Greetings!

- Christophe Pettus
- CEO, PostgreSQL Experts, Inc.
- thebuild.com — personal blog.
- pgexperts.com — company website.
- Twitter @Xof
- christophe.pettus@pgexperts.com
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.
OLD MAN YELLS AT CLOUD
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.
Google
“CloudPets Breach”
**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.
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.
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.
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.
Just a note.

- Kerberos works too, and is probably better than LDAP.
- LDAP is much more common.
- LDAP is easier to fit onto slides.
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!
• Terminate SSL local to the machine that will use the sensitive data.

• Do not use front-end SSL termination or acceleration.

• SSL is not that computationally expensive.

• Interior networks are not that secure.
Google
“cloudbleed”
pg_hba.conf
<table>
<thead>
<tr>
<th># TYPE</th>
<th>DATABASE</th>
<th>USER</th>
<th>ADDRESS</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>local</td>
<td>all</td>
<td>all</td>
<td>all</td>
<td>trust</td>
</tr>
<tr>
<td>TYPE</td>
<td>DATABASE</td>
<td>USER</td>
<td>ADDRESS</td>
<td>METHOD</td>
</tr>
<tr>
<td>--------</td>
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<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>local</td>
<td>all</td>
<td>all</td>
<td></td>
<td>trust</td>
</tr>
</tbody>
</table>
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.
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.
• 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.
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.
• 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.
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.
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.
- Use a well-known library designed by specialists. (And don't use ECB.)
- 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.
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'));
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).
• Make sure you are not logging sensitive information in cleartext!

• This is another good reason to encrypt in the application, not in the database.
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.
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.
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.
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.
Basic Infosec.

• Run appropriate malware-detecting email services.

• Use all of the **OS vendor’s** anti-virus tools.
  • Third-party tools often hurt more than they help.

• 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.
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.
- Without the “forget it” part.
- 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!
Questions?

Christophe Pettus
@xof

thebuild.com
pgexperts.com
Thank you!

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