Practical Magic: Behavior-based Security Design for IoT

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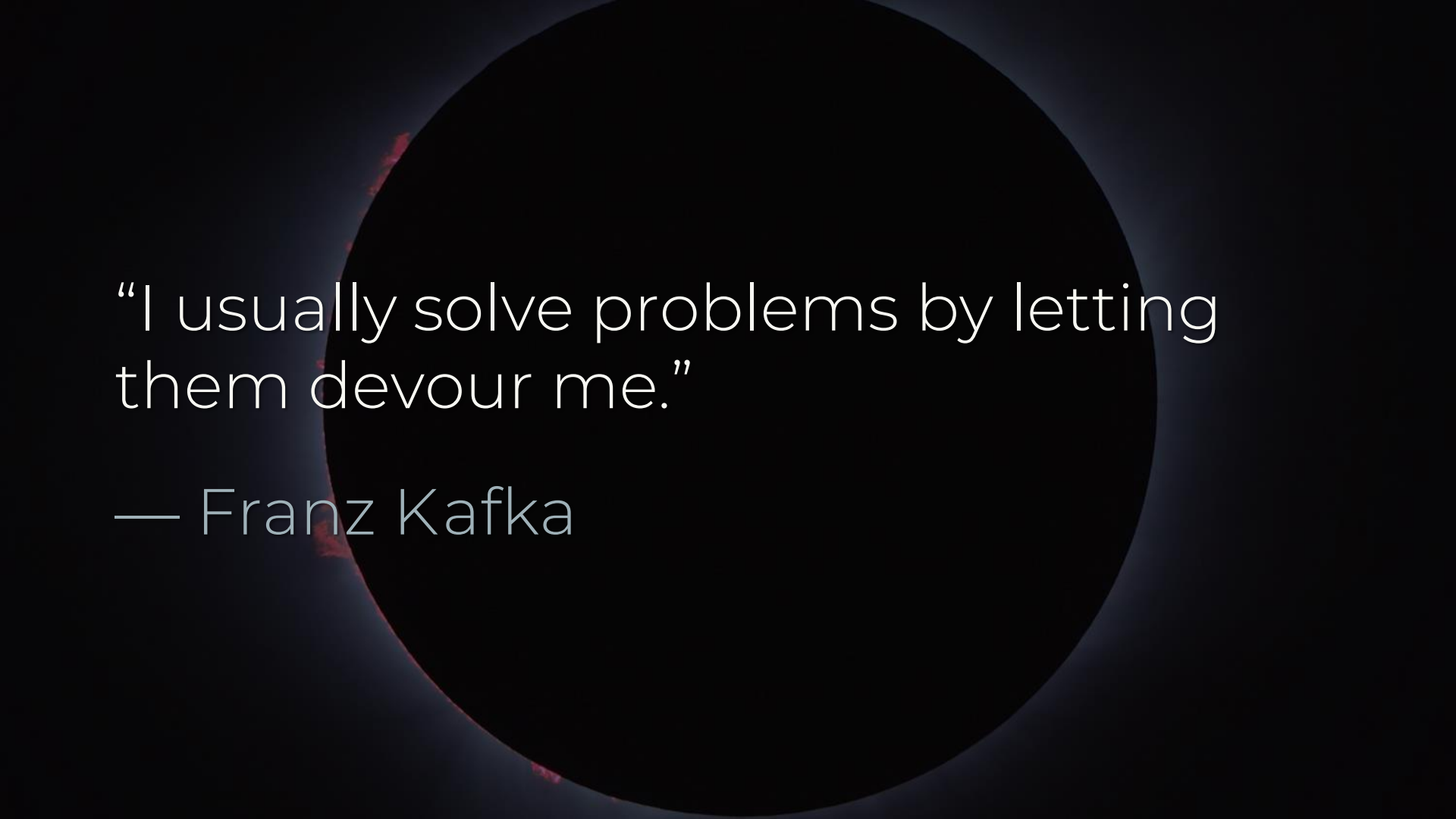
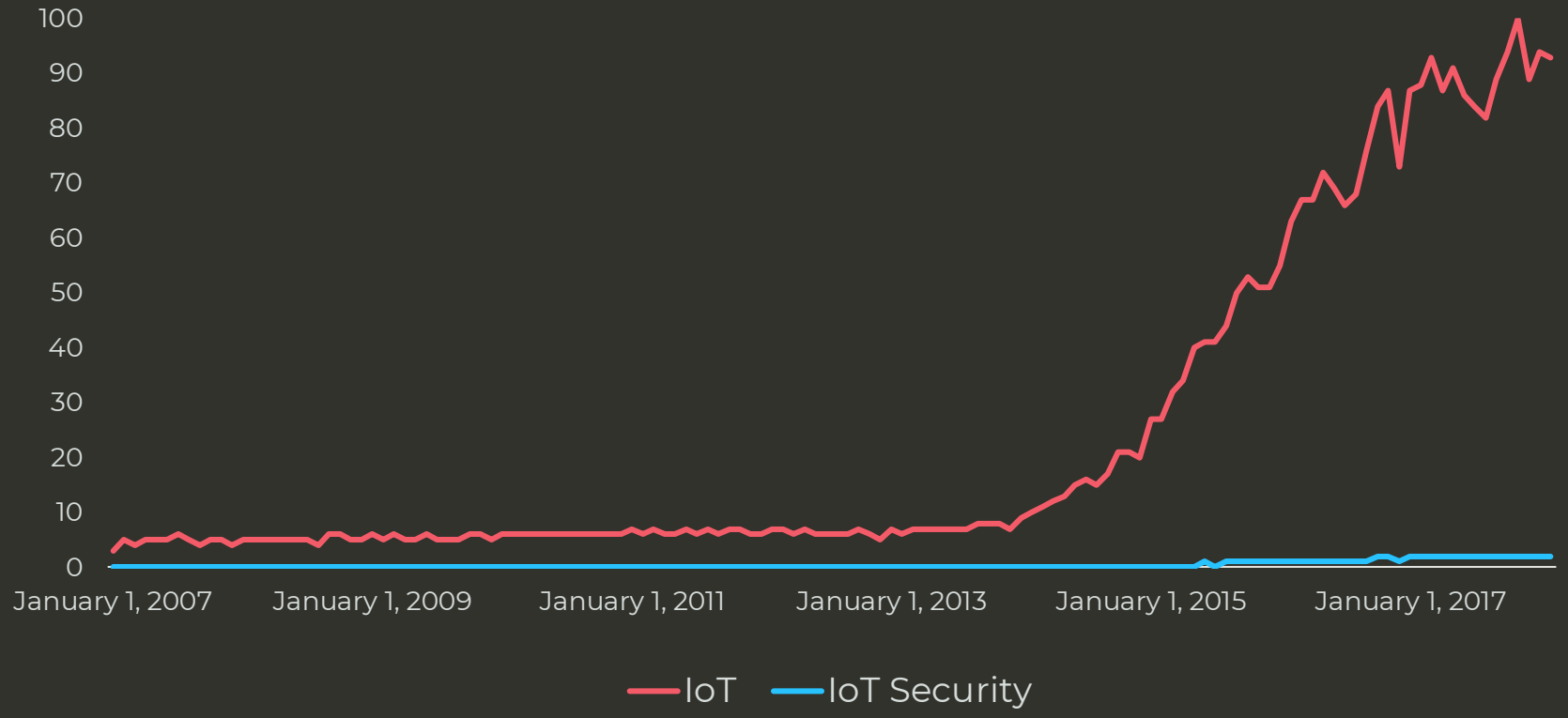
Troopers 2018

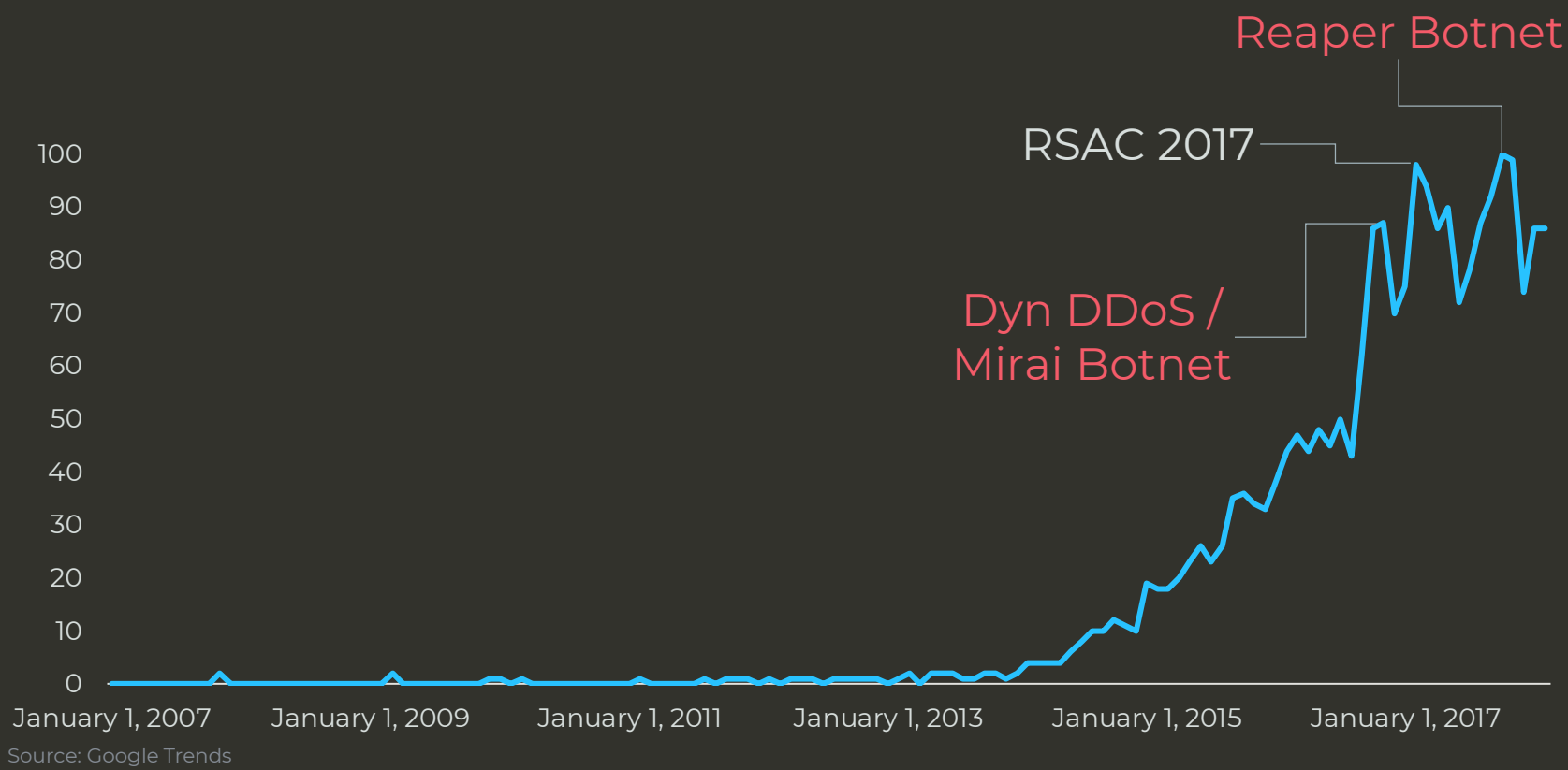

Hi, I'm Kelly
SecurityScorecard


“I usually solve problems by letting them devour me.”
— Franz Kafka



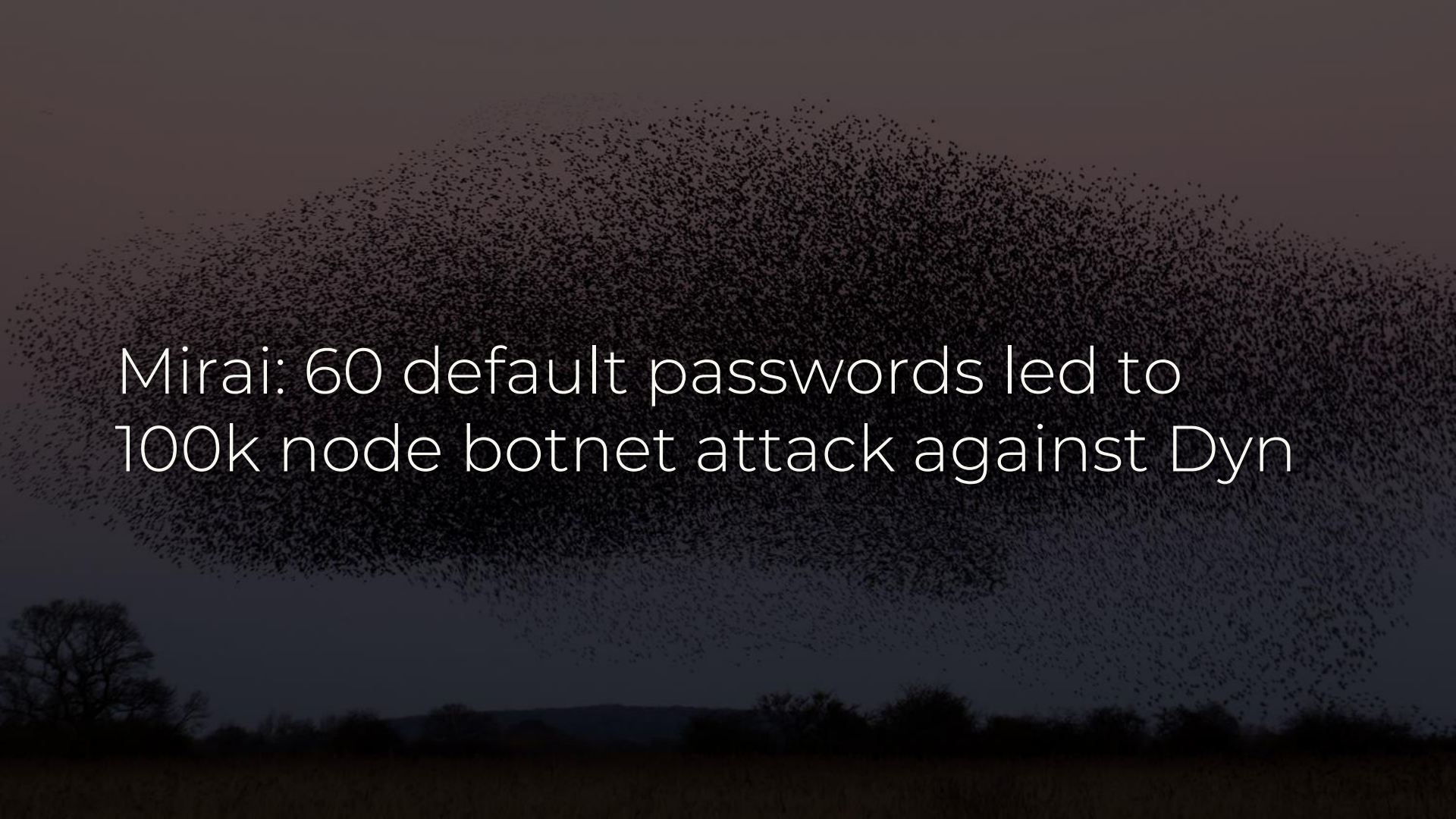
Source: Google Trends


We’re engendering a Kafkaesque paradigm for IoT security

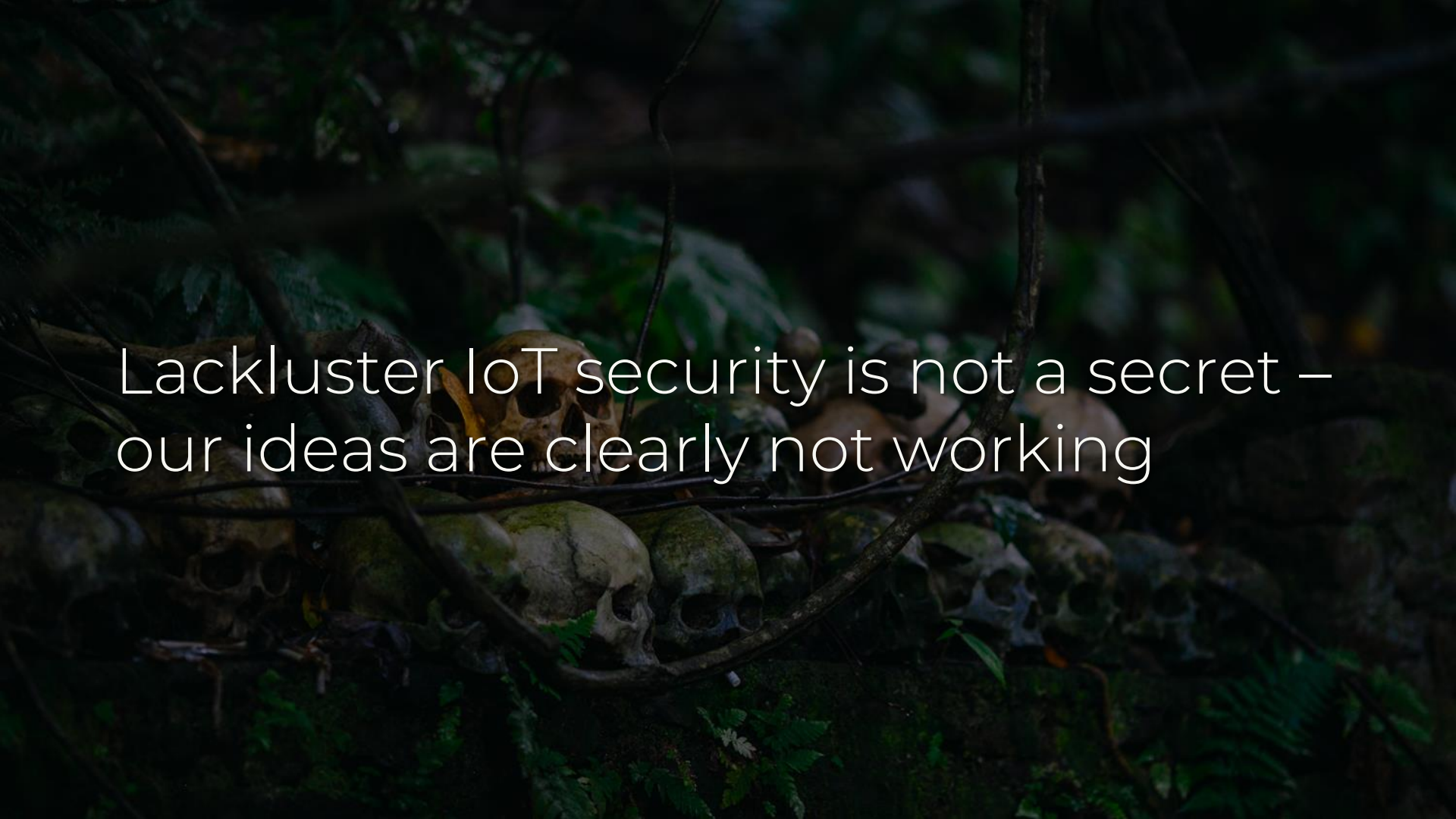


Source: Google Trends


IoT botnets are the first, and ravenous,
boss of the IoT security battle


Mirai: 60 default passwords led to
100k node botnet attack against Dyn


But we’re promoting complexity & a seemingly endless set of hurdles


Lackluster IoT security is not a secret –
our ideas are clearly not working


By understanding behavior, we can
guide choice & support secure habits

1. Existing Suggestions
2. Incentive Problems
3. Behavior-Based Design
4. IoT Security Ideas

Existing Suggestions

FTC recommends building-in security from the beginning (simple as that!)

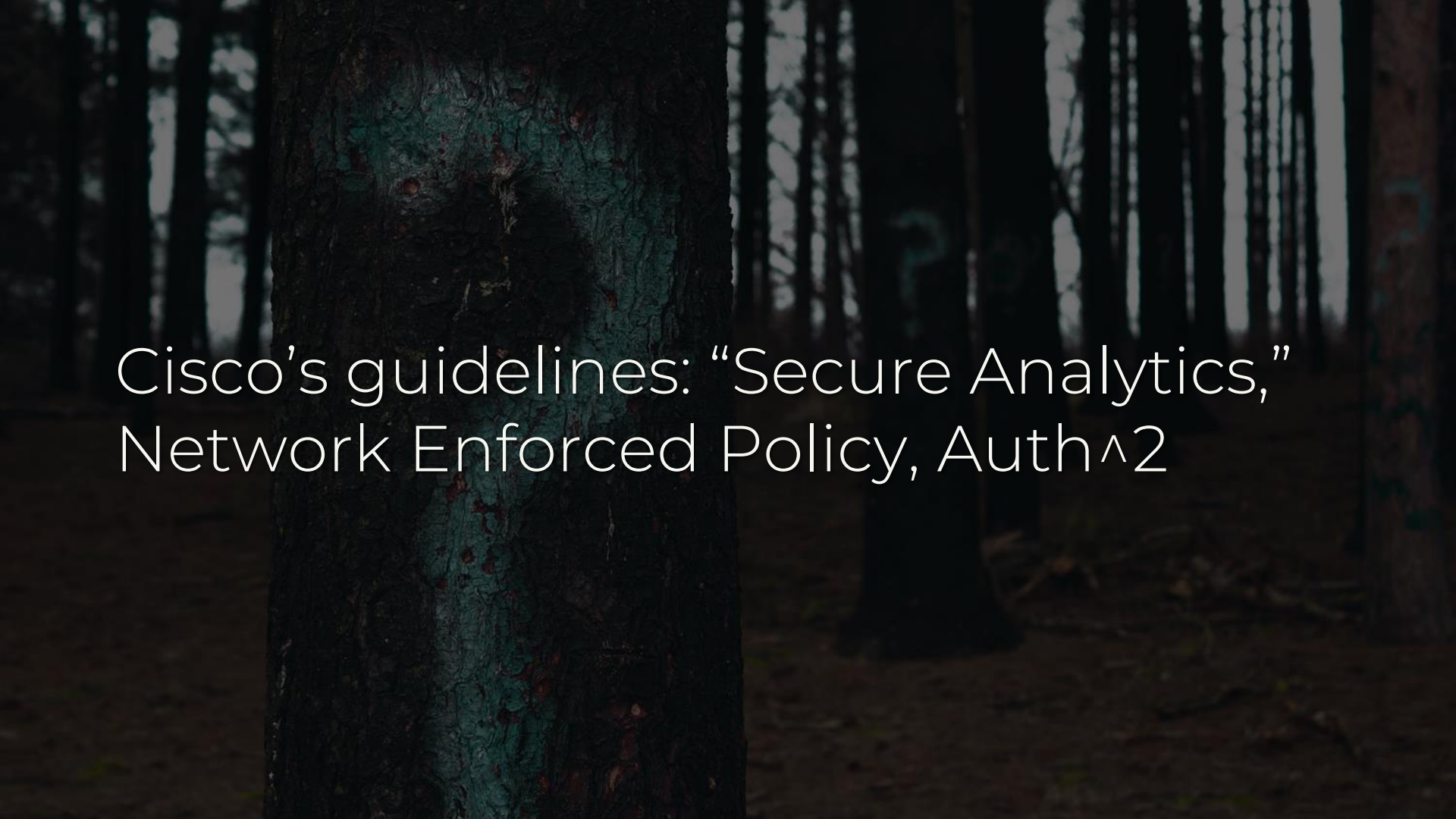
FDA: Pre- & Post-Market Guidelines (H/T @marasawr)

Pre-market: a lot of documentation & threat modelling

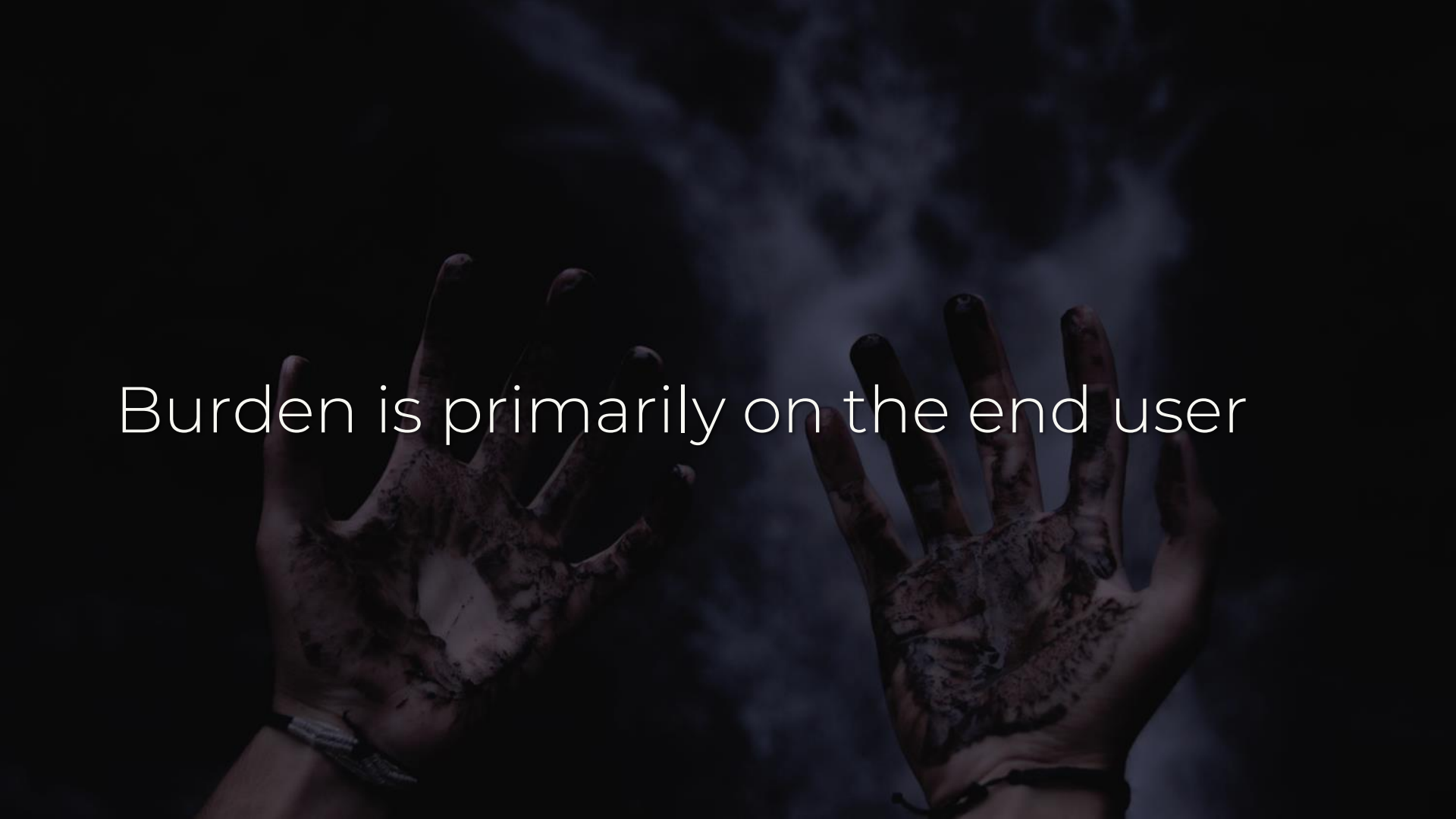
Post-market: monitoring & a mitigation deployment strategy

OWASP: IoT Testing Guide, IoT Attack Surface Areas, Principles of IoT Sec...

Designed for the penetration tester user persona – not developers


Cisco’s guidelines: “Secure Analytics,”
Network Enforced Policy, Auth^2

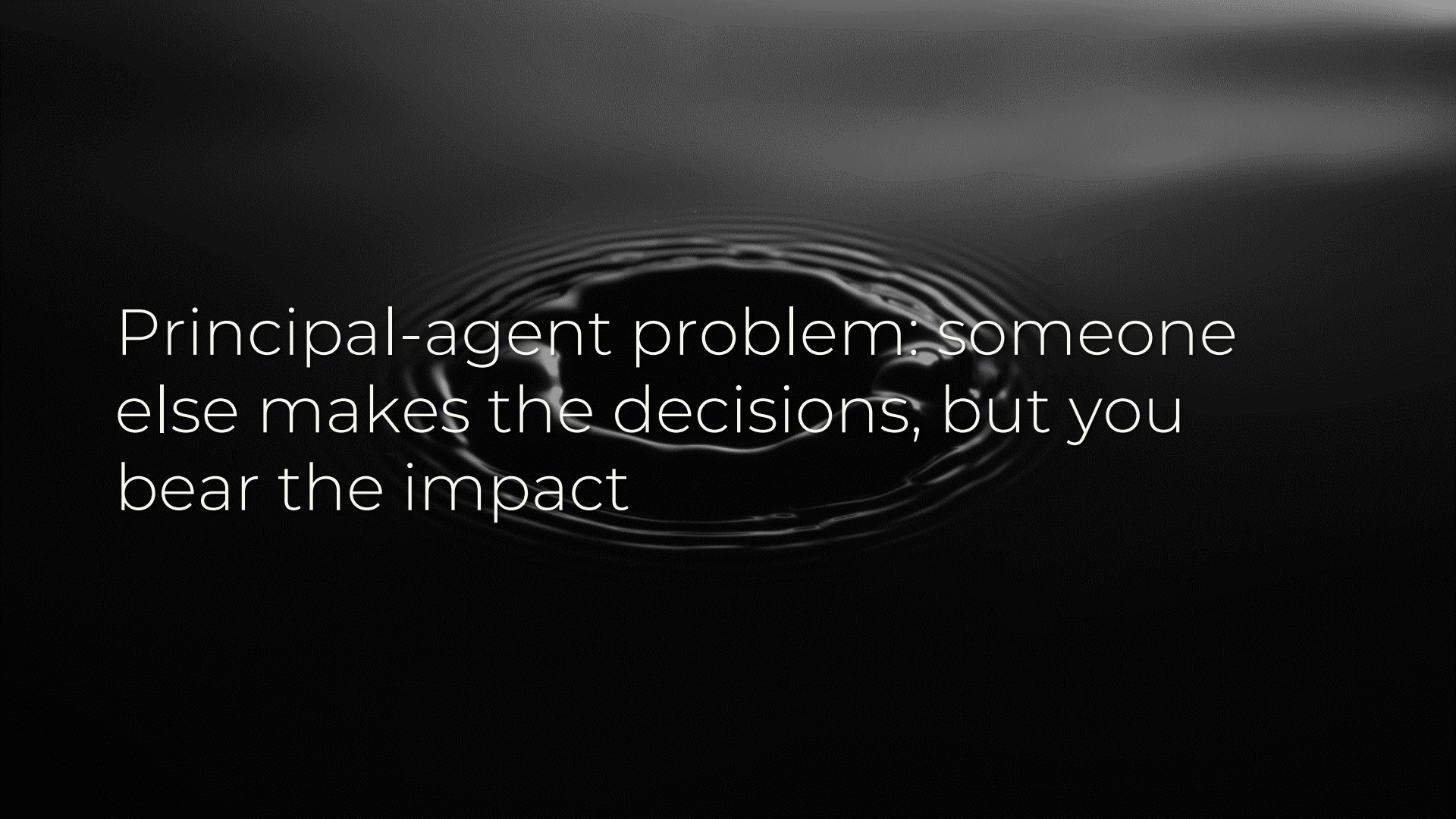
Compensating Controls: post-market remedies by third parties


Burden is primarily on the end user


Actionable, real-time behavioral
analytics for visibility & intelligence...

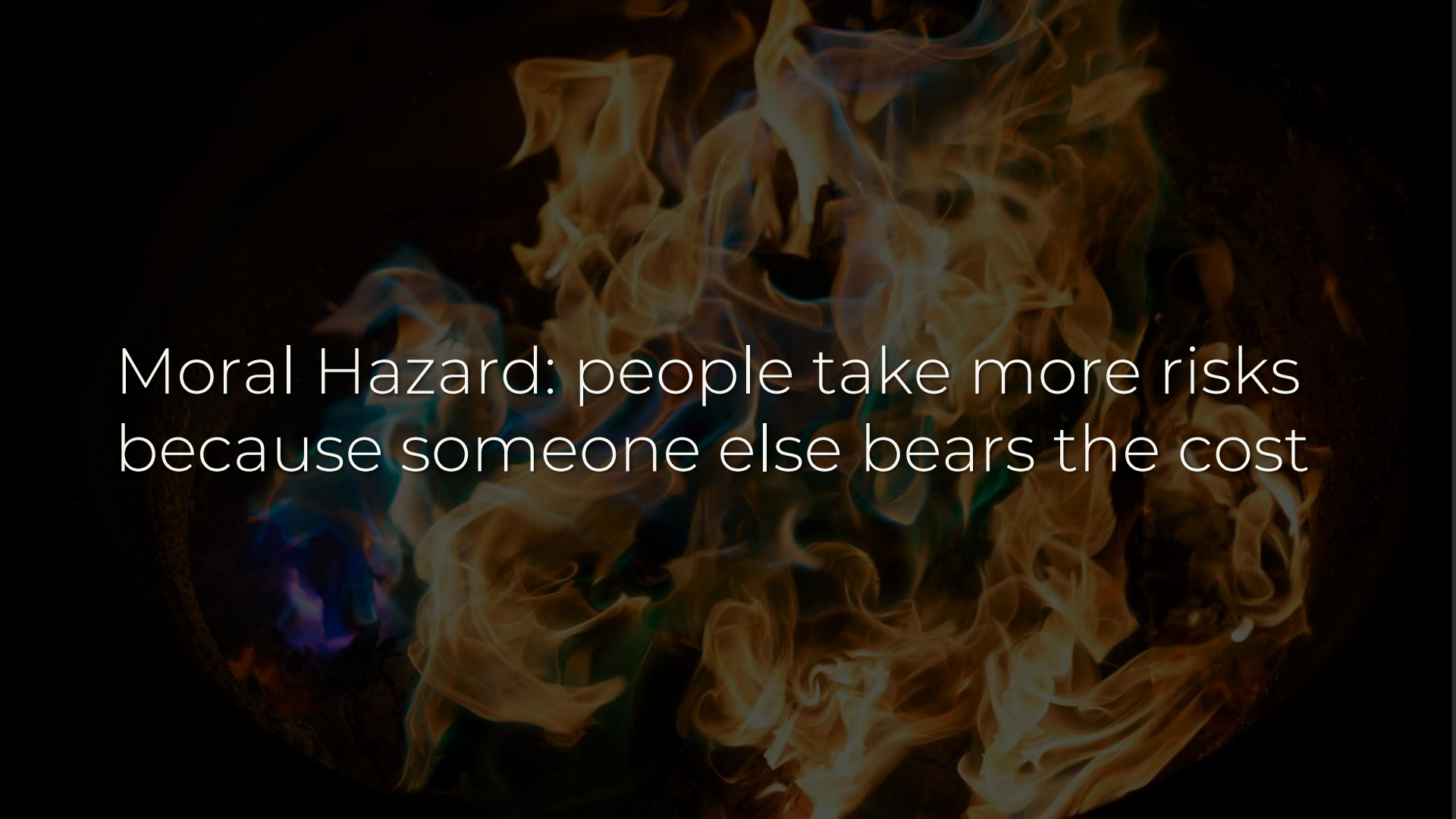
Maybe feasible for enterprises, but what are consumers to do?

Incentive Problems


Principal-agent problem: someone else makes the decisions, but you bear the impact

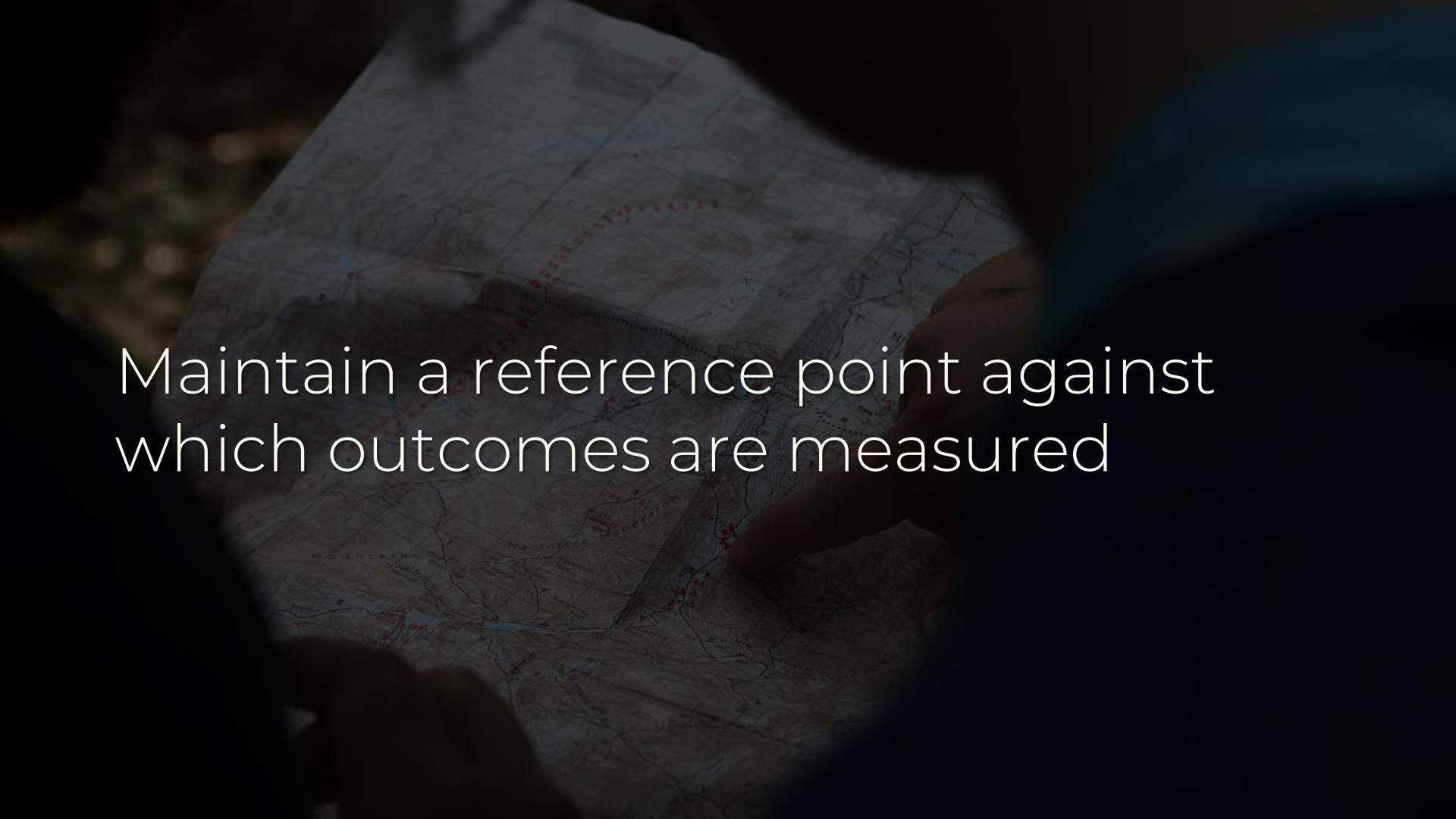
The Agent has their own self-interest.

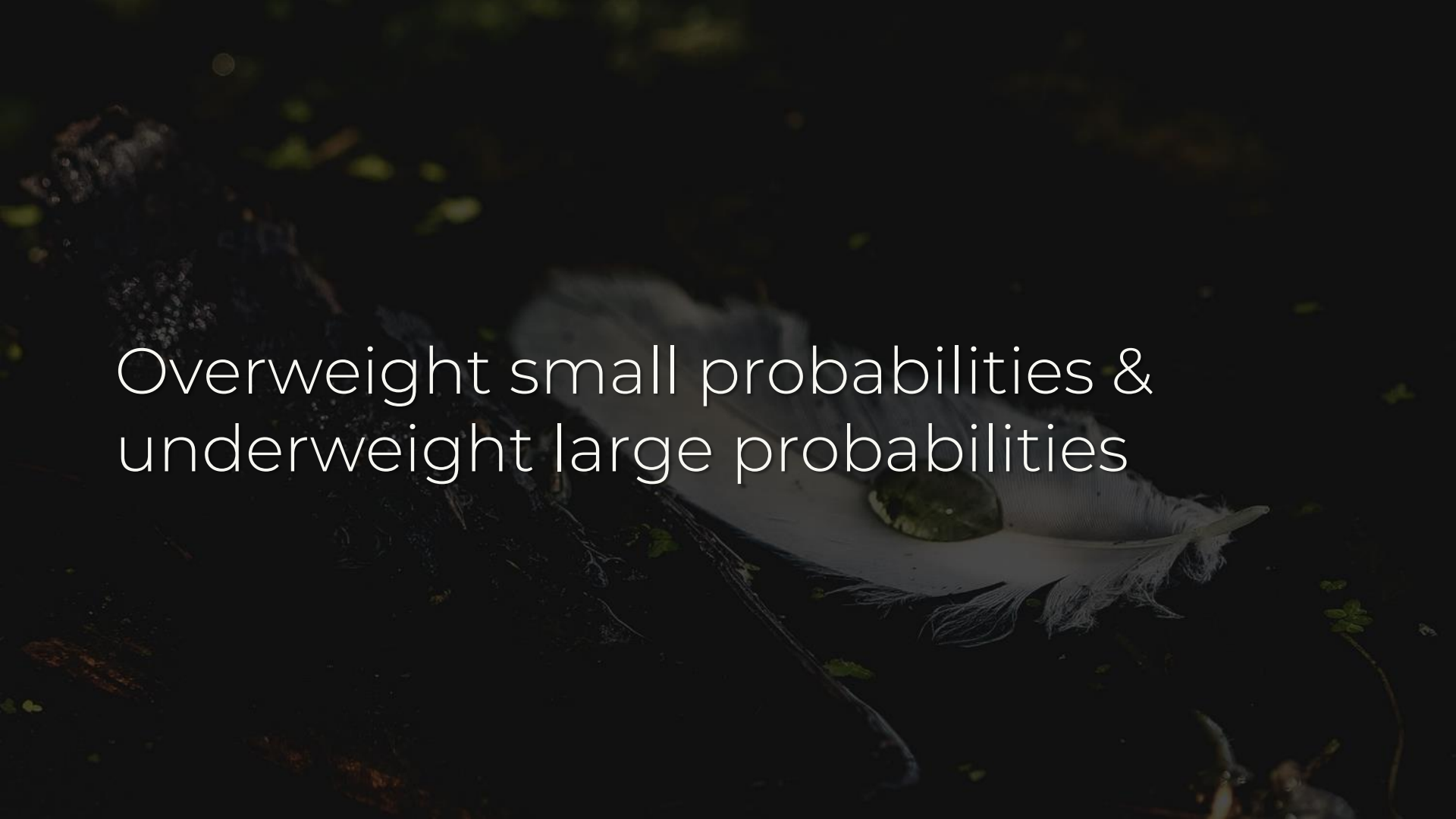
It’s likely not the same as yours.


Moral Hazard: people take more risks
because someone else bears the cost

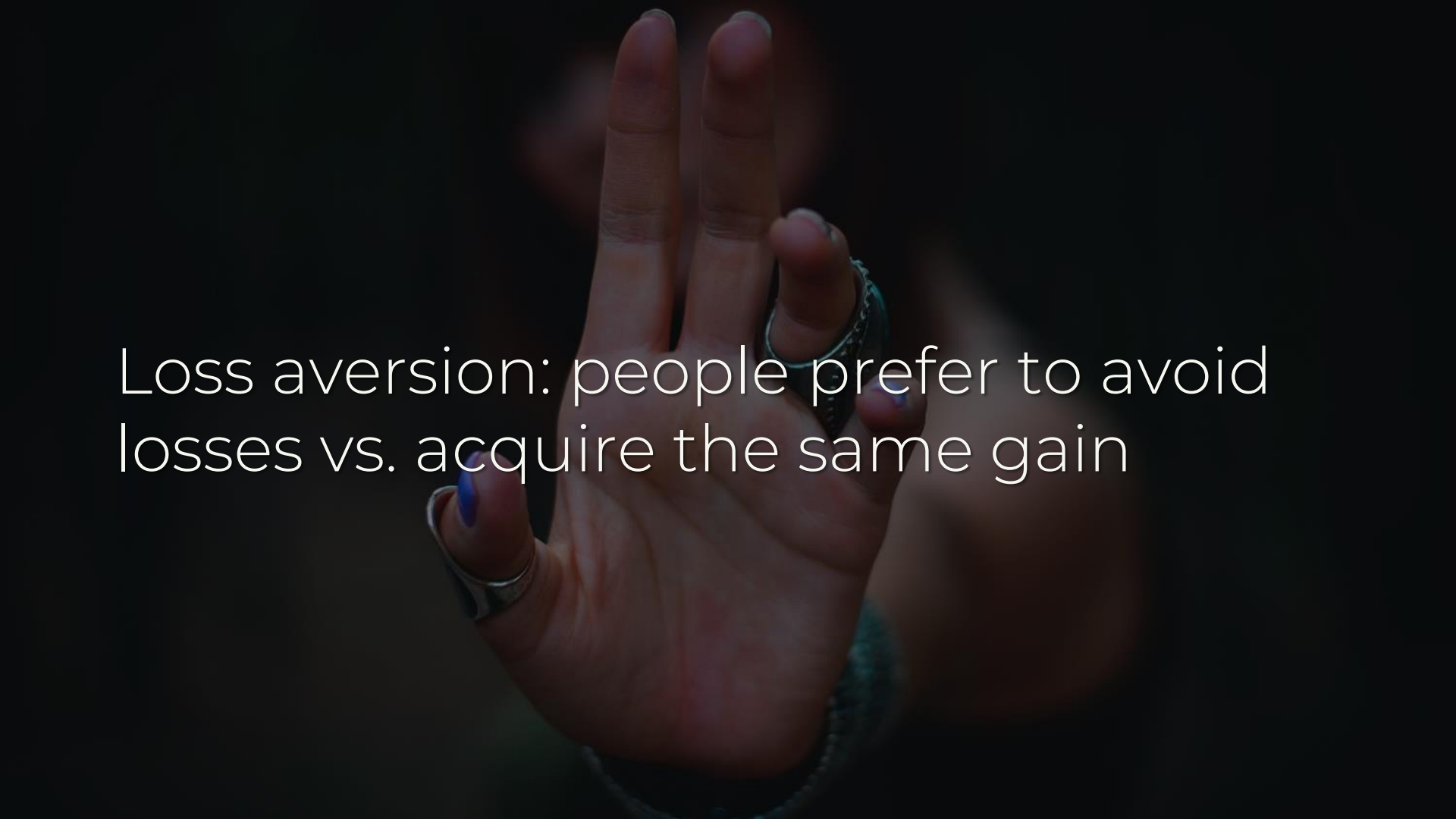
Next level: Equifax's customers aren't the end users whose data is stored

Prospect Theory: people care about relative vs. objective outcomes


Maintain a reference point against
which outcomes are measured


Overweight small probabilities &
underweight large probabilities

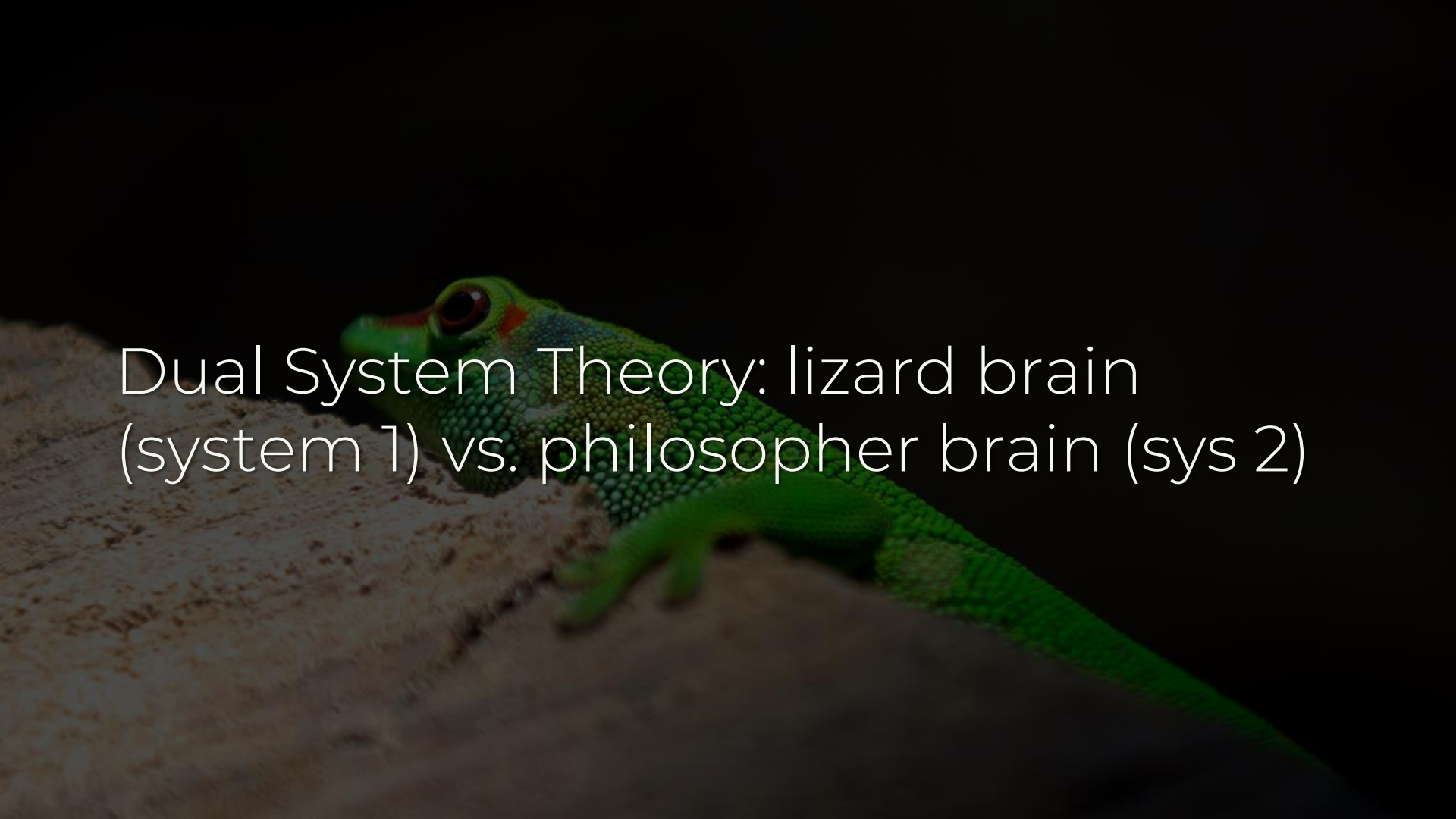
Overhyping low-probability vuln exploitation vs. default passwords


Loss aversion: people prefer to avoid losses vs. acquire the same gain

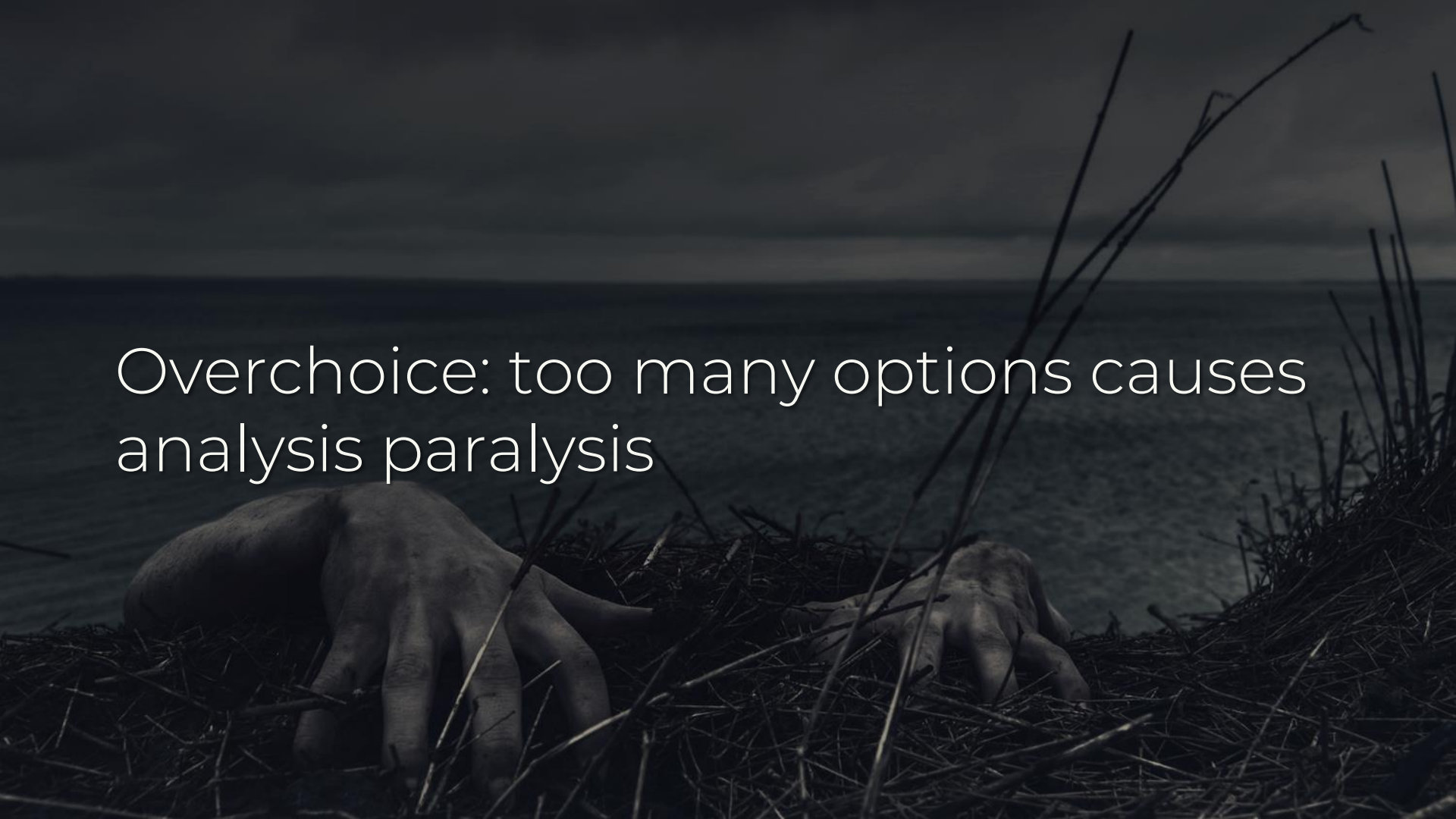
Framing security as a time & cost sink facilitates natural resistance

Hyperbolic discounting: future rewards are discounted vs. present

Many security initiatives are “investments” with long-term benefits


Dual System Theory: lizard brain (system 1) vs. philosopher brain (sys 2)

Most policies work on System 2 – we need to work with System 1 instead


Overchoice: too many options causes analysis paralysis

Which of the 100 items do devs tackle 1st in a 10-page IoT attack surface doc?

We have to work with how people think, not against it

Behavior-based Design


What is choice architecture?

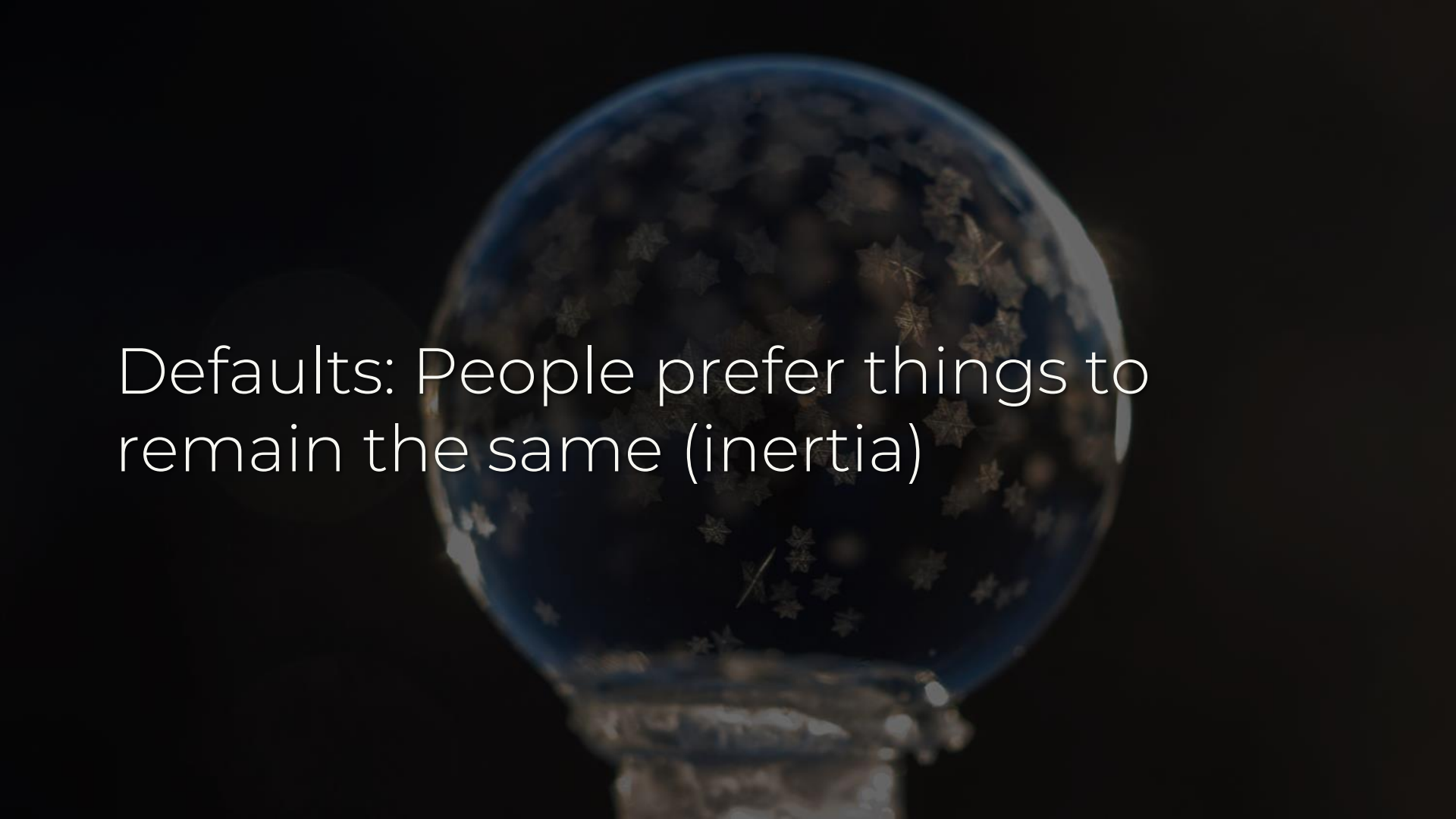
Design presentation of choices to promote improved decision-making

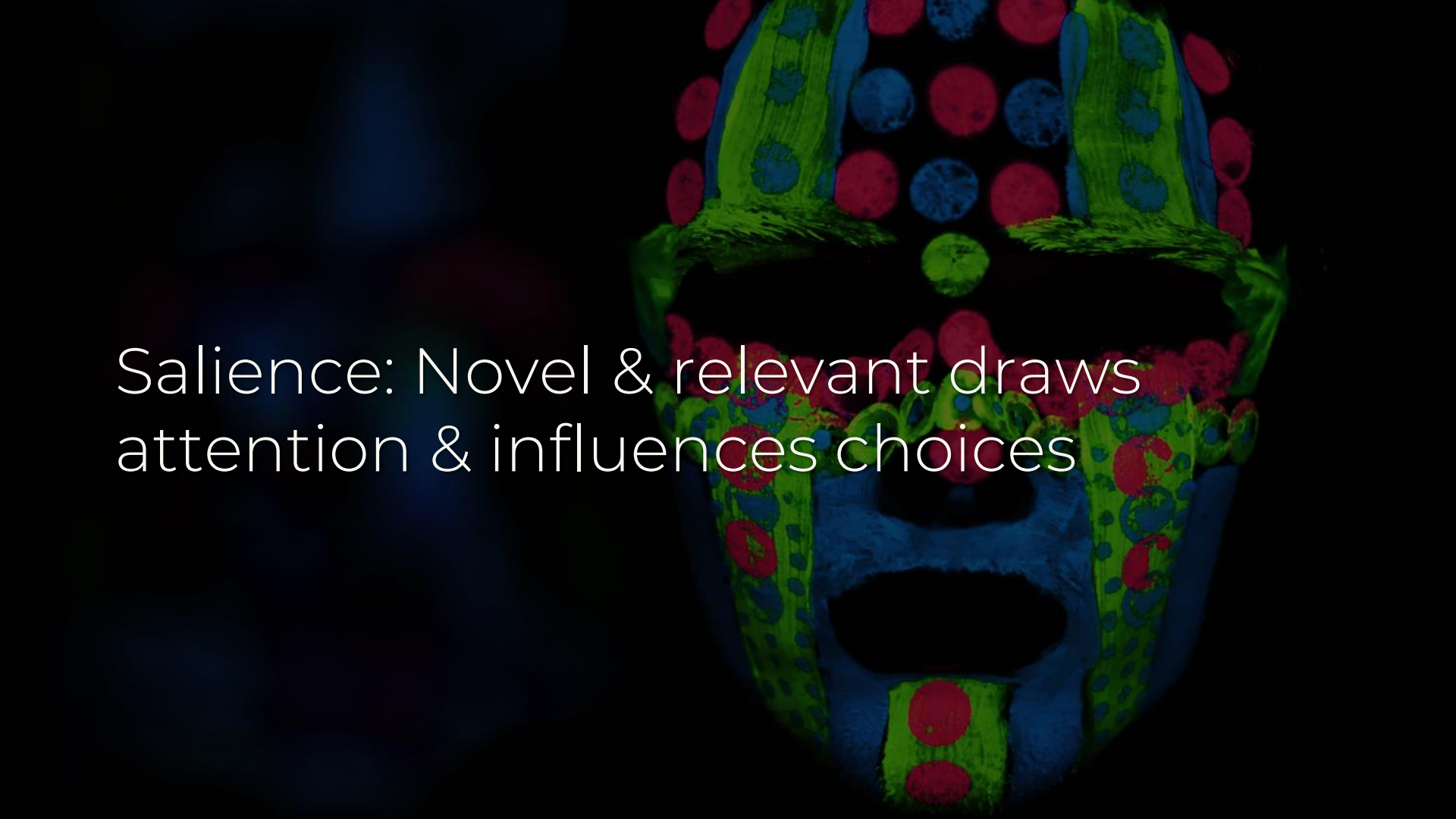
Example: MINDSPACE framework for behavioral design

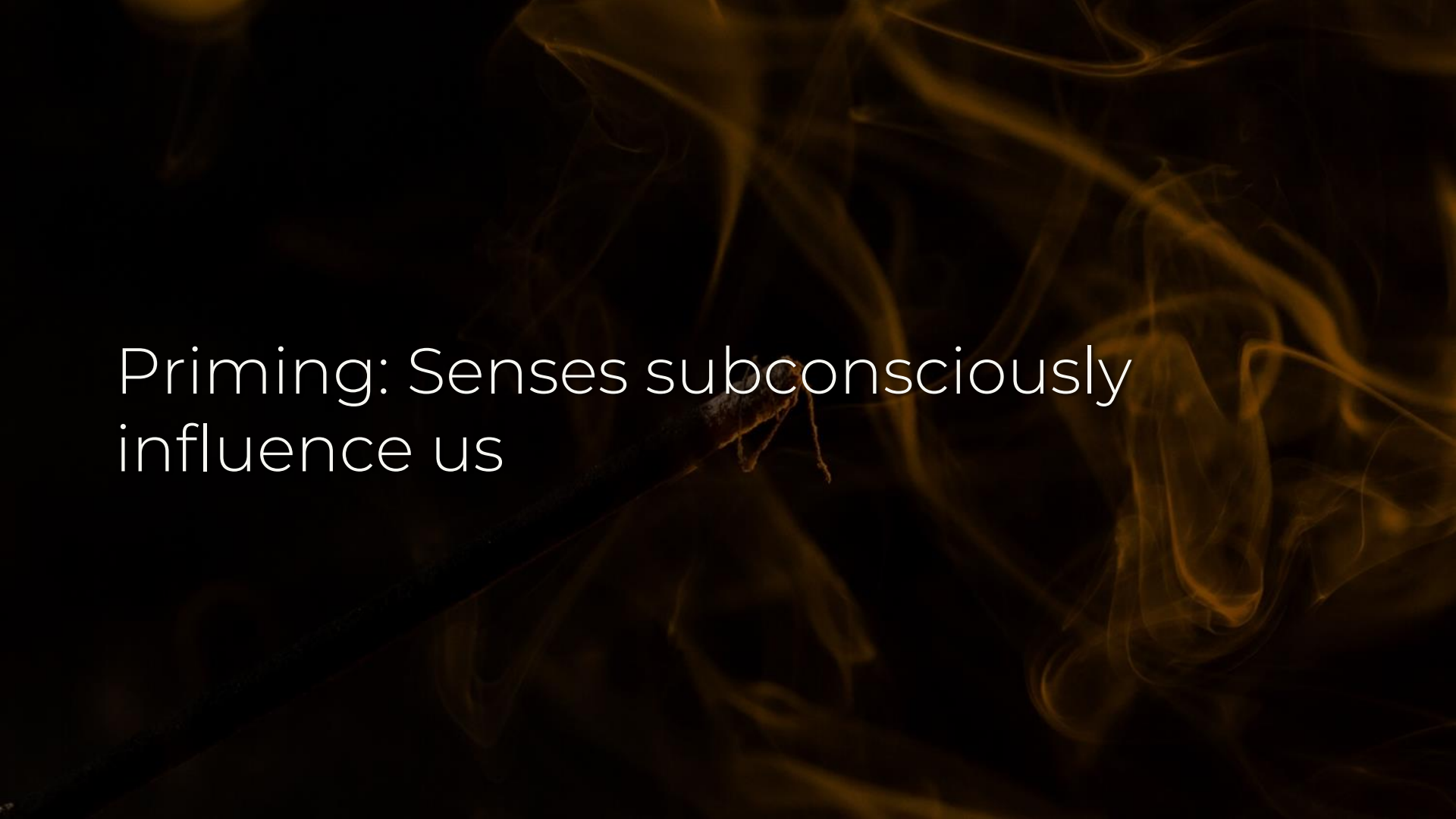

Messenger: people dismiss info from sources they don’t like / respect

Incentives: losses can be more motivating than rewards


Norms: People follow social standards,
(even when counterproductive)


Defaults: People prefer things to
remain the same (inertia)


Salience: Novel & relevant draws
attention & influences choices


Priming: Senses subconsciously
influence us


Affect: Emotional reactions are our brains’ first responders

Commitments: Judgements made in advance to create “automatic” actions

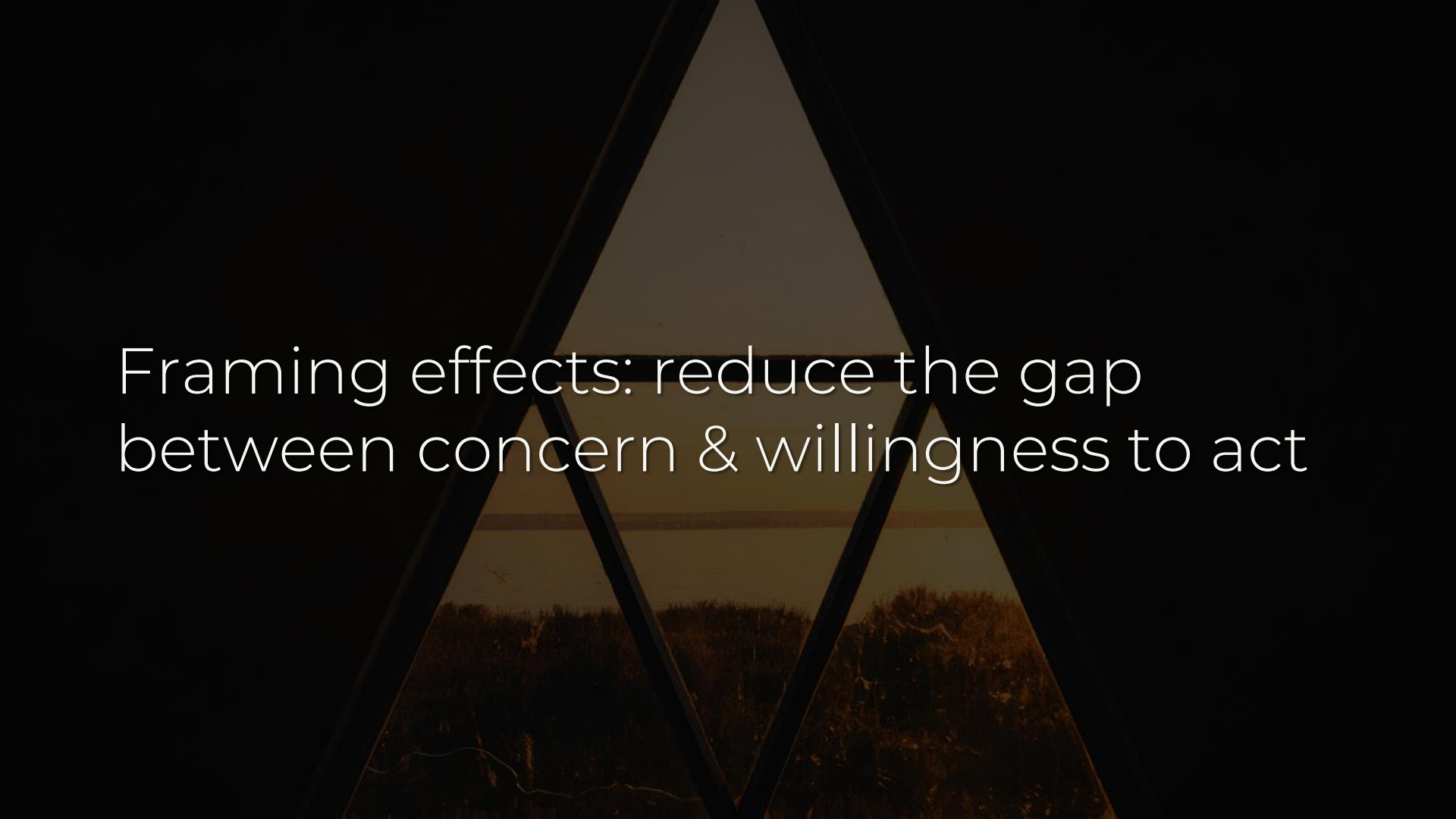

Ego: People like to feel better about themselves & preserve self-image

Reinforcement mechanisms: consequences to guide behavior

Pay-for-performance lacks empirical evidence for fixing moral hazard

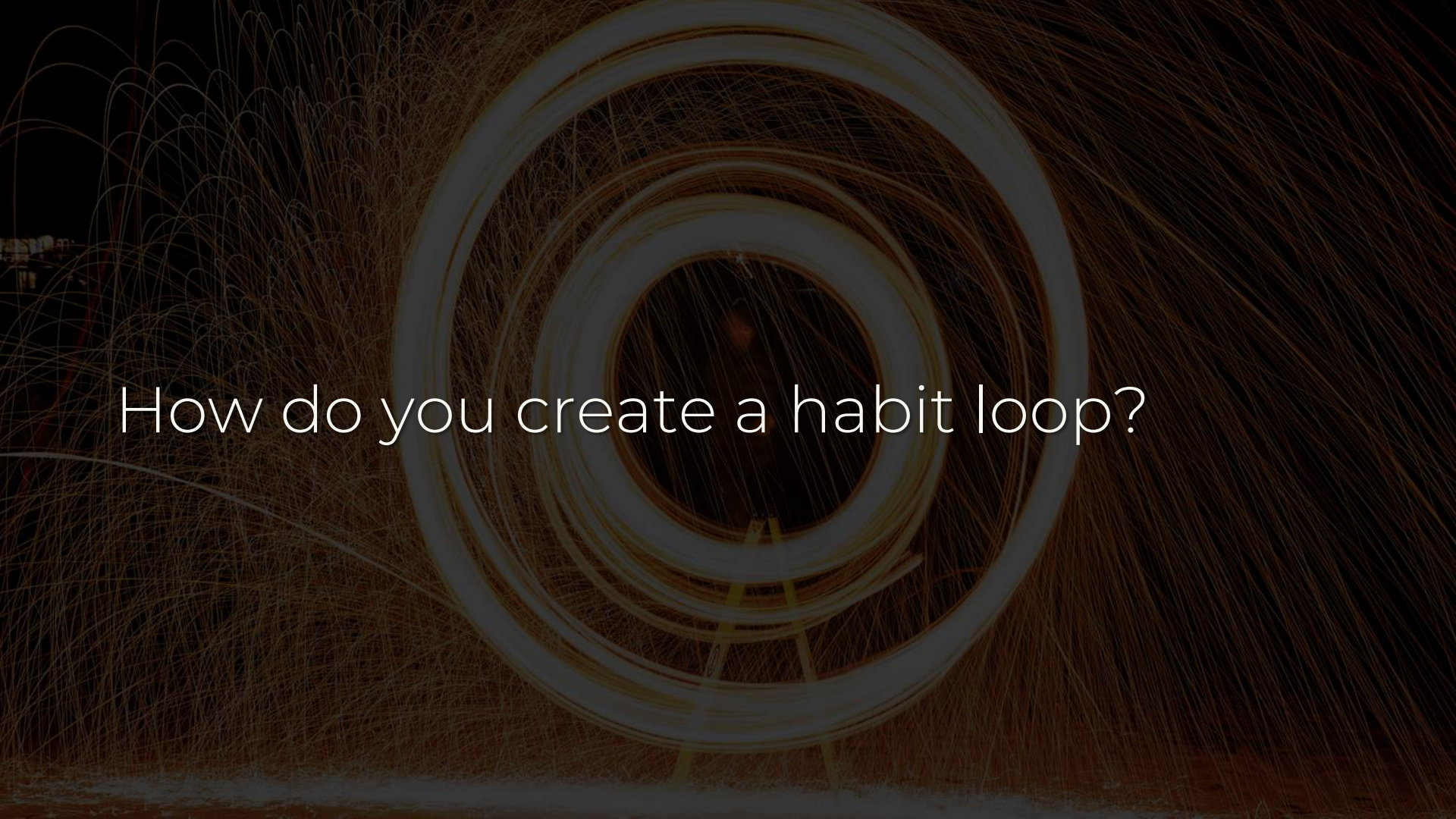
Set clear, achievable goals – “fix all the bugs” is neither

Goal setting must be matched with feedback, ideally immediate



Framing effects: reduce the gap between concern & willingness to act

Focus on leveraging system 1 to your advantage by altering habits


How do you create a habit loop?


Step 1: Routine

Make it stable, frictionless, & fit into existing context

Minimize perceived effort & number of decisions the user has to make

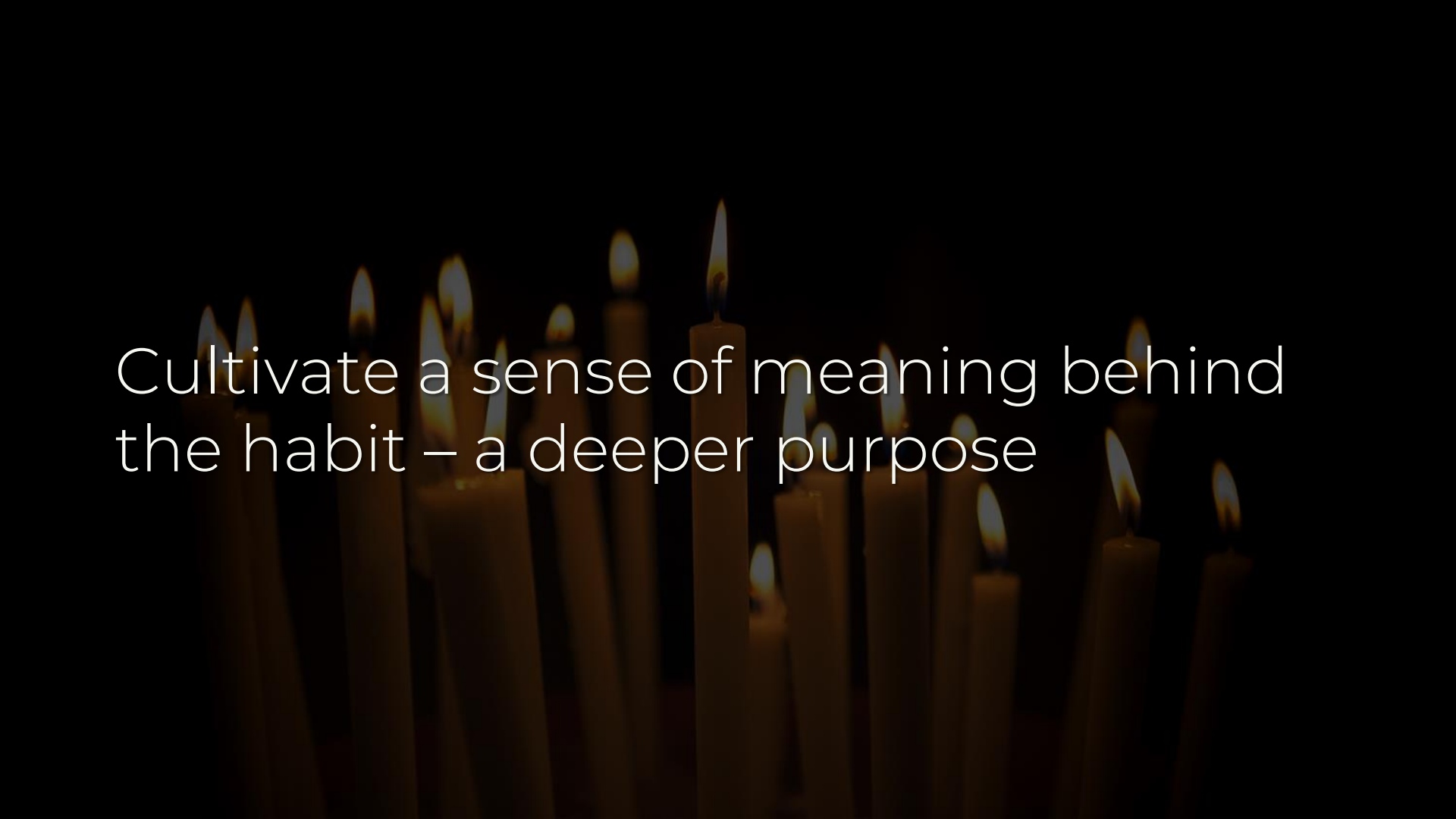
Step 2: Triggers & Rewards

Contextual cues: “If X, do Y”

Magical brew of rewards: mix of short-term & accumulated long-term ones

Step 3: Ingrain

Foster ample opportunities for practice & interaction


Cultivate a sense of meaning behind
the habit – a deeper purpose

People don’t like feeling like habit machines; play into self-identity


Ideas for IoT Sec

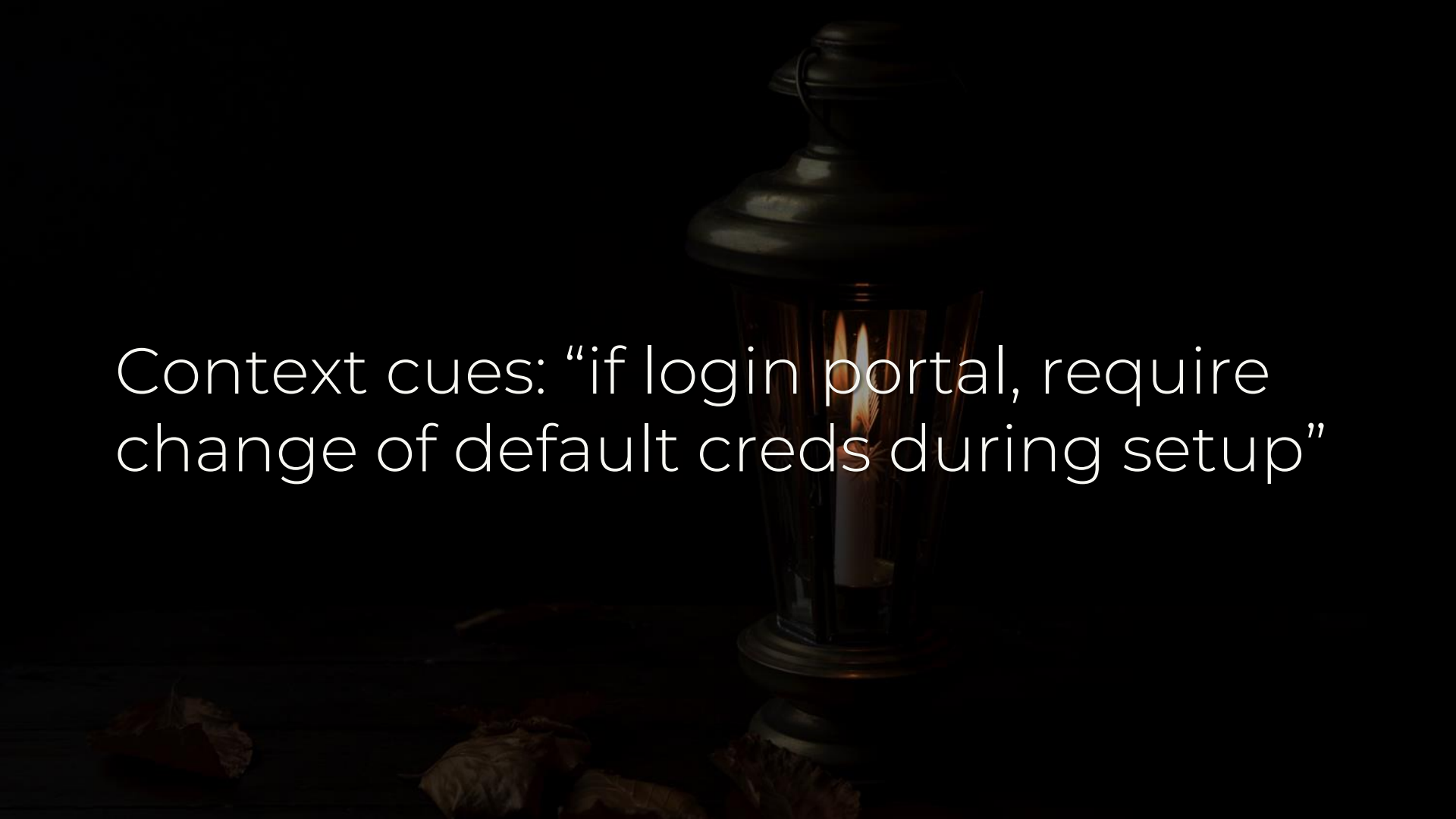

Set concrete goals: “build-in security”
is too nebulous

“Ensure each feature release uses a 10-point checklist” is a clear ask

Value should consider maximum security benefit at minimum cost

How to turn security into a habit?

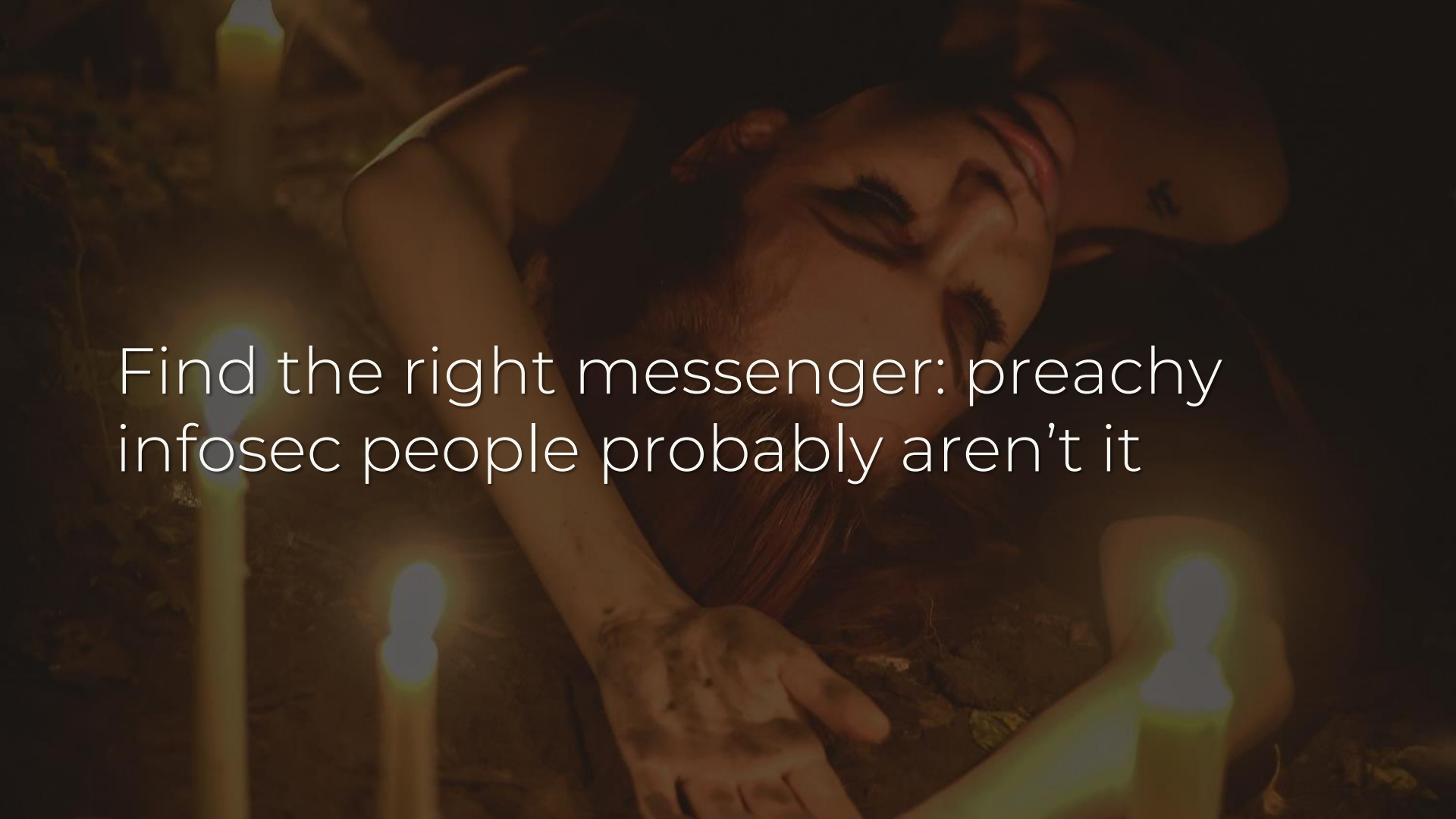
Teams should have a regular, brief time & space to review security goals


Context cues: “if login portal, require change of default creds during setup”

Specify attainable steps with minimal complexity, like a checklist

Security suitably serves as a deeper purpose – frame it as a noble cause

How can we leverage MINDSPACE for IoT security?


Find the right messenger: preachy infosec people probably aren’t it

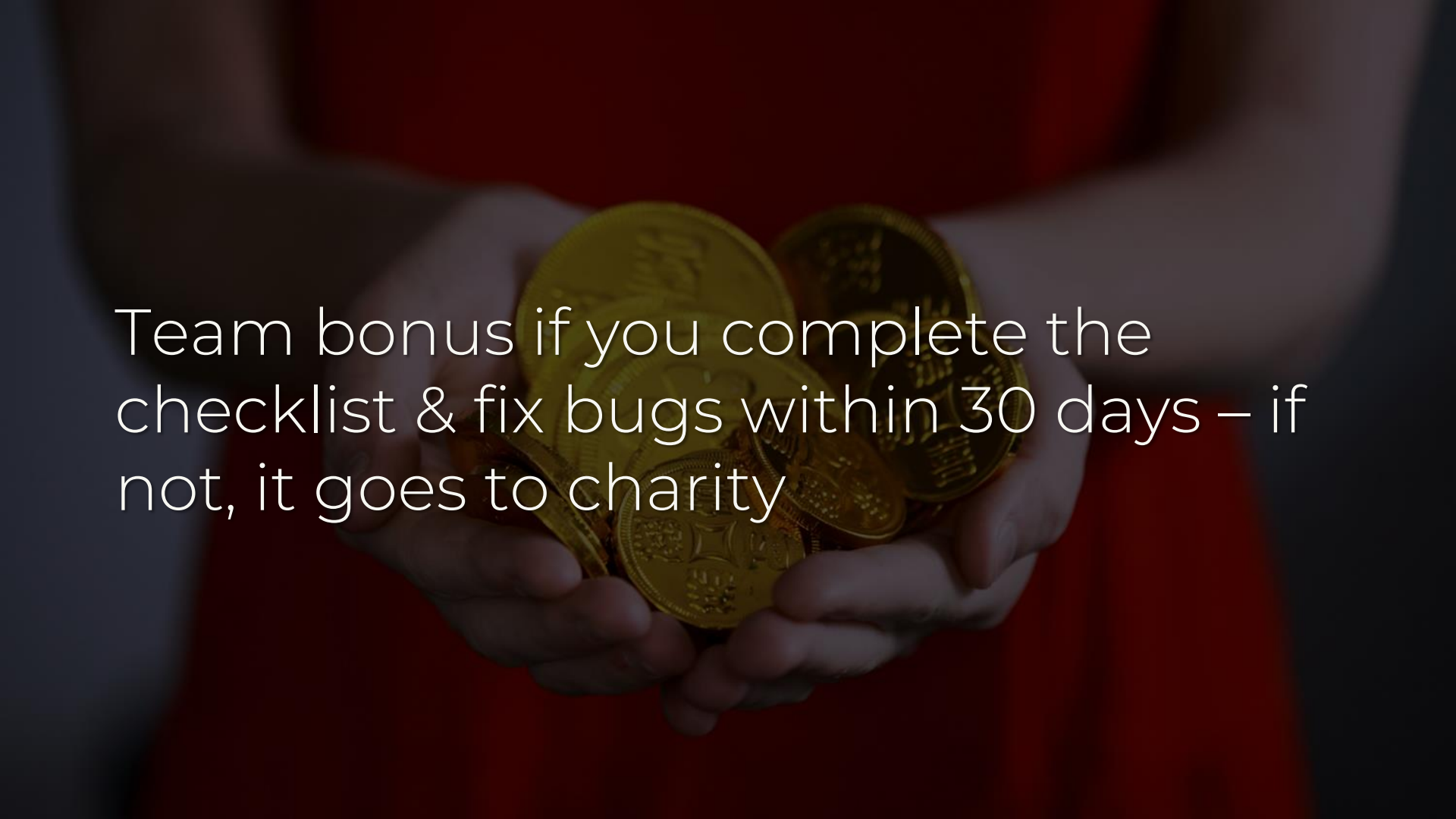
“Gift” budget that is eroded if security goals aren’t met (loss aversion)


Treat security habits as norms: “90% of our developers fix bugs within 3 days”

Show long-term expenses of options to highlight ROI of proactive security


Transparency around quality & cost:
easiest measures with highest impact

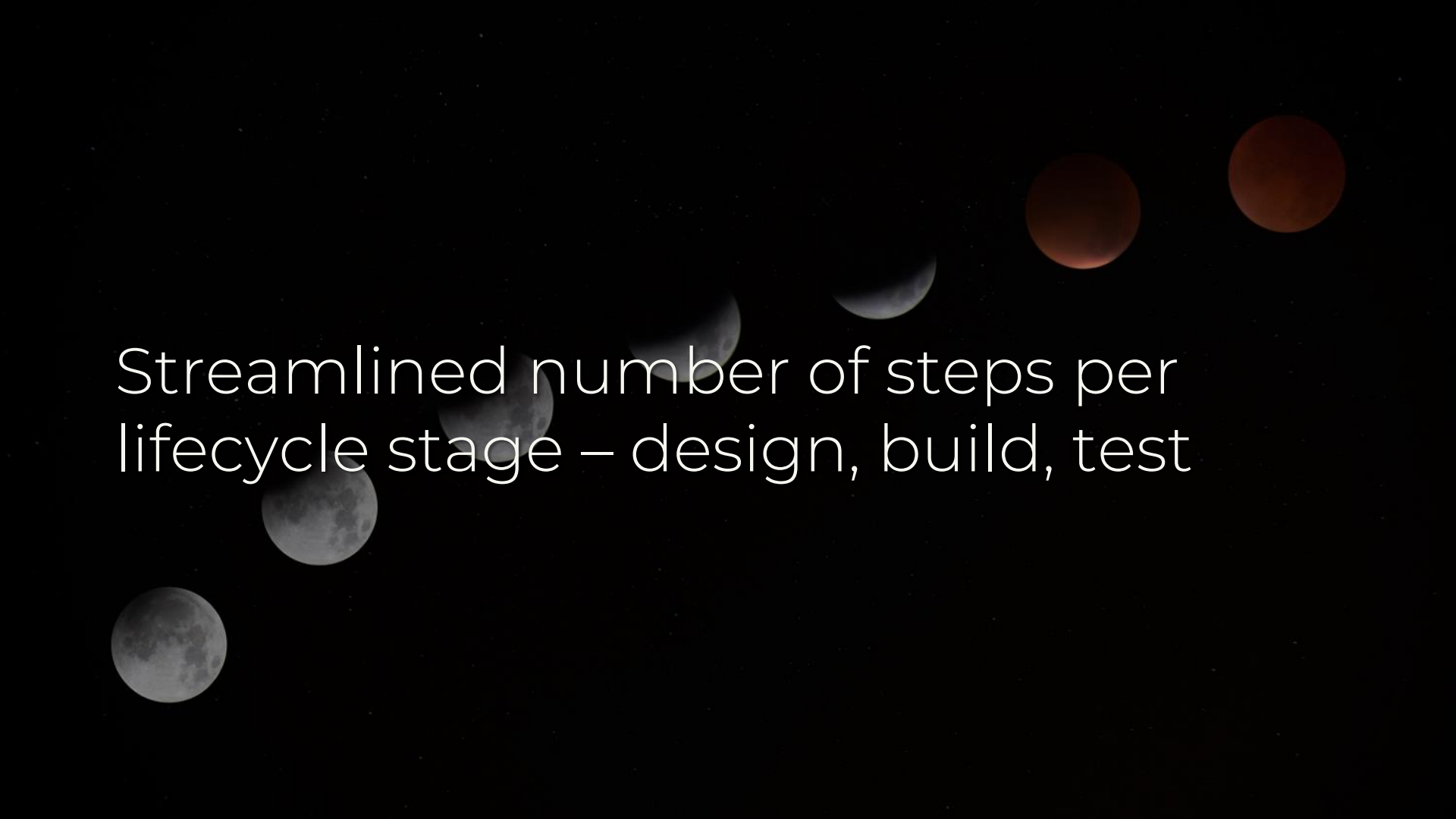
Control instincts to security issues – slow down via threat modelling


Team bonus if you complete the checklist & fix bugs within 30 days – if not, it goes to charity

Black Girls Code, Calyx Institute, IFF Diversity & Inclusion Fund, Mozilla Foundation, Signal Foundation

Public lists of IoT vendors allowing default cred changes (like the Two Factor Auth List)

One-page checklist to ensure & document IoT security basics


Streamlined number of steps per lifecycle stage – design, build, test

1. Design UX workflow to change default passwords (everywhere)

2. Spoof headers to look like most common web servers

3. Encrypt data in transit with SSL or TLS

4. Don’t call bash scripts from the web interface

5. Don’t use custom API protocols – just use REST or SOAP

Design

- Does the device use:
  - A login portal?
    - Yes, and we allow the change of default creds
    - No
  - User Data
    - Yes, & we encrypt data w/ SSL or TLS
    - No
  - Web Interface
    - Yes, and we do not call bash scripts or use custom API protocols
    - No

If internet-connected, spoof headers to appear “normal”

Cross-checking by teams of critical measures to be taken

Build

- Share essential information concerning security steps with the team
- Confirm each team member understands the security requirements
- Have any new features been added since design that require review? (ie interfacing w/ the internet, collecting user data)
- Anticipated Security Events
  - What are the critical or non-routine security controls required?
  - How long will implementation of controls take?
  - What are the anticipated impacts of the controls?

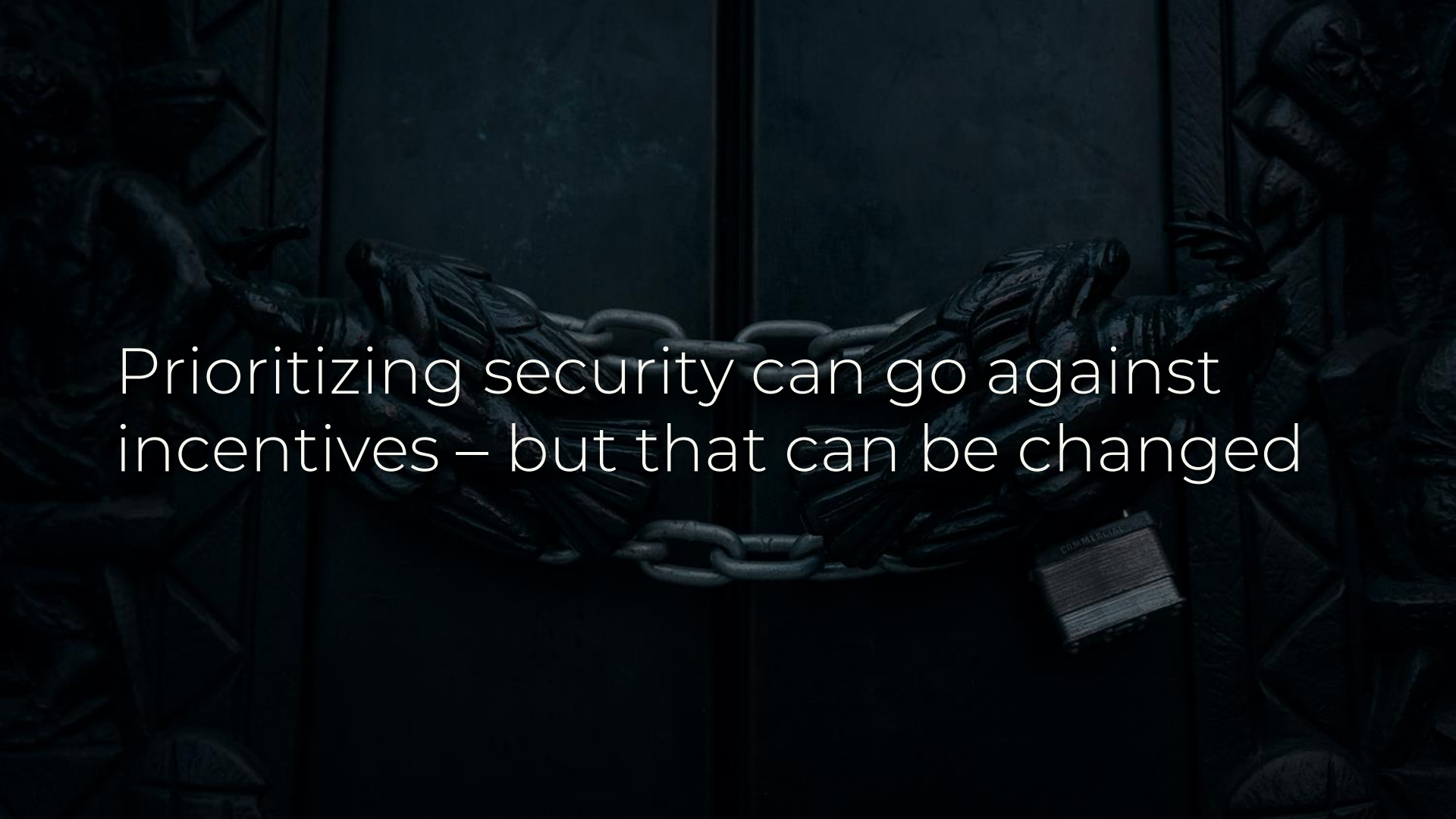
Test

- Tester to confirm:
  - Completion of account controls (default credential alerts, lockouts, 2FA)
  - List of data used by the device, and labelling of user data
  - Whether there are any vulnerabilities to be addressed
- For builders:
  - What are the key concerns around management going forward and any future security concerns?
  - Instructions for immediate post-testing security management are drawn up together

Formalized & usable checklist to be released soon...

Conclusion


IoT security ideas must treat devs as time-constrained humans



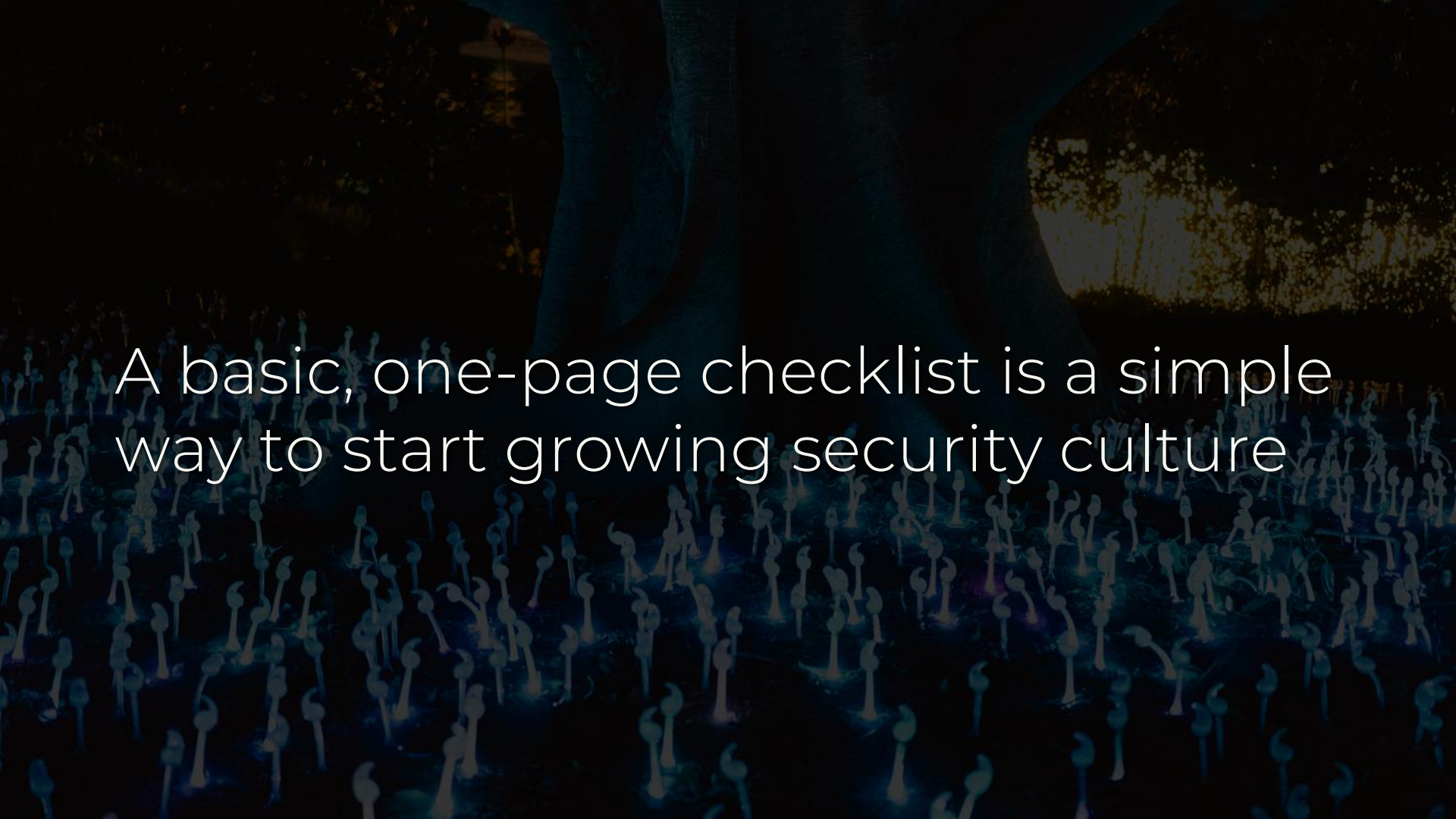
Prioritizing security can go against incentives – but that can be changed


Our complex, “endgame-level”
solutions are too formidable


Compensating controls aren’t enough
– we can’t expect magic post-hoc


But practical magic using behavioral
design can improve decision making


Goal: straightforward ways to erode
risky habits & promote security habits


A basic, one-page checklist is a simple way to start growing security culture


We cannot wallow in sermonizing –
we can’t let the problem devour us


“Good enough is good enough. Good enough always beats perfect.”
– Dan Geer

Suggested reading

- “Approaches based on behavioral economics could help nudge patients and providers toward lower health spending growth,” A. Darzi, F. Greaves, D. King, I. Vlaev
- “Behavior-based Safety Guide,” Ireland Health & Safety Authority
- “Farmer Behaviour, Agricultural Management and Climate Change,” OECD
- “Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices,” FDA
- “Influencing behaviour: The mindspace way,” P. Dolan, et al.
- “Postmarket Management of Cybersecurity in Medical Devices,” FDA
- “A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population,” Alex B. Haynes, et al.
- “The Theory of Value-Based Payment Incentives and Their Application to Health Care,” Conrad DA

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