IEEE COMPUTER SOCIETY

Automated Threat Analysis and Management in a Continuous Integration Pipeline

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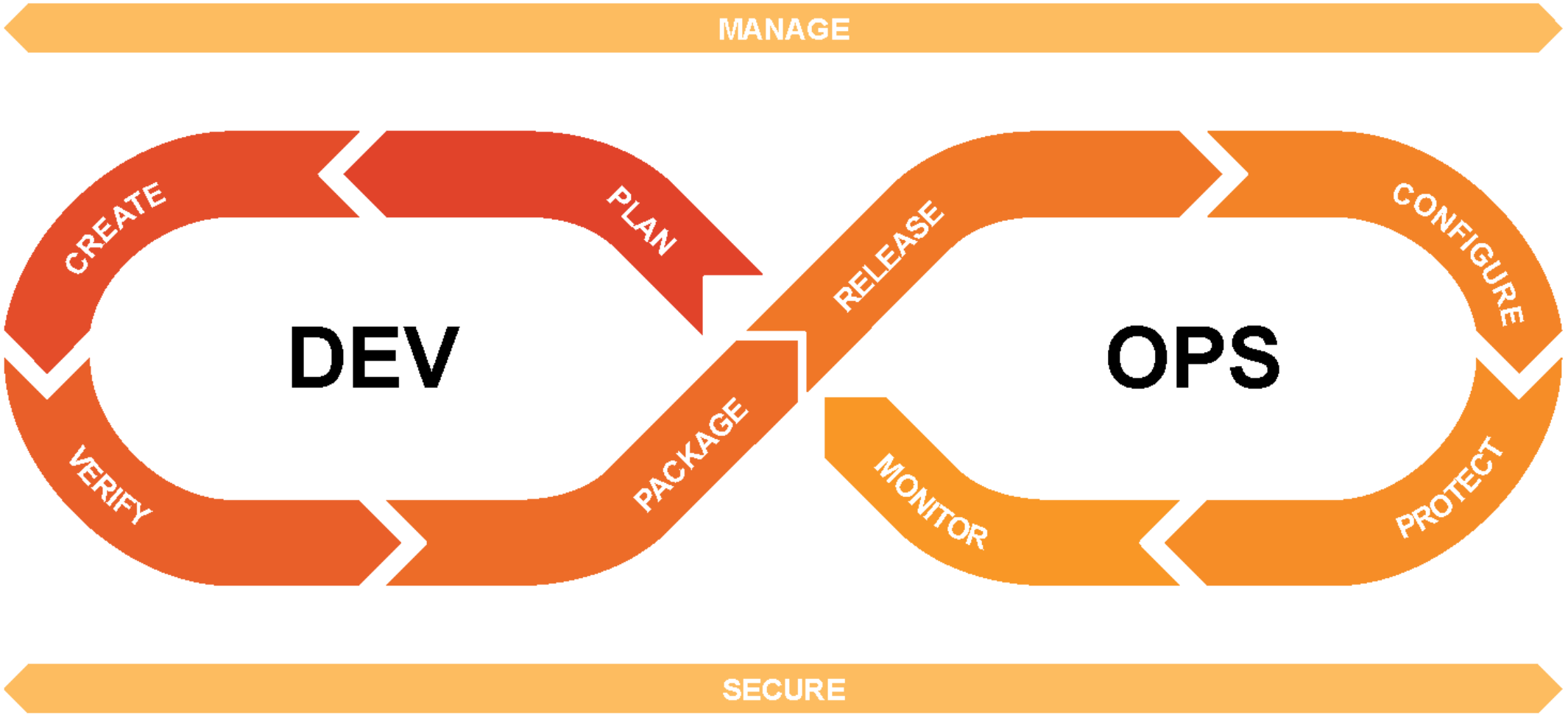
DistriNet

#IEEESecDev

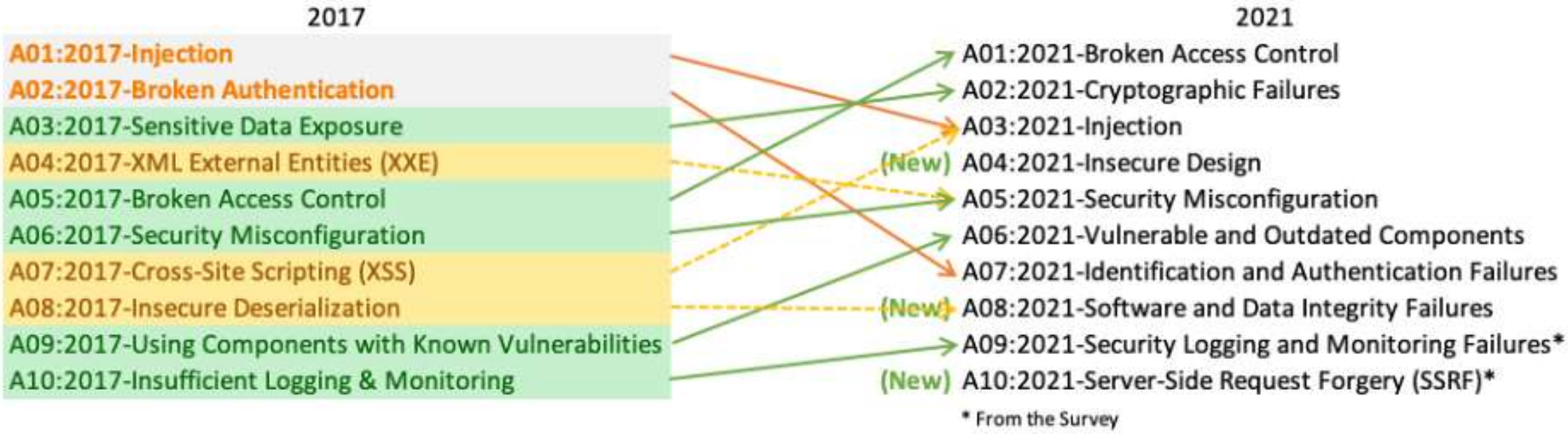
https://secdev.ieee.org/2021

DevOps Lifecycle

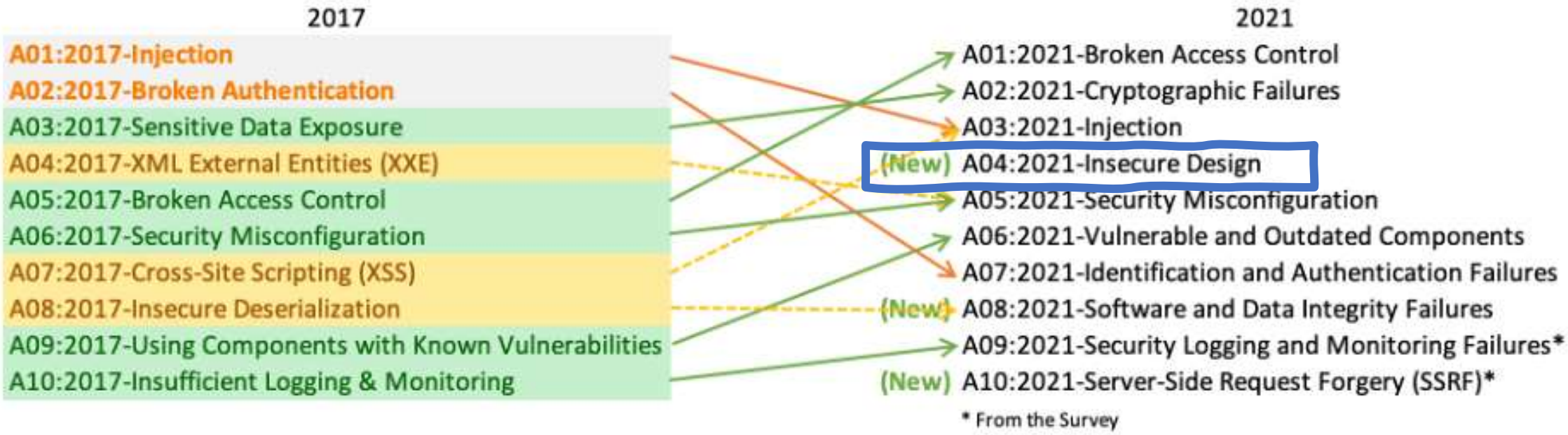


Source: https://about.gitlab.com/stages-devops-lifecycle/

OWASP Top 10 2021



OWASP Top 10 2021



Insecure Design

A04:2021-Insecure Design is a new category for 2021, with a focus on risks related to design flaws. If we genuinely want to "move left" as an industry, we need more threat modeling, secure design patterns and principles, and reference architectures. An insecure design cannot be fixed by a perfect implementation as by definition, needed security controls were never created to defend against specific attacks.

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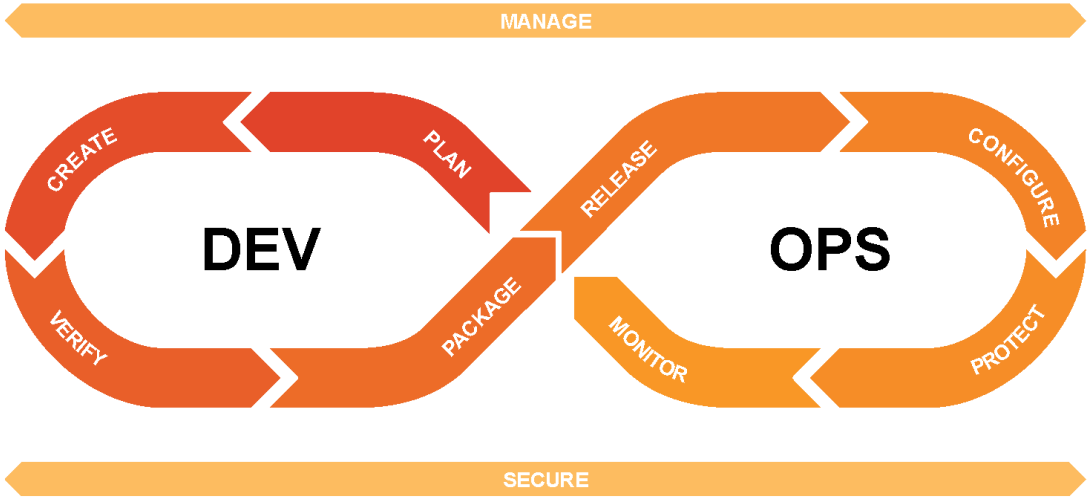
DevOps lifecycle



Progress threat mitigation

Which threats addressed?

Evolution security risk

Moving in the right direction?

Impact proposed changes

Do they introduce new threats?

Source: https://about.gitlab.com/stages-devops-lifecycle/

Frequent threat modeling

To find security design flaws

Threat modeling for systematic analysis design

Often manual exercise

Slow and expensive, frequently single-shot effort

Security expertise

Reliance on limited resource

Existing threat modeling tools support limited embedding in development lifecycle

Manual elicitation

ThreatDragon, ThreatSpec, …

Automated elicitation

Pytm, SPARTA, IriusRisk, ThreatAgile, …

Code analysis implementation-level vulnerabilities

Static and dynamic application security testing (SAST/DAST)

Can we leverage threat modeling tool support in a continuous integration context?

Reduce manual effort

Leverage existing analysis tools

Requires threat analysis engine

Elicit all applicable threats, mitigation status, risk, …

Run analysis in CI/CD pipelines

Enable automated and frequent re-assessment

Automate threat management

Versioning design model

Together with code

Keeping track of threat analysis results

Linked to source code commits

Threat mitigation progress

Track evolution of threats during development

Elicitation engines

Not all tools elicit threats

Manual creation (e.g., ThreatSpec, ThreatDragon)

Elicit mitigated threats for progress monitoring

Existing tools remove mitigated threats (e.g., Pytm)

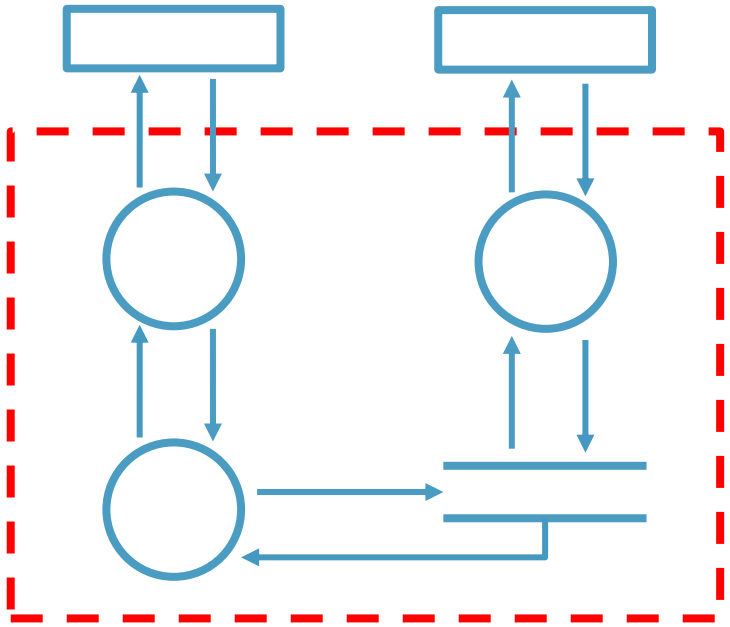
Richer elicitation enables more analyses

Risk, % mitigated, etc.

Leveraged existing engine

SPARTA threat analysis engine

Threat Analysis



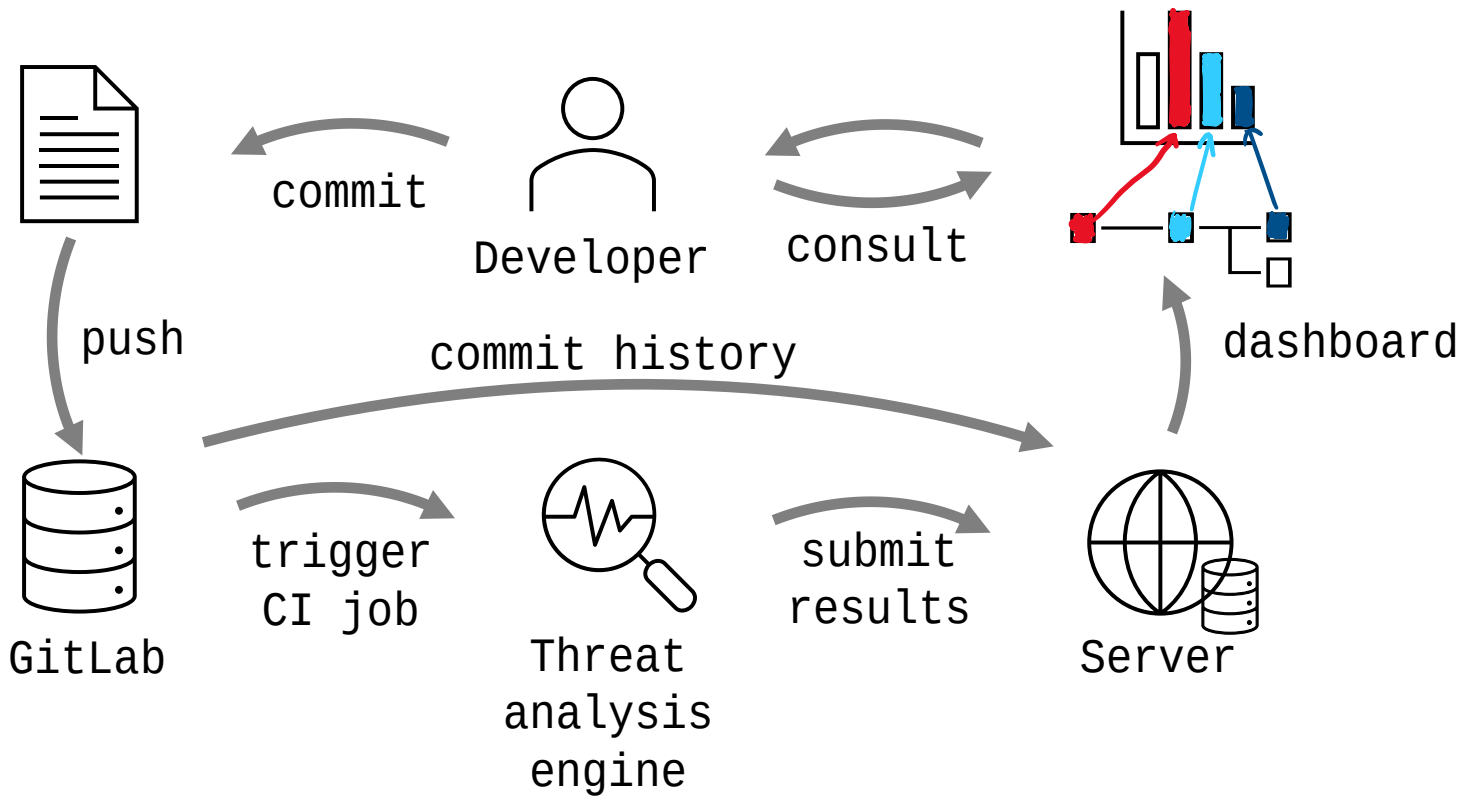
+ security solutions

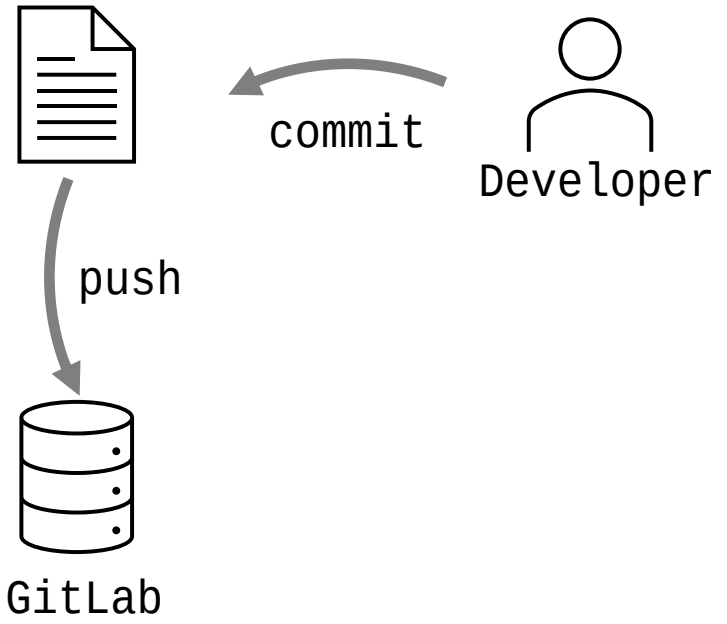
List of threats

+ inherent risk (fully vulnerable)

+ residual risk (considering solutions)

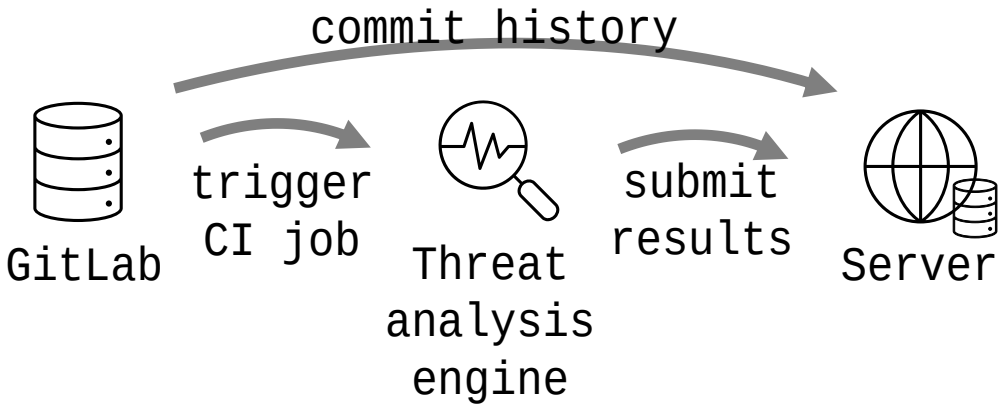
Continuous Threat Analysis & Management





Version model and code

Track evolution system design

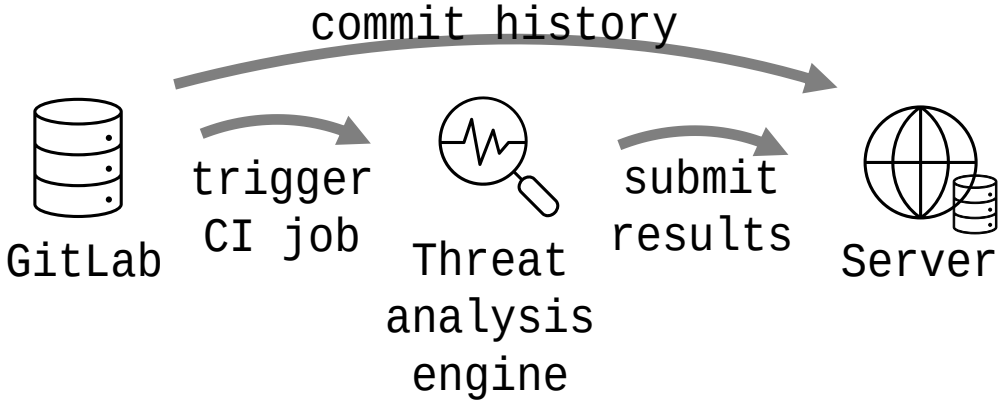


Version model and code

Track evolution system design

Every push triggers CI job

Perform automated assessment



Version model and code

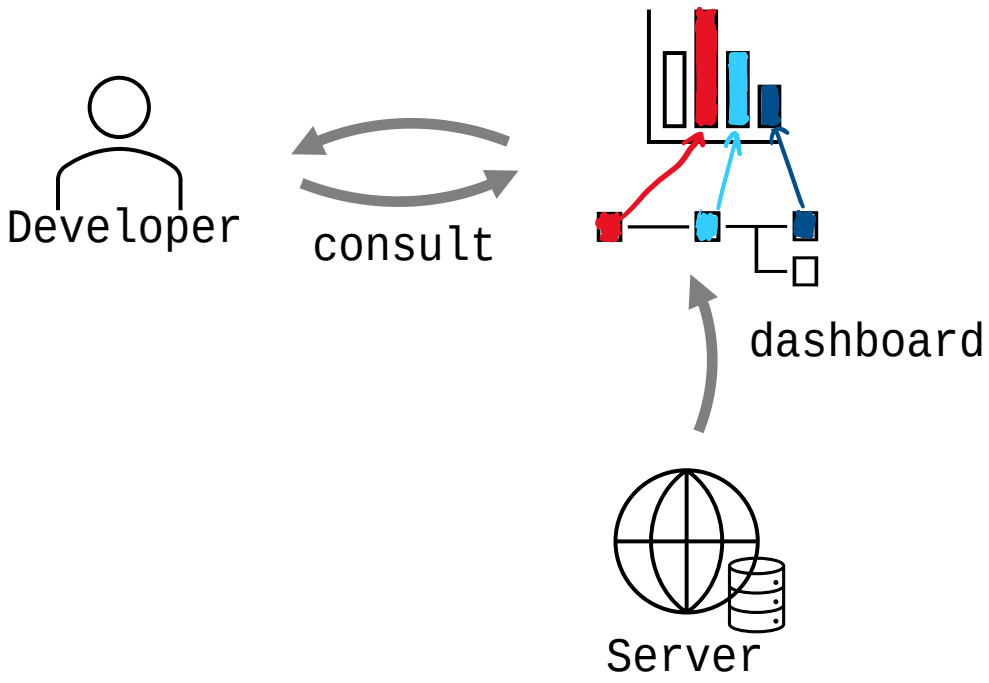
Track evolution system design

Every push triggers CI job

Perform automated assessment

Collect results

Submitted to server, linked to commit



Version model and code

Track evolution system design

Every push triggers CI job

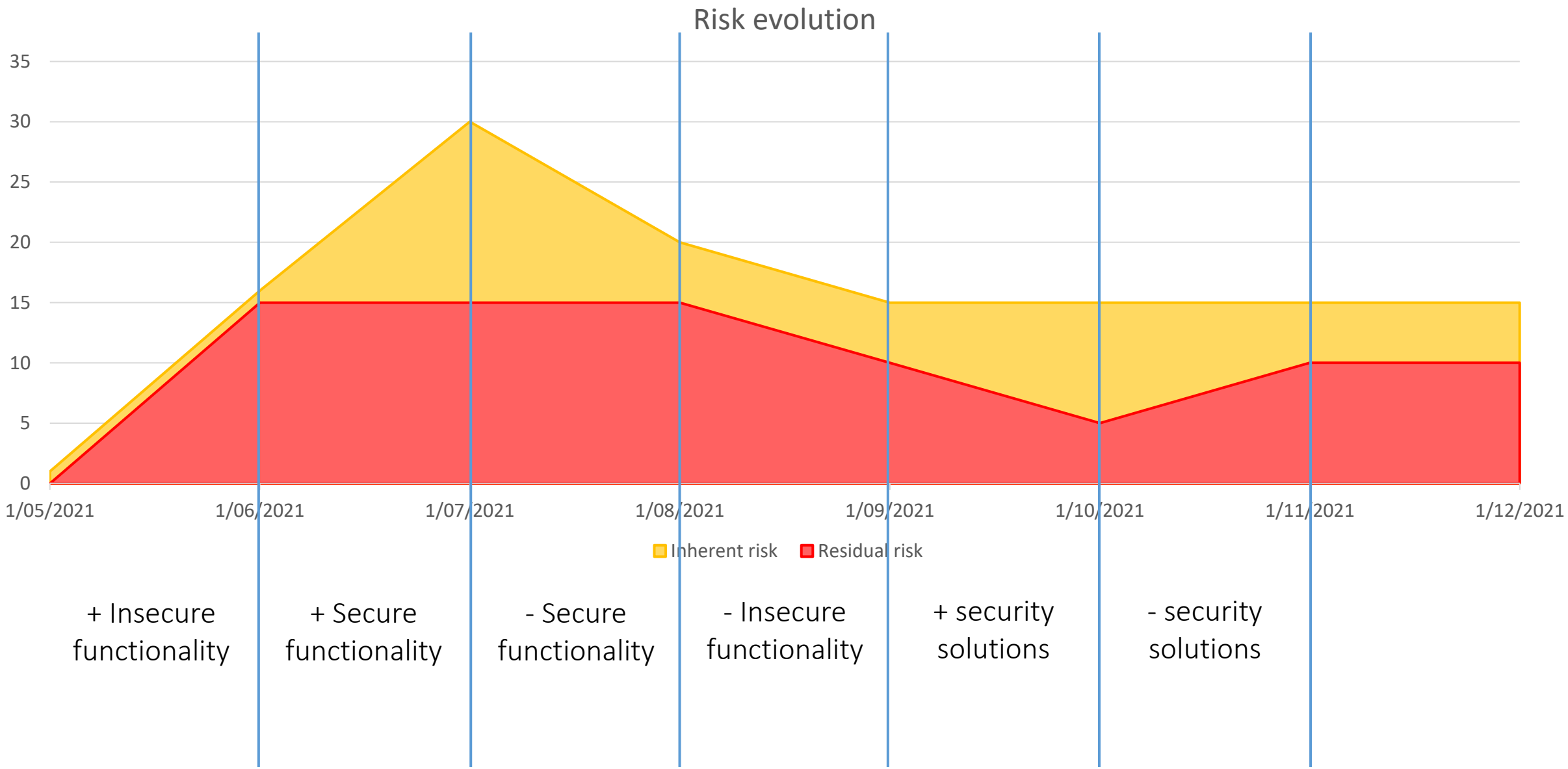
Perform automated assessment

Collect results

Submitted to server, linked to commit

Results dashboard

Present analysis results to user


Risk evolution
35
30
25
20
15
10
5
0
1/05/2021
1/06/2021
1/07/2021
1/08/2021
1/09/2021
1/10/2021
1/11/2021
1/12/2021
Inherent risk
Residual risk
+ Insecure functionality
+ Secure functionality
- Secure functionality
- Insecure functionality
+ security solutions
- security solutions

Addresses threat management concerns

Evolution of security risk

Are measures effective in reducing risk?

Threat mitigation progress

What is the progress in mitigating threats?

Remaining threats to address

What are the most important threats mitigate?

Discussion

1 Input model accuracy

Correspondence between model and code

2 Analysis activities

Types of analysis

3 Security metrics

What to measure for assessing security

1 Input model accuracy

Require model representation

Need model to analyze

Source code annotations

Embed model in code (e.g., threatspec)

Text-based model

Python, YML, … (e.g., pytm, threagile)

1 Input model accuracy

Require model representation

Need model to analyze

Conformance checking

Verify model corresponds to code

Automated reconstruction

Automatically extract model

2 Analysis activities

Threat management progress

Progress in threat mitigation?

Impact proposed changes

Security impact of feature branches?

Effectiveness of specific solutions

Do security solutions have the intended effect?

3 Security metrics

Current metrics

Threat count, inherent risk, residual risk, …

Assess new metrics

Leverage historical analysis results

Conclusion

Step towards tighter integration threat modeling and code

Model together with code

Model from code

Automatic extraction

Threat modeling as a continuous concern

Continuous quality monitoring

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