MADS&P
Security and Privacy Research Group
at UW-Madison

UC San Diego

Experimental Security Analysis of the App Model in Business Collaboration Platforms

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** Equal contribution*
+ Work done while at UW-Madison

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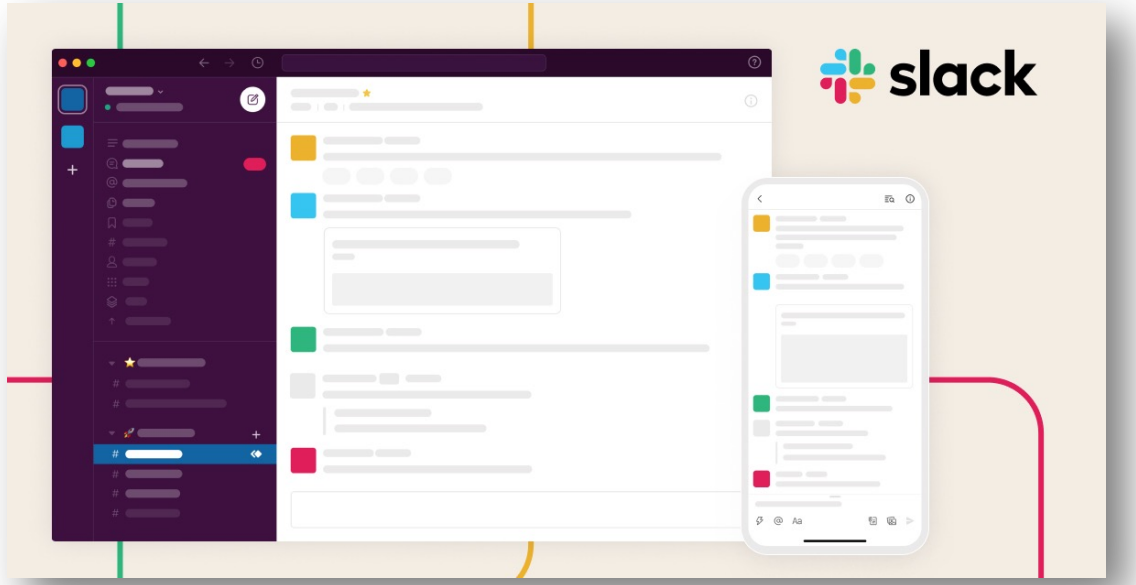
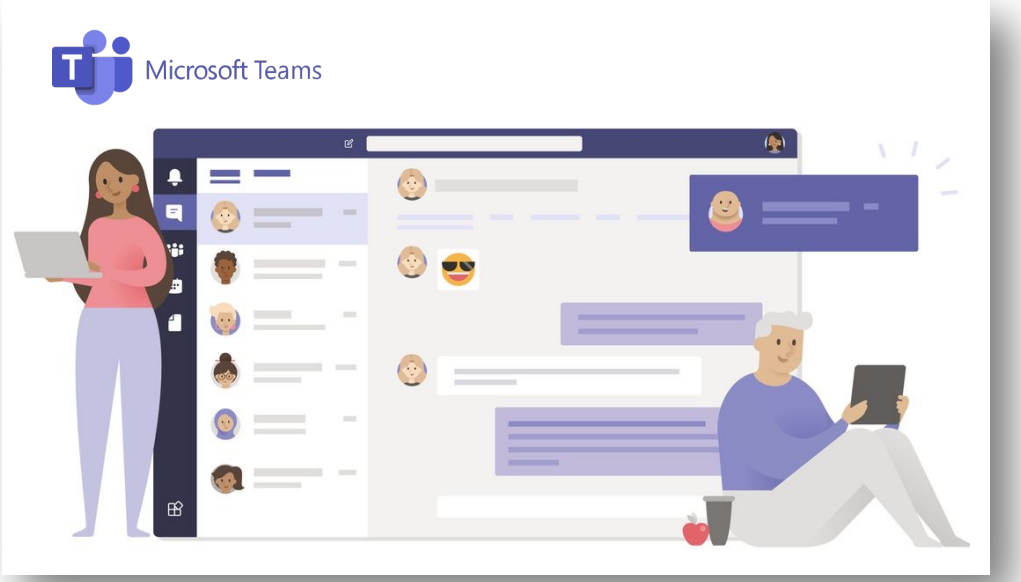
Business Collaboration Platforms (BCPs)

- Productivity & Team Collaboration
- Third-Party Integrations (Apps)





Figures from slack.com and support.microsoft.com

BCPs Have Become A Hub for Sensitive Resources

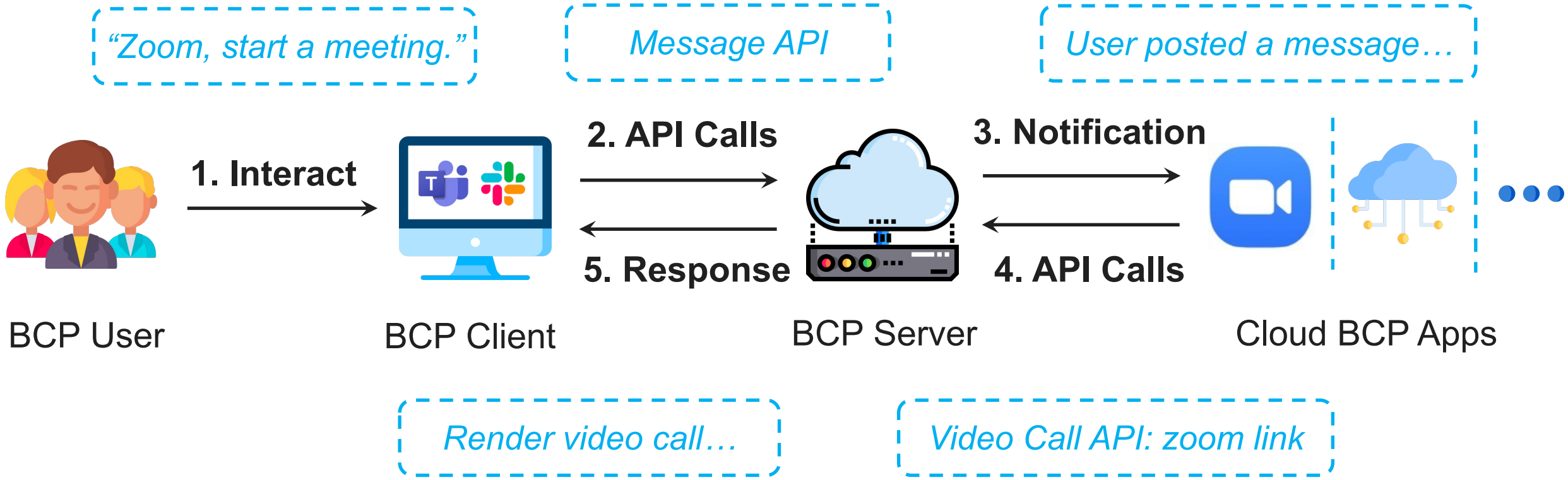
- Zoom Calls
- DropBox File Sharing
- Email Forwarding
- Code Repository Management
- …

What if the apps are malicious?

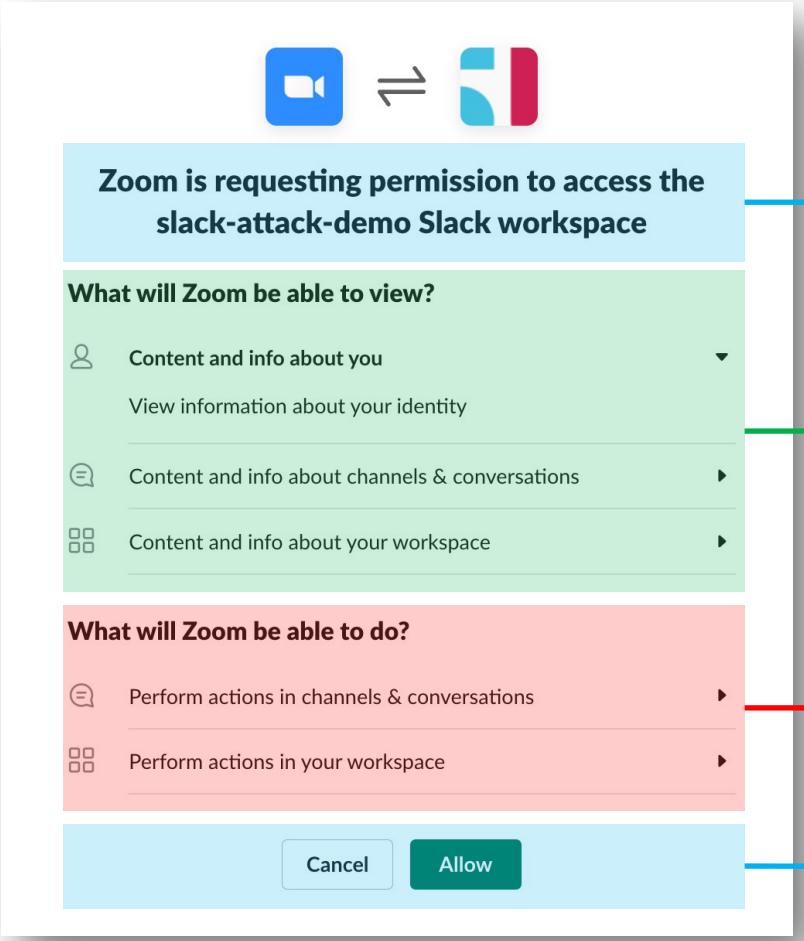
Can BCPs enforce security correctly?

Figure from slack.com

Background: App Workflow



Background: App Installation



1. App Requests Permissions

2. Read Permission Scopes

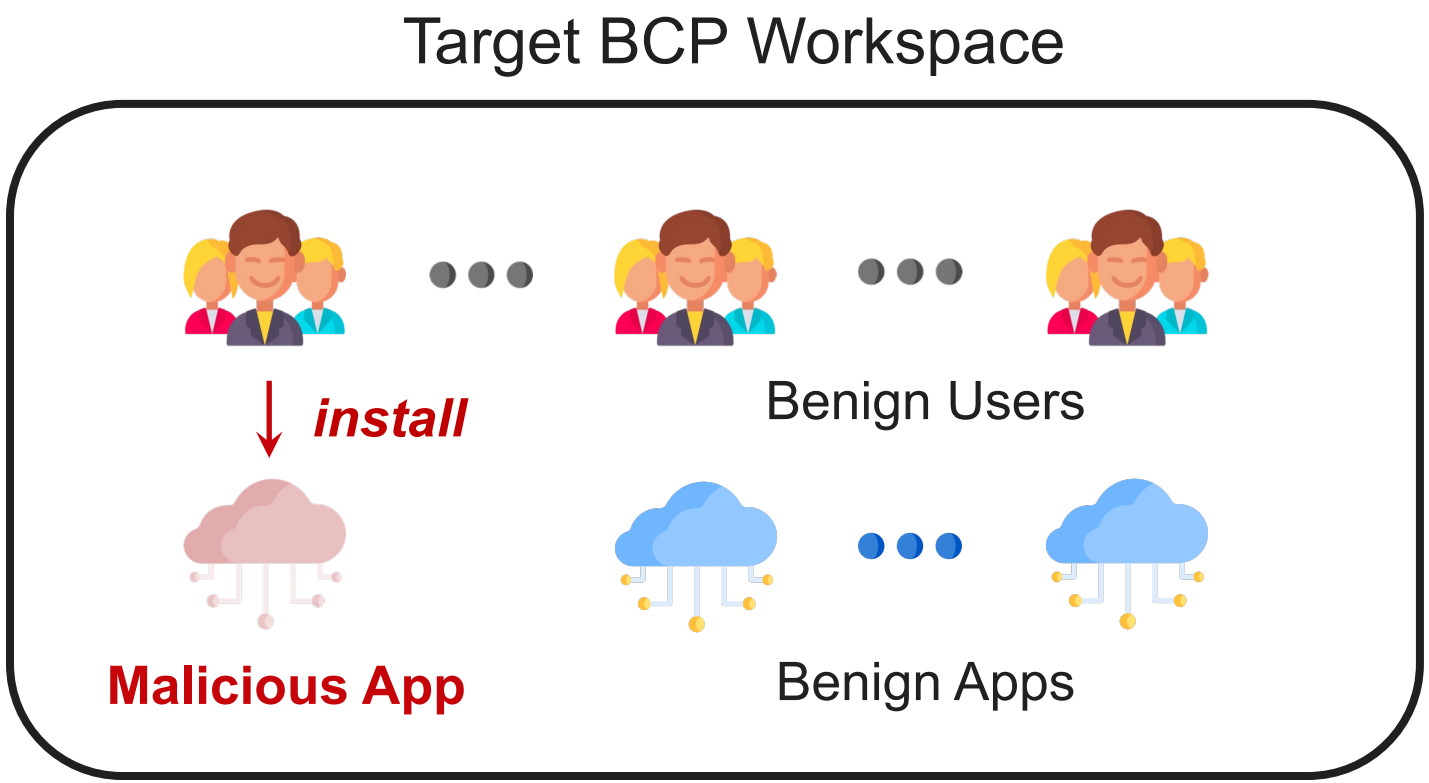
- *Read user identity*
- *Read public messages*

3. Write Permission Scopes

- *Post messages*
- *Post messages on behalf of users*

4. User Approves Permissions

Threat Model: Malicious Apps in BCP

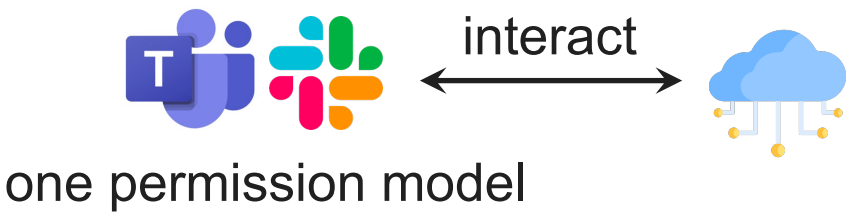


- Attacker tricks the user to install a malicious app
- The user is curious and installs a malicious app
- The benign app becomes malicious

Challenges & Our Methodology

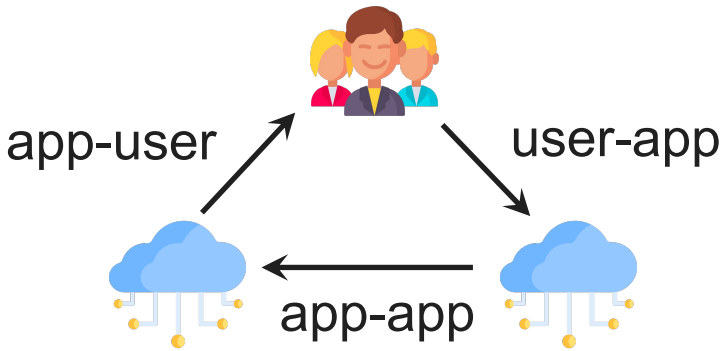
- Incomplete permission model description.

  We extract a unified abstraction.



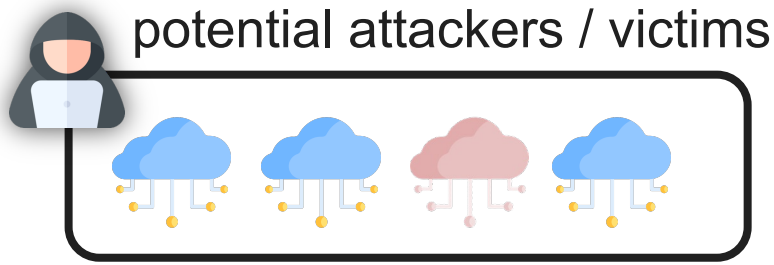
- Closed-source apps in the cloud.

  We examine all possible interactions.



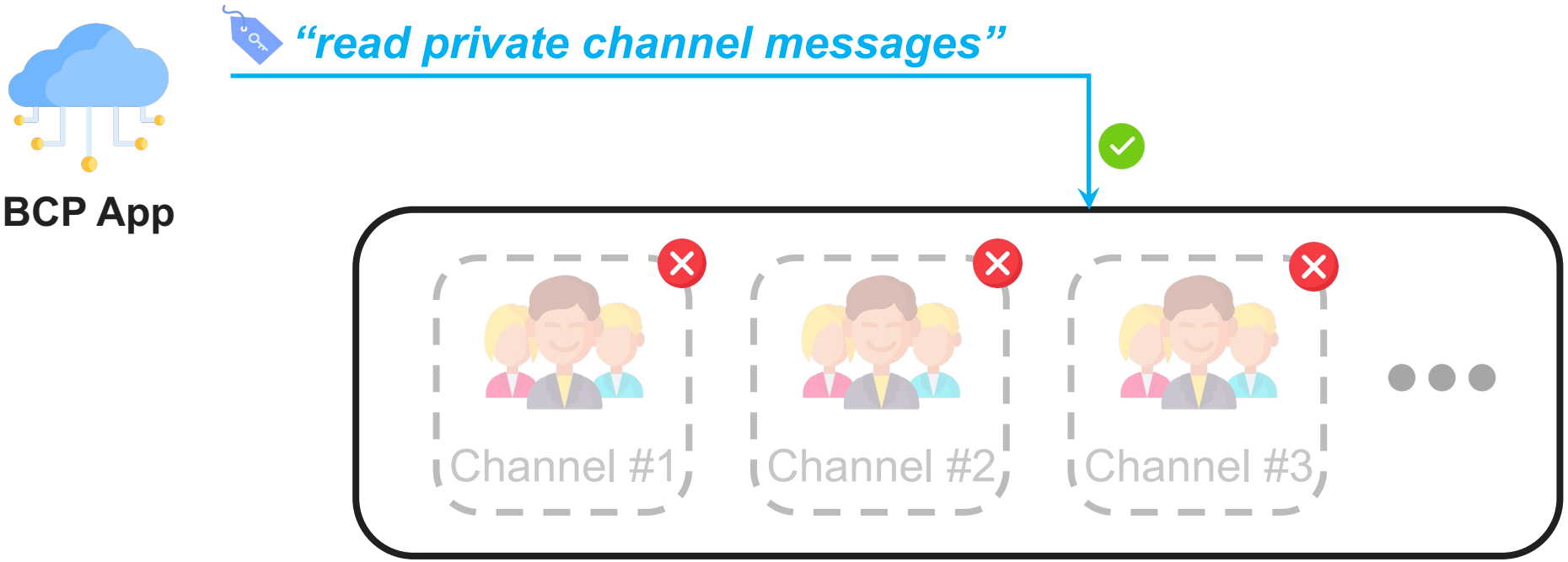
- Unscalable in-depth analysis.

  We estimate potential attackers & victims.



A Two-Level Unified Permission Model

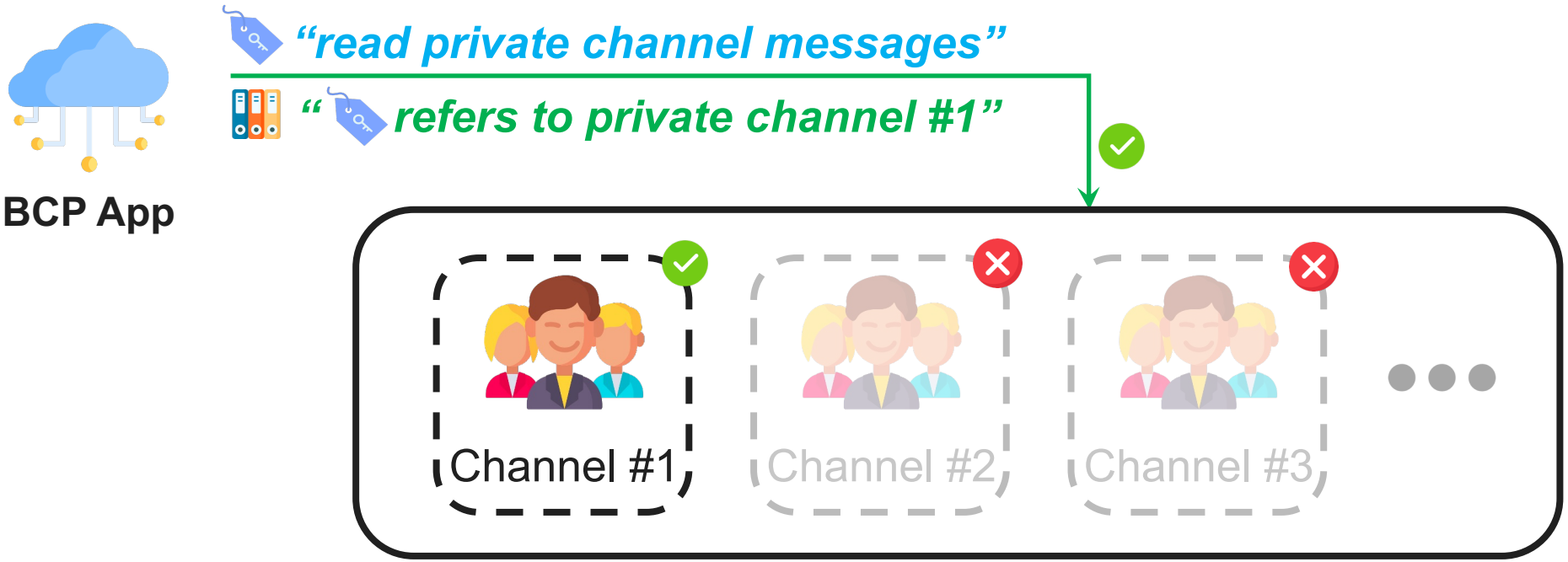
- **Level 1:** coarse-grained OAuth permissions scopes



Resource Group: Private Channels

A Two-Level Unified Permission Model

- **Level 1:** coarse-grained OAuth permissions scopes
- **Level 2:** fine-grained runtime policy checks



Resource Group: Private Channels

Violation of Security Principles

- **Least Privilege**

  Runtime policies are ad-hoc and incomplete.

  "post messages to channels"

  "only if the app joined this channel"

  "post messages to users"

  null

- **Complete Mediation**

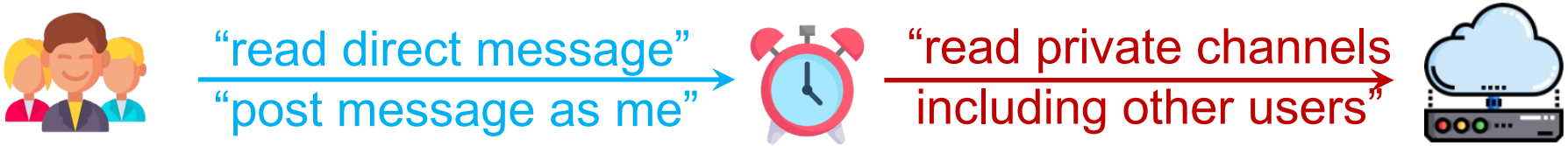
  Provenance of resources are not properly tracked.

All Types of Interactions Are Vulnerable

- **App-to-App Interaction** ➔ *Delegation Attacks*

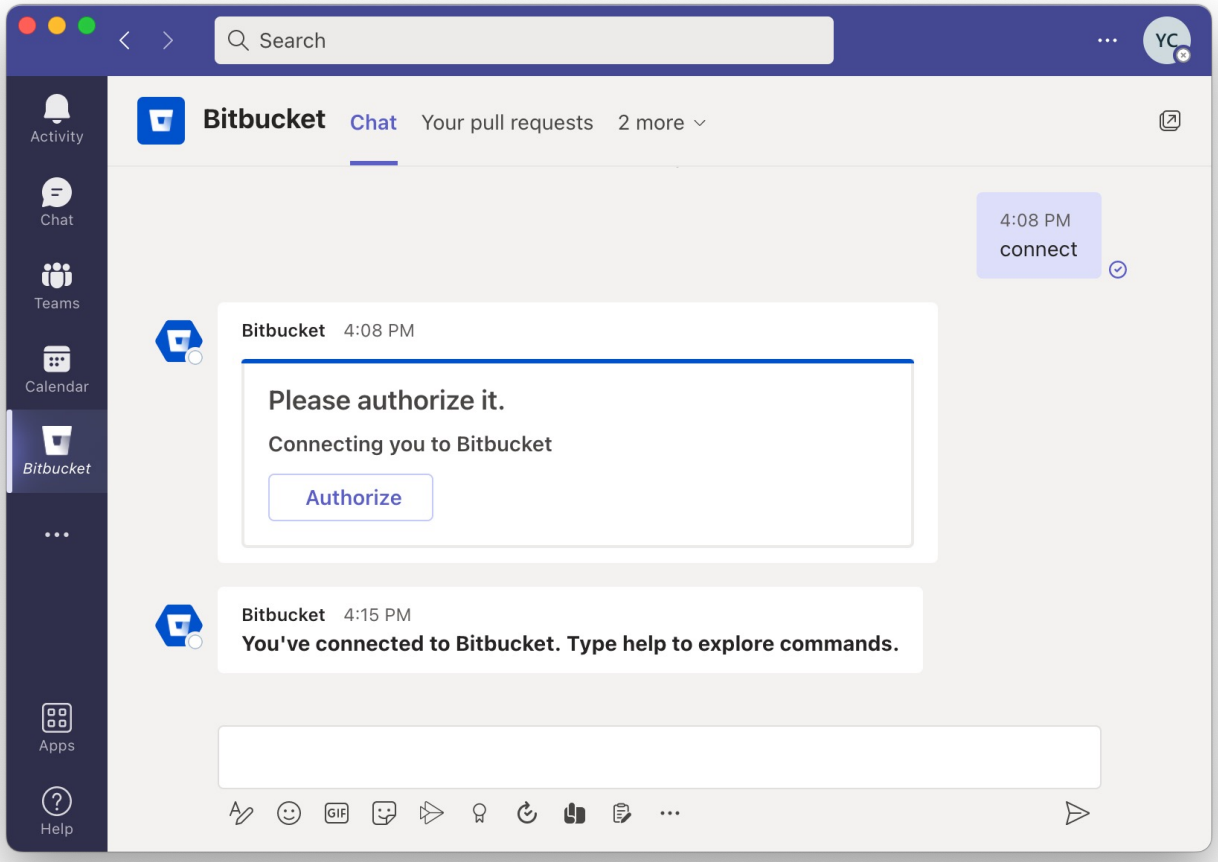
- **User-to-App Interaction** ➔ *Command Hijacking*

- **App-to-User Interaction** ➔ *Privilege Escalation*



Delegation Attack: Merge Malicious PRs

- **Step 1:** User installed Bitbucket app.



“Merge #1”

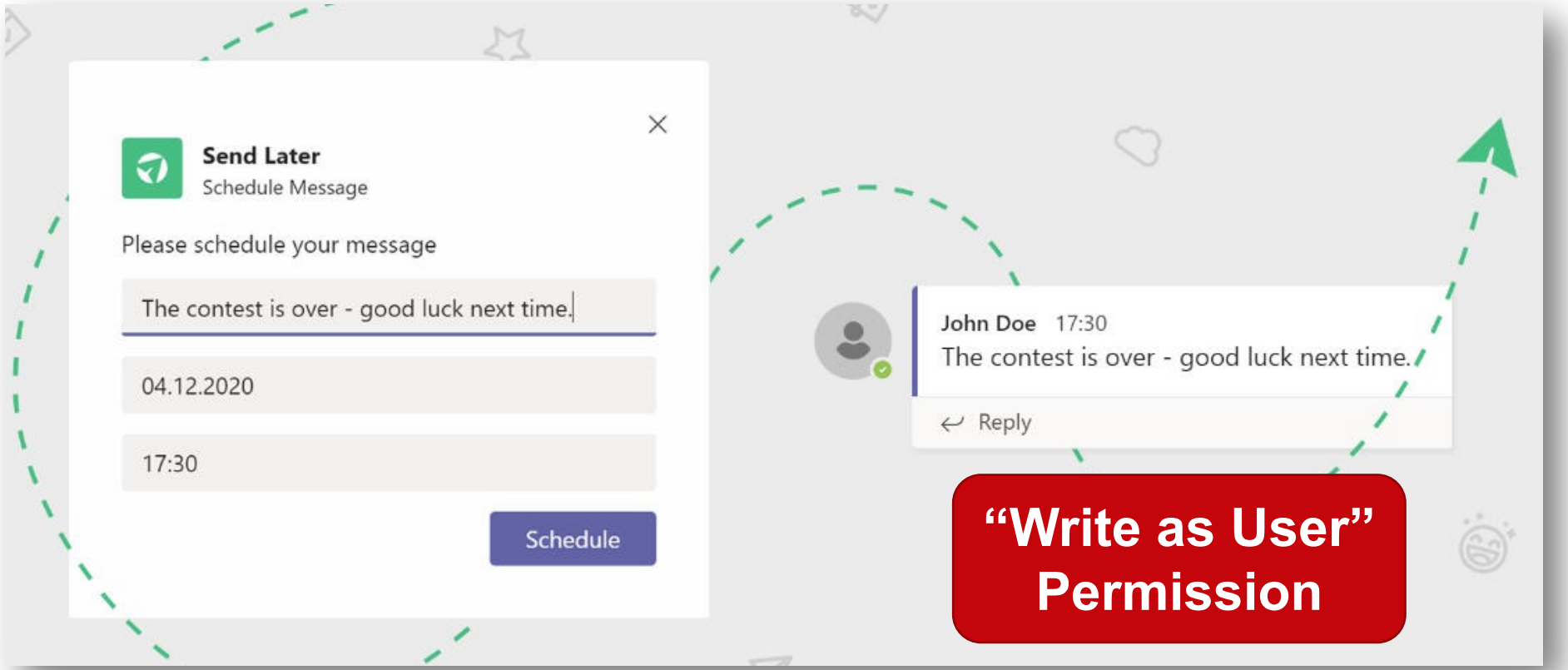
“Confirm merge #1?”

“Yes”

“Merged!”

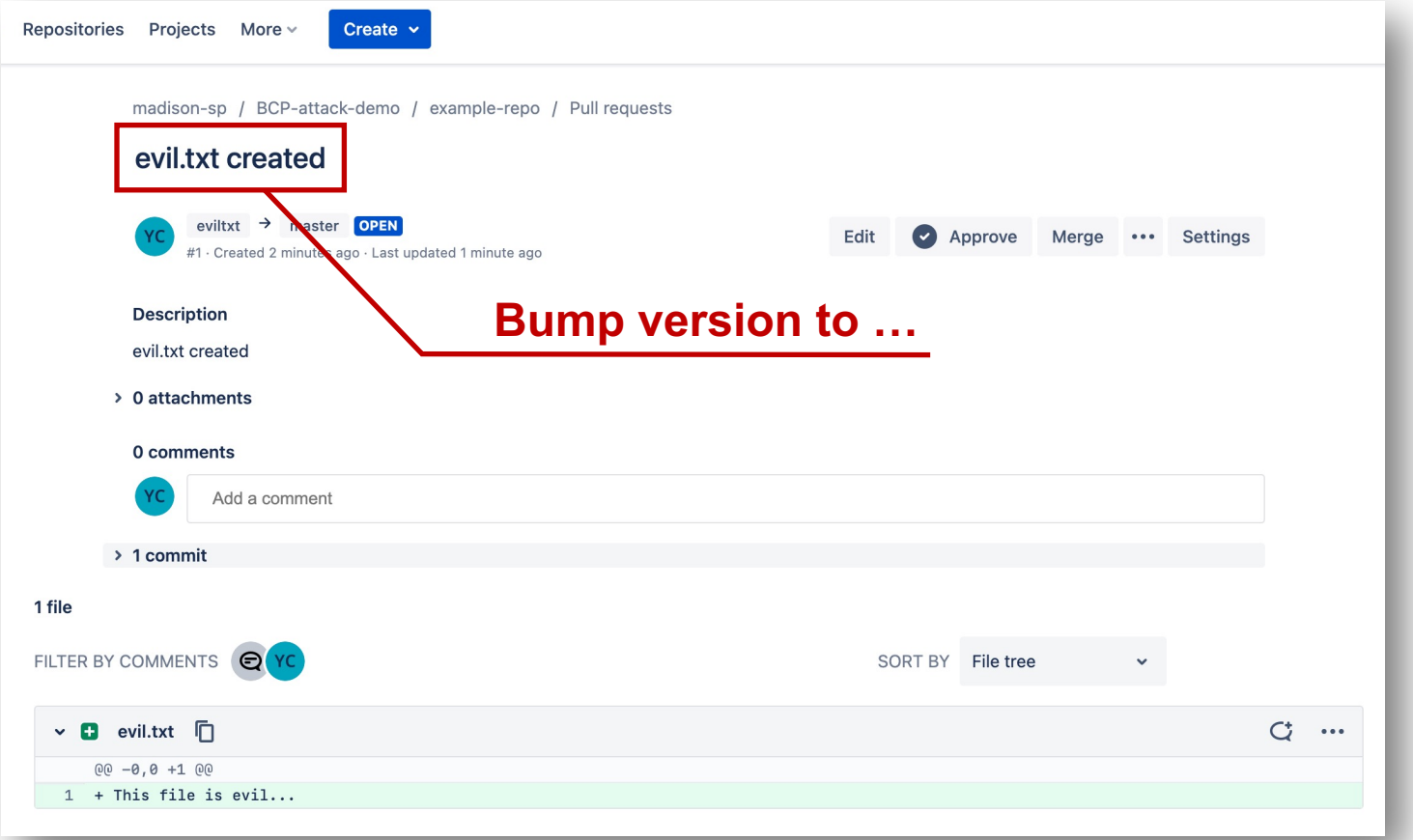
Delegation Attack: Merge Malicious PRs

- **Step 2:** User installed “Send Later” app *(our malicious demo)*.



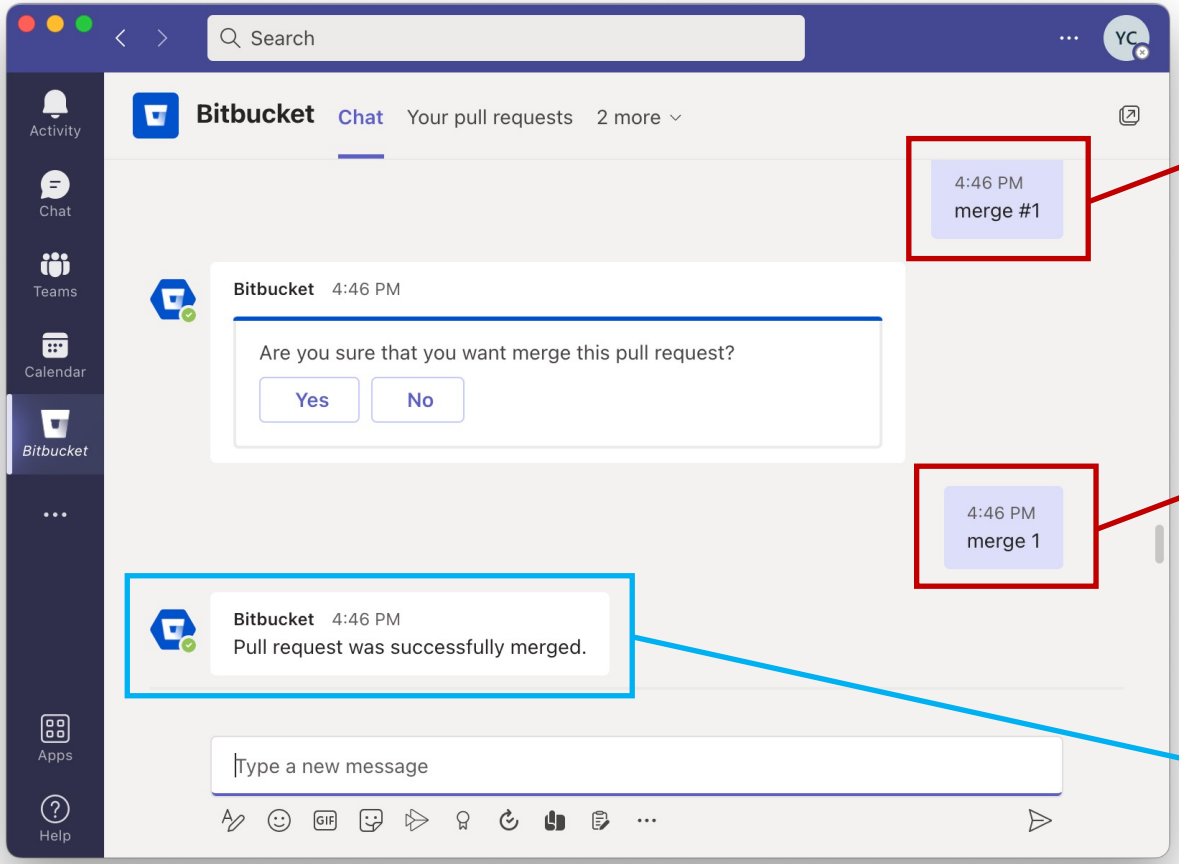
Delegation Attack: Merge Malicious PRs

- **Step 3:** Attacker creates a malicious Pull Request #1.



Delegation Attack: Merge Malicious PRs

- **Step 4:** Malicious "Send Later" app talks to the Bitbucket app.



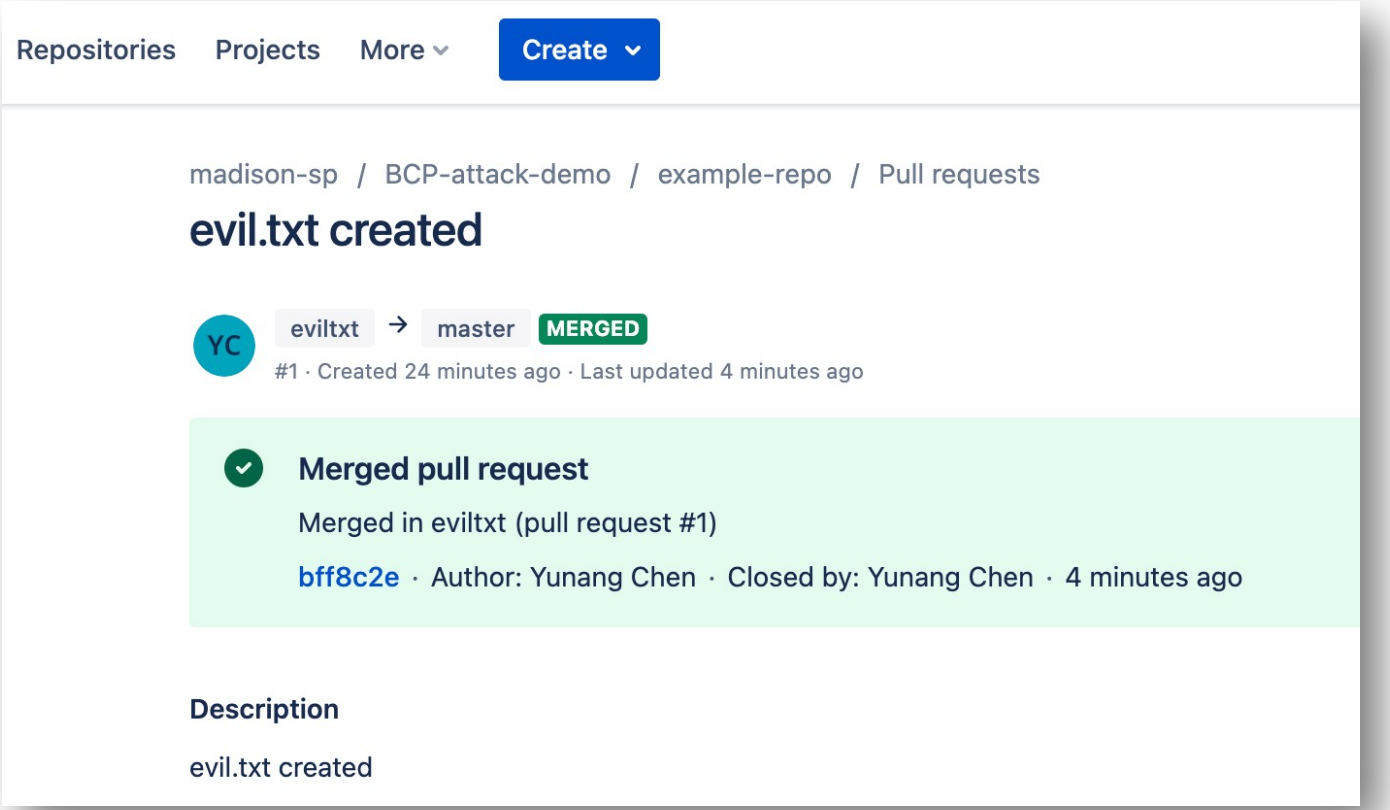
First request "merge #1"

Confirm "merge #1"

"Pull request was successfully merged."

Delegation Attack: Merge Malicious PRs

- **Step 5:** Bitbucket merges the malicious pull request.



Potential Prevalence Analysis

- Collect each app's requested permissions.
- ***Capable Apps*** — *Have write permissions needed for attacks.*
- ***Susceptible Apps*** — *Have read permissions affected by attacks.*

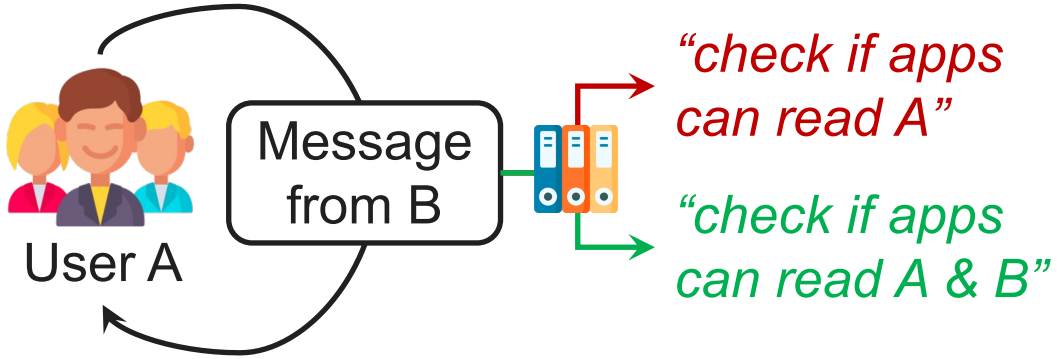
Attacks	# Capable Apps (MS Teams)	# Capable Apps (Slack)	# Susceptible Apps (Slack)
Delegation Attacks	427 (33%)	563 (23%)	1,493 (61%)
Command Hijacking	77 (6%)	270 (11%)	1,266 (52%)
Privilege Escalation	n/a	11	n/a

Countermeasures: Improve Permission Models

Better Design

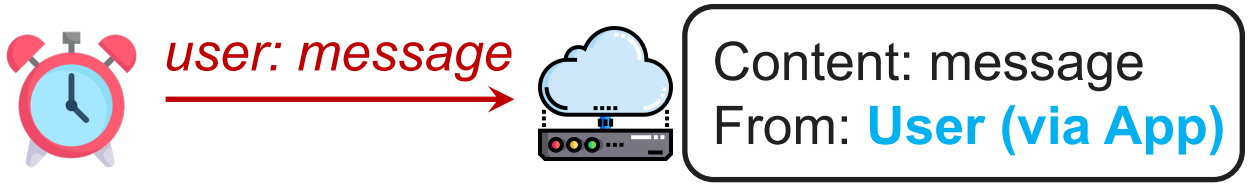
– *Finer-grained Scopes*

– *Stricter Runtime Policies*

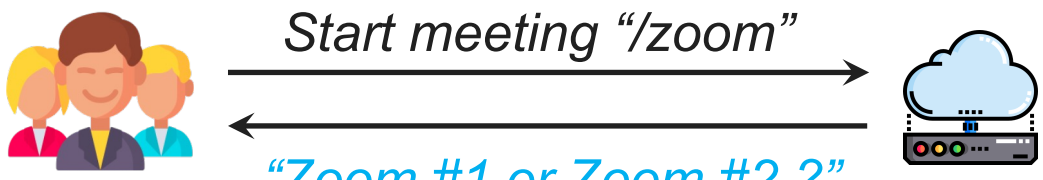


Better Execution

– *Track Provenance of Actions*



– *Explicit User Confirmation*



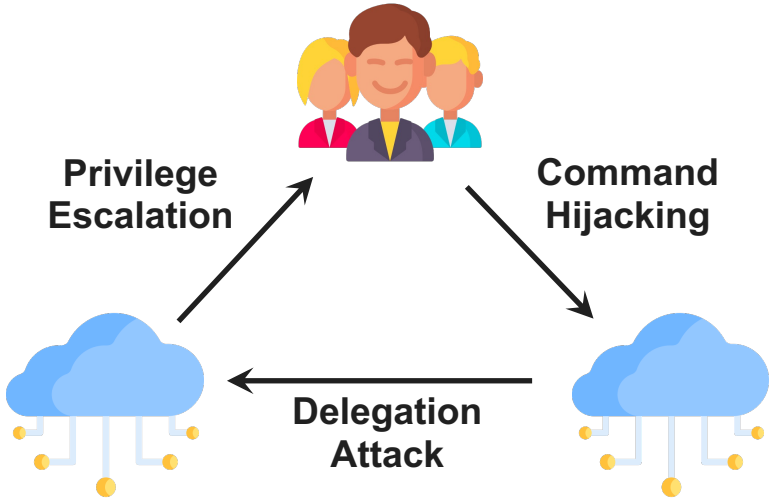
Disclosure & Responses

- Confirmed attacks
- Workspace ➔ a trusted environment
- Administrator ➔ will correctly manage apps

- Our tips for administrators
  - Consider limiting users from installing apps
  - Actively monitor the behavior of installed apps
  - Only approve delegation permissions from trusted apps

Summary

- BCPs have become a hub for **sensitive third-party resources**.
- We provide **security analysis** under malicious apps.
- All types of interactions are **vulnerable & potentially prevalent**.



Paper

Demo