QCon LONDON by InfoQ

COSSACK LABS

Designing stack agnostic, modern, secure architectures

Eugene Pilyankevich,
Chief Technical Officer, Cossack Labs

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#whoami / Speaker intro

- Infosec since mid-90s.
- Designed, supervised development of banking data processing, risk management DSS, cryptographic libraries, high-load services.
- Protected some state secrets, banking data, critical infrastructures, patient records, transactions and payment data.
- CTO, co-founder at Cossack Labs - data security solutions provider (www.cossacklabs.com)
- Life-long interest in how big systems fail and stand against failure.

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Designing
stack agnostic, modern, secure
architectures

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Sounds a bit like CAP theorem, isn't it?

stack agnostic, modern, secure

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1. **Stack agnostic** = Architecture that is not limited with certain implementations or availability of certain types of infrastructure;

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1. **Stack agnostic** = Architecture that is not limited with certain implementations or availability of certain types of infrastructure;
2. **Modern** = Architecture that enables modern design approaches and addresses modern, relevant risks and threat models;

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Sounds a bit like CAP theorem, isn't it?

1. **Stack agnostic** = Architecture that is not limited with certain implementations or availability of certain types of infrastructure;
2. **Modern** = Architecture that enables modern design approaches and addresses modern, relevant risks and threat models;
3. **Secure** = Resilient against chosen risks;

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1. Stack agnostic
2. Modern
3. Secure

SA + M + S

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How do we get to SA + M + S ?

Step 1. **Understand goals of security architecture, why do we need it, what is the value and the benefit?**

Step 2. **Understand necessary design and implementation steps in practical context.**

Step 3. **Understand and overcome limitations during both design and implementation.**

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How do we get to SA + M + S ?

Part 1. **Why do we need security architectures?** Why can't we just build ISMS or just address OWASP Top 10?

Part 2. **Building blocks of security architecture.** Risk management, attack surface, balancing tradeoffs.

Part 3. **Typical approaches to resolving conflicts** and overcoming limitations while preserving SA, M & S.

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WHY? WHY? WHY? WHY? WHY

Why we need security architecture?

WHY? WHY? WHY? WHY? WHY

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Let’s start with a story.

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Not an easy target

ISO 27000

A+ rating in banking security compliance

Annual audits and frequent pentests

… in 2008 we pretty much ahead of the game, we thought.

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Perfect user fraud prevention solution.

Defenders

- Cookie / Session / IP binding
- Concurrent session matching
- Concurrent query analysis
- Rate limiting
- Terms of service enforcement
- Browser fingerprinting
- Complex JS wizardry

Attackers

Yeah, right, let’s see what they came up with now.

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- **Charge customers per request**
- **Void abuser's contracts**

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Attackers

Account misuse and fraud drop below 5% within 180 days.

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Perfect user fraud prevention solution.

Defenders

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- **Concurrent query analysis**
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- Charge customers per request
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👈 **”Prevent it with more code” – engineer’s decision.**

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- **Void abuser's contracts**

👈 ”Prevent it with more code” – engineer's decision.

👈 **”Prevent it closer to the risks” – manager's decision**

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Now prevent injections on public front

Defenders

- Input sanitization: front-end
- Input sanitization: back-end
- mod.security config with 2K LOC of custom rules.

Attackers

The front-end is written in PHP, yeah right.

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Now prevent injections on public front

Defenders

- Input sanitization: front-end
- Input sanitization: back-end
- mod.security config with 2K LOC of custom rules.
- **Prepared statements.**
- **Materialized views.**
- **Domain model, 4-layer validation.**

Attackers

Why it stopped failing in new funny ways now?

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Now prevent injections on public front

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- Input sanitization: front-end
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- mod.security config with 2K LOC of custom rules.
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👈 Security engineer’s decision.

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- mod.security config with 2K LOC of custom rules.
- **Prepared statements.**
- **Materialized views.**
- **Domain model, 4-layer validation.**

👈 Security engineer’s decisions.

👈 System architect’s decisions.

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Why do large companies struggle with this?

- Equifax.
- Heartland Payment Systems.
- JP Morgan.
- RSA Security.
- **Operation Aurora victims**: Google, Juniper, other non-confirmed high-profile targets.

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Why do large companies struggle with this?

- “Big companies are hard, big infrastructures are harder to enforce good policies in”
- “Unexpected attack vector under novel threat model accompanied with forces we were not yet prepared to meet”

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- ¯_(ツ)_/¯

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WHY?

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Humans are unpredictable

Technology is broken

Poor design decisions

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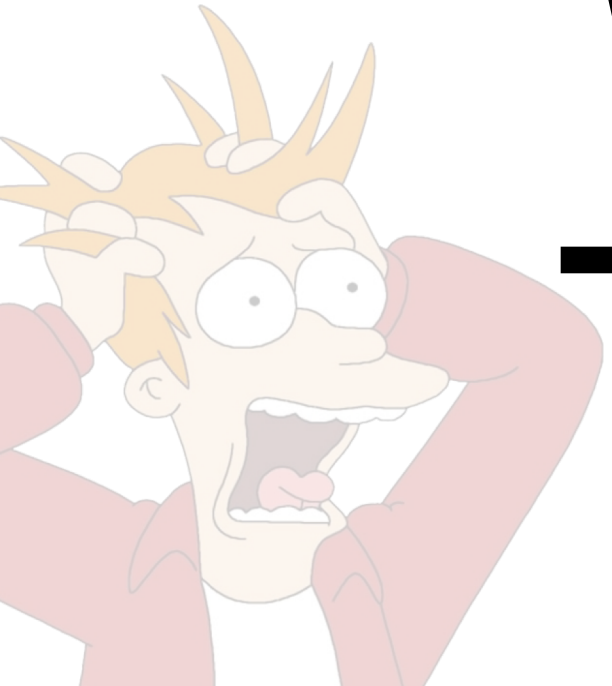
WHY?



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Poor design decisions

”How to get this security goal done and that security concern eliminated?”

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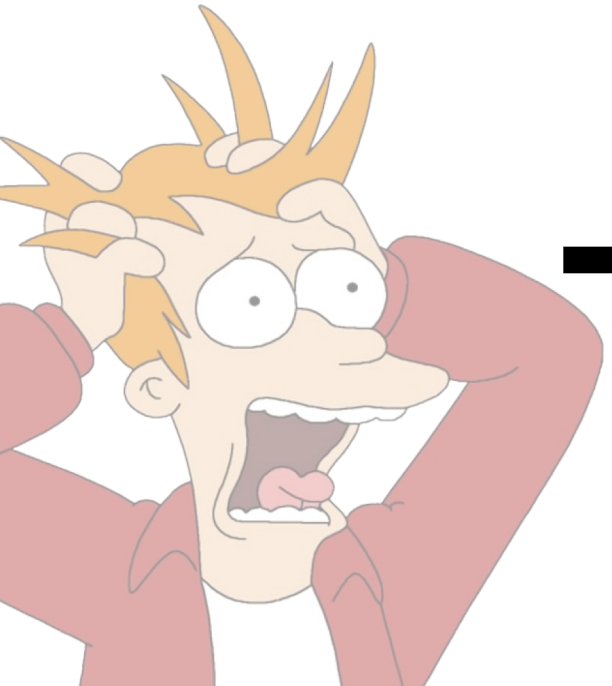
WHY?



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Security…

Has negative business value*
Is hard to grok*
Is confusing and contradictory*

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Security…

Has negative business value*
Is hard to grok*
Is confusing and contradictory*

Unless you're employed in the infosec industry, where it gets even worse.

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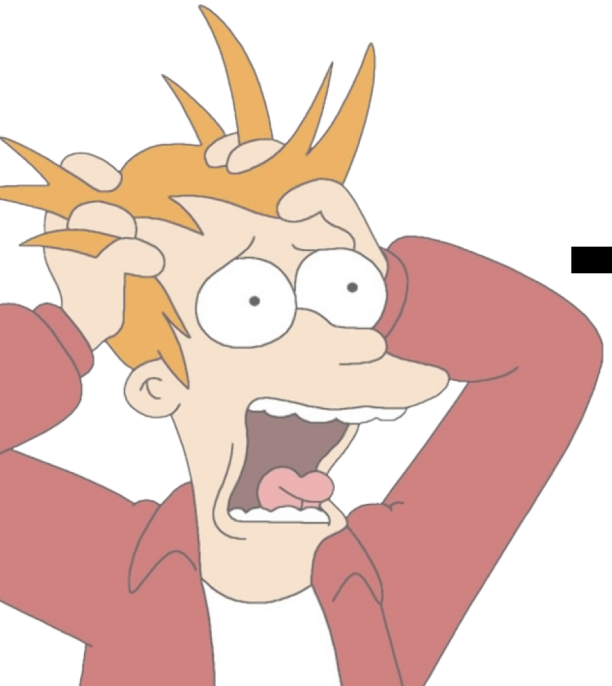
WHY?



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You never know if something is secure or not

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You never know if something is secure or not
… until it’s broken.

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You never know if something is secure or not … until it’s broken.

Then it’s definitely not secure.

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4 types of knowing

Known Known
Known Unknown
Unknown Known
Unknown Unknown

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4 types of knowing

Known Known
Known Unknown
Unknown Known
Unknown Unknown

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4 types of knowing in security

Confusion
Doubt
Fear
Risk aversion

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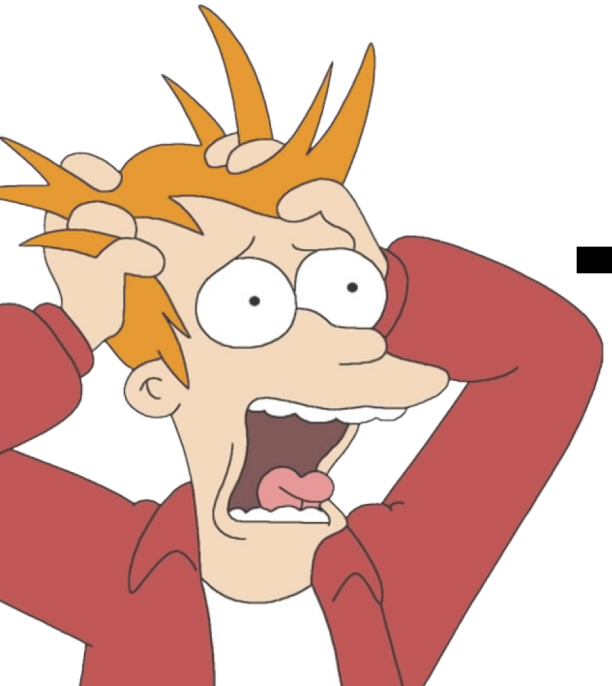
WHY?



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Thinking about 100 things at the same time is quite frustrating.

In absence of clear mental model people make poor decisions about risky and complex systems because risk brings affect & bias.

In absence of well-communicated design principles and acceptance criteria mind is prone to emotional affect.

Ability to think systems and ability to think risk is quite domain-specific if you’re not conscious about it.

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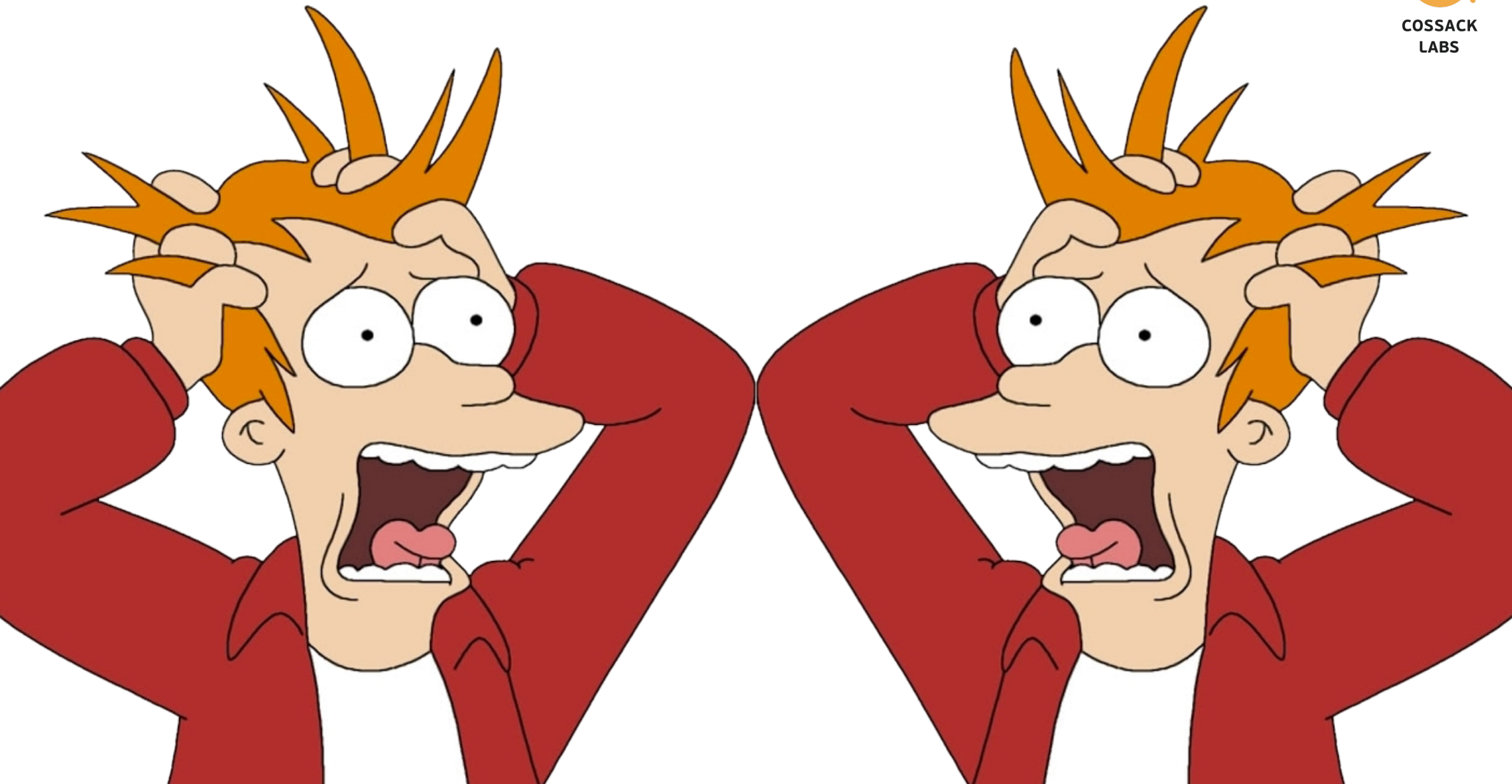
People make more mistakes about risky things under pressure in absence of simple guiding principle.



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Remember story I started with?

Manager’s decisions.

Security engineer’s decisions.

Software engineer’s decisions.

System architect’s decisions.

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Remember story I started with?

Manager’s decisions.

Security engineer’s decisions.

Software engineer’s decisions.

System architect’s decisions.

What is bad for us?

How to prevent that “bad”?

What my stack suggest to do?

What is the right systematic way?

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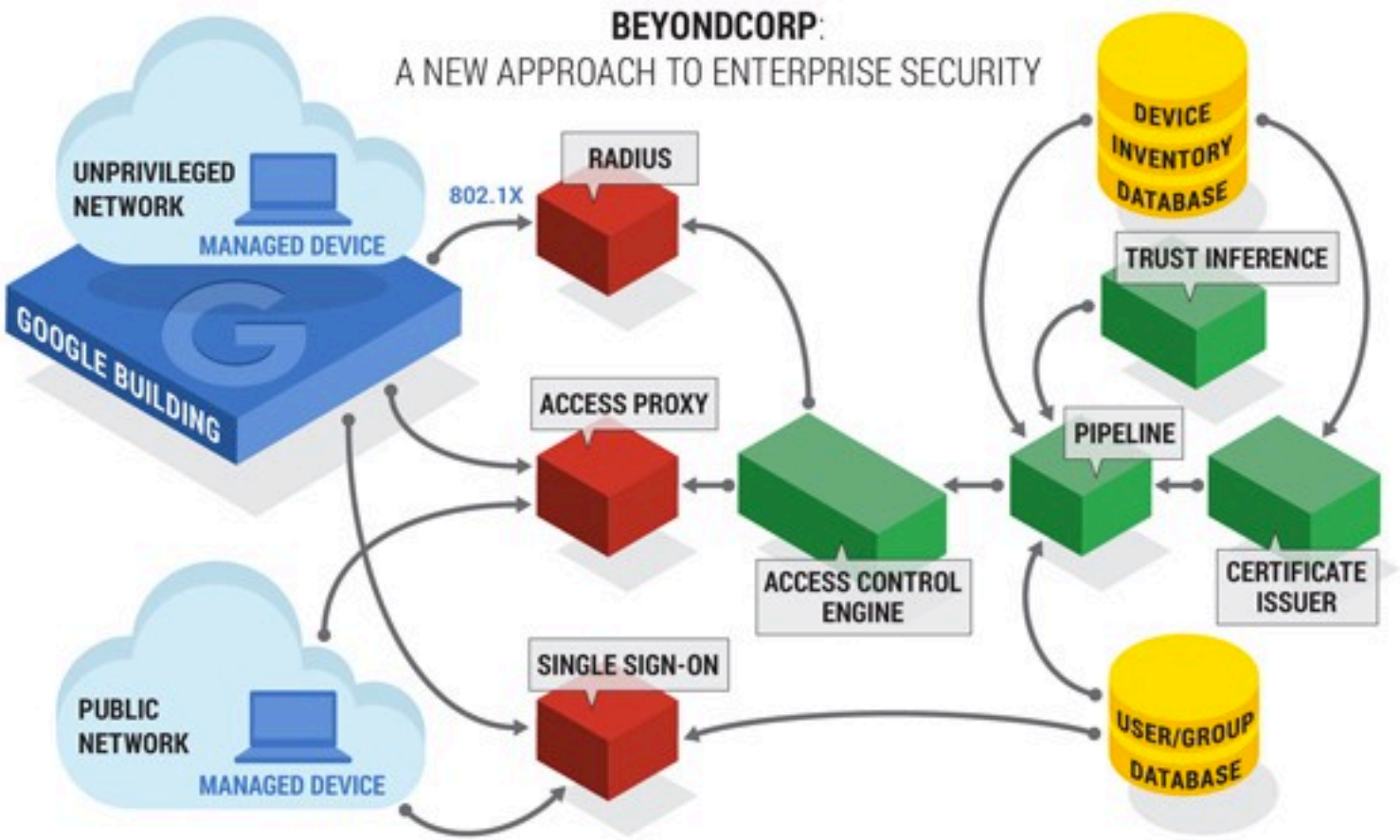
Remember the giants?



BeyondCorp components and access flow

Google: revised the AC architecture.

https://cloud.google.com/beyondcorp/#researchPapers

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Security architecture 101:
👉 Intro

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Goals of security architecture?

We want **understandable and implementable decision system**

that allows us to:

1. Prevent damage to business
2. Manage risks cost-efficiently

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What is security architecture?

Combination of security decisions.

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What is security architecture?

Combination of security decisions, which makes actual system's risks manageable.

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What is security architecture?

Combination of security decisions, which makes actual system's risks manageable in a chosen manner, efficiently.

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What is security architecture?

Combination of security decisions, which makes actual system's risks manageable in a chosen manner, efficiently, while maintaining all other quality attributes of a system on acceptable level.

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How to design the security architecture?

- Understand and manage the risks
- Understand and manage attack surface
- Balance tradeoffs

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Before we do these three things, security effort is just re-painting this door in fancy colors.

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Security architecture 101:

Intro

👉 Understanding risks

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Building secure architecture is similar to building scalable and resilient architecture.

It’s the set of risks that is different, but the approach is the same – you **design against the chosen valid risks** for you.

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You?

NASA

US Navy

https://ivychapel.ink/posts/two-types-of-engineering-for-resiliency/

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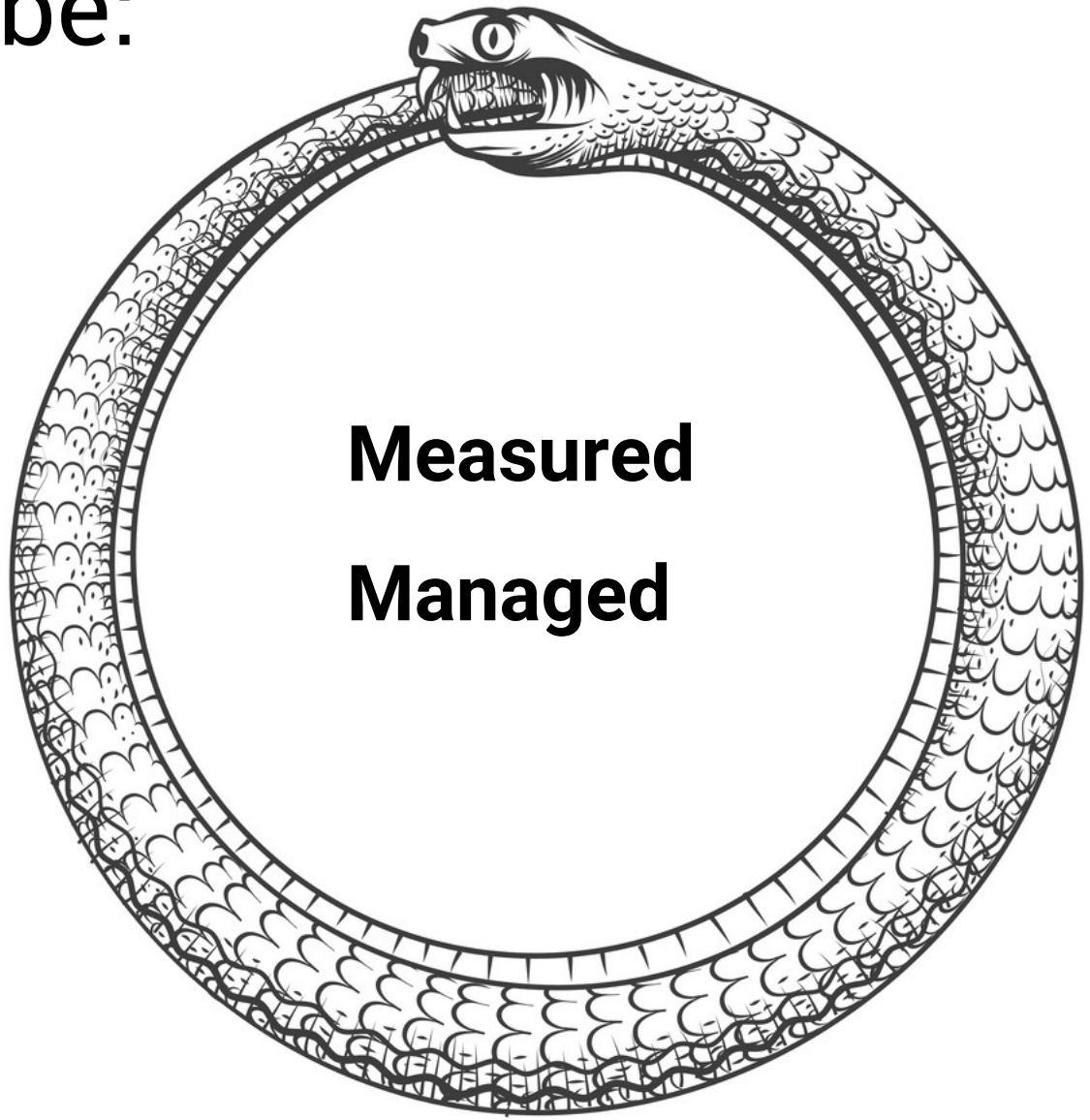
Risk should be:



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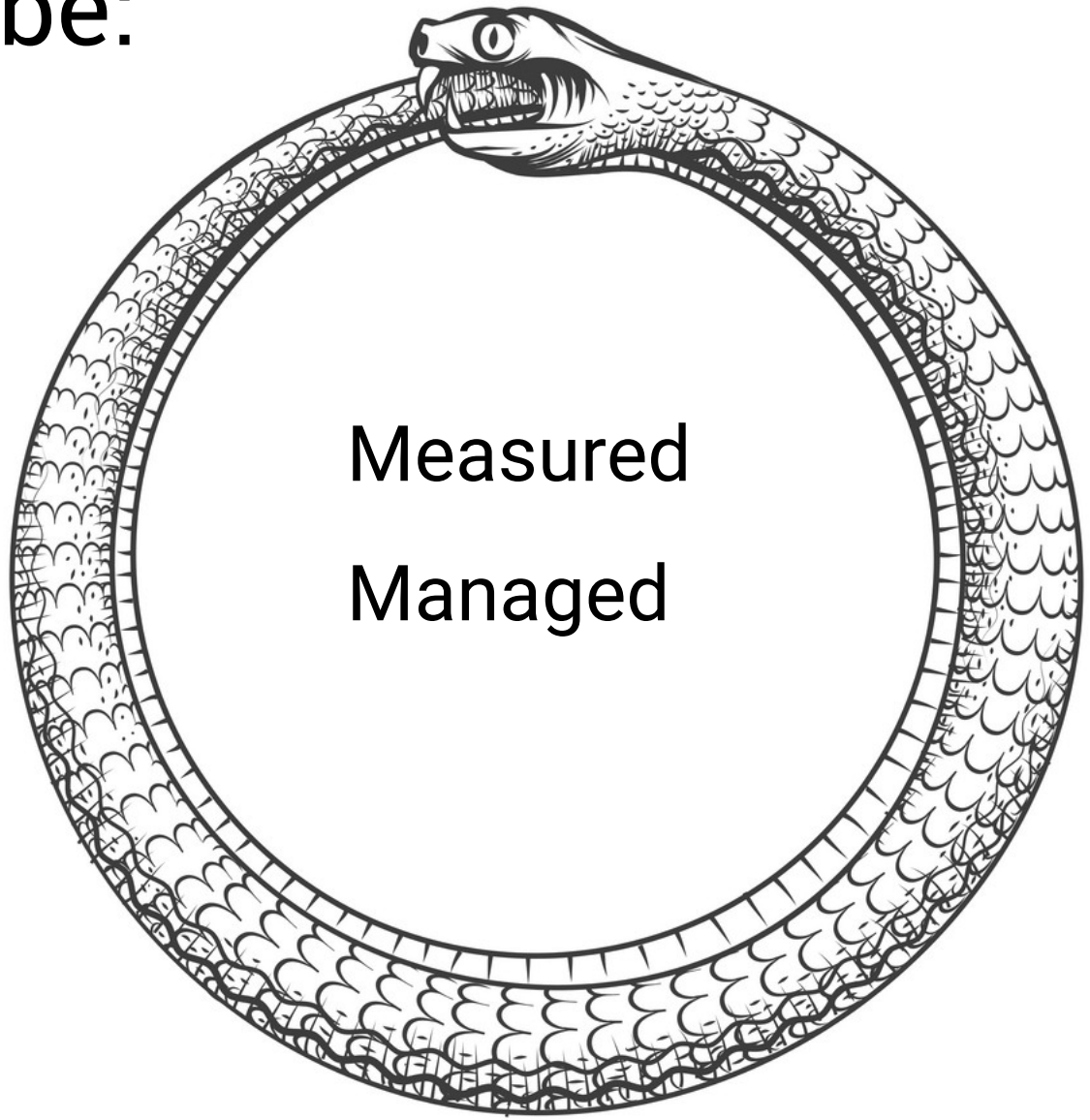
Risk should be:

Quantitatively



Adequately

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Appetite/governance

Identification

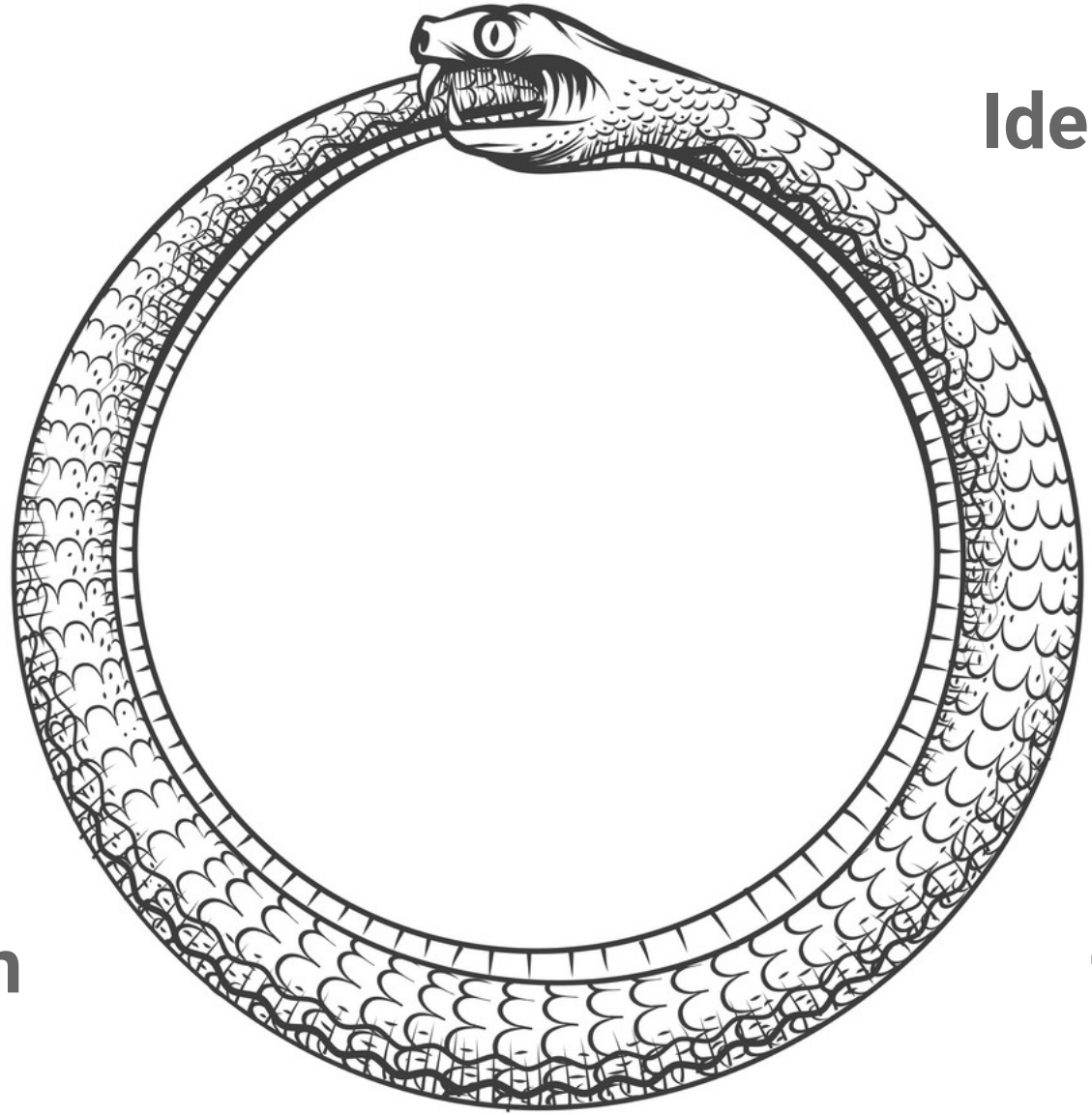
Assessment

Treatment

Mitigation

Acceptance

Monitoring



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Risk management

Questions:

- What is more important to protect and how? Why?
- Should we spend more on this or on that?

Valuable approaches:

- OWASP RAF
- FAIR
- NIST RMF
- COBIT 5
- OCTAVA

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Risks ~ Problem probability

Probable damage

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Remember:
One in a million is next Tuesday.

https://blogs.msdn.microsoft.com/larryosterman/2004/03/30/one-in-a-million-is-next-tuesday/

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Security architecture 101:

Intro

Understanding risks

👉 Understanding attack surface

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Understanding attack surface

Bad people

Bad people

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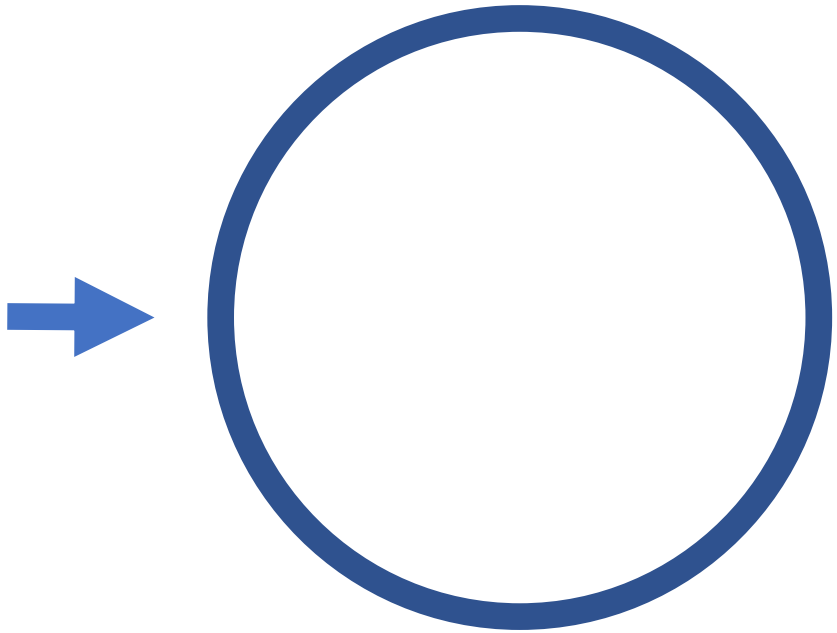
Understanding attack surface

Attack surface



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Understanding attack surface

Attack Surface is every possible way attacker can induce chosen type of loss to your system.

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Attack surface is your friend

Instead of “**protecting every system**”, you can to **focus on protecting the attack surface**.

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Understanding attack surface

- Attackers look for assets.
- Defenders protect boxes.

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Understanding attack surface

- Attackers look for assets.
- Defenders protect boxes.
- Attackers think in graphs.
- Defenders think in lists.

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Understanding attack surface

	Prioritized by damage ☹
• Attackers look for assets.	• Attackers think in graphs.
• Defenders protect boxes.	• Defenders think in lists.
	Not prioritized by risk ☹

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Note: An unfair asymmetry

- **To win against attacker**, you need to ensure that every vector on attack surface is protected.
- **Attacker to win against you**, needs to find one (in worst case several) unprotected attack vectors.

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Managing attack surface

- **Assessing** attack surface.
- **Minimizing** attack surface.
- **Controlling** attack surface.
- **Monitoring** attack surface.
- **Drills**.

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Security architecture 101:

Intro

Understanding risks

Attack surface

👉 Balancing tradeoffs


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Balancing tradeoffs

Risk impact

Cost

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Balancing tradeoffs

Risk impact

Cost

Usability

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Balancing tradeoffs

Risk impact

Cost
Usability
Maintainability

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Balancing tradeoffs

Risk impact

Cost
Usability
Maintainability
Flexibility

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Balancing tradeoffs

- This is not A vs B relationship: security + usability.

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Balancing tradeoffs

- This is not A vs B relationship: security + usability.
- **Pick your battles** – you can’t have all NFRs in a perfect shape.

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Balancing tradeoffs

- This is not A vs B relationship: security + usability.
- **Pick your battles** – you can't have all NFRs in a perfect shape.
- Seek solutions that have:

  Both **acceptable risk impact** and **acceptable baseline qualities** for all NFRs.

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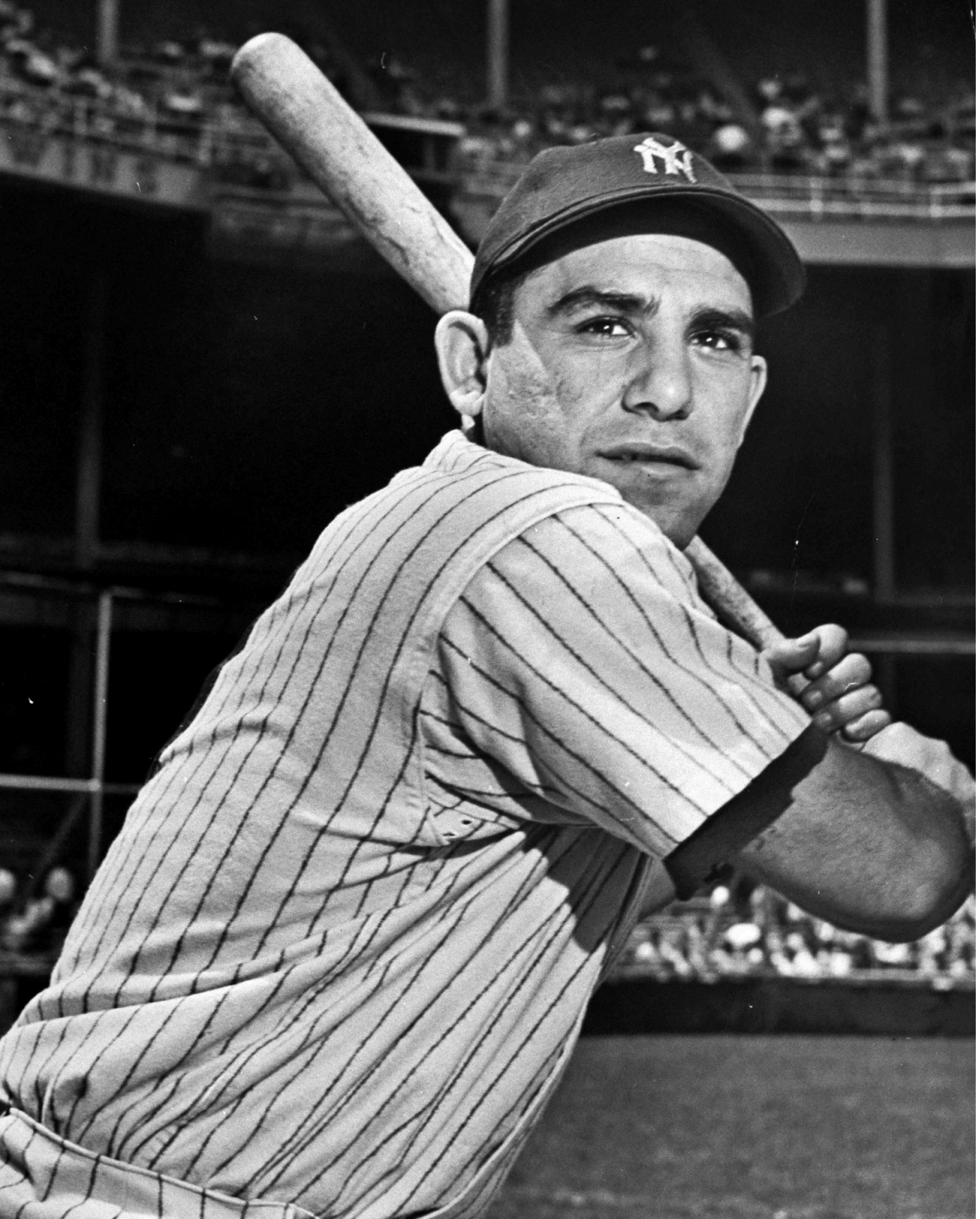
Designing for security:
understanding and overcoming limitations



In theory, there is no difference between theory and practice.

In practice, there is.

Yogi Berra,
New York Yankees,
catcher, coach and manager

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Attack surface is always too big.

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Attack surface is always too big.

- Real attack surface is always just crazy big.
- Variety of technologies, tools and assets is crazy big.
- **The only thing that is not crazy big?**
- **Staff and security budget.**

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Attack surface is always too big.

- **Example**: two power grid monitoring efforts.

  Humongous limitations, mad scale, bad legacy.
  … security?

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Attack surface is always too big.

- **Example**: optimizing SIEM coverage.

  Need more signals, got less eyes.
  Review risk model and decrease the scope (for real).

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Prioritize!

You can’t fix everything.

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Prioritize!

You can’t fix everything.
Choose your battles.

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Is it secure? Trust levels

1. Ultimate “secure”.
2. Nothing is “provably secure” in absolute terms.
3. Raising the bar, raising cost
4. Controlling attack flow.

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Sometimes requirements
conflict with each other!

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Conflicts arise when each problem / risk has separate solution / control.

Conflicts disappear when solutions in system address root causes of problems and risks.

https://ivychapel.ink/posts/on-avoiding-band-aid-security/

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- **Example**: optimizing SIEM coverage.

  Data leakage through audit logs.

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- **Example**: optimizing SIEM coverage.

  Data leakage through audit logs.
  PCI logging requirements vs GDPR requirements.

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- **Example**: optimizing SIEM coverage.

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  Logs are data as well.

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- **Example**: optimizing SIEM coverage.

  Data leakage through audit logs.
  PCI logging requirements vs GDPR requirements.
  Logs are data as well.
  Should we protect them?

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No requirements = infinite rabbit hole.

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Things you don’t need (yet) to succeed

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You don’t need most of security tools (yet).

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You don’t need most of security tools (yet).

That’s just more attack surface.

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You don’t need most of security tools (yet).

That’s just more attack surface.

And more complexity.


SDN
DDoS Protection
DNS Security
Network Firewall
Deception
Network Analysis & Forensics
Endpoint Detection & Response
Application Security Testing
MSSP
Advanced MSS & MDR
Data Security
Encryption
DLP
Data Privacy
Data Centric Security
Mobile Security
Risk & Compliance
Risk Assessment & Visibility
Security Ratings
GRC
Security Awareness & Training
Security Operations & Incident Response
SIEM
Security Incident Response
Momentum CYBER
Threat Intelligence
IoT
IoT Devices
Automotive
Connected Home
Identity & Access Management
Authentication
Digital Risk Management
Security Consulting & Services

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Good architecture is both decision framework and design guide. It not only addresses the risks, it reduces complexity.

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If you’re focused on the risks and attack surface of sensitive assets, technology and stack is rarely an issue.

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Example: IAM + SSO + Zero Trust on top of legacy AD/LDAP system with a dozen of applications you can’t mostly update.

Recap

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What is security architecture?

Combination of security decisions, which makes actual system’s risks manageable in a chosen manner, efficiently, while maintaining all other quality attributes of a system on acceptable level.

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What is security architecture? **TL;DR:**

Set of high-level decisions that simplify security choices, yet drive it in the right direction in coordinated way.

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How to design a security architecture?

- Risk management: **SA + S**
- Attack surface management: **SA + M + S**
- Balance tradeoffs: **M + S**

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How to design a security architecture?

- Risk management: Design against risks
- Attack surface management: Choose your battles wisely
- Balance tradeoffs: Remove conflicts

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How to design a security architecture?

- Risk management: Business, tech decisions
- Attack surface management: Tech, architecture decisions
- Balance tradeoffs: Architecture decisions

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There are various directions for security improvement:

- Improve risk management / risk posture.
- Add security controls and tools.

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Security architecture enables **systematic risk treatment** that is informed by both to make implementation fit both engineering and business FRs and NFRs.

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Thank you!

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