“That’s my perspective from 30 years of doing this”

An Interview Study on Practices, Experiences, and Challenges of Updating Cryptographic Code

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Why Crypto Updates Matter

- Cryptographic code loses security guarantees over time
- SHA-1 deprecation took over a decade
- Post-quantum cryptography transition underway
- Previous work shows many products contain outdated crypto

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"Never implement your own crypto" - but what about updating it?

Research Approach

Research Questions

- RQ1: How do developers become aware of crypto updates?
- RQ2: Why do developers update crypto implementations?
- RQ3: What are the update processes?
- RQ4: What challenges do developers face?

Methodology

- 21 semi-structured interviews
- Experienced developers with crypto update experience
- Mixed recruitment: professional contacts, email, Upwork
- Participants from companies, open-source projects, freelancers

Study Participants (N=21)

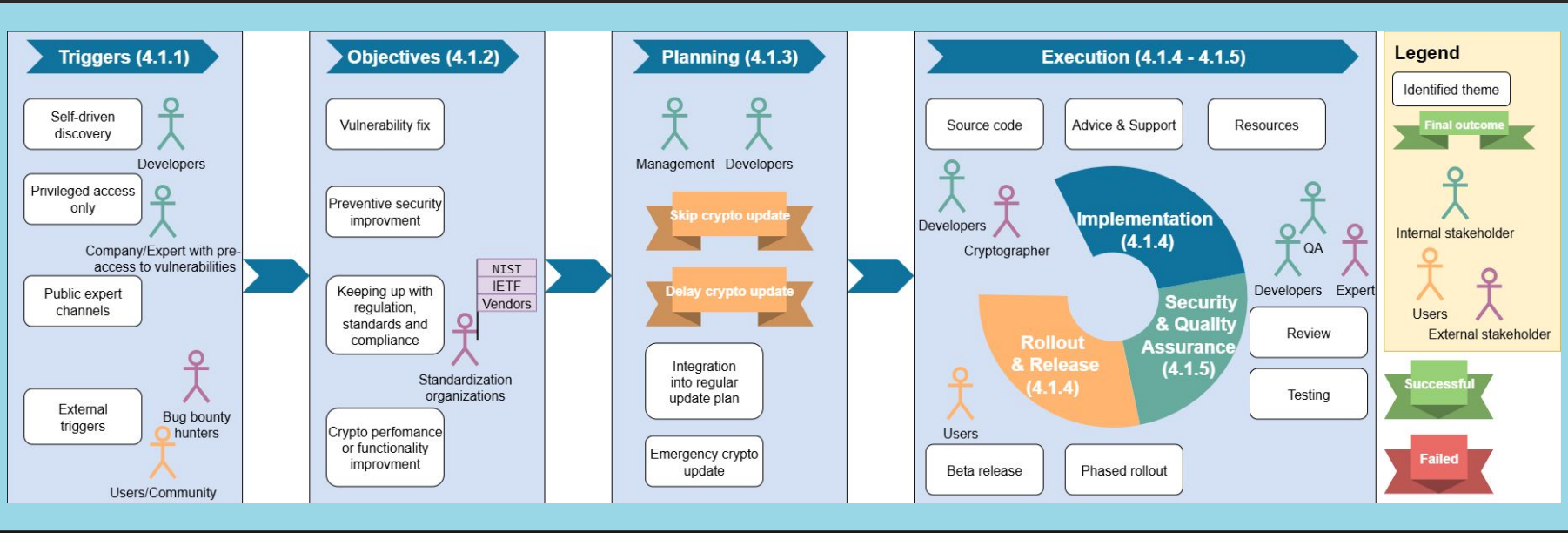
Demographics

- Experience: 1-35 years development, 0-37 years security
- Roles: Software engineers, CTOs, researchers, students
- Projects: Solo projects, companies, open-source
- Education: High school to PhD

Participants

- Group S (13): Self-implemented crypto (libraries, primitives)
- Group U (12): Used existing crypto implementations
- 4 participants in both groups

Six-Phase Update Process



13 Identified Challenges

Categorized by Phase

- **Awareness:** Staying up to date, lack of information
- **Planning:** Changing standards, backward compatibility, legacy support, lack of structured processes
- **Implementation:** Understanding crypto, lack of expertise, documentation issues
- **Quality:** Trust in third-party crypto
- **Rollout:** Technical issues, UI changes, performance problems

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> “One problem is that a lot of the stuff is used in embedded systems and basically systems that don’t change much. You’ve got 10 or 15-year-old implementations.”— P18

Crypto Updates vs. Regular Software Updates

- **Criticality:** Data breach vs. mispositioned logo
- **Review Requirements:** Six-eye rule vs. standard review
- **Complexity:** Algorithm understanding vs. feature implementation
- **Legacy Impact:** Embedded systems with 10-15 year lifespans
- **Expertise Required:** Specialized crypto knowledge vs. general development

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"If you don't update your PDF library, you may have a logo positioned wrongly. But if you don't update a crypto library, you may have your data leaked." — P13

Real-World Examples

- "Following the right people" — P3

- “It has taken ten years. However, at that time, because the project was mostly an open-source side project, for sure, there was no full-time work on this. Maybe it’s half a year in total.”— P9

What Developers Want

Key Desires

- **Education**: Crypto onboarding, continuous learning
- **Expertise**: Dedicated crypto team members
- **Resources**: Better documentation, practical examples
- **Tools**: Improved APIs, automated testing
- **Processes**: Clear best practices, structured approaches

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> "We didn't have any real best practices regarding security audits or security updates." — P7

Our Recommendations

For Developers

- Consider crypto updates in initial design
- Follow crypto experts on social media/blogs
- Treat crypto as permanent technical debt
- Plan for regular crypto reviews

For Library Developers

- Provide secure defaults and migration paths
- Document changes thoroughly
- Consider automated update tools

For Standards Organizations

- Provide actionable change logs
- Include implementation examples
- Simplify explanations for developers

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Preparing for the PQC Transition

- Largest cryptographic transition in history
- Limited experience with PQC implementations
- Multiple updates expected as standards evolve
- Our findings provide crucial insights for this transition

Apply our recommendations proactively

Key Takeaways

Main Findings

- Crypto updates are complex and unique
- Developers lack structured processes
- Backward compatibility is the major challenge
- Better support tools and processes are needed

Future Work

- Automated crypto update detection
- Developer tooling improvements
- Best practices development

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