



Instructions 1

Elevation of Privilege Instructions

Draw a diagram of the system you want to threat model before you deal the cards.

Deal the deck to 3-6 players. Play starts with the 3 of Tampering. Play clockwise, and each player in turn continues using the suit if they have a card in that suit. If the player doesn't have a card from that suit, the player can use another suit. Each round is won by the highest card played in the suit that was led, unless an Elevation of Privilege (EoP) card is played. In that case the high value EoP card wins.

To play a card, read the card, announce your threat and record it. If the player can't link the threat to the system, play proceeds.

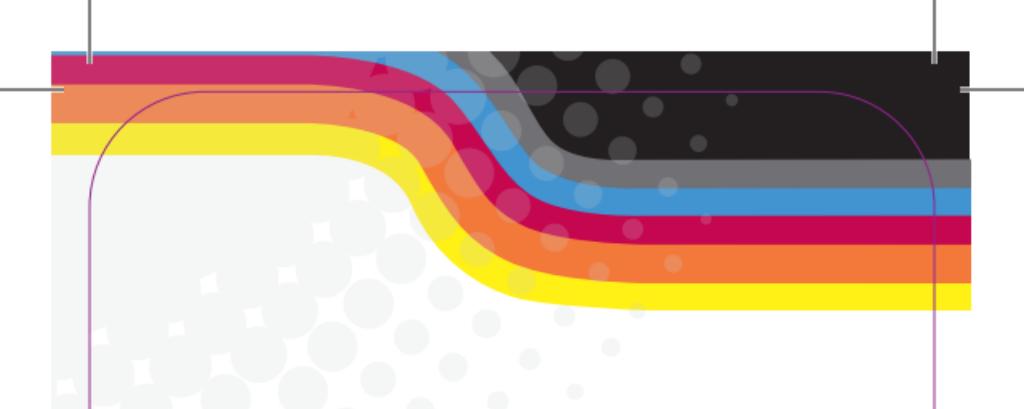
The winner of a hand selects the card (and suit) to lead the next hand. Take a few minutes between hands to think about threats.

Points:

1 for a threat on your card, +1 for taking the trick



Instructions



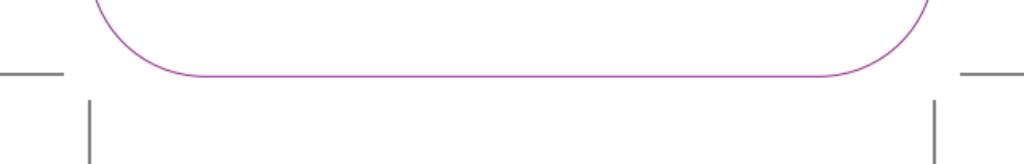
Elevation of Privilege Instructions

Threats should be articulated clearly, testable, and addressable. In the event that a threat leads to an argument, you can resolve it by asking the question: "Would we take an actionable bug, feature request or design change for that?" If the answer is yes, it is a real threat. (This doesn't mean that threats outside of that aren't real, it's simply a way to focus discussion on actionable threats.) Questions that start with "There's a way" should be read as "There's a way...and here's how..." while questions that start with "Your code" should be read "The code we're collectively creating...and here's how."

The deck contains a number of special cards: trumps and open threats. EoP cards are trumps: They take the trick even if they have a lower value than the suit that was led. The ace of each suit is an open threat card. When played, the player must identify a threat not listed on another card.

When all the cards have been played, whoever has the most points wins.

Remember to have fun!



Instructions



Instructions 2

Elevation of Privilege Instructions

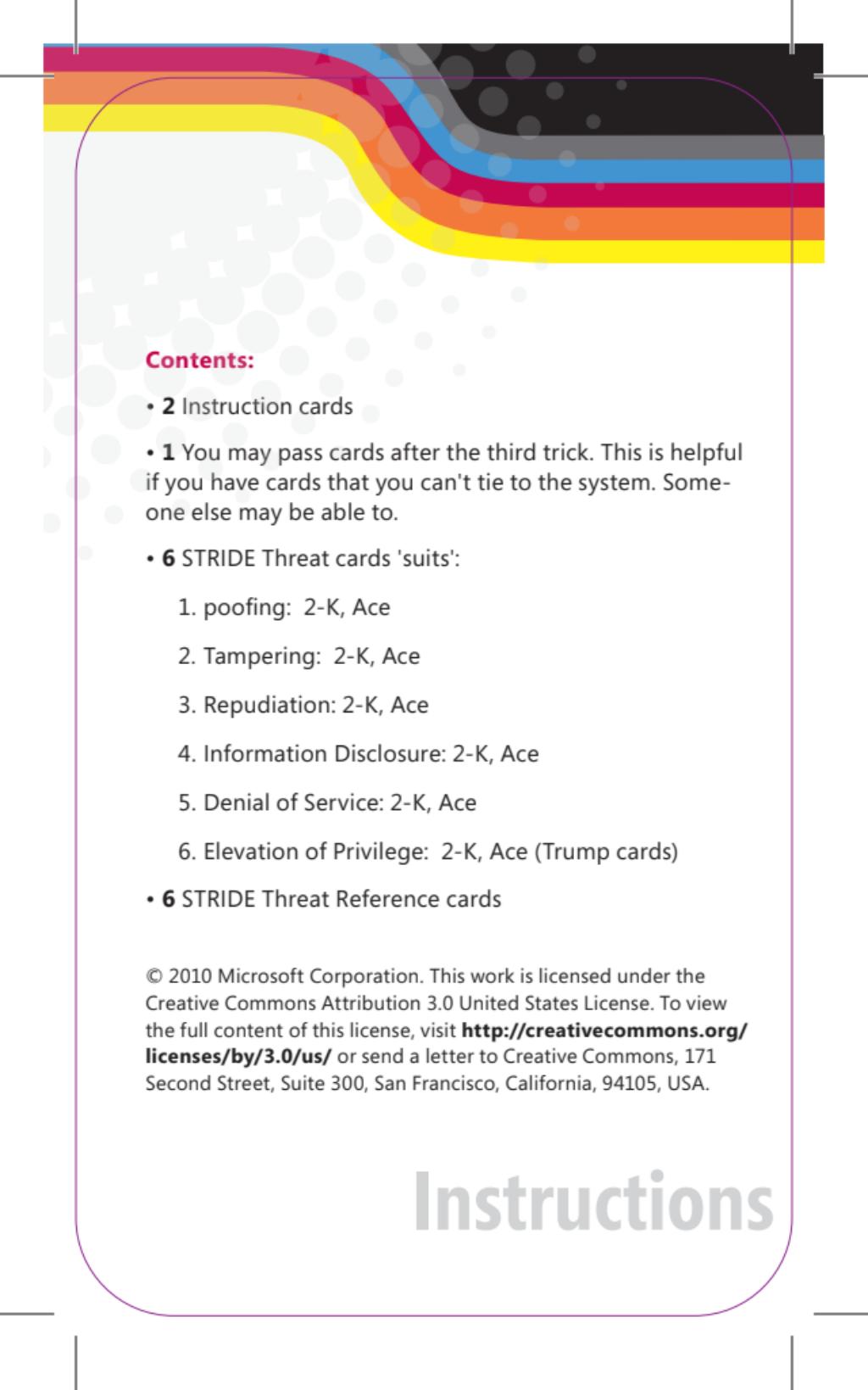
Optional variants:

- You may pass cards after the third trick. This is helpful if you have cards that you can't tie to the system. Someone else may be able to.
- Double the number of points, and give one point for threats on other people's cards.
- Other players may "riff" on the threat and if they do, they get one point per additional threat.
- Limit riffing to no more than 60 seconds.
- Mark up the diagram where the threat occurs.

Questions are listed on the threat cards to help with the aces.

Thanks to Laurie Williams for inspiration.

Instructions



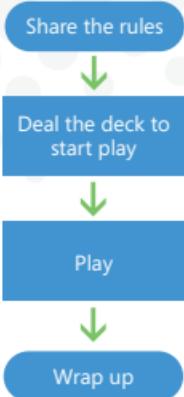
Contents:

- **2** Instruction cards
- **1** You may pass cards after the third trick. This is helpful if you have cards that you can't tie to the system. Someone else may be able to.
- **6** STRIDE Threat cards 'suits':
 1. poofing: 2-K, Ace
 2. Tampering: 2-K, Ace
 3. Repudiation: 2-K, Ace
 4. Information Disclosure: 2-K, Ace
 5. Denial of Service: 2-K, Ace
 6. Elevation of Privilege: 2-K, Ace (Trump cards)
- **6** STRIDE Threat Reference cards

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Instructions

Context



Play

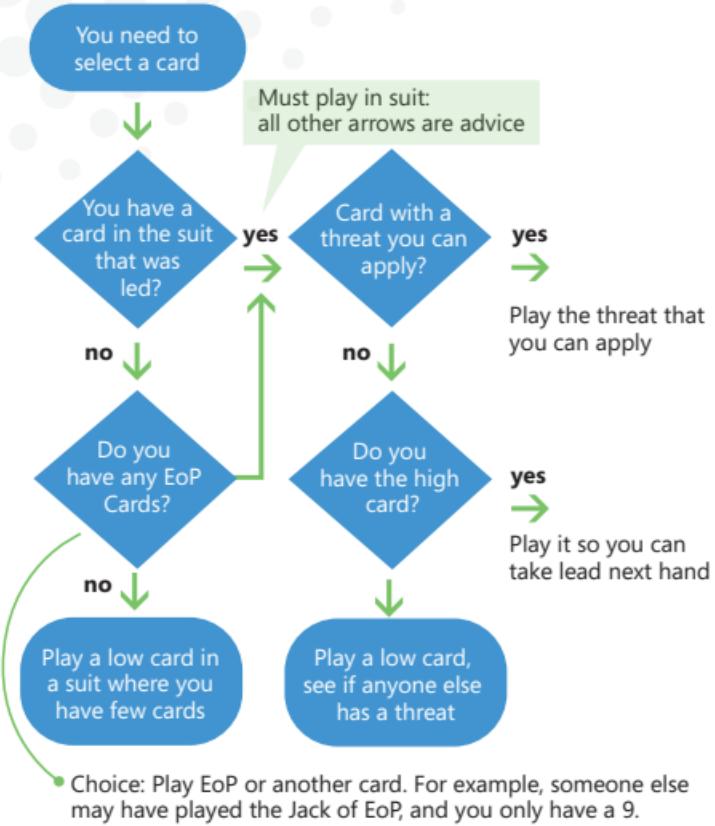
Whoever has 3 of Tampering starts

Whoever has 3 of Tampering:



Strategy: see reverse

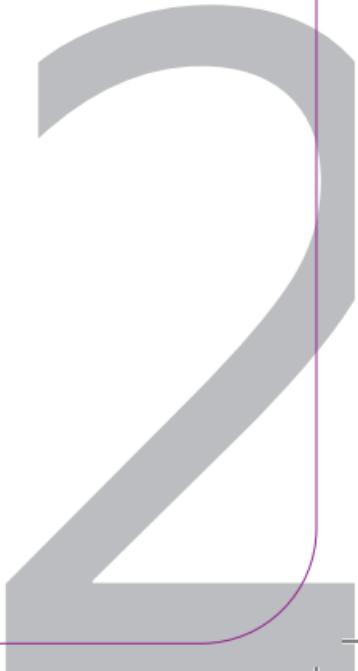
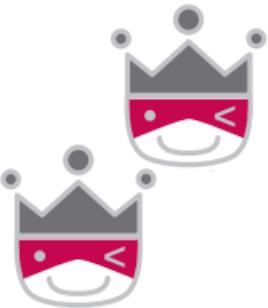
Strategy



2

Spoofing

An attacker could take over the port or socket that the server normally uses



Microsoft®

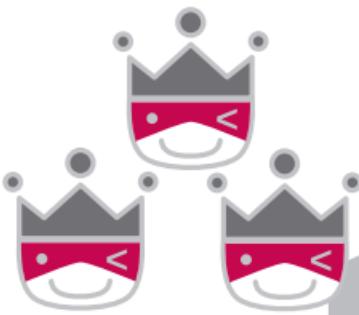
elevation of privilege



3

Spoofing

An attacker could try one credential after another and there's nothing to slow them down (online or offline)



3

Microsoft®

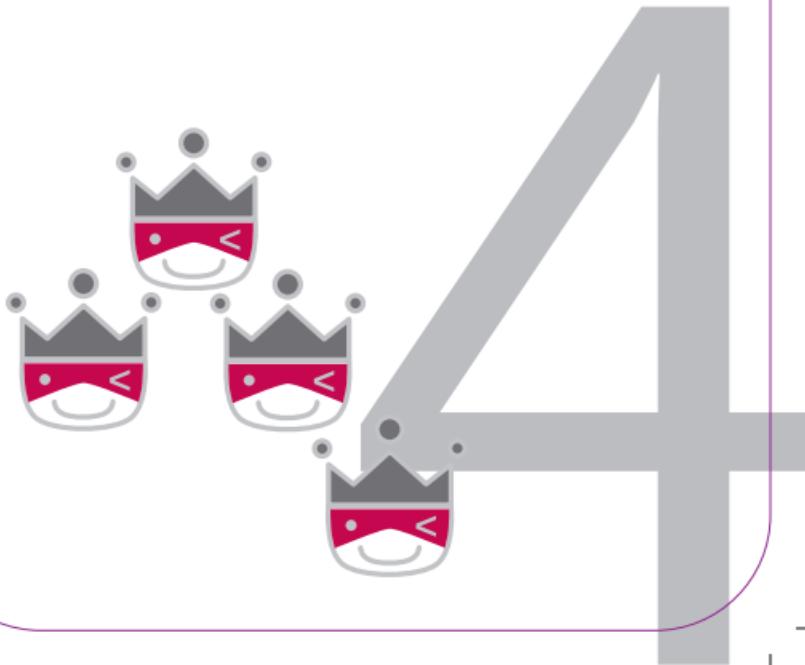
elevation of privilege



4

Spoofing

An attacker can anonymously connect, because we expect authentication to be done at a higher level



Microsoft®

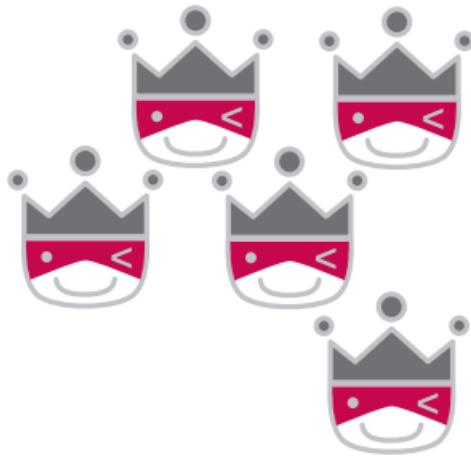
elevation of privilege



5

Spoofing

An attacker can confuse a client because there are too many ways to identify a server



Microsoft®

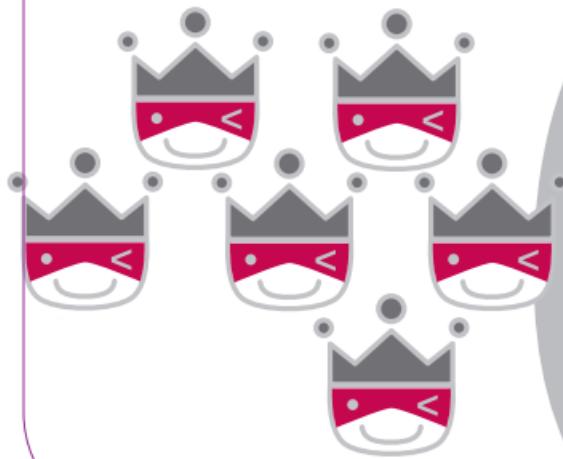
elevation of privilege



6

Spoofing

An attacker can spoof a server because identifiers aren't stored on the client and checked for consistency on re-connection (that is, there's no key persistence)



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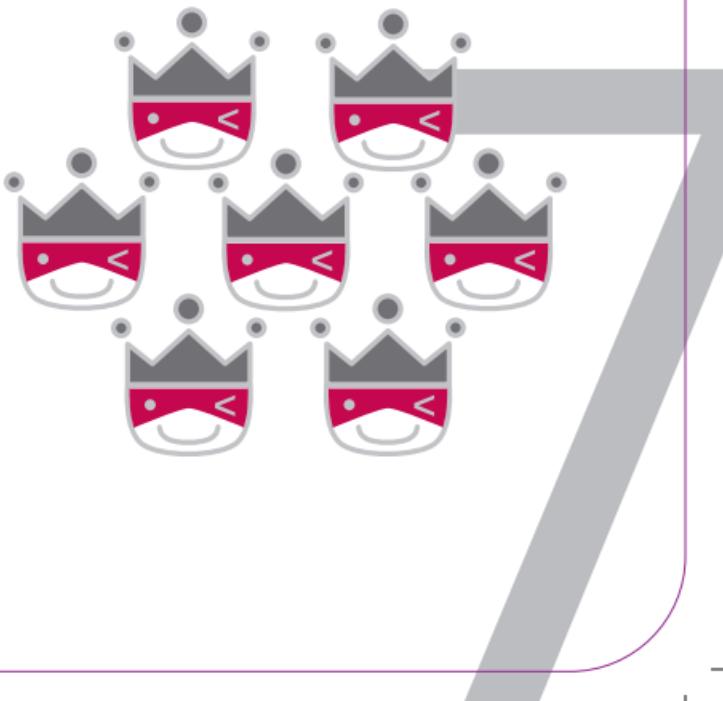
elevation of privilege



7

Spoofing

An attacker can connect to a server or peer over a link that isn't authenticated (and encrypted)



Microsoft®

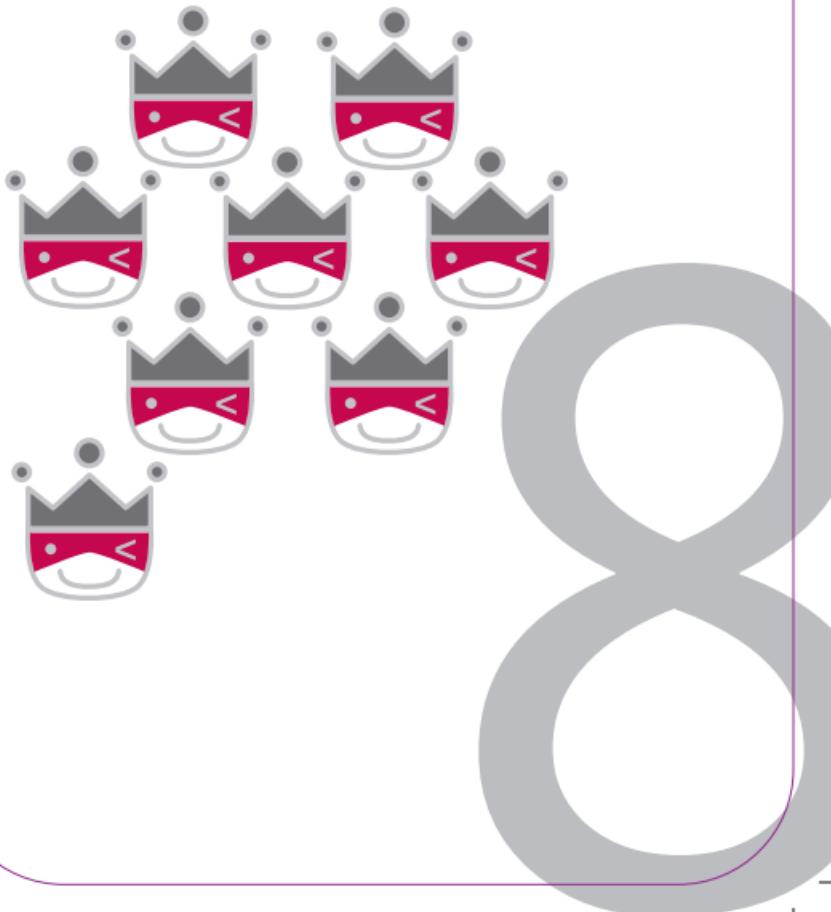
elevation of privilege



8

Spoofing

An attacker could steal credentials stored on the server and reuse them (for example, a key is stored in a world readable file)



Microsoft®

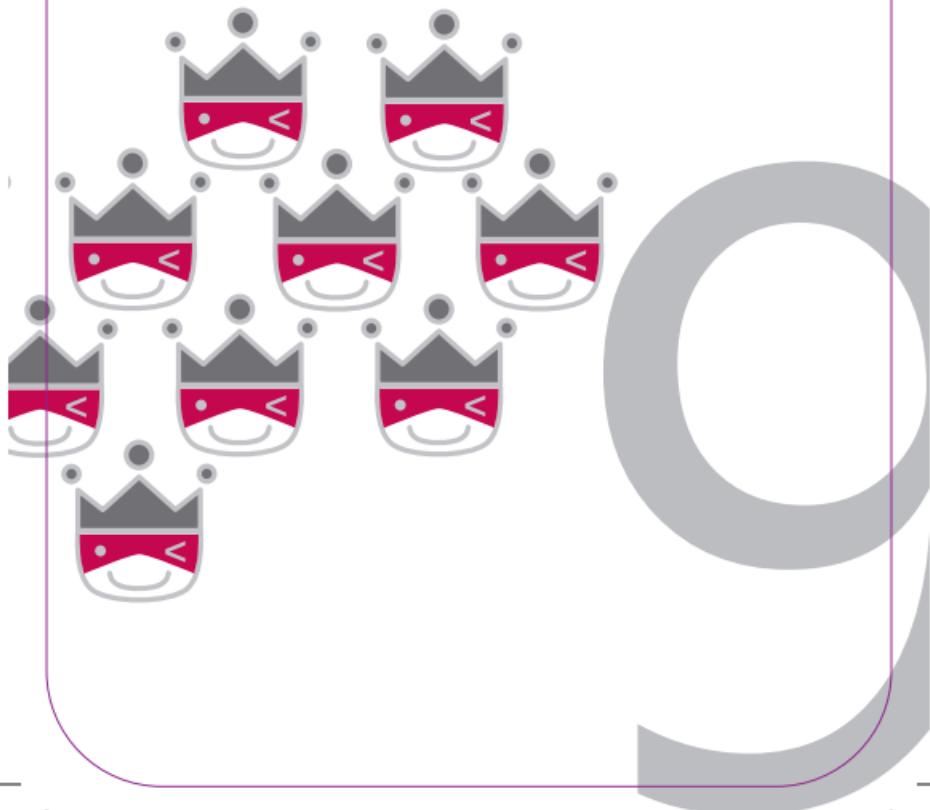
elevation of privilege



9

Spoofing

An attacker who gets a password can reuse it (Use stronger authenticators)



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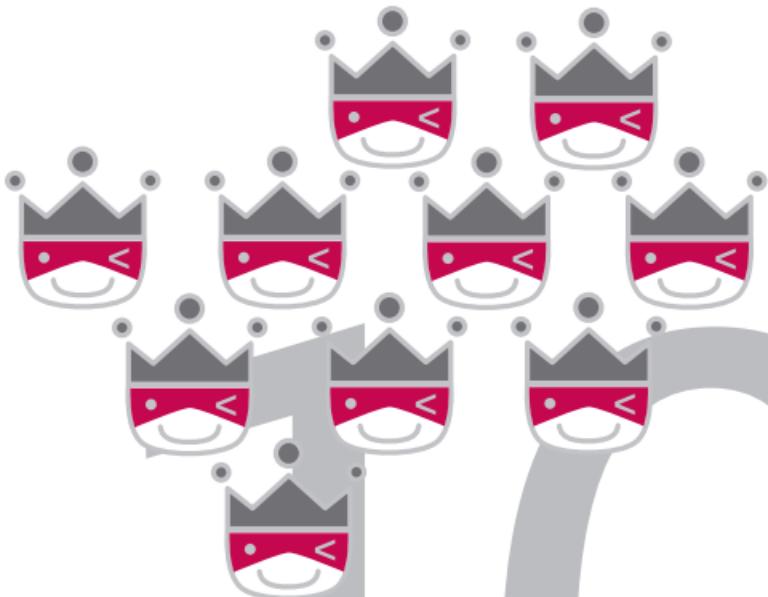
elevation of privilege



10

Spoofing

An attacker can choose to use weaker or no authentication



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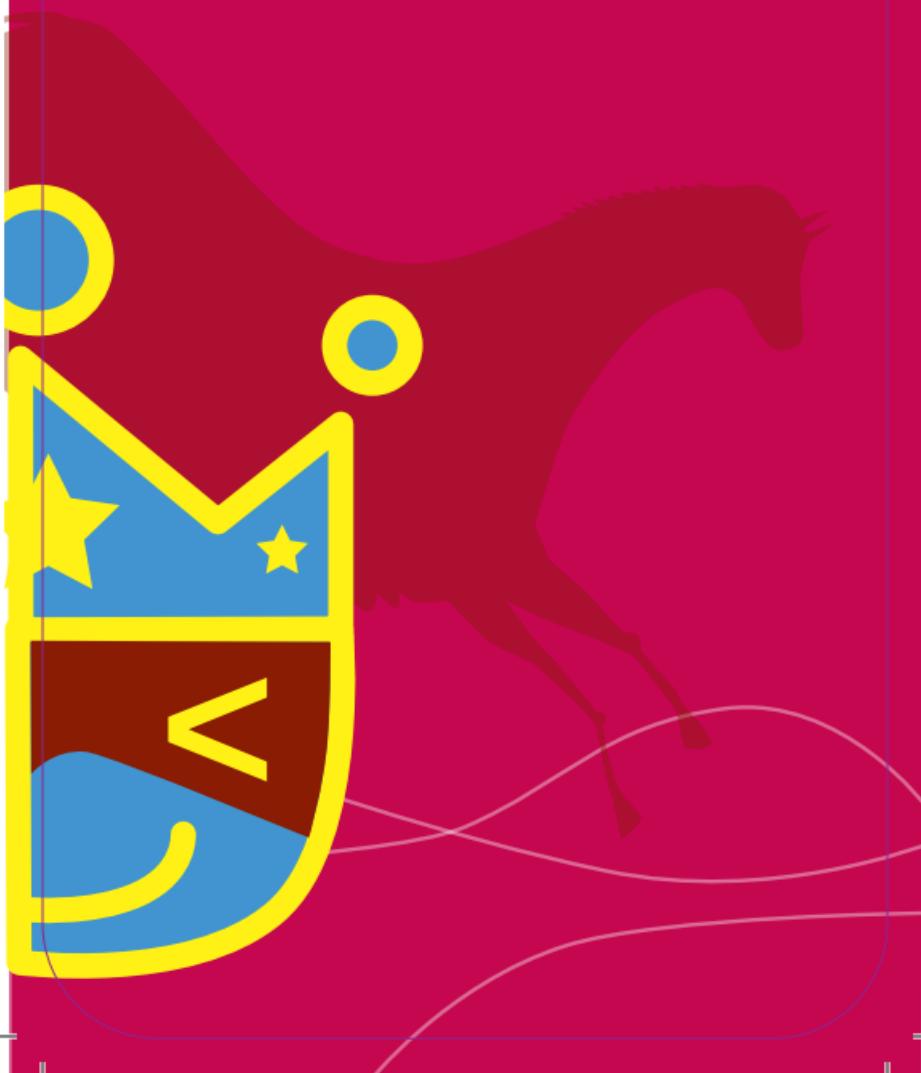
elevation of privilege



J

Spoofing

An attacker could steal credentials stored on the client and reuse them



Microsoft®

elevation of privilege



Q

Spoofing

An attacker could go after the way credentials are updated or recovered (account recovery doesn't require disclosing the old password)



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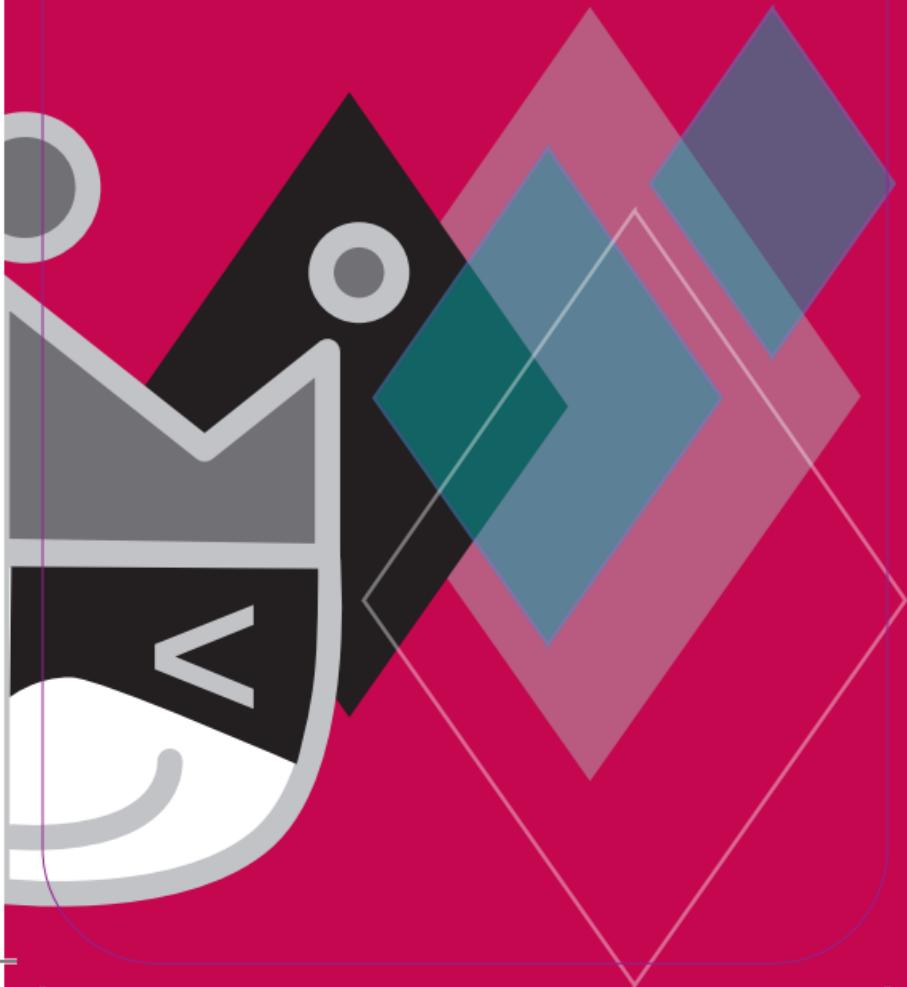
elevation of privilege



K

Spoofing

Your system ships with a default admin password, and doesn't force a change



Microsoft®

elevation of privilege



A

Spoofing

You've invented a new Spoofing attack



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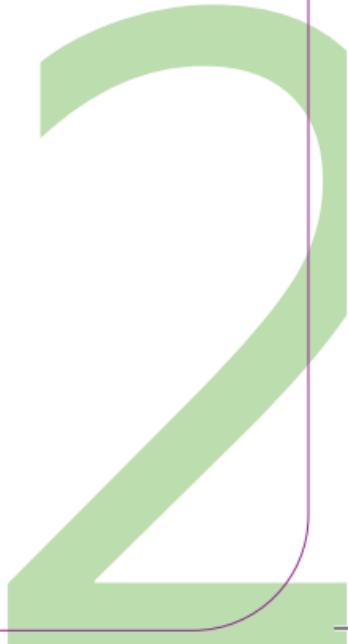
elevation of privilege



2

Tampering

An attacker can take advantage of your custom key exchange or integrity control which you built instead of using standard crypto



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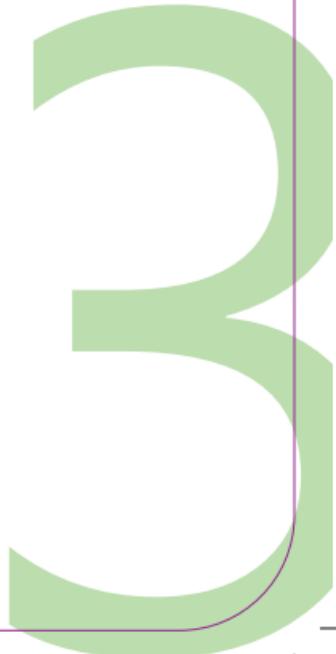
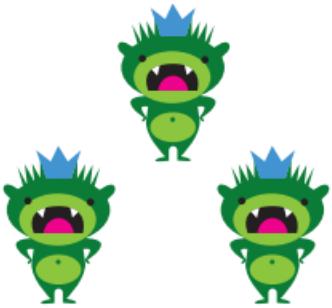
elevation of privilege



3

Tampering

An attacker can modify your build system and produce signed builds of your software



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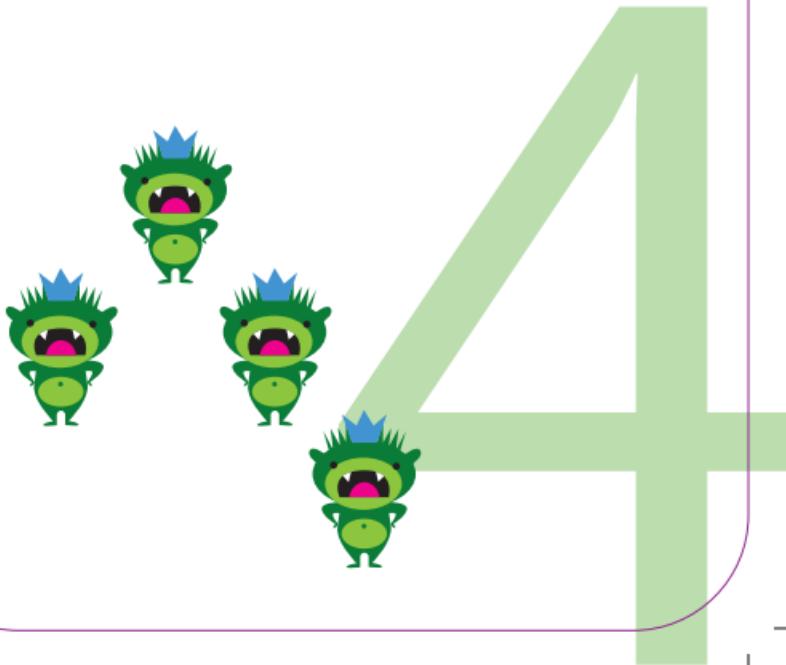
elevation of privilege



4

Tampering

Your code makes access control decisions all over the place, rather than with a security kernel



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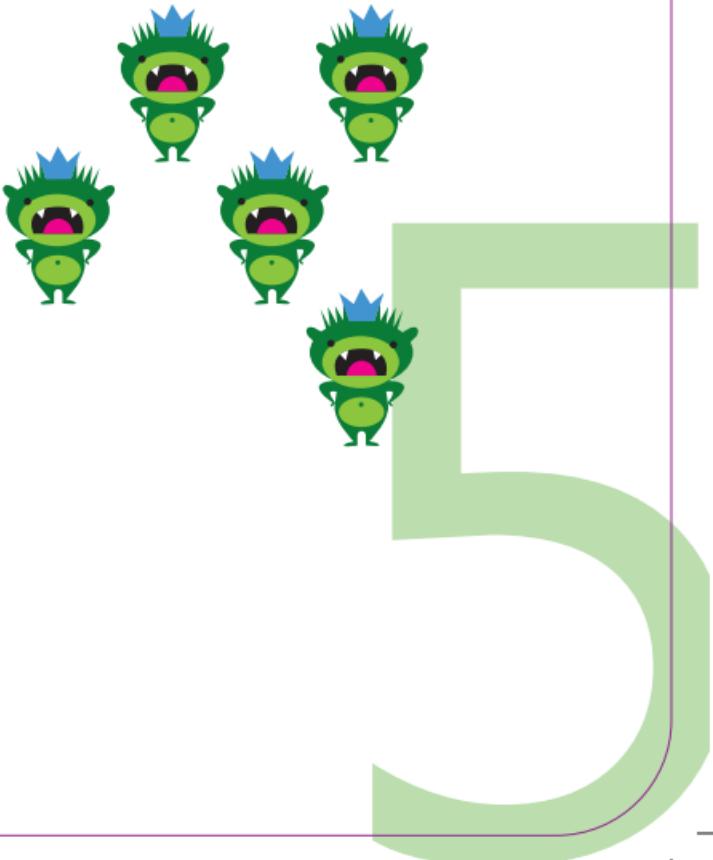
elevation of privilege



5

Tampering

An attacker can replay data without detection because your code doesn't provide timestamps or sequence numbers



Microsoft®

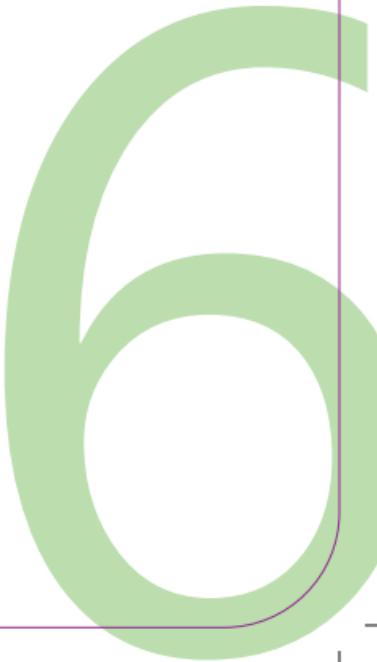
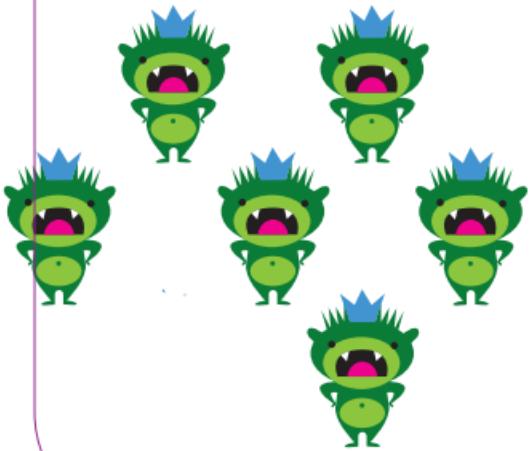
elevation of privilege



6

Tampering

An attacker can write to a data store your code relies on



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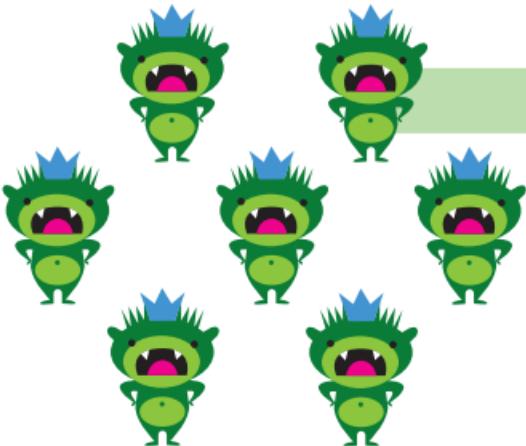
elevation of privilege



7

Tampering

An attacker can bypass permissions because you don't make names canonical before checking access permissions



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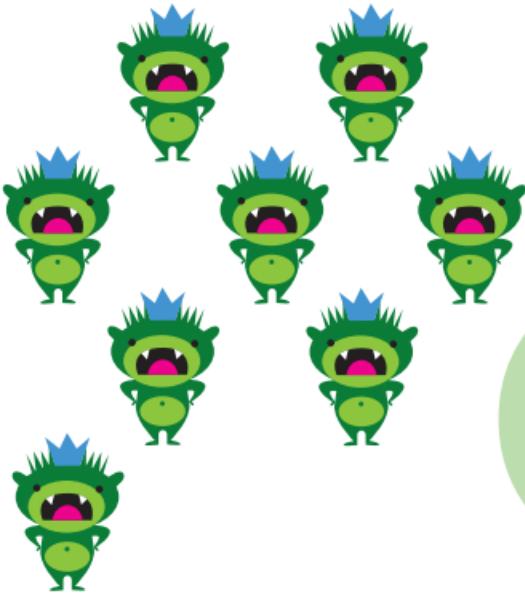
elevation of privilege



8

Tampering

An attacker can manipulate data because there's no integrity protection for data on the network



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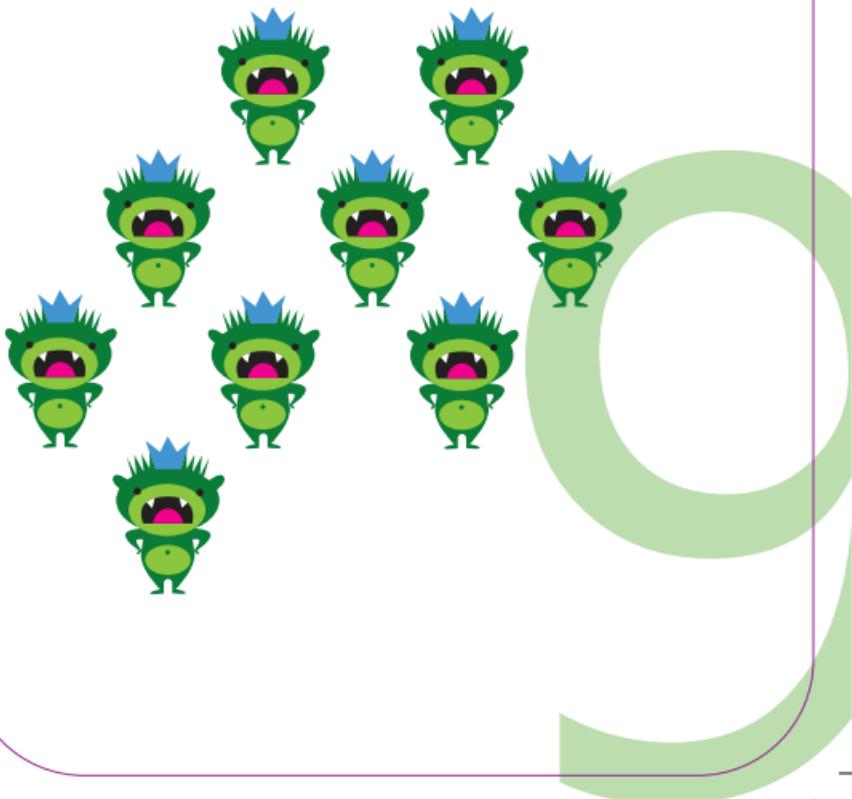
elevation of privilege



9

Tampering

An attacker can provide or control state information



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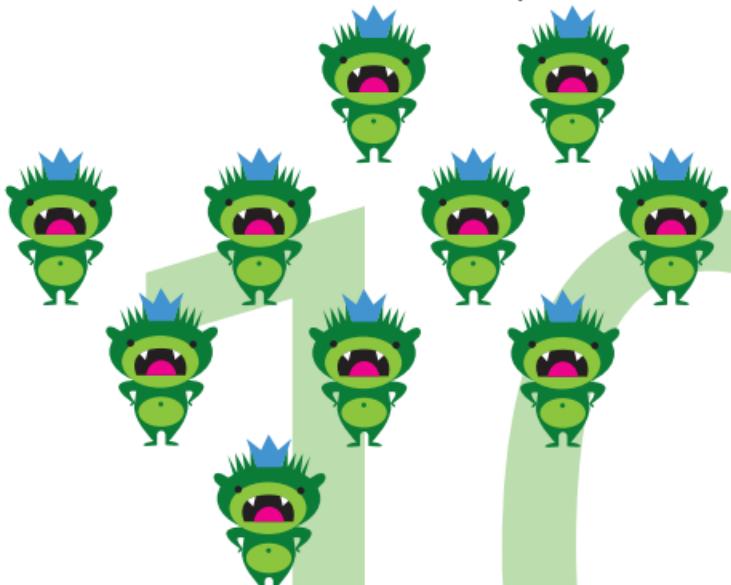
elevation of privilege



10

Tampering

An attacker can alter information in a data store because it has weak/open permissions or includes a group which is equivalent to everyone ("anyone with a Facebook account")



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elevation of privilege



J

Tampering

An attacker can write to some resource because permissions are granted to the world or there are no ACLs



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elevation of privilege



Q

Tampering

An attacker can change parameters over a trust boundary and after validation (for example, important parameters in a hidden field in HTML, or passing a pointer to critical memory)



Microsoft®

elevation of privilege



K

Tampering

An attacker can load code inside your process via an extension point



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elevation of privilege



A

Tampering

You've invented a new Tampering attack



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elevation of privilege



2

Repudiation

An attacker can pass data through the log to attack a log reader, and there's no documentation of what sorts of validation are done

R
R

2

Microsoft®

elevation of privilege



3

Repudiation

A low privilege attacker can read interesting security information in the logs



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elevation of privilege



4

Repudiation

An attacker can alter digital signatures because the digital signature system you're implementing is weak, or uses MACs where it should use a signature



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5

Repudiation

An attacker can alter log messages on a network because they lack strong integrity controls



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elevation of privilege



6

Repudiation

An attacker can create a log entry without a timestamp (or no log entry is timestamped)



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7

Repudiation

An attacker can make the logs wrap around and lose data



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8

Repudiation

An attacker can make a log lose or confuse security information

R R
R R R
R R R
R

8

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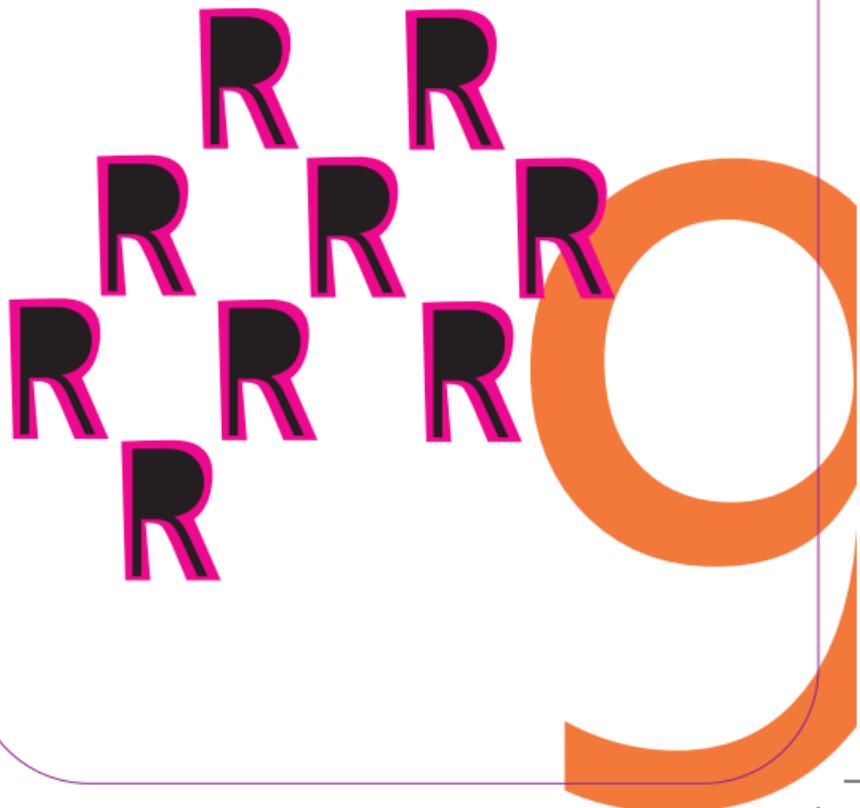
elevation of privilege



9

Repudiation

An attacker can use a shared key to authenticate as different principals, confusing the information in the logs



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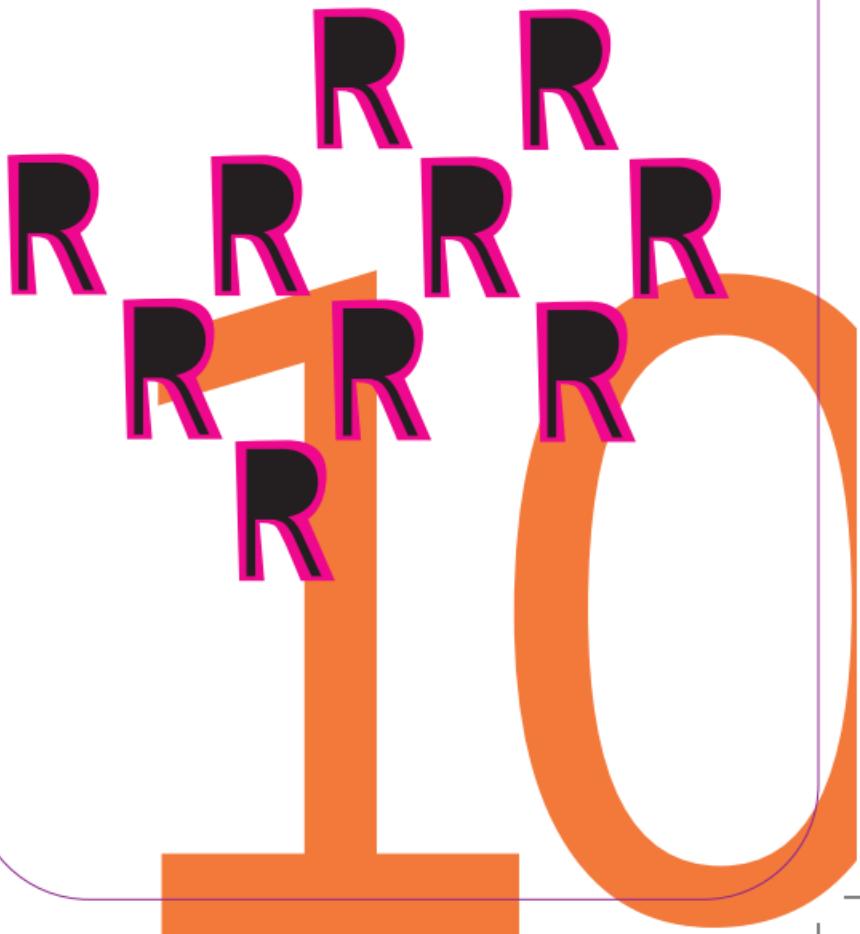
elevation of privilege



10

Repudiation

An attacker can get arbitrary data into logs from unauthenticated (or weakly authenticated) outsiders without validation



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elevation of privilege



J

Repudiation

An attacker can edit logs and there's no way to tell (perhaps because there's no heartbeat option for the logging system)



Microsoft®

elevation of privilege



Q

Repudiation

An attacker can say "I didn't do that," and you'd have no way to prove them wrong



I didn't
do that.

Microsoft®

elevation of privilege



K

Repudiation

The system has no logs



logs = 0

Microsoft®

elevation of privilege



A

Repudiation

You've invented a new Repudiation attack



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elevation of privilege



2

Information Disclosure

An attacker can brute-force file encryption because there's no defense in place (example defense, password stretching)



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elevation of privilege



3

Information Disclosure

An attacker can see error messages with security sensitive content



Microsoft®

elevation of privilege



4

Information Disclosure

An attacker can read content because messages (say, an email or HTTP cookie) aren't encrypted even if the channel is encrypted



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5

Information Disclosure

An attacker may be able to read a document or data because it's encrypted with a non-standard algorithm



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elevation of privilege



6

Information Disclosure

An attacker can read data because it's hidden or occluded (for undo or change tracking) and the user might forget that it's there



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elevation of privilege



7

Information Disclosure

An attacker can act as a 'man in the middle' because you don't authenticate endpoints of a network connection



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8

Information Disclosure

An attacker can access information through a search indexer, logger, or other such mechanism



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9

Information Disclosure

An attacker can read sensitive information in a file with permissive permissions



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elevation of privilege



10

Information Disclosure

An attacker can read information in files or databases with no access controls



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elevation of privilege



J

Information Disclosure

An attacker can discover the fixed key being used to encrypt



Found it!

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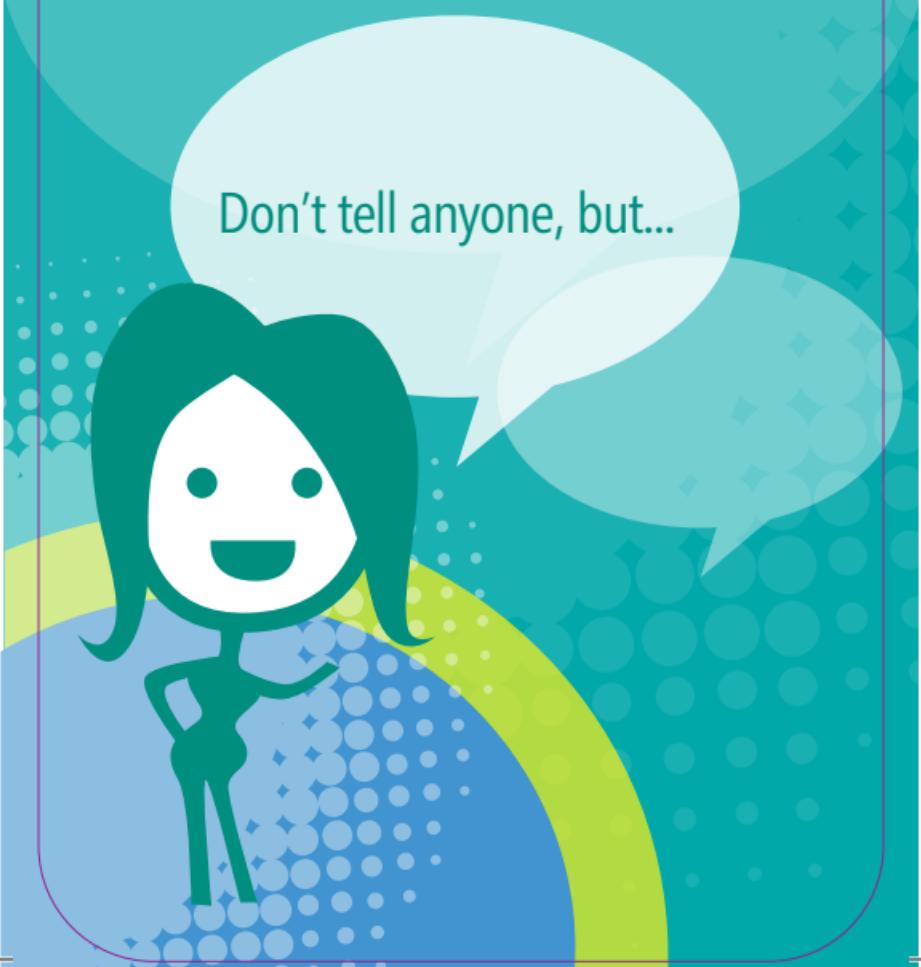
elevation of privilege



Q

Information Disclosure

An attacker can read the entire channel because the channel (say, HTTP or SMTP) isn't encrypted



Don't tell anyone, but...

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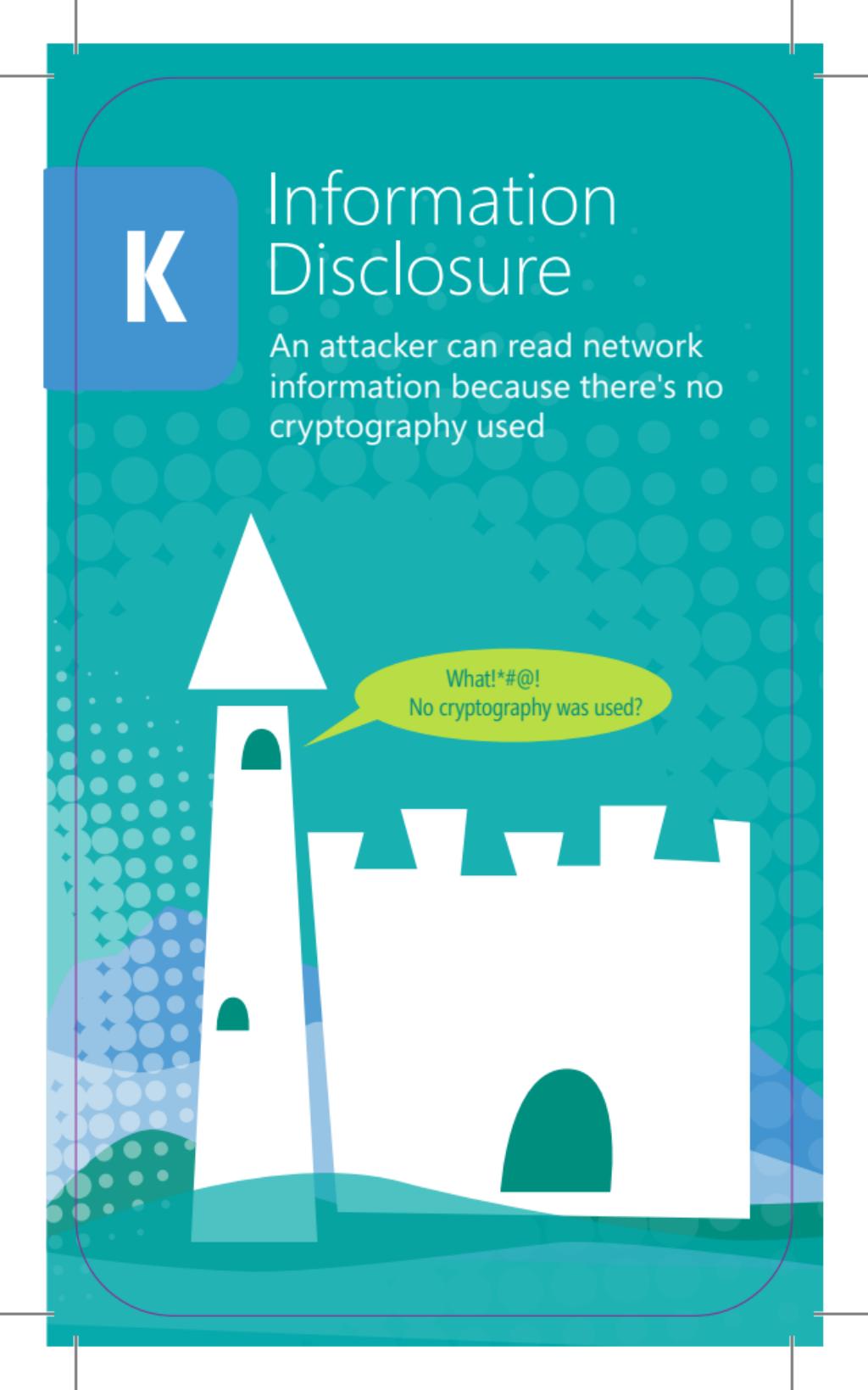
elevation of privilege



K

Information Disclosure

An attacker can read network information because there's no cryptography used



What!*#@!
No cryptography was used?

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elevation of privilege



A

Information Disclosure

You've invented a new Information Disclosure attack



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elevation of privilege



2

Denial of Service

An attacker can make your authentication system unusable or unavailable



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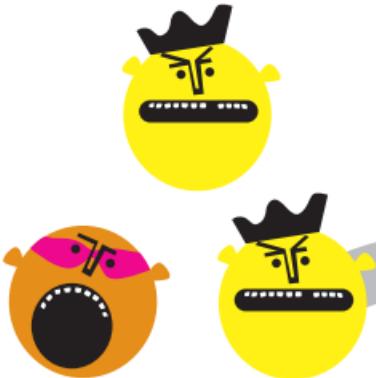
elevation of privilege



3

Denial of Service

An attacker can drain our easily
replacable battery (**battery,**
temporary)



3

Microsoft®

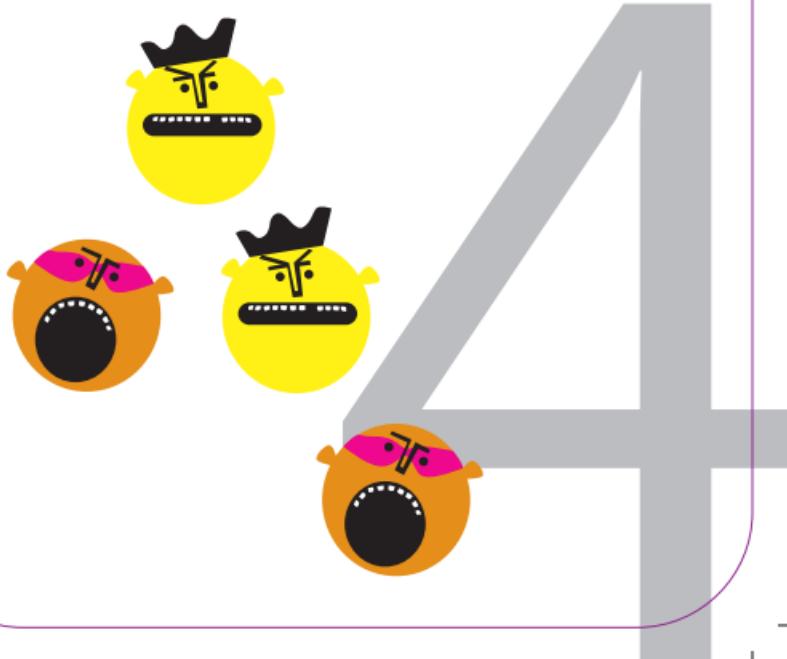
elevation of privilege



4

Denial of Service

An attacker can drain a battery that's hard to replace (**sealed in a phone, an implanted medical device, or in a hard to reach location**) (**battery, persist**)



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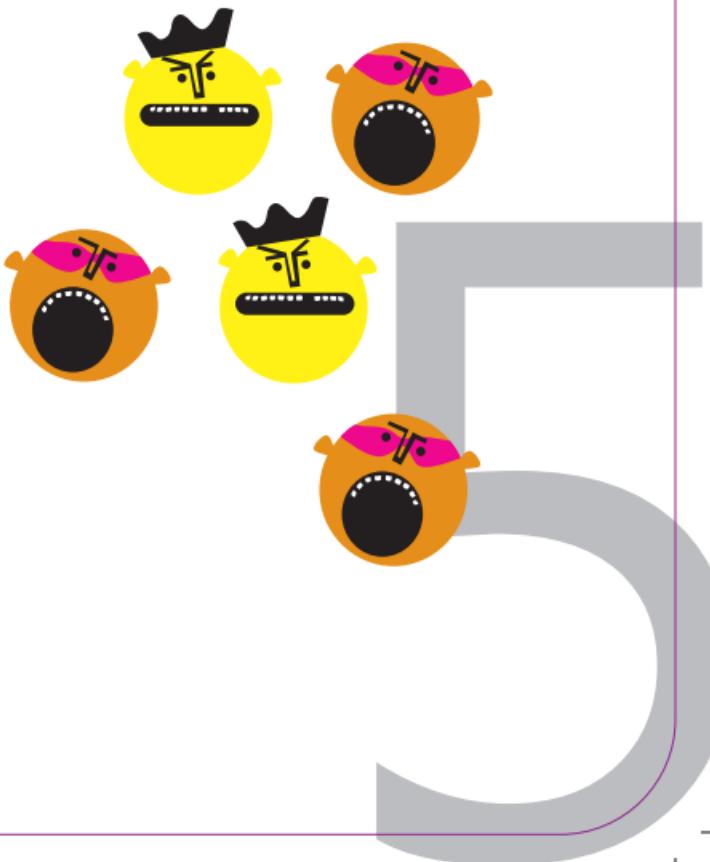
elevation of privilege



5

Denial of Service

An attacker can spend our cloud budget (**budget, persist**)



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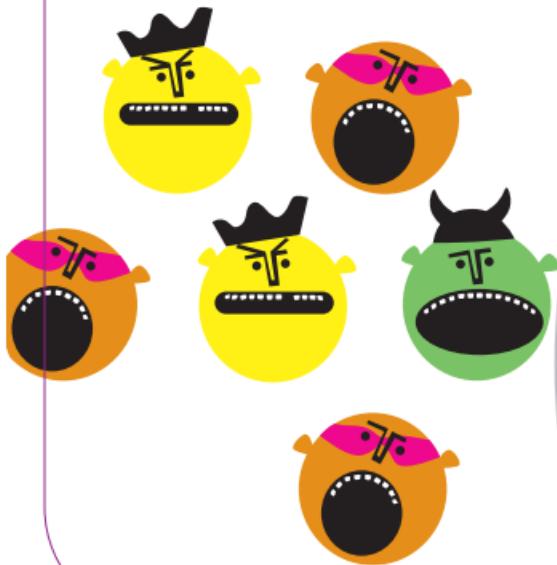
elevation of privilege



6

Denial of Service

An attacker can make a server unavailable or unusable without ever authenticating but the problem goes away when the attacker stops (**server, anonymous, temporary**)



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elevation of privilege



7

Denial of Service

An attacker can make a client unavailable or unusable and the problem persists after the attacker goes away (**client, auth, persist**)



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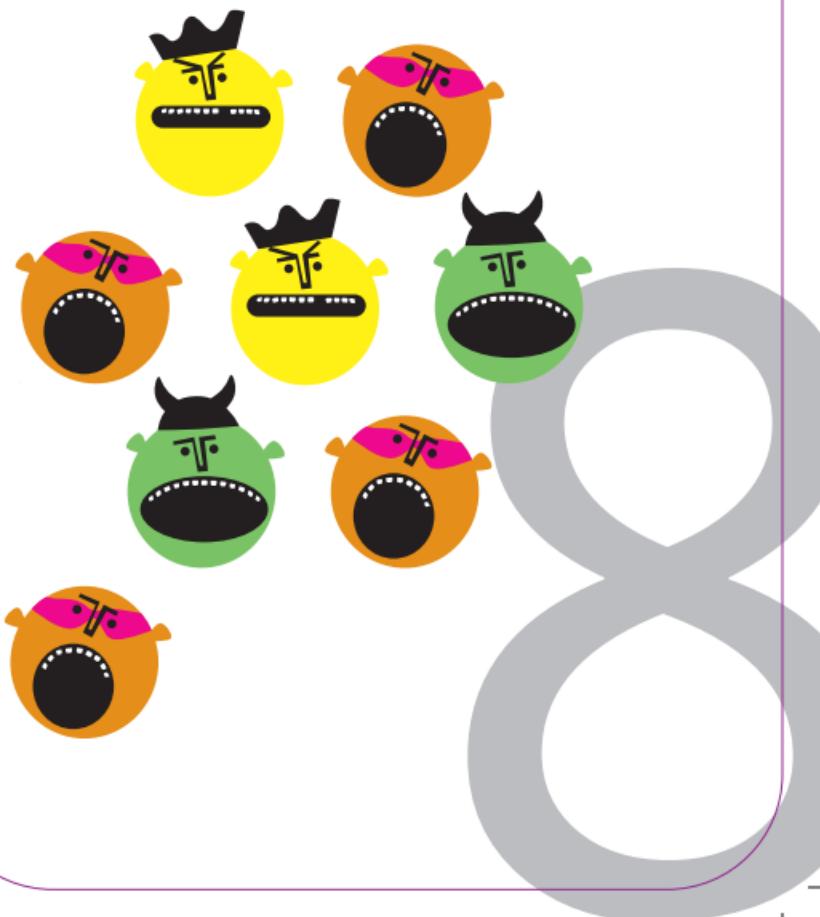
elevation of privilege



8

Denial of Service

An attacker can make a server unavailable or unusable and the problem persists after the attacker goes away (**server, auth, persist**)



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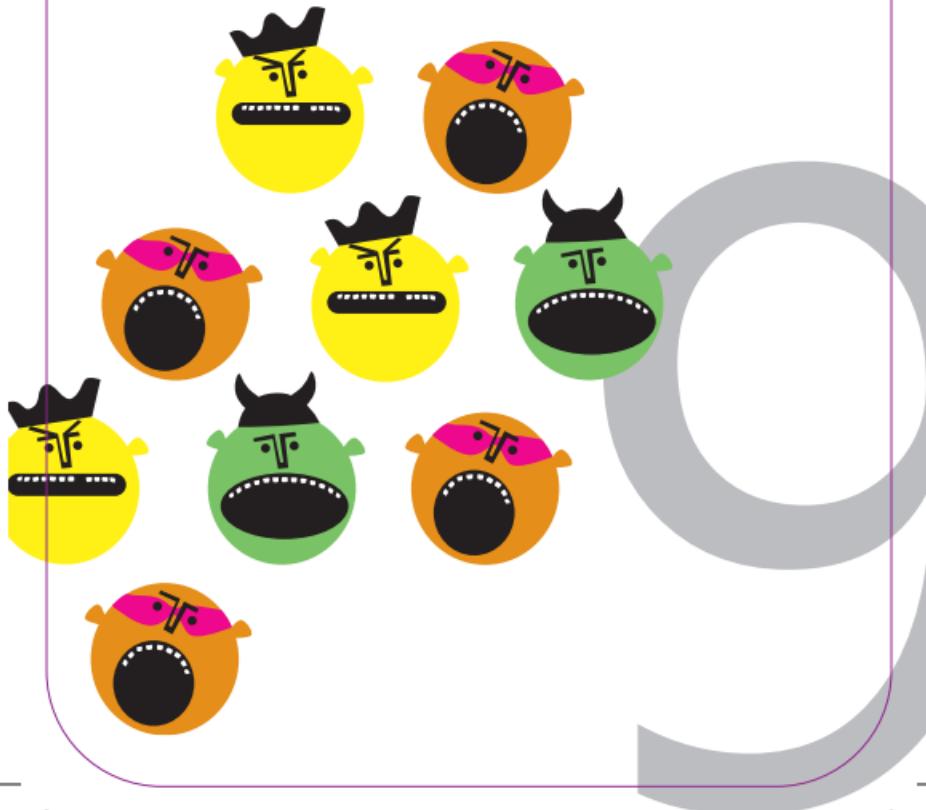
elevation of privilege



9

Denial of Service

An attacker can make a client unavailable or unusable without ever authenticating and the problem persists after the attacker goes away (**client, anon, persist**)



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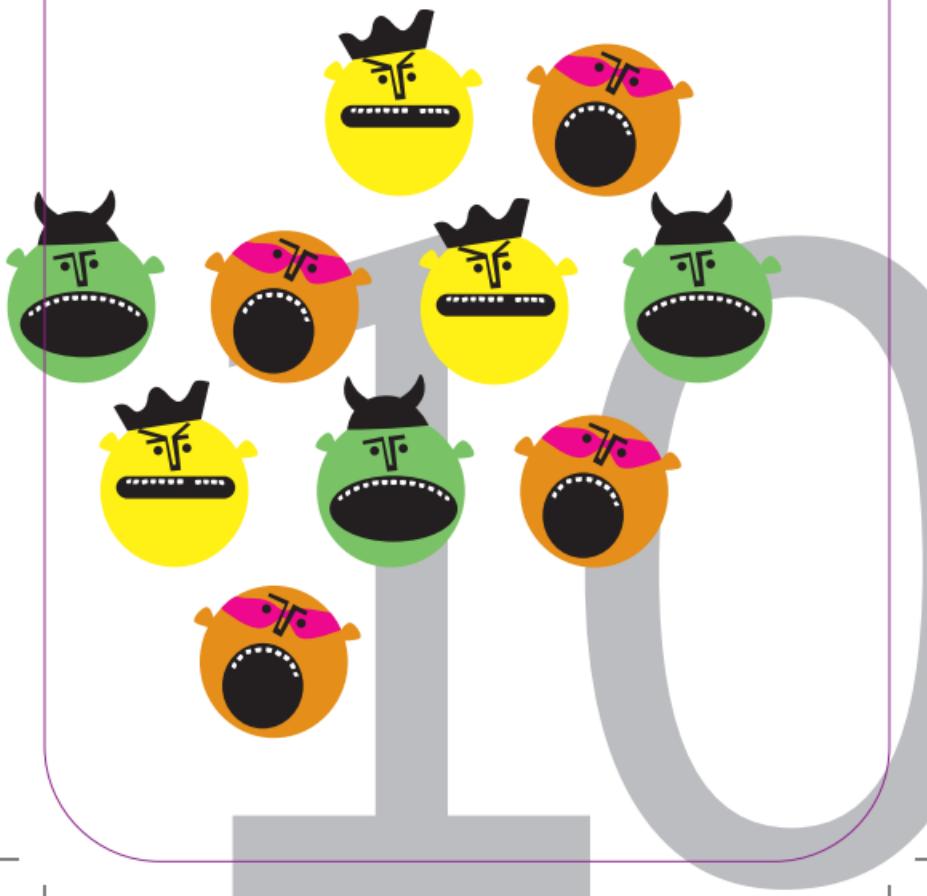
elevation of privilege



10

Denial of Service

An attacker can make a server unavailable or unusable without ever authenticating and the problem persists after the attacker goes away (**server, anonymous, persistent**)



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elevation of privilege



J

Denial of Service

An attacker can cause the logging subsystem to stop working



Microsoft®

elevation of privilege



Q

Denial of Service

An attacker can amplify a Denial of Service attack through this component with amplification on the order of 10 to 1



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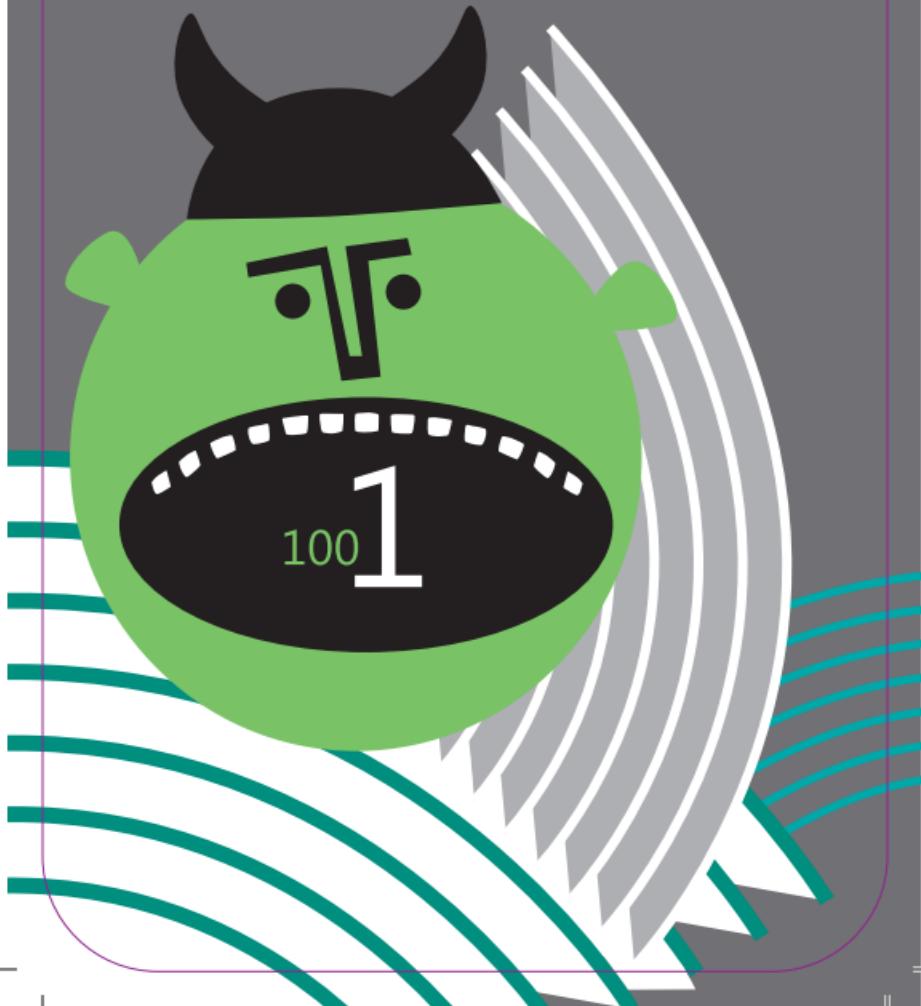
elevation of privilege



K

Denial of Service

An attacker can amplify a Denial of Service attack through this component with amplification on the order of 100 to 1



Microsoft®

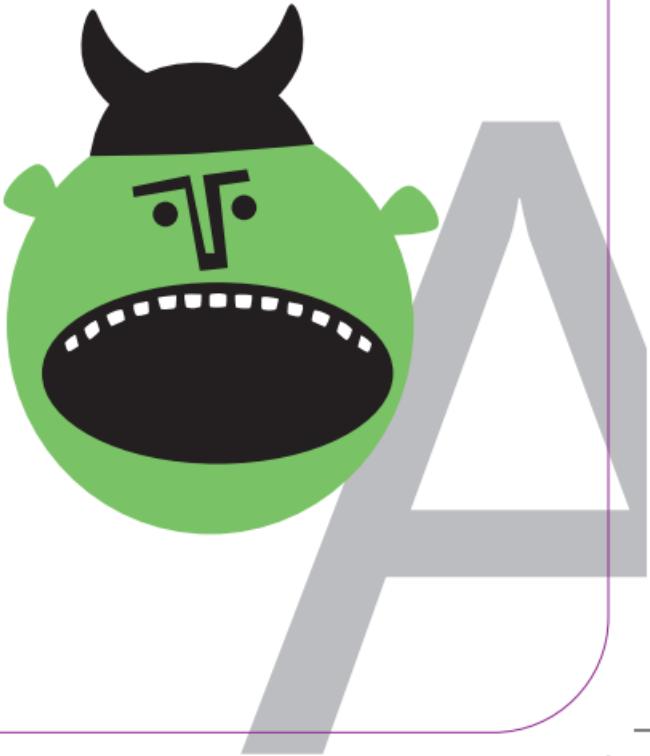
elevation of privilege



A

Denial of Service

You've invented a new Denial of Service attack



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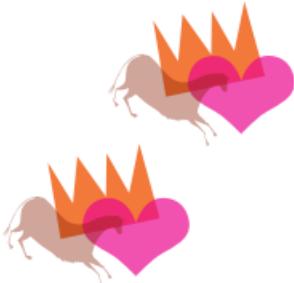
elevation of privilege



2

Elevation of Privilege

An attacker has compromised a key technology supplier



2

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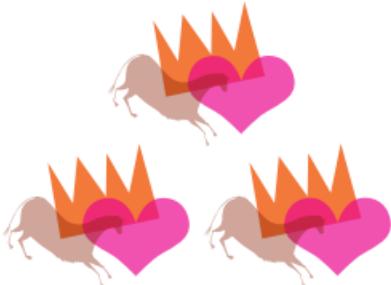
elevation of privilege



3

Elevation of Privilege

An attacker can access the cloud service which manages your devices



3

Microsoft®

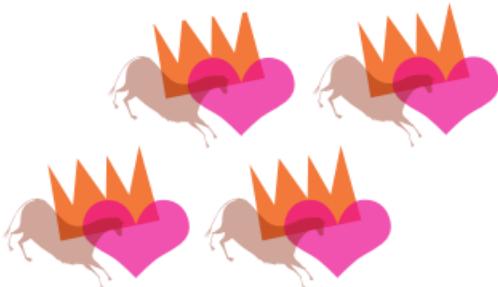
elevation of privilege



4

Elevation of Privilege

An attacker can escape from a container or other sandbox



4

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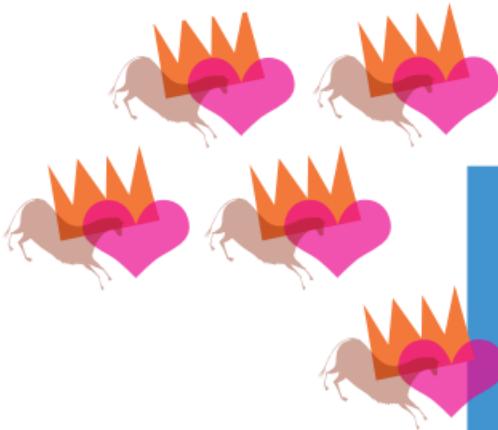
elevation of privilege



5

Elevation of Privilege

An attacker can force data through different validation paths which give different results



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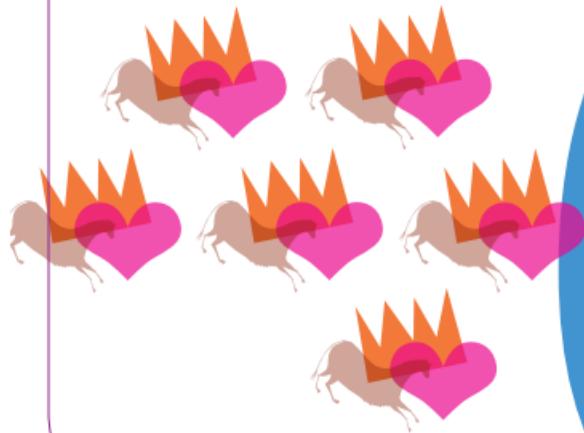
elevation of privilege



6

Elevation of Privilege

An attacker could take advantage of permissions you set, but don't use



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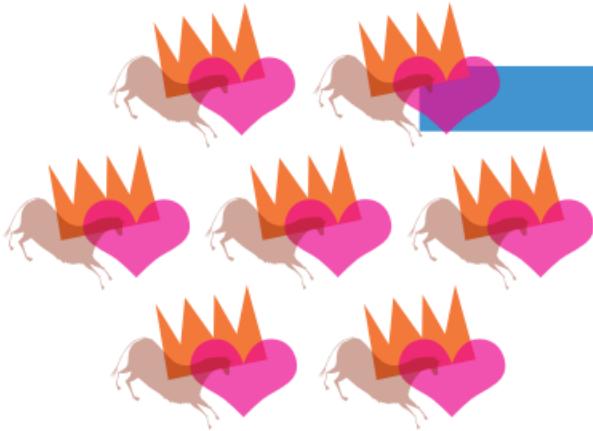
elevation of privilege



7

Elevation of Privilege

An attacker can provide a pointer across a trust boundary, rather than data which can be validated



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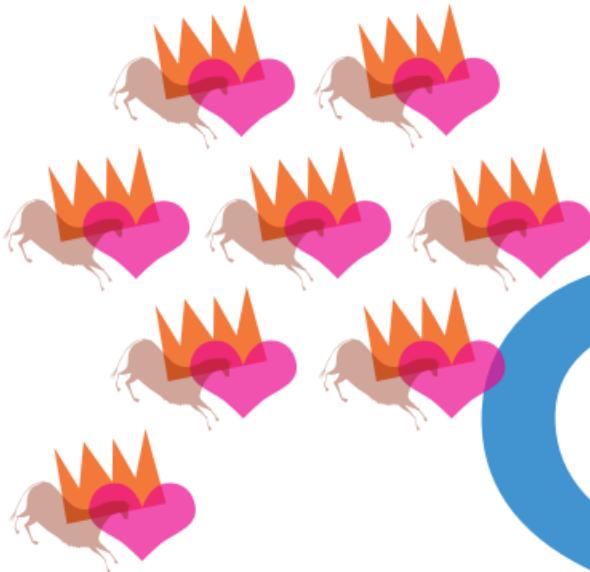
elevation of privilege



8

Elevation of Privilege

An attacker can enter data that is checked while still under their control and used later on the other side of a trust boundary



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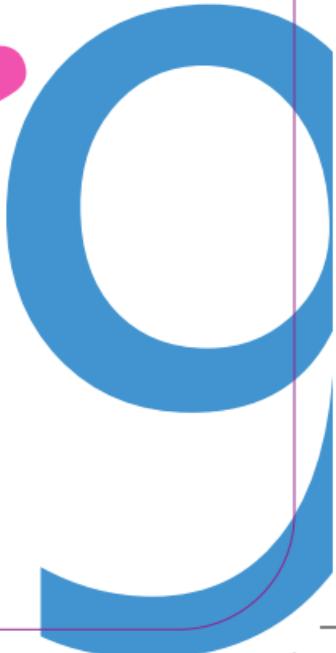
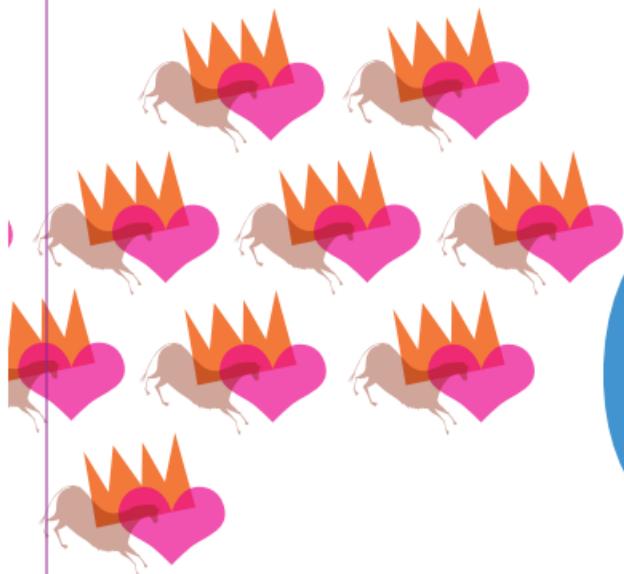
elevation of privilege



9

Elevation of Privilege

There's no reasonable way for a caller to figure out what validation of tainted data you perform before passing it to them



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elevation of privilege



10

Elevation of Privilege

There's no reasonable way for a caller to figure out what security assumptions you make



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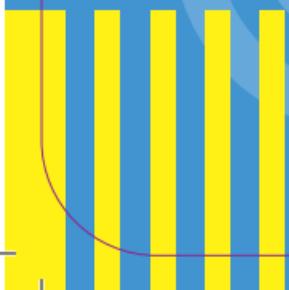
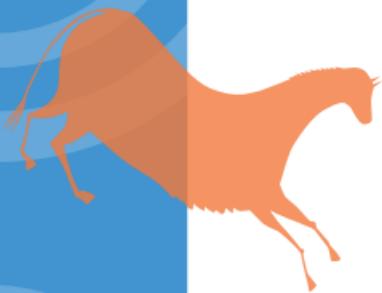
elevation of privilege



J

Elevation of Privilege

An attacker can reflect input back to a user, like cross site scripting



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elevation of privilege





Elevation of Privilege

You include user-generated content within your page, possibly including the content of random URLs



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elevation of privilege





K

Elevation of Privilege

An attacker can inject a command that the system will run at a higher privilege level



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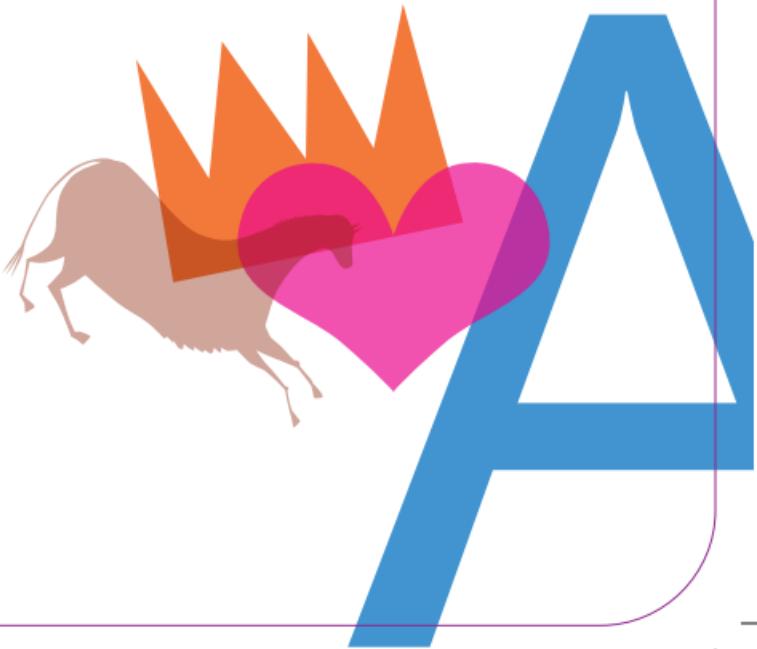
elevation of privilege



A

Elevation of Privilege

You've invented a new Elevation of Privilege attack



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elevation of privilege





Spoofing

2. An attacker could take over the port or socket that the server normally uses
3. An attacker could try one credential after another and there's nothing to slow them down (online or offline)
4. An attacker can anonymously connect, because we expect authentication to be done at a higher level
5. An attacker can confuse a client because there are too many ways to identify a server
6. An attacker can spoof a server because identifiers aren't stored on the client and checked for consistency on re-connection (that is, there's no key persistence)
7. An attacker can connect to a server or peer over a link that isn't authenticated (and encrypted)
8. An attacker could steal credentials stored on the server and reuse them (for example, a key is stored in a world readable file)

continued on back

Spoofing



Spoofing cont.

- 9.** An attacker who gets a password can reuse it (Use stronger authenticators)
- 10.** An attacker can choose to use weaker or no authentication
- J.** An attacker could steal credentials stored on the client and reuse them
- Q.** An attacker could go after the way credentials are updated or recovered (account recovery doesn't require disclosing the old password)
- K.** Your system ships with a default admin password, and doesn't force a change
- A.** You've invented a new Spoofing attack

Spoofing



Tampering

2. An attacker can take advantage of your custom key exchange or integrity control which you built instead of using standard crypto
3. An attacker can modify your build system and produce signed builds of your software
4. Your code makes access control decisions all over the place, rather than with a security kernel
5. An attacker can replay data without detection because your code doesn't provide timestamps or sequence numbers
6. An attacker can write to a data store your code relies on
7. An attacker can bypass permissions because you don't make names canonical before checking access permissions
8. An attacker can manipulate data because there's no integrity protection for data on the network
9. An attacker can provide or control state information

continued on back

Tampering



Tampering cont.

- 10.** An attacker can alter information in a data store because it has weak/open permissions or includes a group which is equivalent to everyone ("anyone with a Facebook account")
- J.** An attacker can write to some resource because permissions are granted to the world or there are no ACLs
- Q.** An attacker can change parameters over a trust boundary and after validation (for example, important parameters in a hidden field in HTML, or passing a pointer to critical memory)
- K.** An attacker can load code inside your process via an extension point
- A.** You've invented a new Tampering attack

Tampering

R

Repudiation

2. An attacker can pass data through the log to attack a log reader, and there's no documentation of what sorts of validation are done
3. A low privilege attacker can read interesting security information in the logs
4. An attacker can alter digital signatures because the digital signature system you're implementing is weak, or uses MACs where it should use a signature
5. An attacker can alter log messages on a network because they lack strong integrity controls
6. An attacker can create a log entry without a timestamp (or no log entry is timestamped)
7. An attacker can make the logs wrap around and lose data
8. An attacker can make a log lose or confuse security information
9. An attacker can use a shared key to authenticate as different principals, confusing the information in the logs

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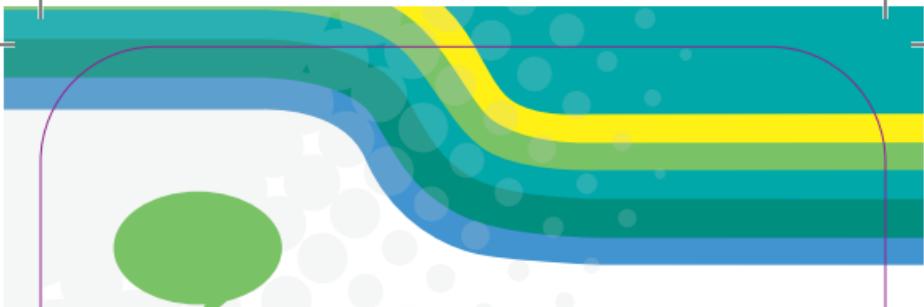
Repudiation

R

Repudiation cont.

- 10.** An attacker can get arbitrary data into logs from unauthenticated (or weakly authenticated) outsiders without validation
- J.** An attacker can edit logs and there's no way to tell (perhaps because there's no heartbeat option for the logging system)
- Q.** An attacker can say "I didn't do that," and you'd have no way to prove them wrong
- K.** The system has no logs
- A.** You've invented a new Repudiation attack

Repudiation



Information Disclosure

2. An attacker can brute-force file encryption because there's no defense in place (example defense, password stretching)
3. An attacker can see error messages with security sensitive content
4. An attacker can read content because messages (say, an email or HTTP cookie) aren't encrypted even if the channel is encrypted
5. An attacker may be able to read a document or data because it's encrypted with a non-standard algorithm
6. An attacker can read data because it's hidden or occluded (for undo or change tracking) and the user might forget that it's there
7. An attacker can act as a 'man in the middle' because you don't authenticate endpoints of a network connection
8. An attacker can access information through a search indexer, logger, or other such mechanism

continued on back

Information Disclosure



Information Disclosure cont.

- 9.** An attacker can read sensitive information in a file with permissive permissions
- 10.** An attacker can read information in files or databases with no access controls
- J.** An attacker can discover the fixed key being used to encrypt
- Q.** An attacker can read the entire channel because the channel (say, HTTP or SMTP) isn't encrypted
- K.** An attacker can read network information because there's no cryptography used
- A.** You've invented a new Information Disclosure attack

Information Disclosure



Denial of Service

2. An attacker can make your authentication system unusable or unavailable
3. An attacker can drain our easily replaceable battery (**battery, temporary**)
4. An attacker can drain a battery that's hard to replace (sealed in a phone, an implanted medical device, or in a hard to reach location)
(battery, persist)
5. An attacker can spend our cloud budget
(budget, persist)
6. An attacker can make a server unavailable or unusable without ever authenticating but the problem goes away when the attacker stops
(server, anonymous, temporary)
7. An attacker can make a client unavailable or unusable and the problem persists after the attacker goes away
(client, auth, persist)

continued on back

Denial of Service



Denial of Service cont.

8. An attacker can make a server unavailable or unusable and the problem persists after the attacker goes away
(server, auth, persist)
 9. An attacker can make a client unavailable or unusable without ever authenticating and the problem persists after the attacker goes away
(client, anon, persist)
 10. An attacker can make a server unavailable or unusable without ever authenticating and the problem persists after the attacker goes away
(server, anonymous, persistent)
- J. An attacker can cause the logging subsystem to stop working
- Q. An attacker can amplify a Denial of Service attack through this component with amplification on the order of 10 to 1
- K. An attacker can amplify a Denial of Service attack through this component with amplification on the order of 100 to 1
- A. You've invented a new Denial of Service attack

Denial of Service



Elevation of Privilege

2. An attacker has compromised a key technology supplier
3. An attacker can access the cloud service which manages your devices
4. An attacker can escape from a container or other sandbox
5. An attacker can force data through different validation paths which give different results
6. An attacker could take advantage of permissions you set, but don't use
7. An attacker can provide a pointer across a trust boundary, rather than data which can be validated
8. An attacker can enter data that is checked while still under their control and used later on the other side of a trust boundary
9. There's no reasonable way for a caller to figure out what validation of tainted data you perform before passing it to them

continued on back

Elevation of Privilege



Elevation of Privilege cont.

- 10.** There's no reasonable way for a caller to figure out what security assumptions you make
- J.** An attacker can reflect input back to a user, like cross site scripting
- Q.** You include user-generated content within your page, possibly including the content of random URLs
- K.** An attacker can inject a command that the system will run at a higher privilege level
- A.** You've invented a new Elevation of Privilege attack

Elevation of Privilege



About

Threat Modeling

The Elevation of Privilege game is designed to be the easiest way to start looking at your design from a security perspective. It's one way to threat model, intended to be picked up and used by any development group. Because the game uses STRIDE threats, it gives you a framework for thinking, and specific actionable examples of those threats.

STRIDE stands for:

Spoofing: Impersonating something or someone else.

Tampering: Modifying data or code.

Repudiation: Claiming not to have performed an action.

Information Disclosure: Exposing information to someone not authorized to see it.

Denial of Service: Denying or degrading service to users.

Elevation of Privilege: Gain capabilities without proper authorization.

At www.microsoft.com/security/sdl/eop we have videos, score sheets and tips and tricks for playing.





SDL

The Elevation of Privilege game is a fun and easy way to get started understanding the security of your systems by threat modeling. As you discover and correct design-level security problems, it's worth thinking about the other ways security issues can creep into your code. Microsoft has a large collection of free resources available to help you get started with the Security Development Lifecycle (SDL).

To learn more about threat modeling and the Microsoft Security Development Lifecycle, visit our website at microsoft.com/sdl/

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Security Development Lifecycle