DevOps in Regulated Environments

Achieving Continuous Compliance at Speed

Balancing Risk, Speed, Feedback and Control

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Disclaimers

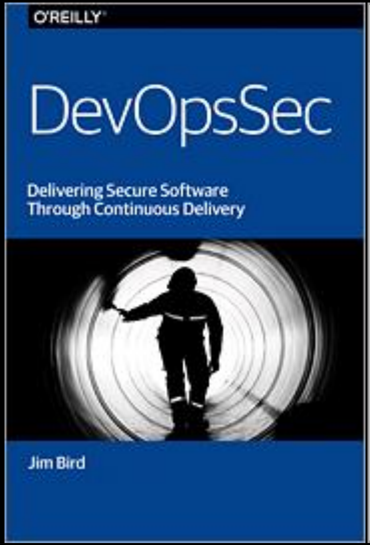
- I am not a lawyer, and I’m not offering legal advice
- I’m not representing my employer

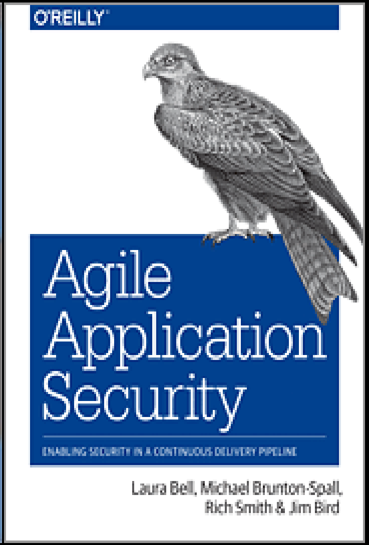
Then why listen to me?

- 20+ years experience in global financial services and fintech
- Worked with stock exchanges, investment banks, and central banks in 30 countries
- CTO of a major institutional trading platform
- Experience with many different regulators

In my spare time…

- SANS Analyst and co-author of SANS DEV-534 Secure DevOps
- OWASP (Cheat Sheet series, Proactive Controls co-lead)
- Write about AppSec, Agile and DevOps: books and blogs

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Agile Application Security
ENABLING SECURITY IN A CONTINUOUS DELIVERY PIPELINE
Laura Bell, Michael Brunton-Spall, Rich Smith & Jim Bird

Finding the right balance between speed, cost, feedback and control, when meeting your regulatory obligations

ACHIEVING COMPLIANCE

Drivers and Conflicts

- **Speed:** Agile, MVPs, hypothesis-driven design, Continuous Deployment and Continuous Flow. Cycle time to delivery and velocity – compliance can't block delivery
- **Cost:** minimize cost of change, eliminate waste and bottlenecks and delays and overhead, Lean optimization, working software over documentation. Keeping compliance and auditing costs to a minimum. Scaling (up and down)
- **Feedback:** DevOps teams iterate and run experiments (A/B) in production with real users, experiment-driven design… lots of throw away changes… requires quick/measurable feedback. Compliance can't get in the way of feedback
- **Control:** risk management and governance, management accountability, assurance, approvals, and auditing. ITIL and COBIT and NIST/ISO standards. Conflicts with continuously improving, self-managing, self-service DevOps teams

Compliance Approaches

Prescriptive

- Rules-Based: regulations tell you what you have to do, how often, what evidence is required
- You know what auditors are looking for
- You – and auditors – can build checklists
- Sets minimum standards – but discourages organizations from doing more than the minimum
- Too much in some areas, not enough in others
- Examples: PCI-DSS, safety regs, FISMA, FedRAMP

Descriptive

- Outcome-based: regulations tell you what you can/cannot do, but not how to do it
- Directional, appeals to "recognized best practices", "adequate and reasonable"
- Compliance is in the opinion of the auditor
- Allows for innovation, but….
- …creates uncertainty: are we doing "the right things", are we doing enough?
- You will need to defend your program (**and your assessment of risk**) to auditors and others
- Pushes organizations (and auditors) towards recognized frameworks (ISO 27001, NIST 800-53, COBIT, SOC 2…)
- Examples: HIPAA, Reg SCI, SOX 404

What Auditors Look for…

- **Scope:** everyone clearly understands what data/systems/networks and what activities are in/out of scope
- **Privacy:** classifying, tracking and protecting private/confidential/sensitive data
- **Risk management:** top down (management accountable), continuous review and implementation, policy-driven and procedural, active (respond to new/changing threats)
- **Approvals:** management authorization, protection against malicious insiders and fraud
- **Separation of Duties:** no one person has control end-to-end, “need to know” access to data
- **Awareness:** regular training on compliance requirements, policies are reviewed/published, NDAs…
- **Assurance:** regular testing and evaluation of controls
- **Auditing:** evidence and traceability
- **Consistency:** walk the talk, internal and external reviews to identify exceptions (red flags)
- **Corrective Actions:** failures will happen (at least minor failures), but you must show that problems were understood and remediated
- **Sufficient and Appropriate:** structured and comprehensive controls, standards, certification

What you want from compliance

- **Just enough:** you don’t get an award for being “more compliant” – minimize costs and overhead
- **Free:** where possible, take advantage of work that people are already doing
- **Clear:** everyone should know when they are doing things right/wrong
- **Measurable:** you can tell if you are doing things right/wong
- **Practical:** rules that people can and will follow
- **Shareable:** work can be reused across systems/teams
- **Consistent:** checks/tests that work every time
- **Non-blocking:** don’t stop people from getting useful work done

Risk Management for DevOps

Compliance is about **understanding, managing and minimizing risk** – and proving that you are doing this

- Technical and project risks are handled **implicitly** in Agile (Scrum cycle + XP practices)
- Compliance requires **explicit** risk management (especially for security, privacy, legal risks) – add to backlog
- Top-down risk management: policies, control objectives, reviewed and communicated
- Upfront reviews: understand/assess technical, operational and compliance risks – Netflix's **"Paved Road"**
- Operational risks: change/release control (small changes done often so change is routine, dark launching, canaries), automation, aligning test and production, metrics/monitoring to detect exceptions and failures
- Build and delivery **pipelines provide control plane**: build risk management into workflows around the pipeline (including reviews, testing, approvals, notifications)
- OWASP Top 10 for application security risks: awareness, training, scanning and reviews
- Retrospectives and postmortems: leverage to assess and improve, think of reviews and **feedback loops as risk management controls**, involve security/compliance, record outcomes
- **Transparency** and collaboration: reduce misunderstandings and missed requirements, solves problems better/faster, improves feedback – use as a risk management tool

Data Privacy for DevOps

- Understand privacy obligations upfront – and when rules change – legal requirements and your organization's privacy notices
- Document your obligations and make sure that everyone understands them – reviews, training
- Legal requirements – translate into concrete requirements for teams – compliance stories and compliance in stories (review them with legal)
- Map out data and sensitivity levels – where data is created, updated, stored, accessed (everywhere – watch out for spreadsheets, tempfiles, caches, build artifacts…)
  - Minimize use of private data – only what is absolutely necessary
  - Crypto (detailed requirements), masking and tokenization (pseudo-anonymization…)
  - Access control
  - Auditing
  - Retention (and right to use, right to erasure)
- Be extremely careful when using production data for testing
- Ties directly to security… vulnerabilities/weaknesses compromise privacy, preventing and handling data breaches

Getting compliance out of policy statements, contracts and checklists and into code and tests

COMPLIANCE AS CODE

Compliance as Code

- Like “Infrastructure as Code”…. Get policies and procedures into code and automated tests
  - Implement **policies in configuration recipes**: provisioning and hardening (servers, databases, applications, firewalls….), pipeline workflows, scanning rules, check-in filters (secrets, banned functions), component/dependency analysis (OWASP Dependency-Check)
  - See dev-sec.io for hardening recipes (Chef, Puppet, Ansible) and SIMP Project (Puppet modules, open sourced in collaboration with NSA)
  - Automated tests to assert policies: SAST, DAST, compliance and vulnerability scanning, TDD/BDD (**test first = compliance first**), Gauntlt, InSpec/Serverspec
  - Runbooks become automated build, deployment and release orchestration instructions
- All code (including configuration and tests and test data) is checked in (revision history, approvals), reviewed, scanned, and tested (yes, you need to **test your tests!**)
- **Code in repo** becomes the **single source of truth** for your technical controls – protect it
- Compliance rules often detailed and fussy, so review/test carefully
- Automatic execution on every change: assurance, evidence, pipelines block if checks fail
- “**DevOps Kata**” – walk through deploying a change to a single line of code, trace every step

Writing code for auditors

- Auditors don’t (usually) understand code, engineers don’t understand why not
- Unit tests are not that useful, but unit test coverage is
- Declarative code is easier to audit – look at the end state, not all of the steps in between
- Engineers need to write clean, clear, well-structured code
- Annotate configuration recipes and playbooks (tie back to rules/policies)

Writing code for Auditors

InSpec: automated compliance checks

- Open source framework (like Serverspec) to write declarative compliance tests on Linux and Windows
- Also available for AWS, Azure and VMWare
- Annotations to define priority (based on risk/impact), and tie back to documented compliance controls
- Language for Chef Compliance product but you don't need Chef to use it

```
control "sshd-11" do
  impact 1.0
  title "Server: Set protocol version to SSHv2"
  desc "Set the SSH protocol version to 2. Don't
use legacy insecure SSHv1 connections anymore."
  tag security: "level-1"
  tag "openssh-server"
  ref "Server Security Guide v.1.0" url: "http://..."

  describe sshd_config do
    its('Protocol') { should cmp 2 }
  end
end
```

Engineers and auditors

- Compliance as code creates “opportunities” for engineers and auditors to work together
- Engineers and auditors are methodical, stubborn, and certain that they are right
- Some auditors are sharp, engaged, practical, creative, good to work with: others… not so much
- Engineers need to understand the auditor’s goals, rules, priorities, and why the audit is necessary: make sure that engineers understand and buy in upfront
- Auditors are not friends: never try to hide mistakes or oversights, but don’t offer information that they don’t ask for, if in doubt refer questions to management
- Auditors are not enemies: don’t attack the process or audit standard, don’t try to intimidate them, don’t patronize them
- Auditor questions and challenges are not attacks on the engineer’s competency – don’t be defensive
- Clarify requirements, make sure that everyone is satisfied with the evidence – auditors will ask for evidence that worked for them in the past, but there may be a better/simpler way for everyone
- Patience (on both sides) is required

Integrating compliance into development/engineering workflows

CONTINUOUS COMPLIANCE

Compliance as Stories

- Provide the team training up front: **especially product owners/managers** so they understand compliance/privacy obligations/constraints
- Compliance and security stories
  - Translate compliance and legal requirements/constraints into concrete work for engineers to do, and problems for them to solve
  - Include compliance steps in "conditions of satisfaction" and "definition of done" for user stories – and write tests to check them (**negative tests!**)
  - Write security stories for security controls
  - Write compliance stories for required reports, other evidence, audits
  - Add to backlog, update as needed
- Make compliance requirements explicit, clear and visible to everyone

Continuous Compliance

- Infrastructure provisioning/configuration through code
  - Secure Baseline: manage configuration and patches, apply hardening rules automatically
  - Production and Testing: prove that environments are in sync
  - No snowflakes: reset automatically if config drifts or tear down/rebuild on every change (immutable)
- CI/ CD pipeline for all changes: repeatable and consistent, automatic tests and checks
  - Repos to support everything as code (source and binary)
  - Runbooks into deployer rules and run-time checks
  - Move checklists into automated tests that pass/fail
  - Code reviews: leverage SAST and tools like Gerrit, review for risk not style (understandability, correctness – tie back to stories and conditions of acceptance, and safety/security – defensive coding)
  - Logs as evidence: log all steps, protect the logs and repos and build/delivery chain
- Scan everything and scan often
  - Run-time, code and dependencies, apps, containers, network
  - Feed findings into backlog to be remediated, and to GRC system for tracking (through APIs)

DevOps Audit Defense Toolkit

- Free, community built process framework based on a fictional organization (as described in “The Phoenix Project” book)
- Not recognized “best practice” but can be used as a template for continuous compliance
- Identify risks and controls, then map them to Continuous Deployment workflow
  - Track stories, bugs and vulnerabilities electronically for traceability (Jira tickets)
  - Check into repo using comment tag linking back to ticket
  - All code is scanned using approved tools and rules
  - Code reviews using tools (Gerrit, Review Board…) to enforce reviews and provide audit trail
  - CI/CD workflows – traceability and control from check in to deployment
  - TDD with test coverage thresholds – ensures that responsible testing is done
  - Artifacts are protected (signed and stored in repos)
  - Programmable configuration management (Chef, Puppet, Ansible) using same pipeline approach (check in, CI, CD, with scanning, testing, automated deployment)
  - All changes are done through CD pipeline: detective change control to alert on other changes
  - Metrics and “telemetry” part of reviews/requirements to provide feedback from production

Metrics and Feedback

- Use feedback to drive compliance and risk management – like other DevOps feedback
- DevOps teams are “metrics obsessed” (“measure everything”). Take advantage of this:
  - Automated test frequency and coverage
  - Scanning frequency and coverage
  - Vulnerability data from scanning/testing: #, severity, how long left open (in code, dependencies and run-time environment)
  - Defect density (security and logical/functional bugs)
  - Deployment success/failure – correlate with frequency/size of change, type of change
  - Mean time to detect/recover from failures and cycle time to deploy – window of vulnerability
- Measure cycle time to delivery and **impact of compliance on cycle time**
- Trend analysis and dashboards – use metrics to identify risks in teams/systems
- Dark spots (where you don’t have measurement) are risk areas

Understanding and overcoming objections from auditors, and creating a program that will make everyone (engineers, auditors, managers…) happy

OVERCOMING OBJECTIONS

Concerns/Sticking Points

Auditor Concerns	Addressing Them
Separation of Duties – unauthorized or untested changes, malicious insiders, fraud Continuous Deployment (self service deploys)	Pipeline – not people – makes changes Auditing and detective change control Testing – coverage and "conditions of satisfaction" Optional approval step
Change Control/Authorization	Product Owner represents management They approve all stories and acceptance Peer reviews/pairing for all code changes All changes are standardized, transparent
Access Control "You Build it, You Run it" means developers need production access	Pipeline – not people – makes changes Read-Only access for developers Encryptions tokens, pseudonymization

Concerns/Sticking Points

Auditor Concerns	Addressing Them
Documentation and evidence “Working Software over Documentation” Stories on sticky notes and card walls, models on white boards – just enough to understand	Upfront policies – defined, communicated Tickets and tests – requirements, verification Configuration policies in code (and tests) Code repos and version control Log everything – write once, archived
Standards and Best Practices Reference frameworks for auditors	Teams need flexibility to choose tools, tests But core controls/policies need to be consistent Changes to rules, workflows approved by CAB Tools that reference back to OWASP Top 10, CIS…

Keeping Auditors, Engineers AND Managers Happy

- Provide engineers with problems, give them some freedom (and accountability) to come up with solutions and to iterate
- Fit into how teams work (tools, steps) based on environment and risk – don’t dictate, adapt – no one right way, tools may vary between projects, as long as policy goals are met
- Involve auditors upfront and get their buy in – walk through examples/code (DevOps Kata)
- Focus on controls/checks that are simple, repeatable, easy to explain, automated
- Always capture evidence: tickets, logs, version history, chat, email read receipts…
- Continuous Delivery: changes are deployed through tools/process – not by a person (SoD)
- Audit/spot check regularly to make sure that controls are actually working
- Rely on detective and compensating controls (“Trust, but Verify”)
- Manual reviews/approvals are expensive: make them lightweight and make them count
- Some “compliance theater” may be required… but keep it to a minimum

Conclusion

- Translate boring/vague legalese into stories, “conditions of satisfaction” and “definition of done” – make them visible to everyone, problems that engineers can/must understand and solve
- Getting everything into code is a good thing! (different, but much more powerful)
- Build on CI/CD, build pipelines and test automation – not just about speed…. this puts focus and visibility where you want it: on your main path to production
- Do things that you should be doing anyway – and create evidence to show to your auditors
- Tracking work in tickets instead of post-its is a drag, but can be done in a Lean way
- Try to make compliance and risk management transparent to engineers
- Iterate, review and continuously improve – build on retrospection and feedback loops in Agile/Lean/DevOps for compliance and risk management
- People talking to each other and solving problems together and learning together is a good thing!
- DevOps teams must work in a consistent, disciplined and thoughtful way – but that’s the point of compliance in the first place
- It will take time to replace all paper and spreadsheets, and get people to understand and accept changes, but it’s worth it

For more information

- DevOps Audit Defense Toolkit: https://itrevolution.com/devops-audit-defense-toolkit/
- DevOps Handbook: https://itrevolution.com/book/the-devops-handbook/
- Dev-Sec.io hardening framework: http://dev-sec.io/
- SIMP Hardening Project: https://simp-project.com/
- Risk Management Theater/re: https://continuousdelivery.com/2013/08/risk-management-theatre/
- Continuous Delivery and ITIL Change management: https://continuousdelivery.com/2010/11/continuous-delivery-and-itil-change-management/
- DevOps Kata – deploy a single line of code: http://devopsy.com/blog/2013/08/16/devops-kata-single-line-of-code/
- Lean Enterprise Chapter 12: http://shop.oreilly.com/product/0636920030355.do
- The Phoenix Project: https://itrevolution.com/book/the-phoenix-project/