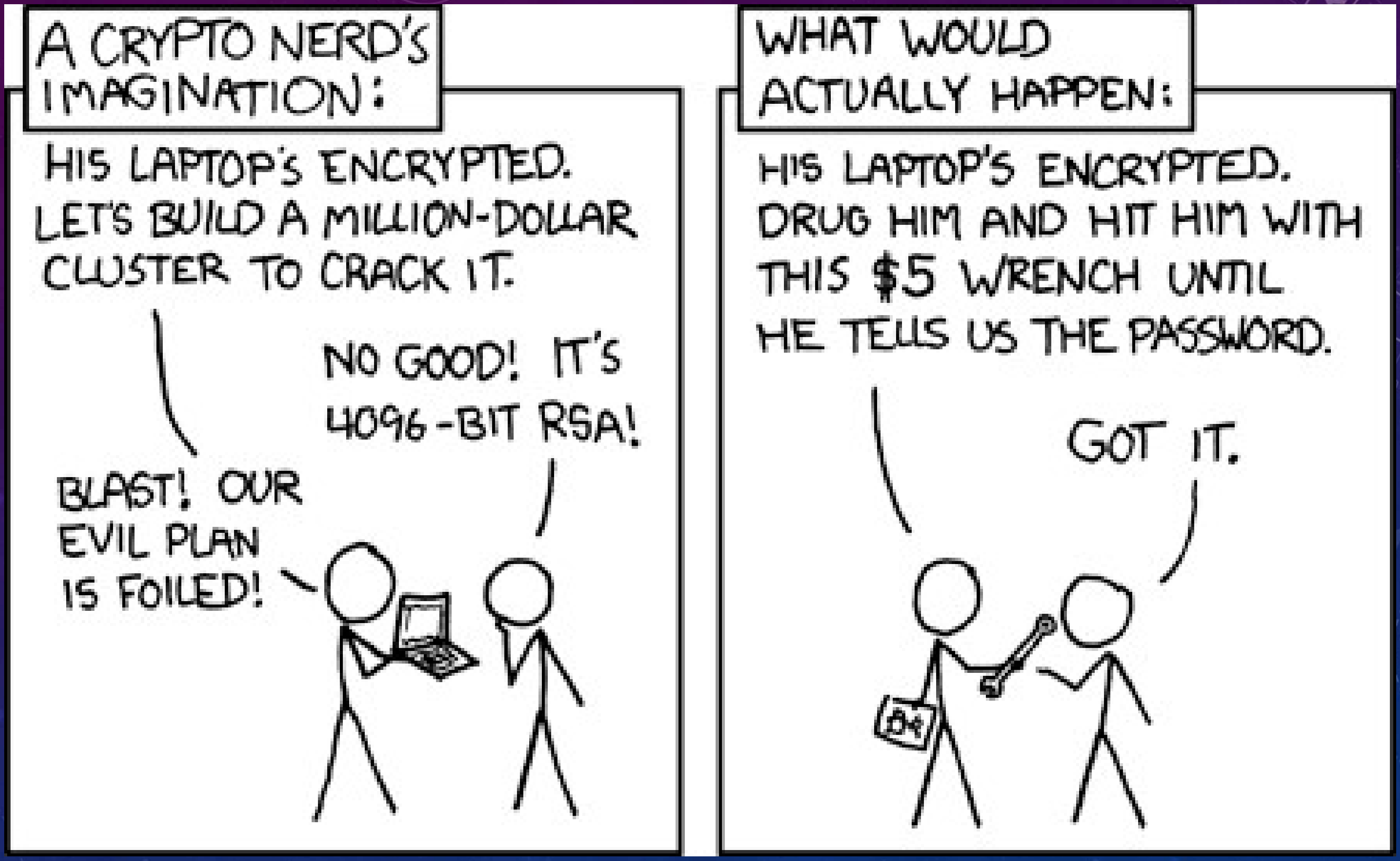
LIST OF STANDARDIZED COMPONENTS

SECURITY THROUGH OBSCURITY

IS A TERRIBLE IDEA

THREAT MODELING EXAMPLES

- Rob a bank?
- Steal a car?
- Short-n-easy examples
  - Threat modeling of movies/heroes (Batman)
  - Physical security
- Criminal Gang
  - Other criminal gangs
  - Police raids
  - Killing a puppy


A CRYPTO NERD'S IMAGINATION:
HIS LAPTOP'S ENCRYPTED. LET'S BUILD A MILLION-DOLLAR CLUSTER TO CRACK IT.
NO GOOD! IT'S 4096-BIT RSA!
BLAST! OUR EVIL PLAN IS FOILED!
WHAT WOULD ACTUALLY HAPPEN:
HIS LAPTOP'S ENCRYPTED. DRUG HIM AND HIT HIM WITH THIS $5 WRENCH UNTIL HE TELLS US THE PASSWORD.
GOT IT.

METHODOLOGIES

- **Attack Trees**
- STRIDE
- PASTA
- CVSS
- Security Cards

- … and plenty of others!

THREAT MODELING: STRIDE

Spoofing

Tampering

Repudiation

Information Disclosure

Denial of Services

Elevation of Privileges

STRIDE

SPOOFING

In the context of information security, and especially network security, a spoofing attack is a situation in which a person or program successfully identifies as another by falsifying data, to gain an illegitimate advantage.

TAMPERING

Tampering can refer to many forms of sabotage but the term is often used to mean intentional modification of products in a way that would make them harmful to the consumer.

REPUDIATION

In digital security, non-repudiation means a service that provides proof of the integrity and origin of data, or an authentication that can be said to be genuine with high confidence.

INFO DISCLOSURE

Information disclosure is the unwanted dissemination of data, technology, or privacy. legal and political issues surrounding them. It is a violation of data privacy[2] or data protection. The challenge of data privacy is to use data

DENIAL OF SERVICE

A denial-of-service attack (DoS attack) is a cyber-attack in which the perpetrator seeks to make a machine or network resource unavailable to its intended users by temporarily or indefinitely disrupting services of a host connected to the

ELEVATION OF PRIVLEGE

Privilege escalation is the act of exploiting a bug, design flaw or configuration oversight in an operating system or software application to gain elevated access to resources that are normally protected from an application or user.

THREAT MODELING: STRIDE

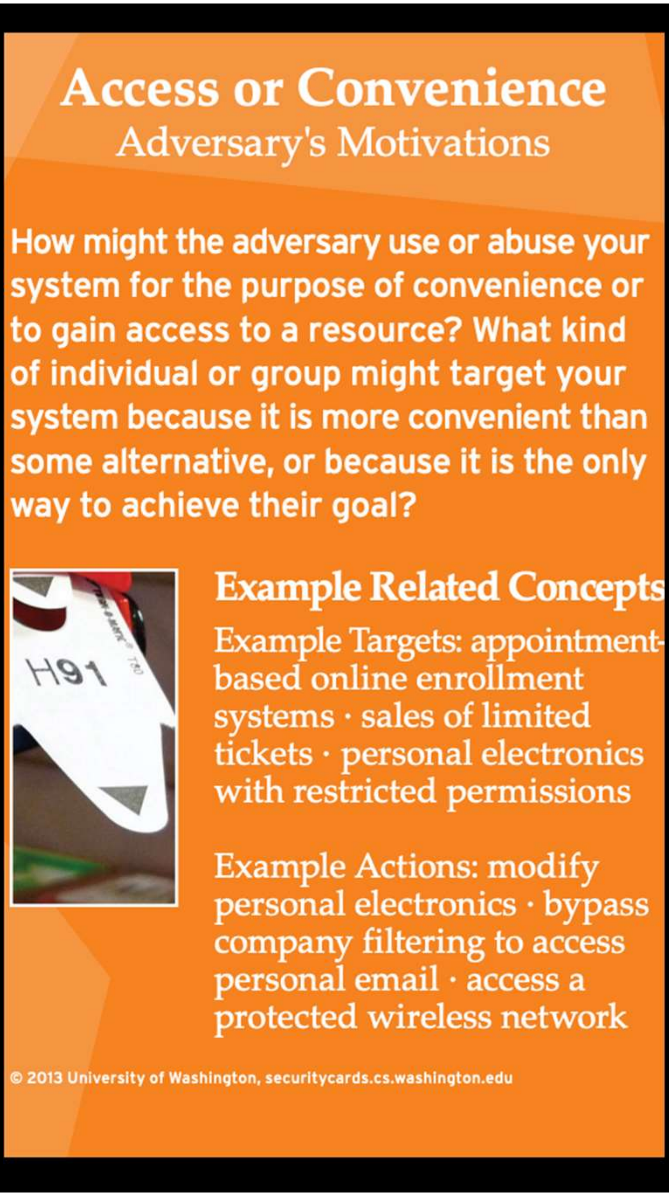
- Provides a good methodology
- Various areas people could start with
- Tools available!
  - Microsoft Threat Modeling tool
  - OWASP Threat Dragon
- Adopted by Microsoft, Github, …

SECRETS IN A GIT REPOSITORY

Category	Threat	Description	Mitigation
Information Disclosure	Credentials Theft	An unauthorized person could get to the credentials, later on this could be used to alter potentially sensitive/vital information.	Least privilege principle; dynamic, generated credentials (if possible, with time limited validity).
Repudiation	Performing operations on someone else's behalf	Sharing secrets makes non-repudiation impossible – there's always a space for justified doubt about who could actually be the initiator of a potentially harmful actions.	Least privilege, no shared secrets, strong authentication, good audit logs.
Tampering	Rewriting a crucial secret.	When a write permission on the secrets is also shared by a group of individuals, it's possible to harm services by rewriting the stored secret (either deliberately or by accident).	Secrets versioning, strict roles and least privilege.

THREAT MODELING: SECURITY CARDS

- Gamification of threat modeling!
- 4 different categories of cards ("dimensions")
  - Human Impact
  - Adversary's Motivation
  - Adversary's Resources
  - Adversary's Methods
- Interactive



Access or Convenience

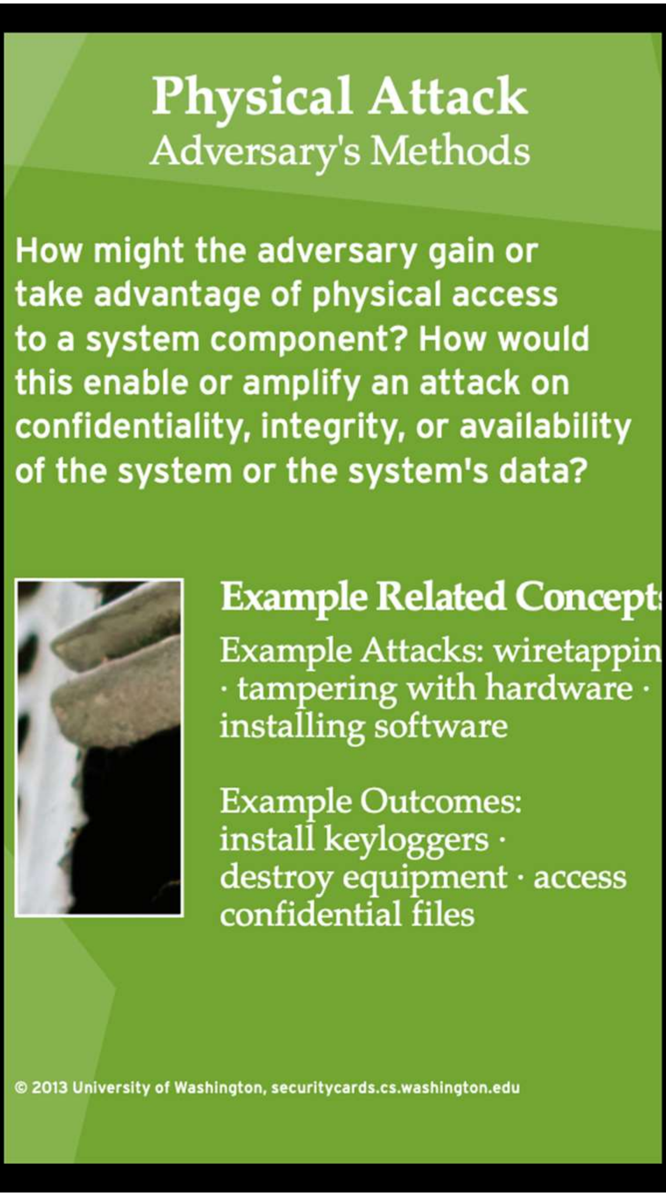
Adversary's Motivations

How might the adversary use or abuse your system for the purpose of convenience or to gain access to a resource? What kind of individual or group might target your system because it is more convenient than some alternative, or because it is the only way to achieve their goal?

Example Related Concepts

Example Targets: appointment-based online enrollment systems · sales of limited tickets · personal electronics with restricted permissions

Example Actions: modify personal electronics · bypass company filtering to access personal email · access a protected wireless network



Physical Attack

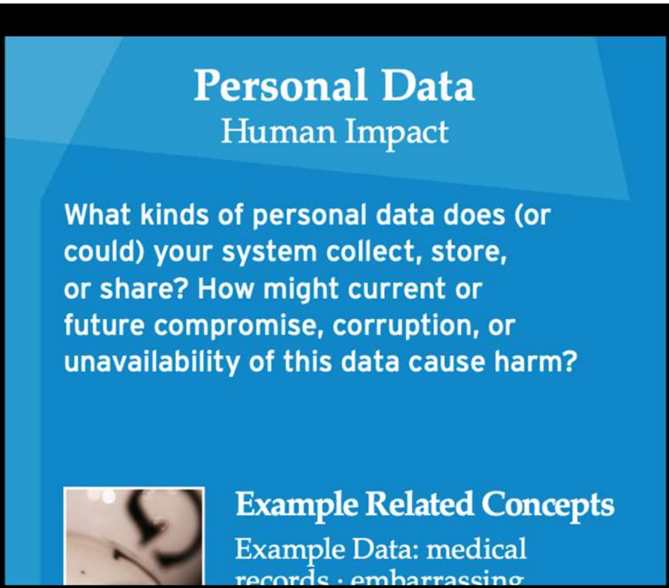
Adversary's Methods

How might the adversary gain or take advantage of physical access to a system component? How would this enable or amplify an attack on confidentiality, integrity, or availability of the system or the system's data?

Example Related Concepts

Example Attacks: wiretappin · tampering with hardware · installing software

Example Outcomes: install keyloggers · destroy equipment · access confidential files



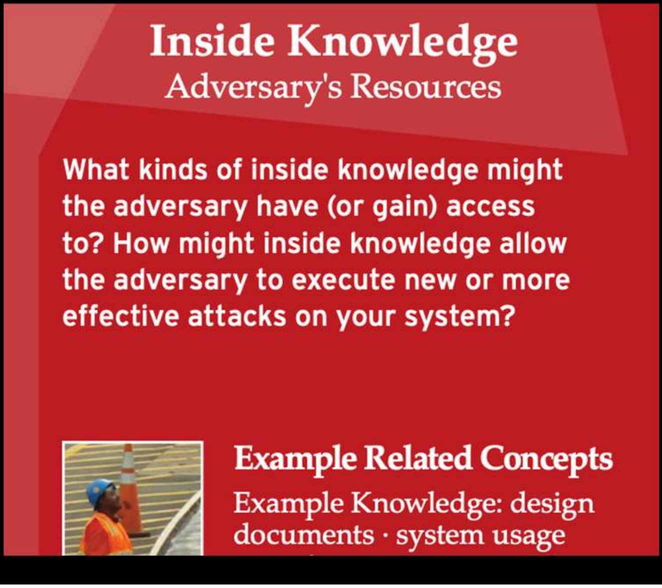
Personal Data

Human Impact

What kinds of personal data does (or could) your system collect, store, or share? How might current or future compromise, corruption, or unavailability of this data cause harm?

Example Related Concepts

Example Data: medical records · embarrassing



Inside Knowledge

Adversary's Resources

What kinds of inside knowledge might the adversary have (or gain) access to? How might inside knowledge allow the adversary to execute new or more effective attacks on your system?

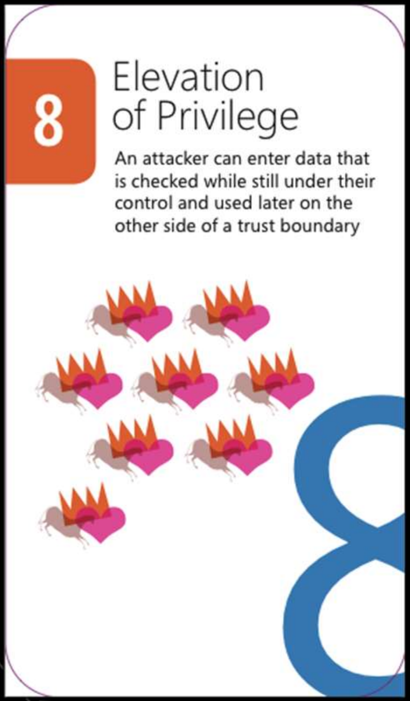
Example Related Concepts

Example Knowledge: design documents · system usage

THREAT MODELING: SECURITY CARDS

- Custom cards possible
- Extensions:
  - Elevation of Privilege cards (Microsoft)
  - Elevation of Privacy cards (F-Secure)
  - Cornucopia (OWASP)

EOP VS CORNUCOPIA



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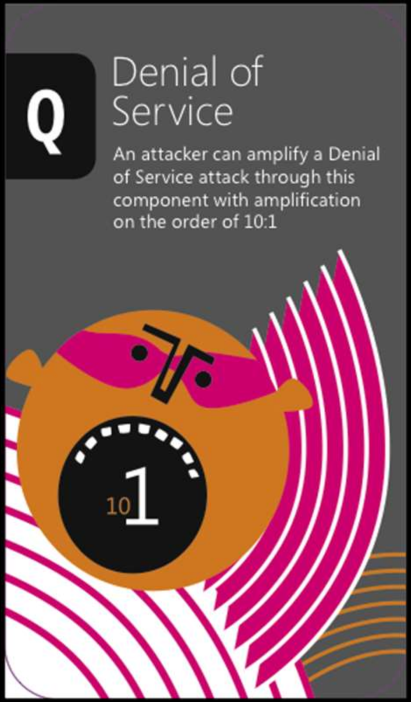
Elevation of Privilege

An attacker can enter data that is checked while still under their control and used later on the other side of a trust boundary



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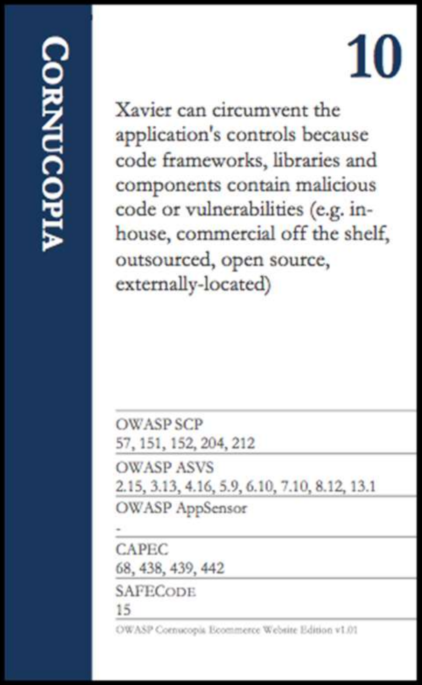
Denial of Service

An attacker can amplify a Denial of Service attack through this component with amplification on the order of 10:1



CORNUCOPIA

10

Xavier can circumvent the application's controls because code frameworks, libraries and components contain malicious code or vulnerabilities (e.g. in-house, commercial off the shelf, outsourced, open source, externally-located)

OWASP SCP
57, 151, 152, 204, 212

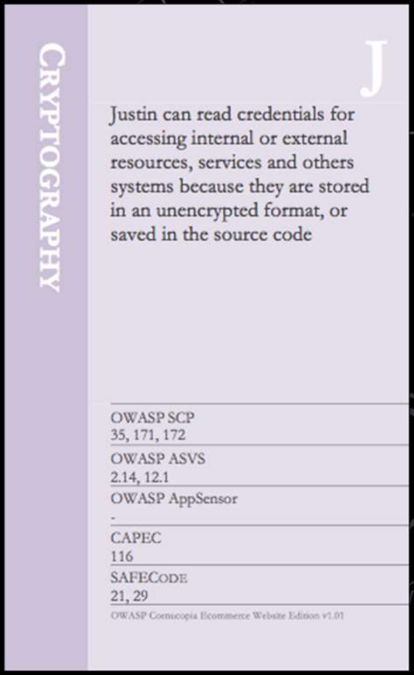
OWASP ASVS
2.15, 3.13, 4.16, 5.9, 6.10, 7.10, 8.12, 13.1

OWASP AppSensor
-

CAPEC
68, 438, 439, 442

SAFECODE
15

OWASP Cornucopia Ecommerce Website Edition v1.01



CRYPTOGRAPHY

J

Justin can read credentials for accessing internal or external resources, services and others systems because they are stored in an unencrypted format, or saved in the source code

OWASP SCP
35, 171, 172

OWASP ASVS
2.14, 12.1

OWASP AppSensor
-

CAPEC
116

SAFECODE
21, 29

OWASP Cornucopia Ecommerce Website Edition v1.01

PRACTICAL THREAT MODELING

THERE'S NOTHING MORE PRACTICAL THAN A GOOD THEORY!

SECURITY STARTS WITH U!

HOW TO THREAT MODEL EFFICIENTLY

- **Security engineers** threat model every story
  - Delays!
- **Software engineers** threat model every story
  - Too much time spent on reviews.
  - Teaming with Security
- **Software engineers** assess risk on every story
  - A questionnaire supporting their decisions
  - "When a software engineer feels they must choose between doing security and doing engineering, you have lost the battle."

SECURITY QUESTIONNAIRE SAMPLE

- Does it deal with customer data?
- Does it communicate over network?
- Is this a critical component?
- Does your component require authentication?
- Does your project introduce or utilize a third-party library?
- Are you implementing or modifying any APIs?
- Does your project utilize a database via SQL?
- …

HOW TO THREAT MODEL EFFICIENTLY

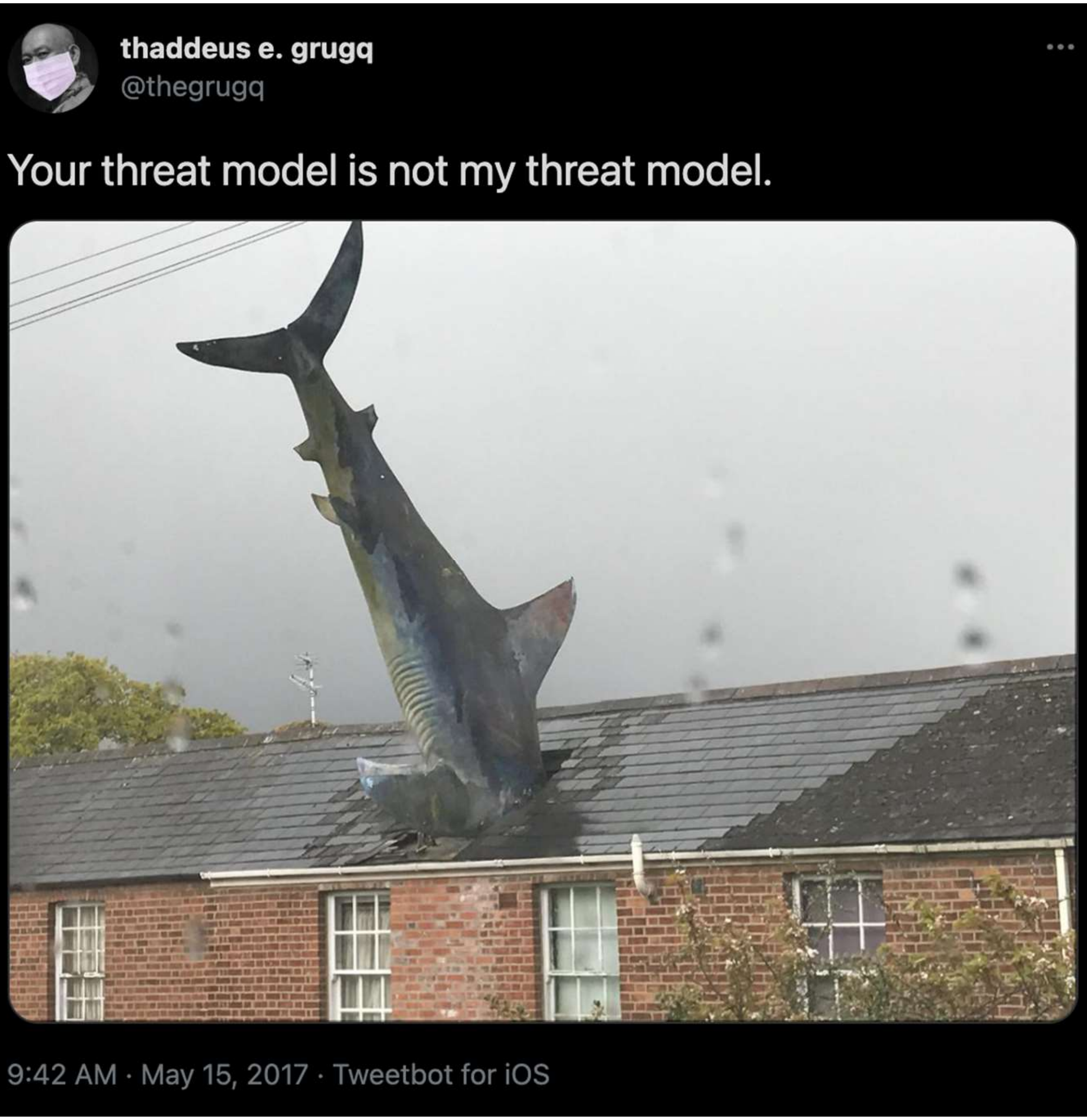
- **What works**
  - Shifting left, like a boss
  - Re-usable reviewed and assessed components
  - Proper threat modeling and risk assessment for the critical ones
  - Questionnaire to support the activity
    - Security impact criteria
  - Security Engineers teaming up with software engineers and developers

- Mutual respect and understanding

RISK MITIGATION ACTIONS

- Remove the threat
  - e.g. by removing the respective functionality
- Mitigate
  - e.g. through standard practices like encryption
  - “What cannot be mitigated could perhaps be monitored.”
- Accept
  - be careful about “accepting” risk for your customers
- Transfer
  - e.g. via license agreements or terms of service

YOUR THREAT MODEL IS NOT MY THREAT MODEL



thaddeus e. grugq
@thegrugq

Your threat model is not my threat model.

9:42 AM · May 15, 2017 · Tweetbot for iOS

SERIOUS LIFE QUESTIONS

- What is the purpose of life?
- Shall I patch the vulnerability on my internal server?
- Can we keep the default admin password?
- What is the air-speed velocity of an unladen swallow?
- Can we keep the thermal exhaust port as it is now?
- What is the difference between living and existing?
- Is 42 a perfect number?
- Could sharks be a serious threat to my house?

Depends on your threat model.

QUESTIONS?

NOTES

- Agile Threat Modeling
  - https://martinfowler.com/articles/agile-threat-modelling.html
- AppSec at scale
  - https://r2c.dev/blog/2021/appsec-development-keeping-it-all-together-at-scale/?s=09