Securing PostgreSQL

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Greetings!

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We’re Here To Do The Impossible.

- “Security” is not a single topic or a single practice.
- Essentially everything you do has security implications.
- Perfect security is impossible.
- All life is a tradeoff, followed by certain death.

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OLD MAN YELLS AT CLOUD

A Crazy Man Is Yelling At Me.

- Every installation makes tradeoffs on utility, convenience, and security.
- Almost no one does everything we'll do here. That's (probably) OK.
- Just make sure you understand what the risks are, and how to mitigate them.

The Stack.

- Host system.
- PostgreSQL itself.
  - Access to the database server.
- The data in PostgreSQL.
  - Encryption, permissions, etc.
- The application.

The Host.

- If the database server host is compromised, nothing else matters.
- Assume that local privilege escalation will always be a thing.
  - Always assume a local user can get root.
  - … because they probably can.

DIRTY COW

Minimize Attack Surface.

- Always put your database server behind a firewall / VPC.
- Never expose port 5432 to the public internet.
- On AWS, everything is the public internet.

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No Direct SSH.

- Do not allow direct public logins via SSH to the database host. Require a hop through a specific bastion host.
- Restrict access to the bastion host by VPN or IP; do not simply trust bare SSH (even on a nonstandard port).
    - Everyone tries 2222 now. C'mon.

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You Don’t Need That.

- Don’t run unnecessary services on your database host.
- No application server, IRC server, mail server, giant mysterious Java VM the last sysadmin installed…
- Run nmap against it and see what’s open.

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iptables is your friend.

- Or whatever local firewall you have.
- Restrict access just to expected servers.
- Don't rely on just pg_hba.conf.
- Especially important in a cloud hosting environment.

And Do The Basics.

- For system administration, use specific users and sudo; never, ever allow root logins.
- Use a password manager. Always always always.
- For critical passwords, use split passwords with dual custody.

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Keep up to date!

- Always subscribe to the pgsql-announce list.
- Always immediately apply any security-related updates.
- Also subscribe to the appropriate security list for your platform.
- Keep up to date with patches, already!

Apply Patches Promptly.

- Make it someone’s job.
- Make sure they do it.
- Never, ever allow a critical security patch to go unheeded.
- Ever ever ever.

In a perfect world...

- Use multi-factor authentication for all logins (VPN, host, etc.).
- Use LDAP for all logins (so that credentials can be revoked globally).
- Require password rotation.
- At an absolute minimum, never reuse passwords.

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Google “codespaces”

The Glass House

- Make sure your machines are properly secured in the data center.
- This means real security (access control, video, mantrap, biometrics) on your server room.
- Make sure your cloud provider provides this for the cloud they are providing to you!

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pg_hba.conf

```
# TYPE  DATABASE        USER            ADDRESS                 METHOD
local   all             all                                     trust
```

```
# TYPE  DATABASE        U               ADDRESS                 METHOD
local   all             all                                     trust
```

Securing the Database Instance.

- There is no such thing as "trust" mode authentication. Forget it ever existed.
- Always require specific users, even superusers.
- Do not use the postgres Unix or database user. Require specific users.
- LDAP is your "friend," here.

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But what about “postgres”?

- Create a nasty password for it, keep it in dual custody.
- Never use it except in dire emergency.
- Don’t allow non-local logins for it (or any other superuser).
- Don’t use it for routine system administration tasks.

listen_address

- Set it to the specific addresses that you know are on the right networks.
- listen_address = '*' is for the brave.
- In a cloud environment, you can't always guarantee that all interfaces are within a VPC.

pg_hba.conf

- Use LDAP to manage credentials.
- Every user and role should have its own PostgreSQL role.
- Only grant the permissions that role actually needs.
- A data analyst does not need to drop tables.

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Passwords.

- If not using LDAP, PostgreSQL passwords must be singletons.
- MD5 passwords might as well be cleartext at this point.
- Don’t reuse PostgreSQL user passwords anywhere else.
- Make them horrible and long.

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“web”

- Most common bad habit: the singleton web user than can do anything.
- This is made worse by some frameworks’ migration system.
- Fight it. Only give app roles the minimum that they need to work.
- Lock it down to app server IPs.

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Connections.

- Require SSL and CA certificates.
- Especially in cloud environments.
- Anything less runs the risk of MitM attacks.

Data Security.

- Every database has sensitive information.
- Just customer and order info is sensitive.
- Some things are really sensitive.
  - Credit cards, health records, utility bills…
- Essential to protect it against theft.

“We’ll Just Park Here.”

- “No problem! We’ve layered luks on top of lvm on top of EBS, and we’re all set!”
- No.
- Full disk encryption is useless.
- Let me say that again.

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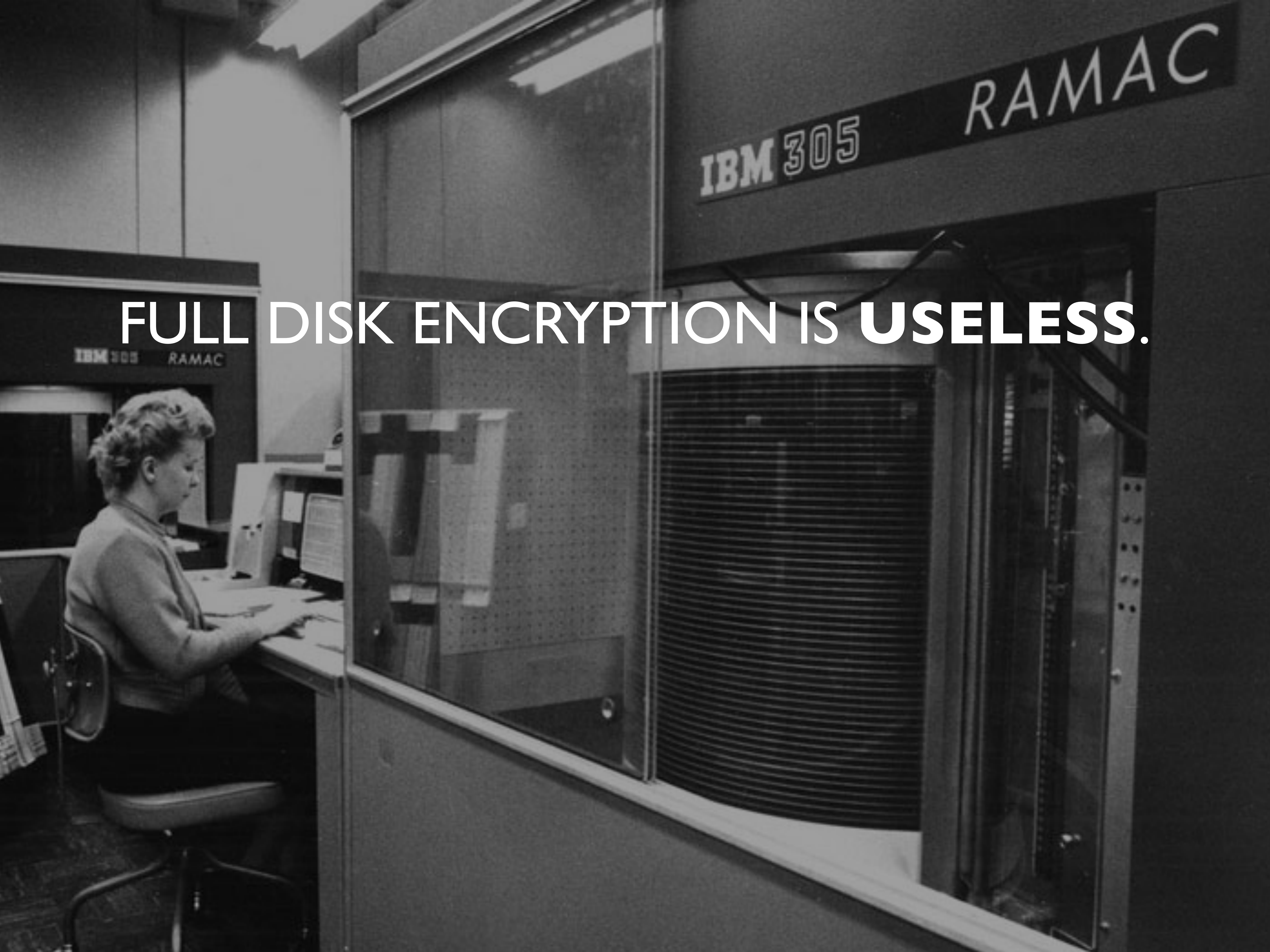
FULL DISK ENCRYPTION IS **USELESS**.



FDE protects against…

- … theft of the media.
- That's it.
- That is about 0.00000002% of the actual intrusions that you have to worry about.
- Easy rule: If psql can read it in cleartext, it's not secure.
- (It's a great idea for laptops, of course.)

That Being Said.

- Sometimes, regulations or contracts require full-disk encryption.
  - Ugh. Fine.
- Make sure your key management is safe.
  - Don’t bake keys into startup scripts, etc.

Per-Column Encryption.

- Always encrypt specific columns, not entire database or disk.
- Better performance, higher security.
- Key management is a pain.
- Automatic restart in a high-security environment is essentially impossible.
  - Assume a human will be in the loop.

Per-Column Techniques.

- Encrypt each column as TEXT or bytea.
  - Good for small items: credit cards, etc.
- Create a JSON blob, encrypt that, store it as bytea.
  - More complex things, like medical records.

Good Crypto Hygiene.

- Use a well-known secure algorithm (AES256 is considered the standard).
- **Never** roll your own crypto.
- Do not bake keys into code or store them in repositories.

Indexing.

- You often have to store a partial version, or hash, of a value for indexing purposes.
- Example: CSRs may need to look up an order by credit card number.
- There's nothing wrong with this, BUT:

Be careful with hashes!

- It's very easy to reverse some hashes, especially if you have partial data!
- Store the minimum necessary.
- Use a strong hash, like SHA-256.

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So, how about pgcrypto?

- pgcrypto is a /contrib module that contains cryptography functions.
- Why not use it to encrypt the data?
- I mean, it's just sitting there, right?

```
INSERT INTO super_secret_table(card)
   VALUES(
      pgp_sym_encrypt(‘4111111111111111’,
                      ‘mysuperpassword’));
```

```
2016-05-19 10:40:42.524 PDT,"xof","xof",
99245,"[local]",573dfa20.183ad,9,"INSERT",
2016-05-19 10:38:40 PDT,2/0,0,LOG,
00000,"duration: 1.712 ms  statement: INSERT
INTO super_secret_table(card)
VALUES(pgp_sym_encrypt('4111111111111111',
'mysuperpassword'));",,,,,,,,,"psql"
```

Not so great.

- Be careful about what you expose in text logs.
- That "diagnostic" pgbadger run with log_min_statement_duration = 0?
- Always do the encryption in the application, not in the database.

Log Everything!

- Connections, disconnections, DML changes.
- Make sure logs are kept secure and cannot be tampered with (rsyslog, etc.)
- Make sure that the log record can be traced back to an individual person.
- Log *all* activity by directly-connecting users (as opposed to the application).

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BUT!

- Make sure you are not logging sensitive information in cleartext!
- This is another good reason to encrypt in the application, not in the database.

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Restrict the Data.

- … don’t give every developer production system access.
- … identify and qualify the system administrators who need global system access.
- … scrub data that comes out of production for development testing.

Backup Security.

- Be sure your backups are as secure as your primary database.
- A recent backup is just as good as your production system for a data theft.
- If using a shared cloud store like S3, make sure contents are properly encrypted and private.

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Row-Level Security.

- Restricts access to data by row, rather than just by database object.
- Conceptually, a “mandatory view” applied based on access controls.
- Allows removal of sensitive columns, multi-tenancy in a table, etc.

Application Security.

- After all that, this is not where most breaches happen.
- Most breaches are either application breaches or malware-infected clients.
- POS tills, compromised user workstations.

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Application Basics.

- Always use proper parameter substitution in your library!
- Never build SQL by text substitution unless it is absolutely necessary (for example, variable table names).
- All user input is hostile and wants to kill you all the time.

API Hygiene

- Always require TLS 1.2 for all remote APIs.
- For dedicated clients (mobile apps, etc.) use proper certificate management.
- Make API keys long, unique, and random.
- Log everything.

Prepare for War.

- Detect unusual access patterns and take action.
- Blocking, rate-limiting, admin alerts, etc.
- Users will generally share passwords across systems.
    - Use Captchas to reduce automated attack risks.

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Application Testing.

- Make security testing a critical part of testing.
- Always write tests that deliberately try to get around security controls.
- Get new engineers to try to hack your system, and praise them highly if they do.

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Basic Infosec.

- Run appropriate malware-detecting email services.
- Use all of the OS vendor's anti-virus tools.
- Follow @SwiftOnSecurity.

Trust, but Verify.

- Hire external penetration testing firms. Encourage developers to poke at security.
- Hire security audit companies that actually understand security, not just run pen test scripts.

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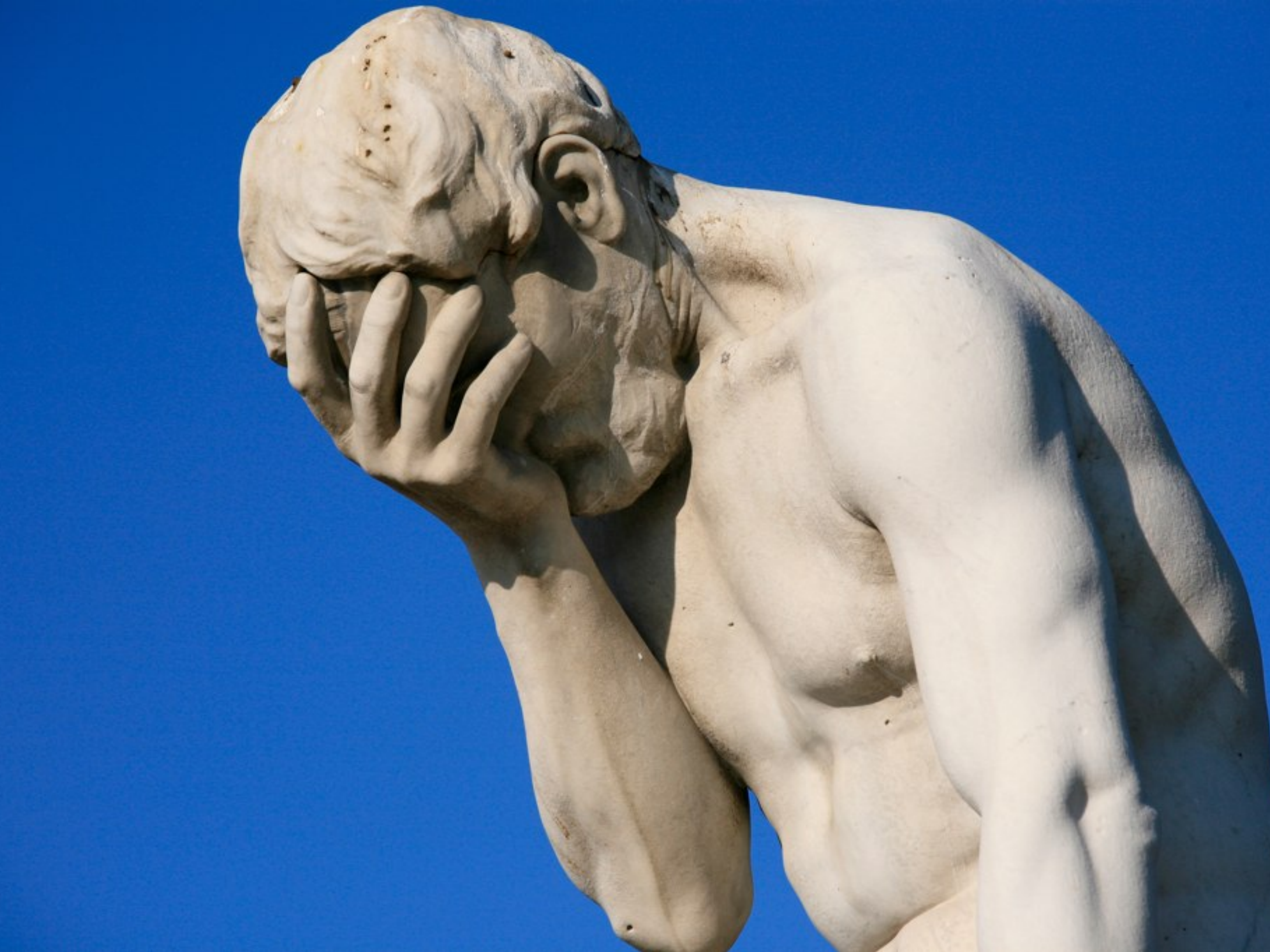
This actually happened.

- “We need you to disable your firewall.”
    - “Um, why?”
- “Our penetration test script is failing because the firewall won’t let it through.”
    - “This… sounds kind of like what a firewall is supposed to do, to me.”

By now, you are probably…



We're doomed.

- Data security is a lot of work.
- You will never be perfectly secure.
- Even the most secure companies get intrusions.
- Life is full of pain and despair.

Have hope!

- Do as much "set it and forget it" security as possible.
- Do regular audits and destruction tests (great things for new engineers to do).
- Be sure that the company, from the top, takes security seriously.

Life is full of tough choices.

- You will always trade off some security for convenience.
- But don't get complacent and have convenience become the most important thing.
- Make security one of the things the organization is proud of!

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Questions?

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Thank you!

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