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SECURE BY DESIGN

Security Design Principles for the Working Architect

Eoin Woods
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BACKGROUND

- **Eoin Woods**
  - **CTO at Endava** (technology services, ~5000 people)
  - **10 years in product development** - Bull, Sybase, InterTrust
  - **10 years in capital markets applications** - UBS and BGI
  - Software dev engineer, then architect, now CTO
- Author, editor, speaker, community guy

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CONTENT

- **What is security** and why do we care?
- What are **security principles**, why are they **useful**?
- **Security design principles**
  - 10 important principles useful in practice
- **Improving application security** in real teams

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REVISITING SECURITY

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REVISITING SECURITY

- We all know security is important - but **why**?
  - protection against **malice**, **mistakes** and **mischance**
  - theft, fraud, destruction, disruption
- Security is a **risk management** business
  - **loss** of time, money, privacy, reputation, advantage
  - **insurance model** - balance costs against risk of loss

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ASPECTS OF SECURITY PRACTICE

Secure Application Design

Secure Application Implementation

Secure Infrastructure Design

Secure Infrastructure Deployment

Secure System Operation

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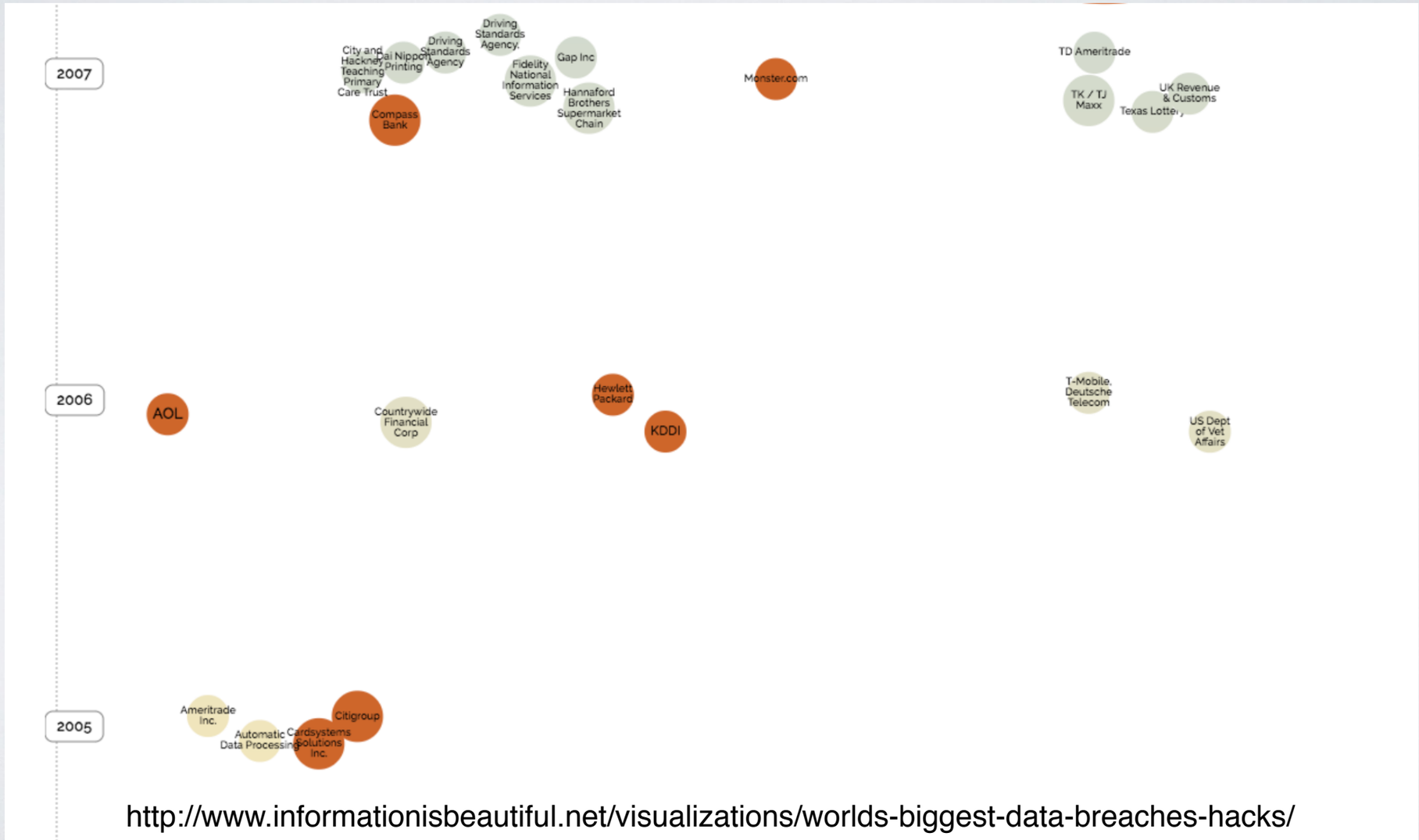
DATA BREACHES 2005 - 2007



http://www.informationisbeautiful.net/visualizations/worlds-biggest-data-breaches-hacks/

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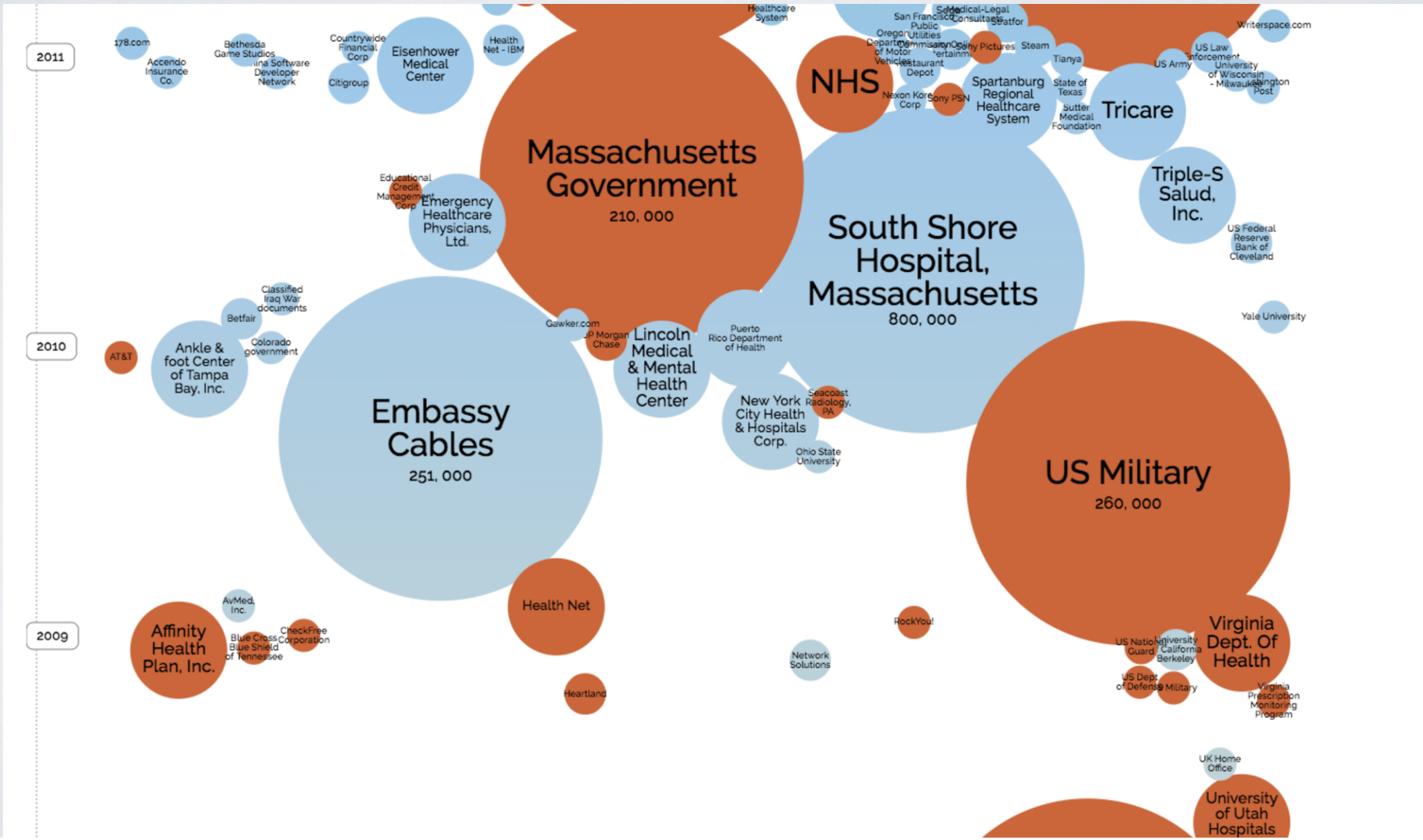
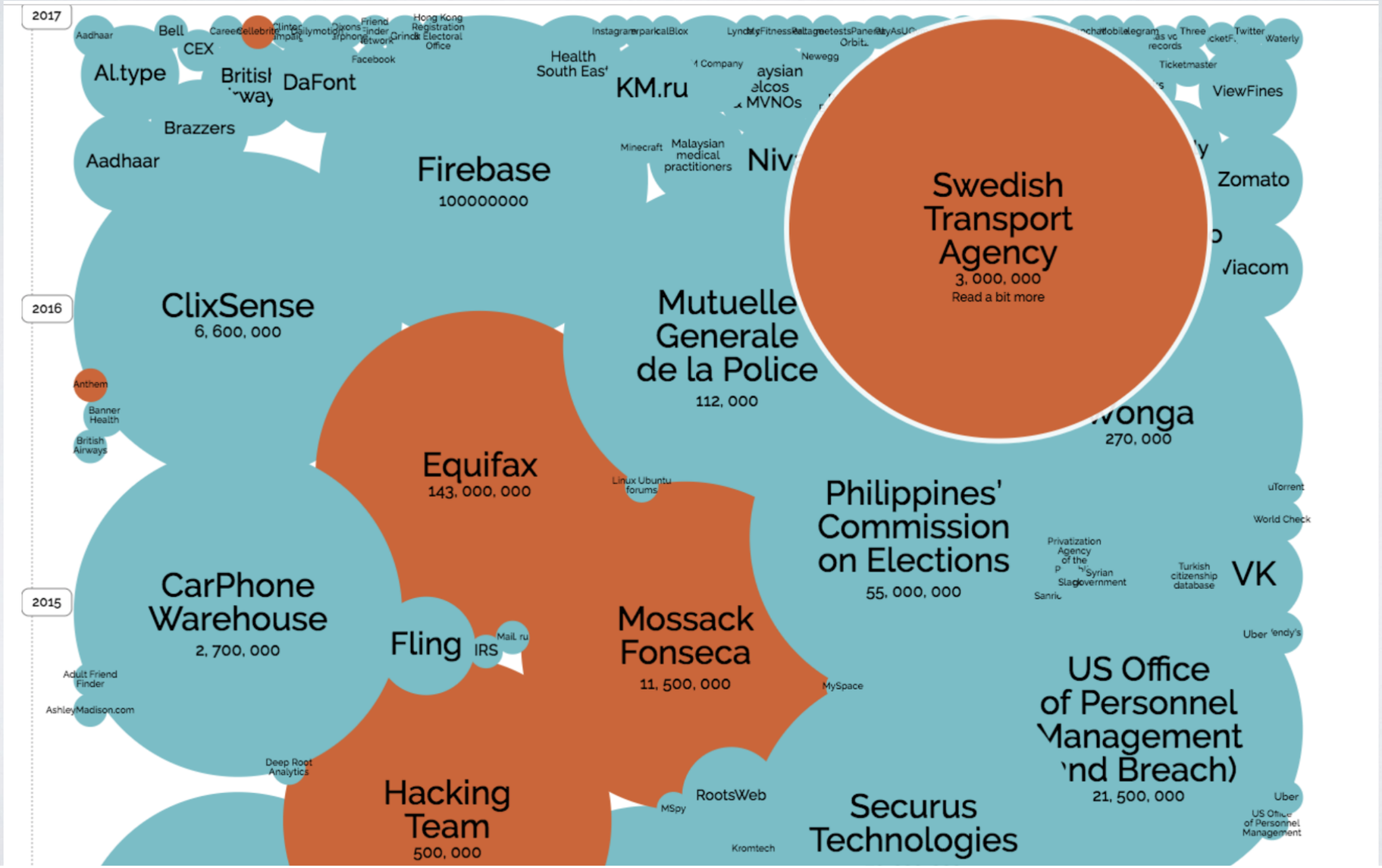
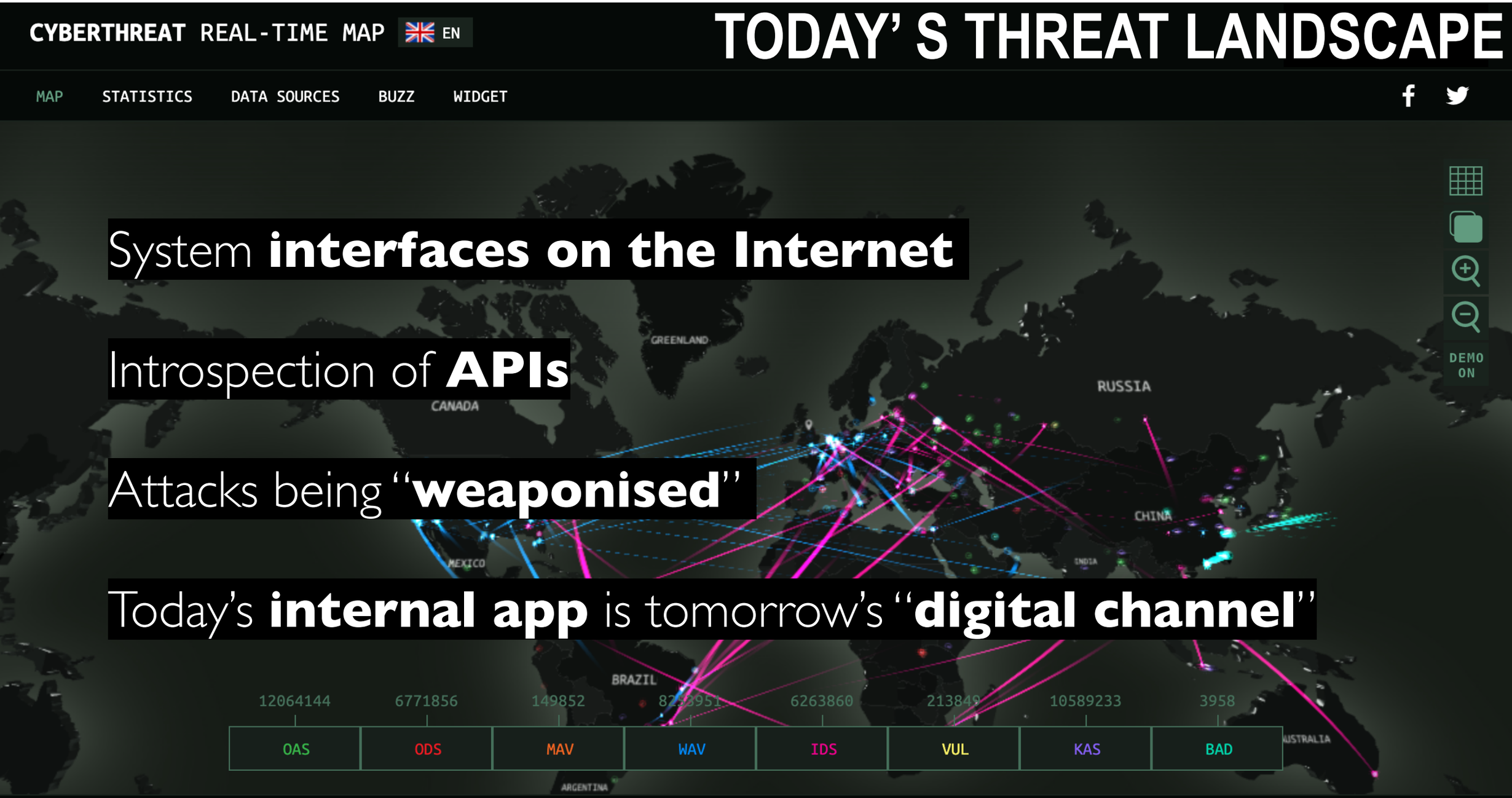
DATA BREACHES 2009 - 2011



DATA BREACHES 2015 - 2018



TODAY' S THREAT LANDSCAPE



System **interfaces on the Internet**

Introspection of **APIs**

Attacks being "**weaponised**"

Today's **internal app** is tomorrow's "**digital channel**"

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SECURITY PRINCIPLES

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SECURITY DESIGN PRINCIPLES

What is a "**principle**" ?

*a fundamental **truth or proposition** serving as the foundation for **belief or action*** [OED]

We define a **security design principle** as ….

*a declarative **statement** made with the intention of **guiding security design decisions** in order to meet the goals of a system*

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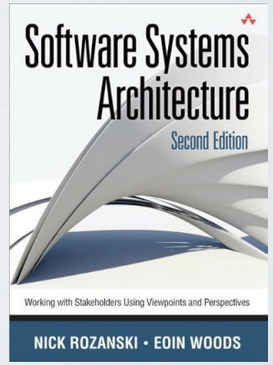
SECURITY DESIGN PRINCIPLES

- There are **many sets** of security design principles
  - Viega & McGraw (10), OWASP (10), NIST (33), NCSC (44), Cliff Berg (185) …
  - Many similarities between them at fundamental level
- I have distilled **10 key principles** as a basic set
  - these are brief summaries for slide presentation
  - www.viewpoints-and-perspectives.info



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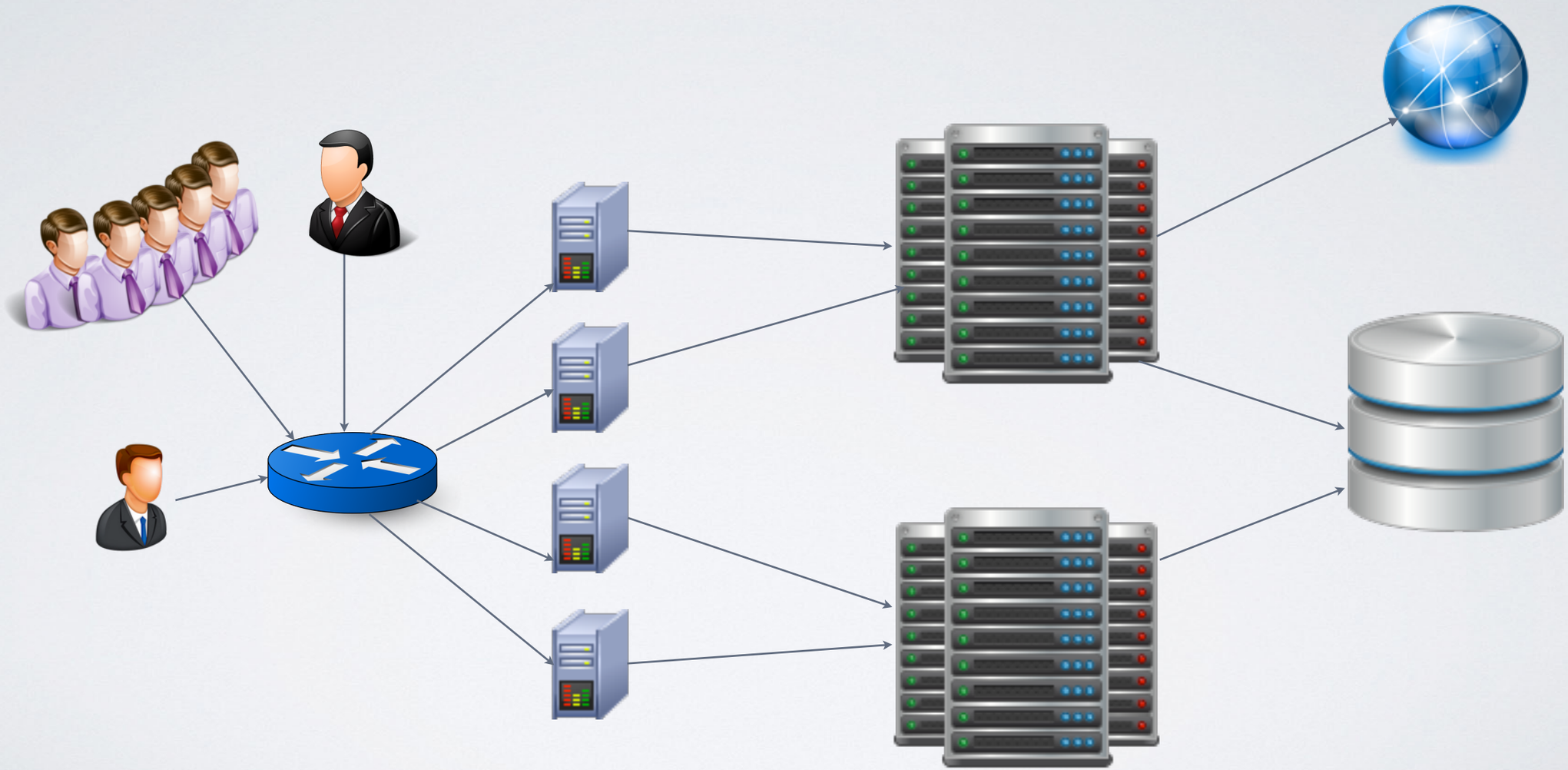
A SYSTEM TO BE SECURED



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10 KEY SECURITY PRINCIPLES

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TEN KEY SECURITY PRINCIPLES

- Assign the **least privilege** possible
- Separate **responsibilities**
- **Trust cautiously**
- **Simplest** solution possible
- **Audit** sensitive events
- **Fail securely** & use **secure defaults**
- Never rely upon **obscurity**
- Implement **defence in depth**
- **Never invent** security technology
- Find the **weakest link**

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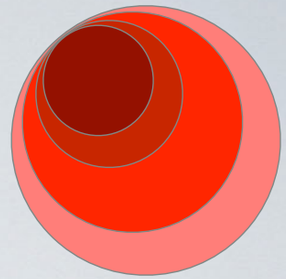
1- LEAST PRIVILEGE



Why?	Broad privileges allow malicious or accidental access to protected resources
Principle	Limit privileges to the minimum for the context
Tradeoff	Less convenient; less efficient; more complexity
Example	Run server processes as their own users with exactly the set of privileges they require

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2 - SEPARATE RESPONSIBILITIES

Why?	Achieve control and accountability, limit the impact of successful attacks, make attacks less attractive
Principle	Separate and compartmentalise responsibilities and privileges
Tradeoff	Development and testing costs; operational complexity: troubleshooting more difficult
Example	"Payments" module administrators have no access to or control over "Orders" module features

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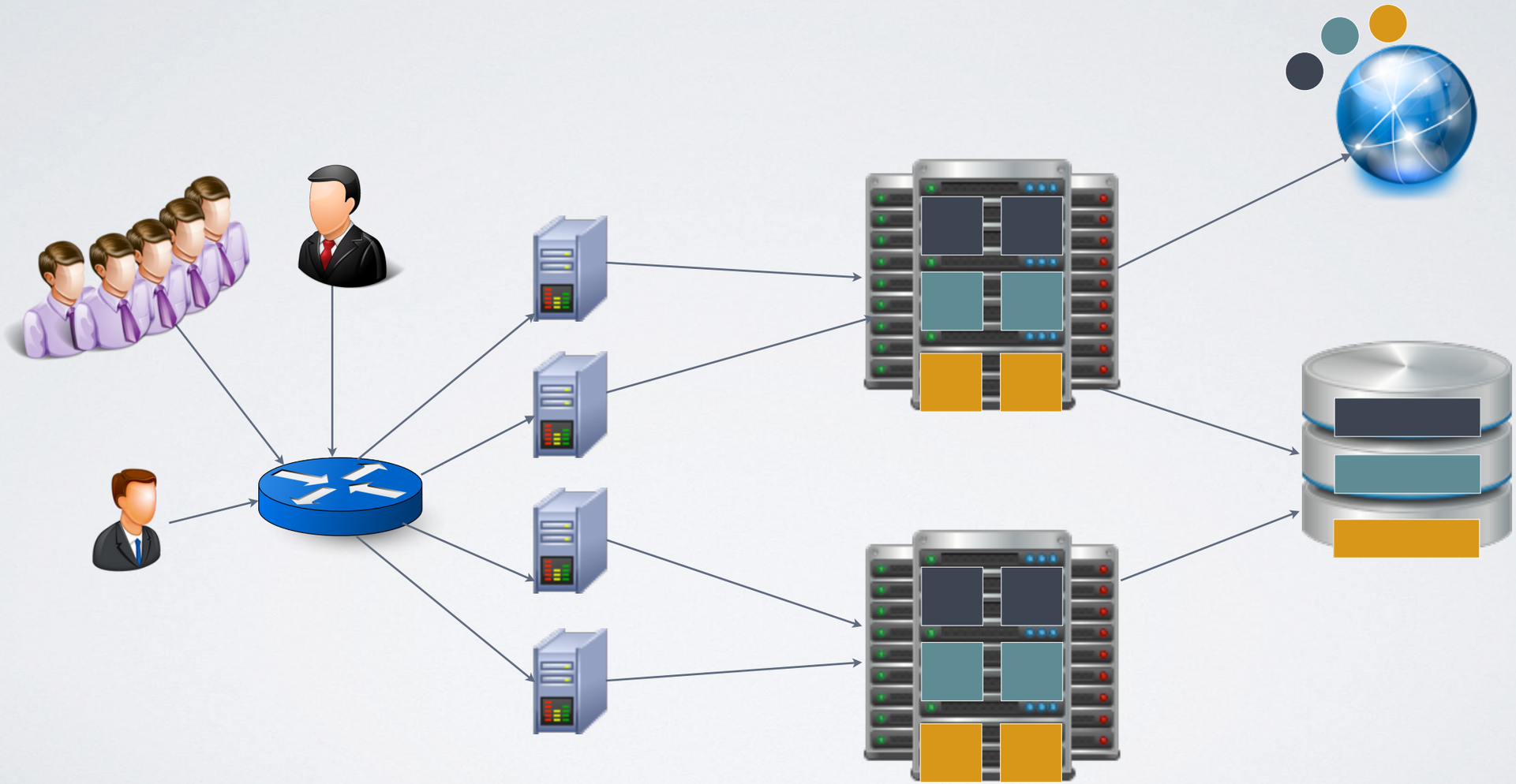
2 - SEPARATE RESPONSIBILITIES



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3- TRUST CAUTIOUSLY

Why?	Many security problems caused by inserting malicious intermediaries in communication paths
Principle	Assume unknown entities are untrusted, have a clear process to establish trust, validate who is connecting
Tradeoff	Operational complexity (particularly failure recovery); reliability; some development overhead
Example	Don't accept untrusted RMI connections, use client certificates, credentials or network controls

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3- TRUST

Why?

Many security pr
intermediaries in

Principle

Assume unknow
process to estab

Tradeoff

Operational com
reliability; some c

Example

Don't accept unt
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Why?	Many security problems caused by inserting malicious intermediaries in communication paths
Principle	Assume unknown entities are untrusted, have a clear process to establish trust, validate who is connecting
Tradeoff	Operational complexity (particularly failure recovery); reliability; some development overhead
Example	Reject untrusted RPC connections, authenticate clients, check 3rd party components, scan your open source

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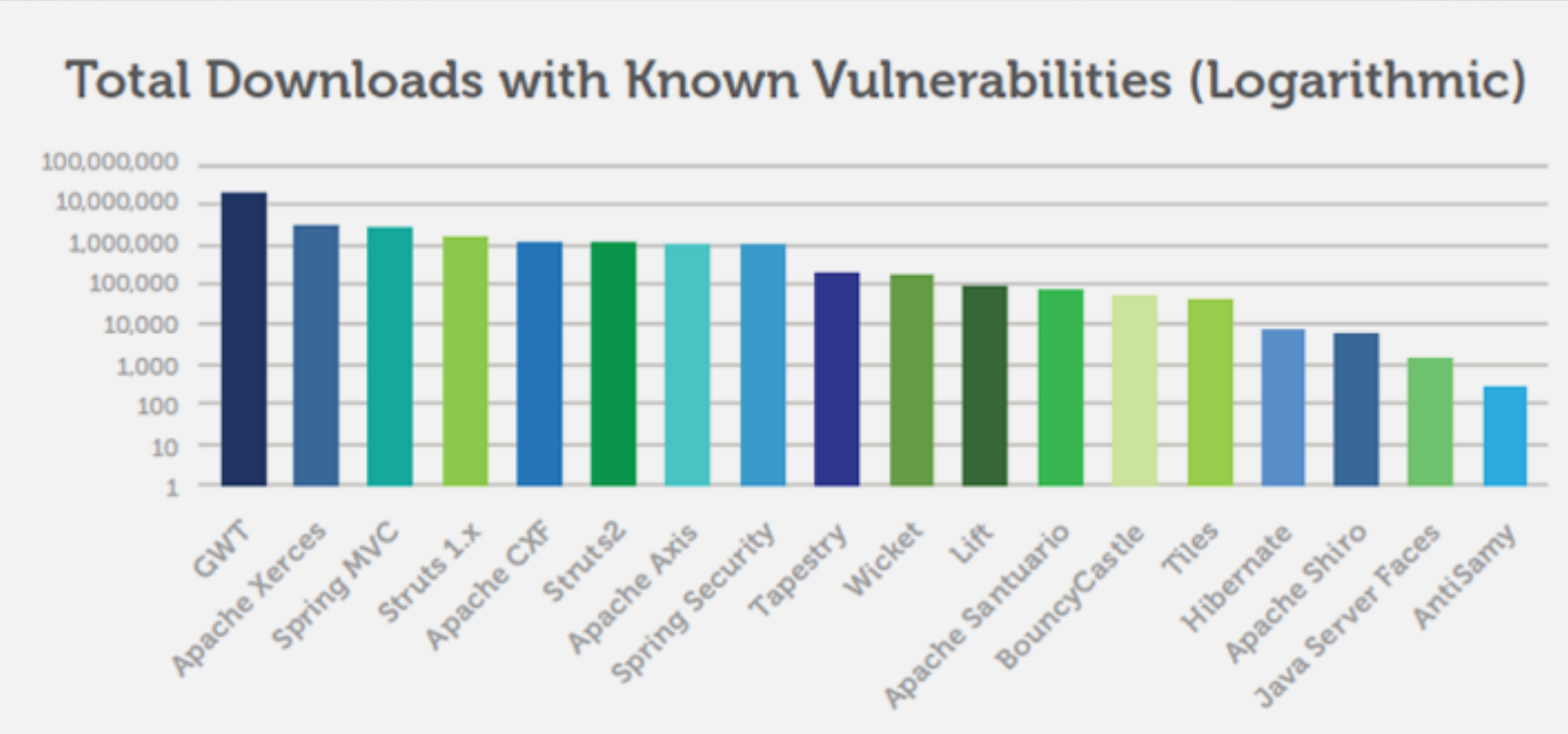
3 - TRUST CAUTIOUSLY



https://www.aspectsecurity.com/research-presentations/the-unfortunate-reality-of-insecure-libraries

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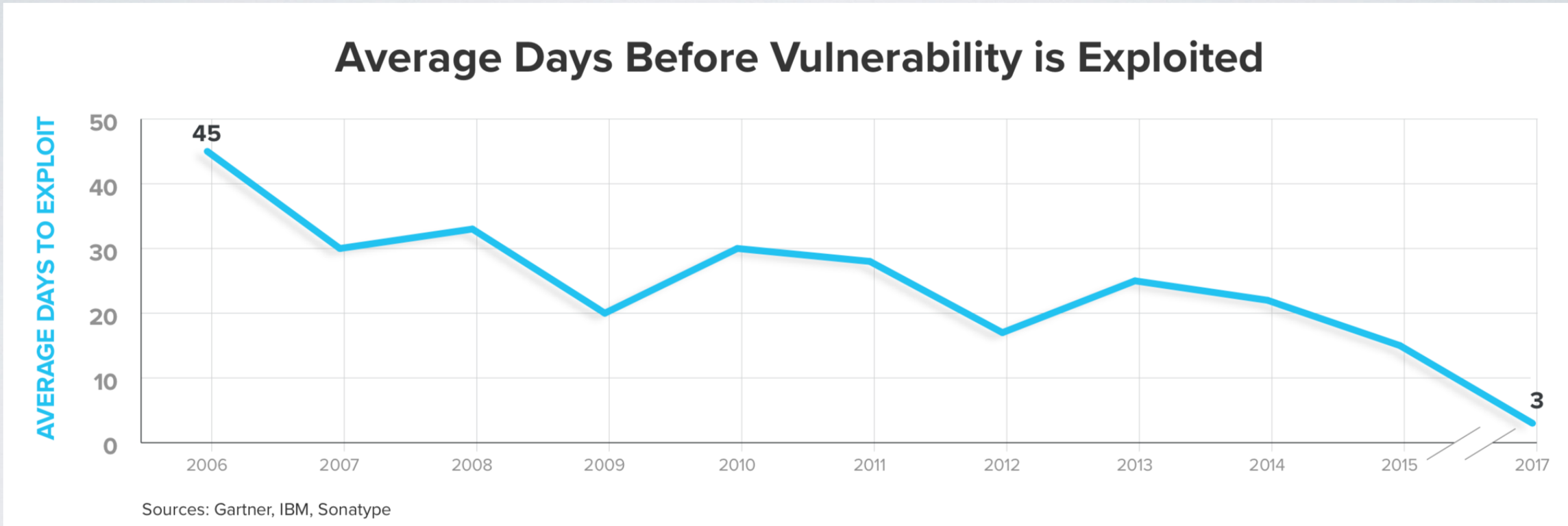

Sonatype 2018 State of the Software Supply Chain Report

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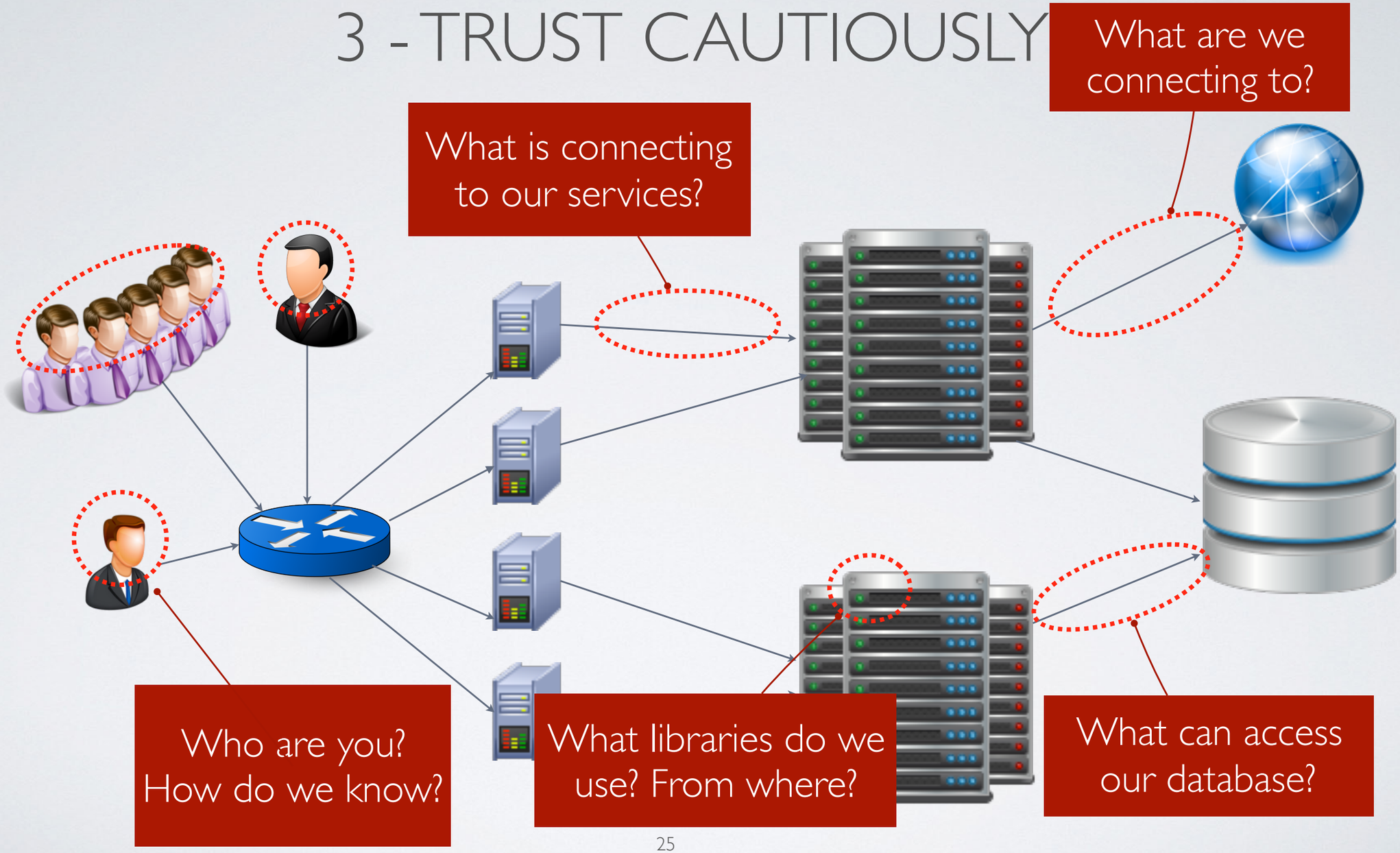

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4- SIMPLEST SOLUTION POSSIBLE

*The **price** of **reliability** is the pursuit of the utmost **simplicity** - **C.A.R. Hoare***

Why?	Security requires understanding of the design - complexity rarely understood - simplicity allows analysis
Principle	Actively design for simplicity - avoid complex failure modes, implicit behaviour, unnecessary features, …
Tradeoff	Hard decisions on features and sophistication; Needs serious design effort to be simple
Example	Does the system really need dynamic runtime configuration via a custom DSL?

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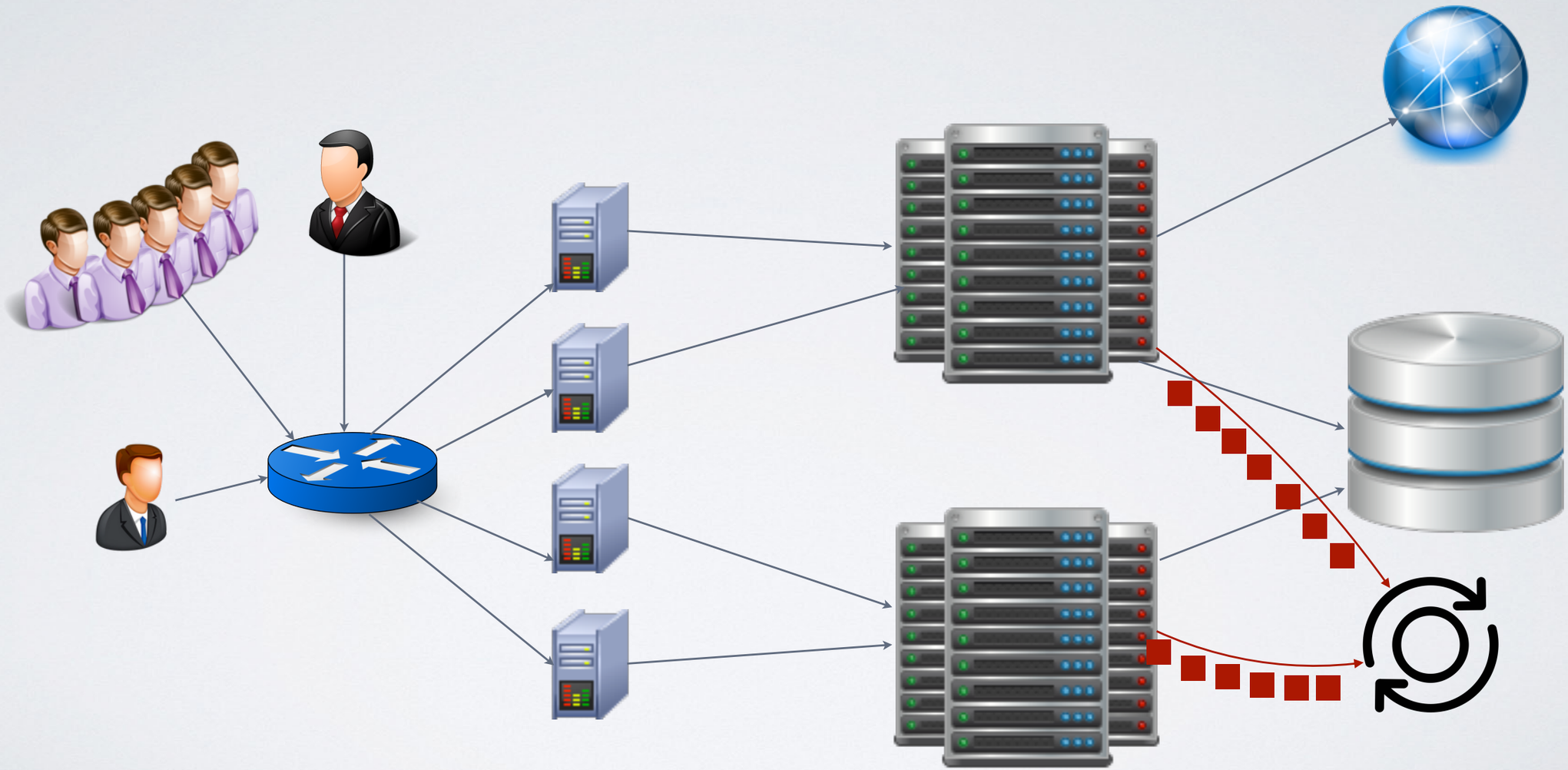
5 - AUDIT SENSITIVE EVENTS

Why?	Provide record of activity, deter wrong doing, provide a log to reconstruct the past, provide a monitoring point
Principle	Record all security significant events in a tamper-resistant store
Tradeoff	Performance; operational complexity; dev cost
Example	Record changes to "core" business entities in an append-only store with (user, ip, timestamp, entity, event)

5 - AUDIT SENSITIVE EVENTS



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6 - SECURE DEFAULTS & FAIL SECURELY

Why?	Default passwords, ports & rules are "open doors" Failure and restart states often default to "insecure"
Principle	Force changes to security sensitive parameters Think through failures - to be secure but recoverable
Tradeoff	Convenience
Example	Don't allow "`SYSTEM/MANAGER`" logins after installation On failure don't disable or reset security controls

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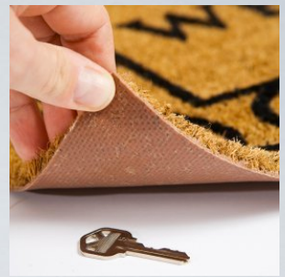
7 - NEVER RELY ON OBSCURITY



Why?	Hiding things is difficult - someone is going to find them, accidentally if not on purpose
Principle	Assume attacker with perfect knowledge, this forces secure system design
Tradeoff	Designing a truly secure system takes time and effort
Example	Assume an attacker will guess a "port knock" network request sequence or a password obfuscation technique

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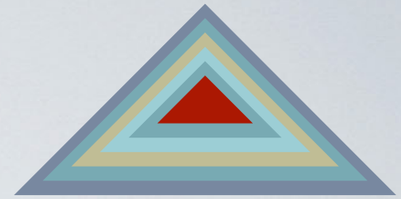
8 - DEFENCE IN DEPTH



Why?	Systems do get attacked, breaches do happen, mistakes are made - need to minimise impact
Principle	Don't rely on single point of security, secure every level, stop failures at one level propagating
Tradeoff	Redundancy of policy; complex permissioning and troubleshooting; can make recovery difficult
Example	Access control in UI, services, database, OS

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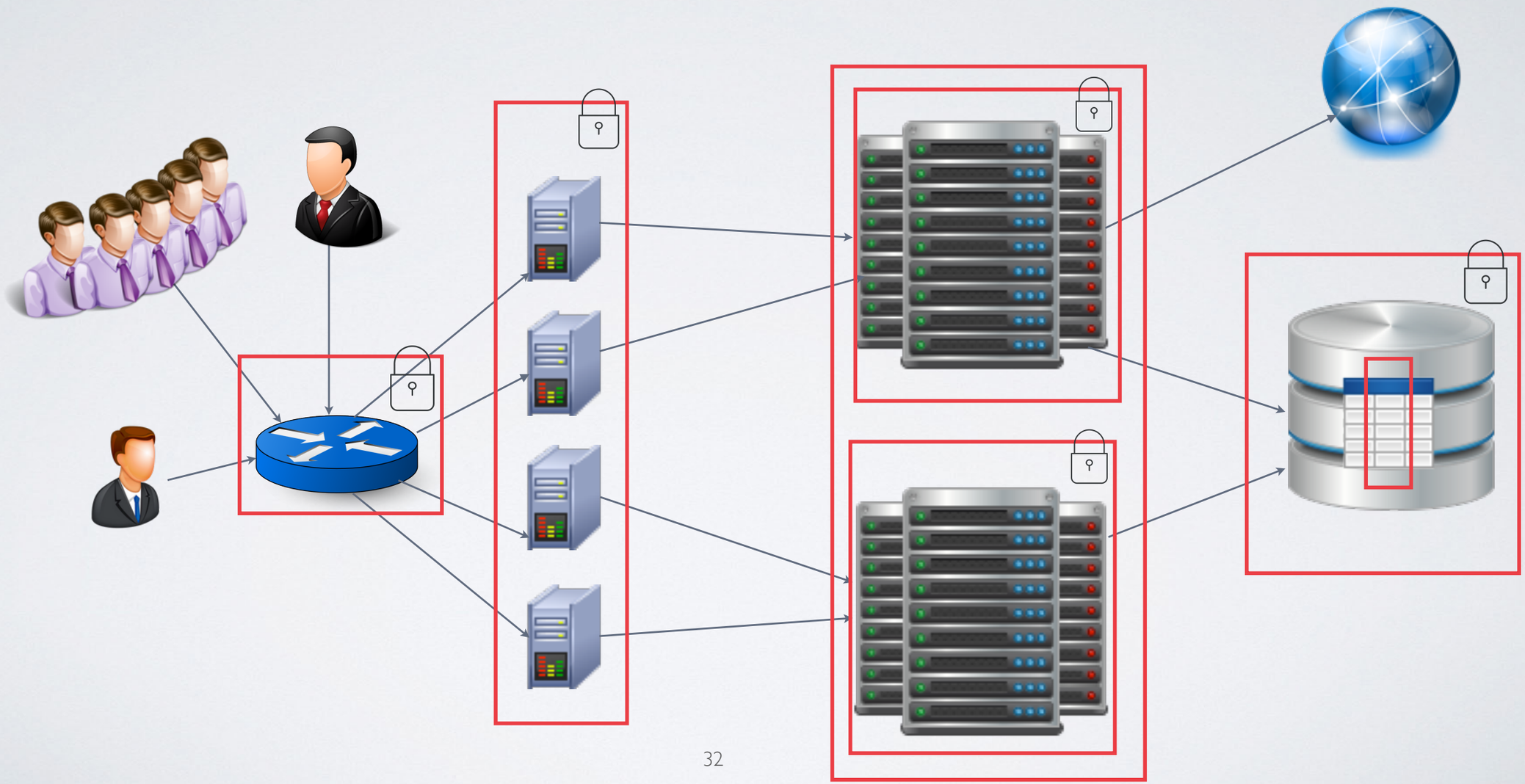
8 - DEFENCE IN DEPTH



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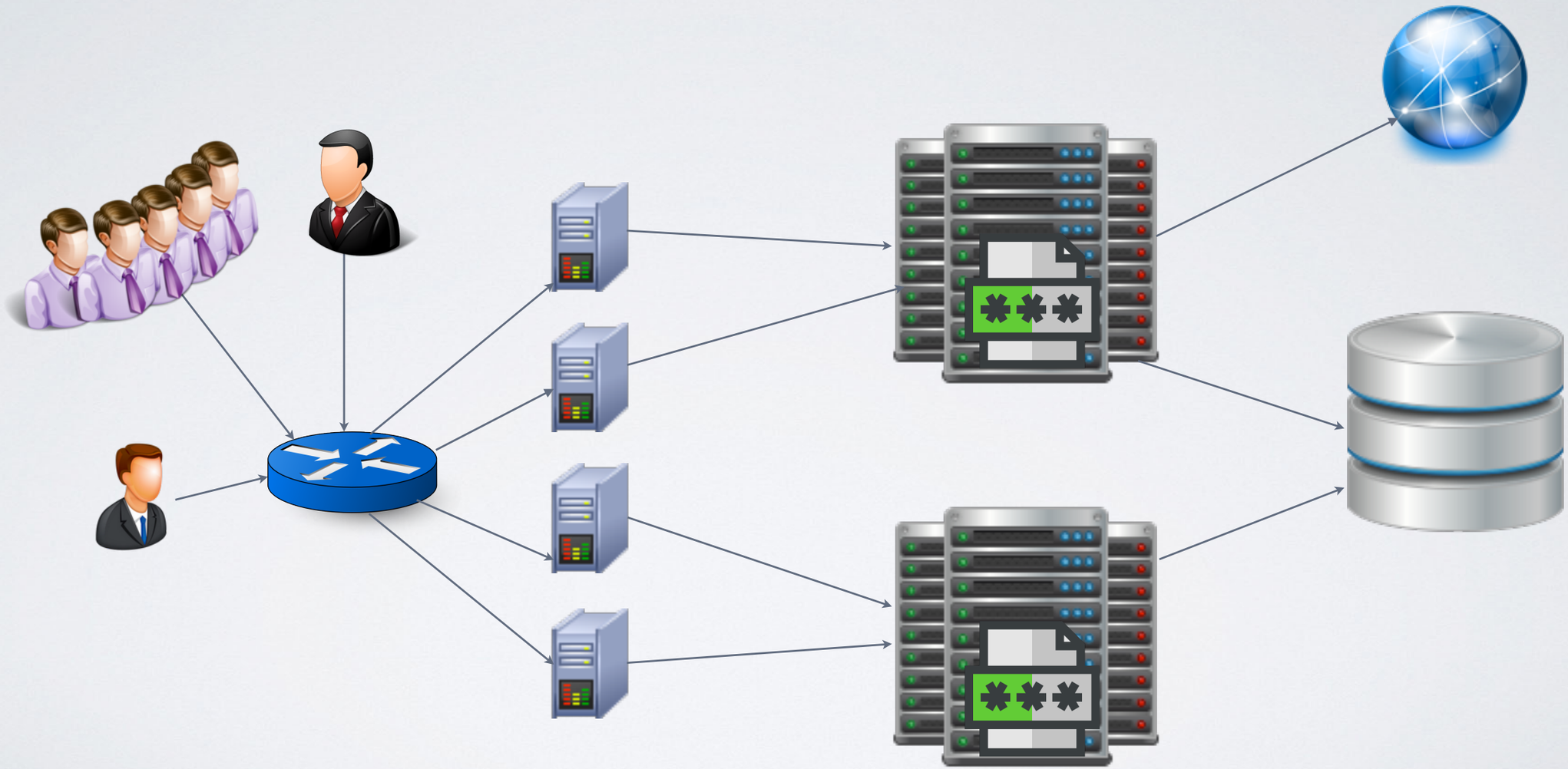
9 - NEVER INVENT SECURITY TECH

Why?	Security technology is difficult to create - avoiding vulnerabilities is difficult
Principle	Don't create your own security technology - always use a proven component
Tradeoff	Time to assess security technology; effort to learn it; complexity
Example	Don't invent your own SSO mechanism, secret storage or crypto libraries … choose proven components

9 - NEVER INVENT SECURITY TECHNOLOGY



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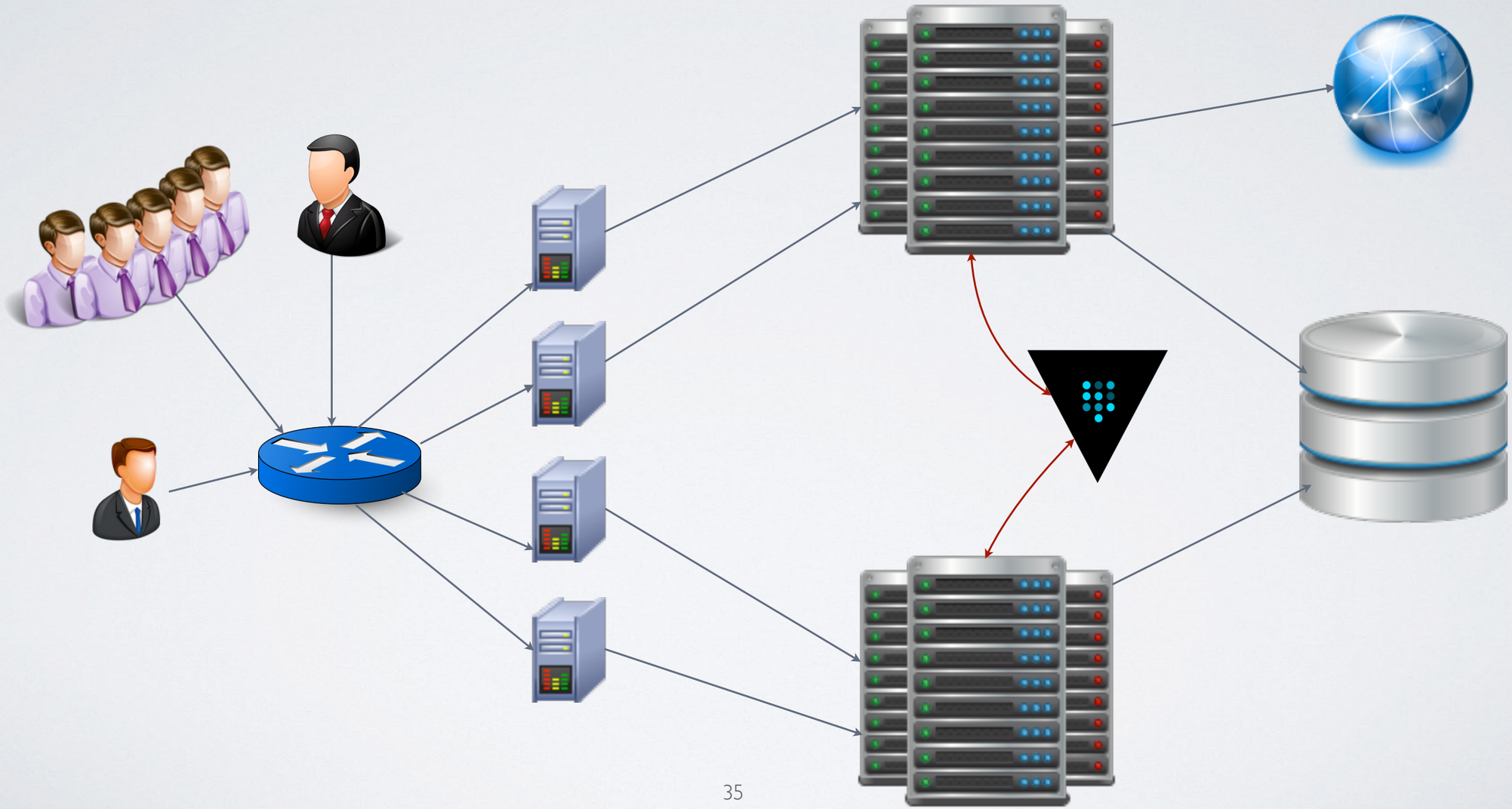

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10 - SECURE THE WEAKEST LINK

Why?	"Paper Wall" problem - common when focus is on technologies not threats
Principle	Find the weakest link in the security chain and strengthen it - repeat! (Threat modelling)
Tradeoff	Significant effort required; often reveals problems at the least convenient moment!
Example	Data privacy threat => encrypted communication but with unencrypted database storage and backups

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SECURITY IN REAL TEAMS

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SOME COMMON CONCERNS

Will this cost a lot?

Where do we start?

Who is involved?

What tools do we use?

Can we do this with agile?

Won't this slow everything down?

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SOME OBSERVATIONS

- Some **individuals** will find it **fascinating**, some will **hate** it
- Teams will need **guidance and inspiration**
- Teams need to **own their security process**
  - But a clearly defined **starting point** and **standards** very valuable
- A clear **roadmap** helps to avoid overload

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SOME USEFUL TACTICS

- Form a group of **security champions** - invest in them
  - involve many roles (BA, developer, tester, architect, …)
- **Communicate importance** of security from the top
  - and from the customer
- Make the **right thing the easy thing**
  - checklists and templates, clear guidance, packaged tools
- Be prepared for the process to **take time**

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USUALLY A GRADUAL PROCESS

EXPERT APPLICATION SECURITY TEAM

COMPETENT APPLICATION SECURITY TEAM

INFORMED APPLICATION SECURITY TEAM

SECURITY AWARE TEAM

NO SECURITY PRACTICE

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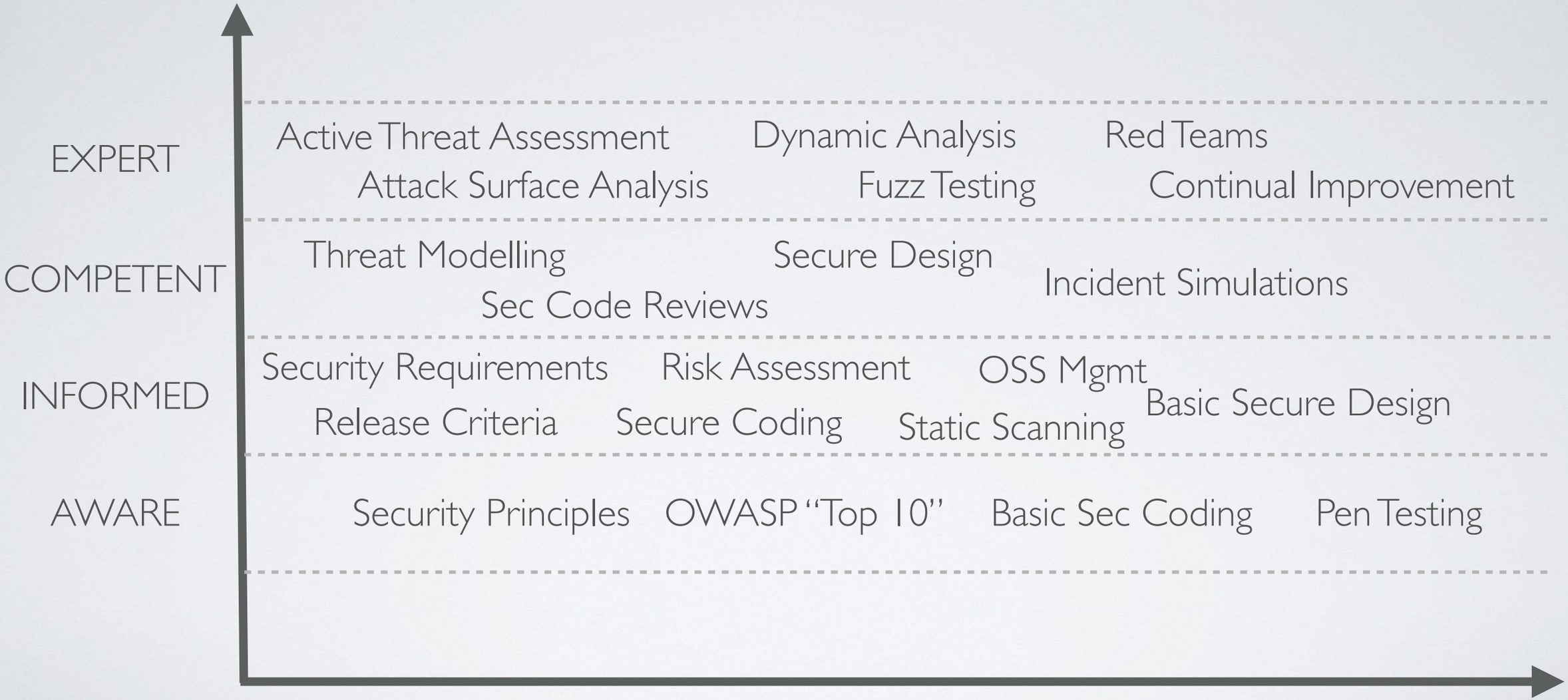
EXAMPLE CAPABILITY PLAN



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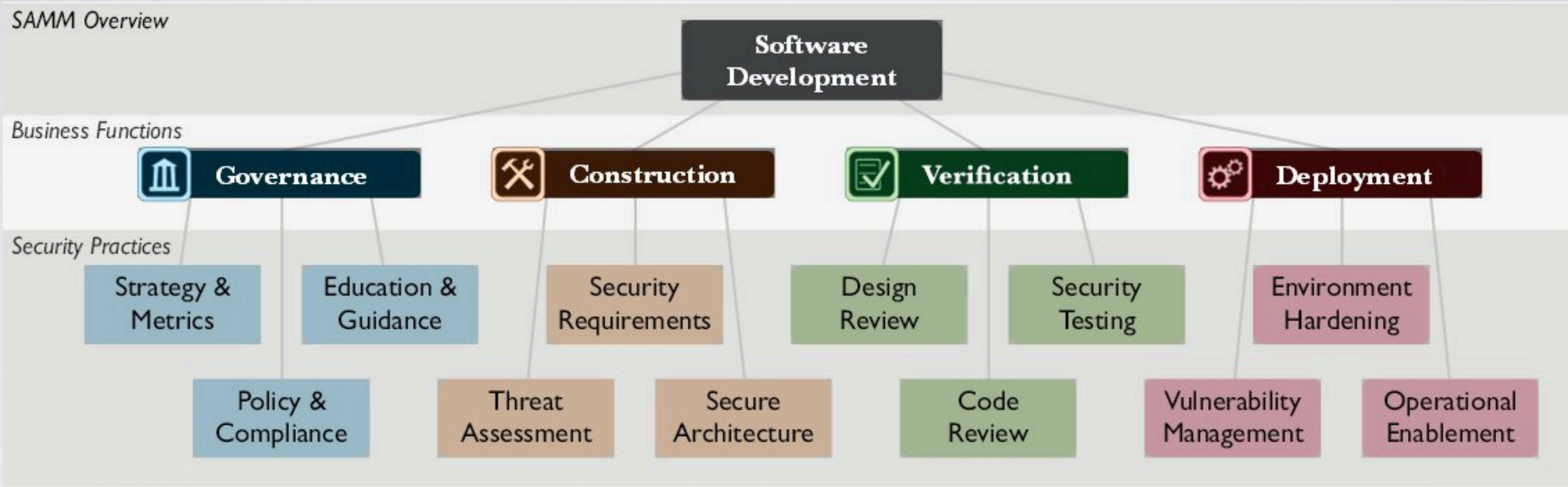
OWASP SAMM



http://www.opensamm.org

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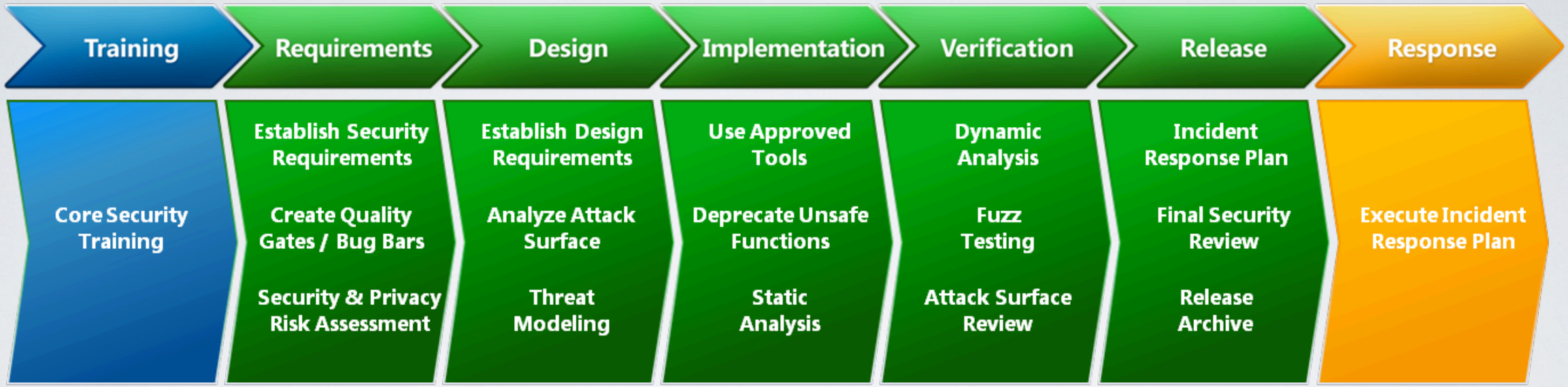
MICROSOFT SDL



https://www.microsoft.com/en-us/sdl/

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TO RECAP …

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GETTING TEAMS DOING IT

EXPERT APPLICATION SECURITY TEAM

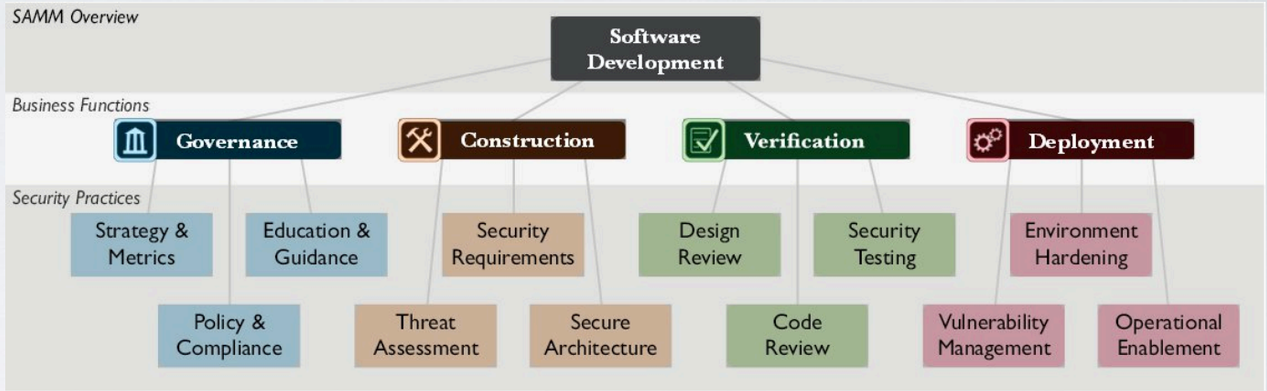
COMPETENT APPLICATION SECURITY TEAM

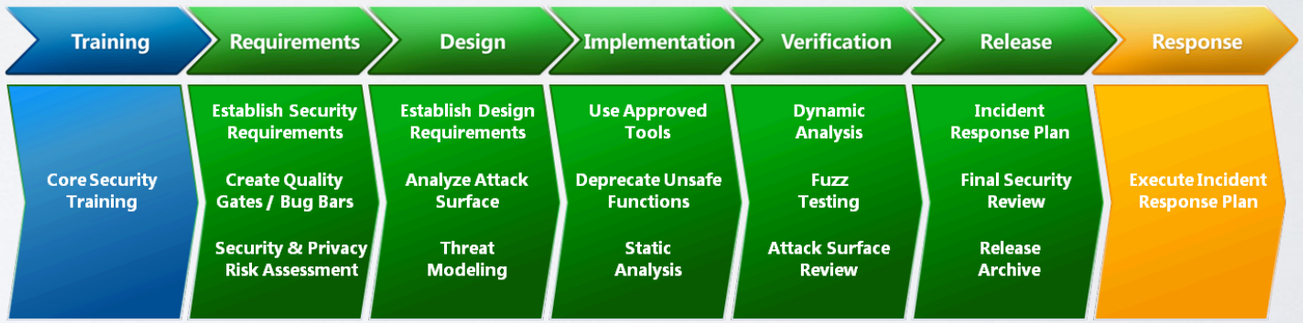
INFORMED APPLICATION SECURITY TEAM

SECURITY AWARE TEAM

NO SECURITY PRACTICE

Continuous Process





Towards Secure SDLC

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REFERENCES

- UK Government NCSC Security Principles:
  https://www.ncsc.gov.uk/guidance/security-design-principles-digital-services-main
- NIST Engineering Principles for IT Security:
  http://csrc.nist.gov/publications/nistpubs/800-27A/SP800-27-RevA.pdf
- Short intro to McGraw's set:
  http://www.zdnet.com/article/gary-mcgraw-10-steps-to-secure-software/
- OWASP Principles set:
  https://www.owasp.org/index.php/Category:Principle

BOOKS


Adam Shostack
threat modeling
designing for security
Software Systems Architecture
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APPLIED CRYPTOGRAPHY
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THANK YOU

QUESTIONS?

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