Securing PostgreSQL From External Attack

BRUCE MOMJIAN

Database systems are rich with attack vectors to exploit. This presentation explores the many potential PostgreSQL external vulnerabilities and shows how they can be secured. *Includes concepts from Magnus Hagander*

https://momjian.us/presentations

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Attack Vectors

https://www.flickr.com/photos/twalmsley/

External Attack Vectors

- 'Trust' security
- Passwords / authentication theft
- Network snooping
- Network pass-through spoofing
- Server / backup theft
- Data encryption

Additional details can be found at https://momjian.us/main/blogs/pgblog_categories.html#security.

Internal Attack Vectors (Not Covered)

- Database object permissions
- SQL injection attacks
- Application vulnerability
- Operating system compromise

Authentication Security

https://www.flickr.com/photos/brookward/

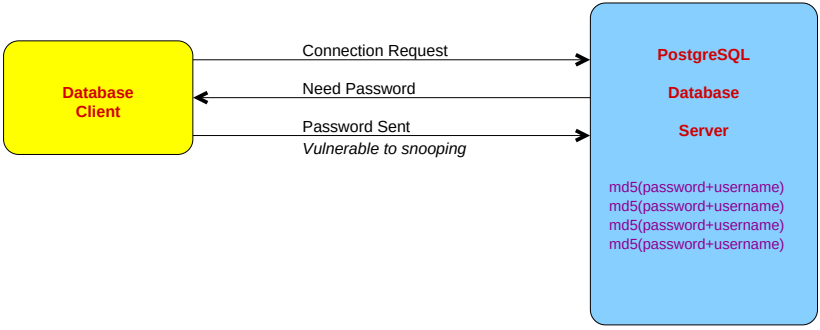
Avoid “Trust” Security in pg_hba.conf

```
# TYPE  DATABASE    USER        CIDR-ADDRESS          METHOD
# "local" is for Unix domain socket connections only
local   all         all                               trust
# IPv4 local connections:
host    all         all         127.0.0.1/32          trust
# IPv6 local connections:
host    all         all         ::1/128               trust
```

Solution: Use the initdb *-A* flag, i.e., you don’t want to see this:

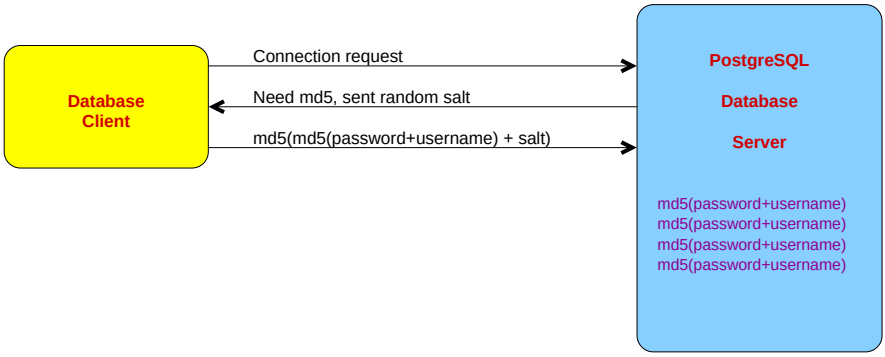
> *WARNING: enabling "trust" authentication for local connections*
> *You can change this by editing pg_hba.conf or using the -A option the*
> *next time you run initdb.*

Password Snooping

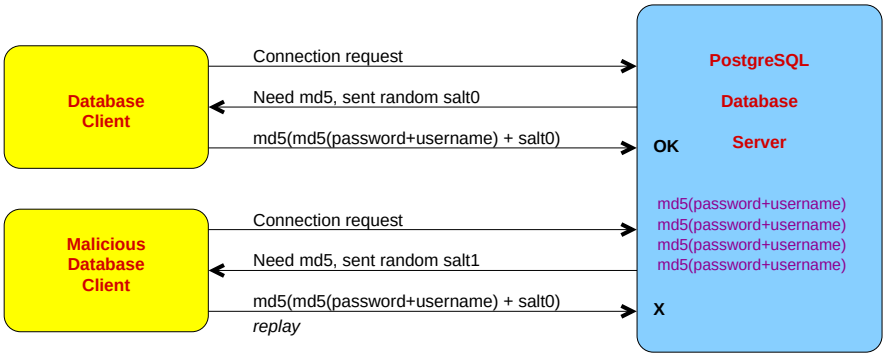


Using 'username' in the MD5 string prevents the same password used by different users from appearing the same. It also adds some randomness to the md5 checksums.

MD5 Authentication Prevents Password Snooping



MD5 Authentication Prevents Password Replay

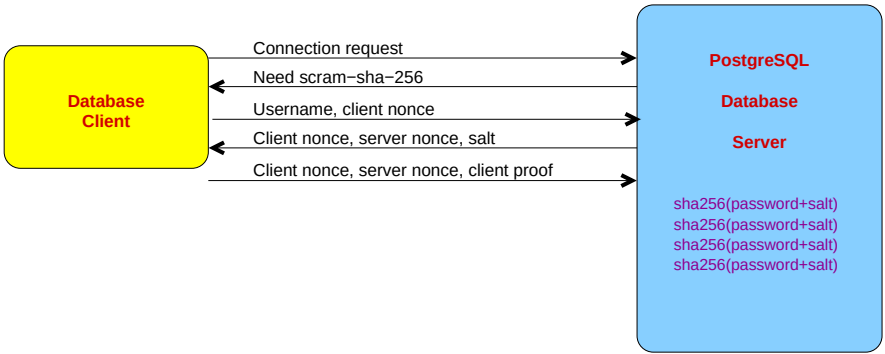


salt is a random four-byte integer so millions of connection attempts might allow the reuse of an old authentication reply.

SCRAM Authentication

scram-sha-256, available in Postgres 10, eliminates less-secure MD5, and avoids the risk of duplicate salt values being replayed. SCRAM with channel binding, available in Postgres 13, allows authentication, similar to certificate authentication. *scram-sha-256* is the default in Postgres 14.

SCRAM-SHA-256 Authentication



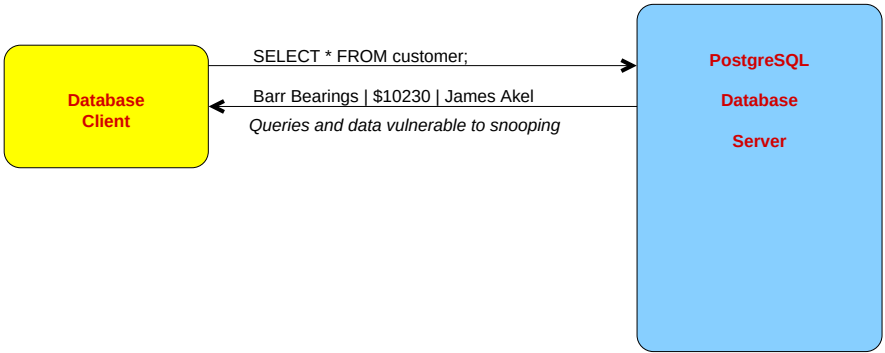
https://en.wikipedia.org/wiki/Salted_Challenge_Response_Authentication_Mechanism

Password Attacks

- Weak passwords
- Reuse of old passwords
- Brute-force password attacks

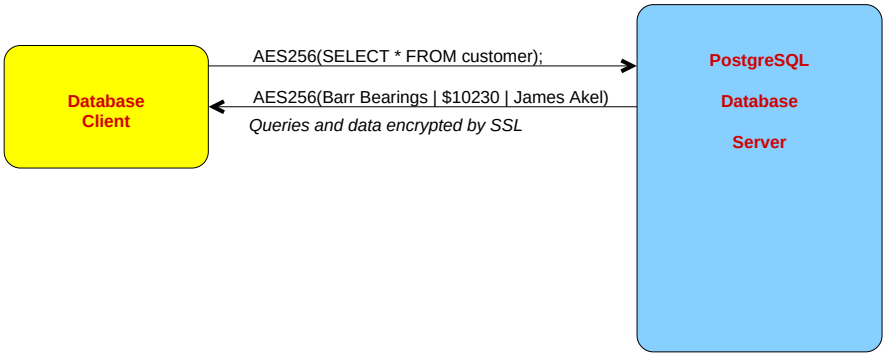
None of these vulnerabilities is prevented by Postgres directly, but external authentication methods, like LDAP, PAM, and SSPI, can prevent them. Some authentication methods are difficult to use with connection pooling.

Queries and Data Still Vulnerable to Network Snooping



Password changes are also vulnerable to snooping.

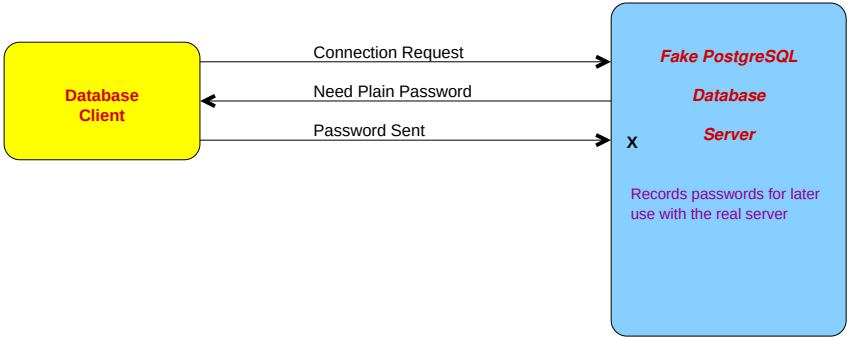
SSL Prevents Snooping By Encrypting Queries and Data



Preventing Spoofing

https://www.flickr.com/photos/tomhickmore/

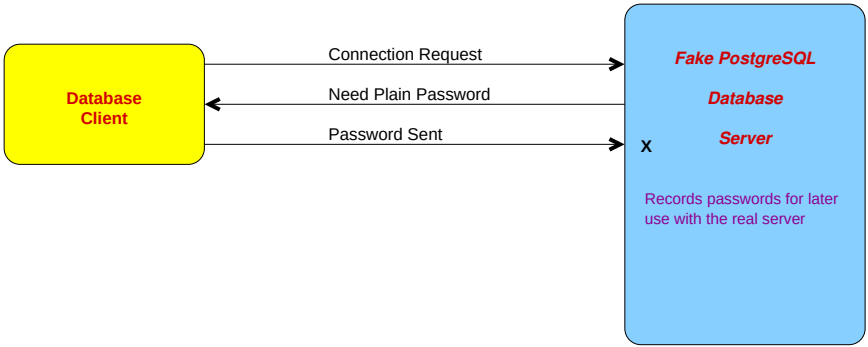
Localhost Spoofing While the Database Server Is Down



Uses a fake socket or binds to port 5432 while the real server is down. (/tmp is world−writable and 5432 is not a root−only port. libpq's "requirepeer" helps here.)

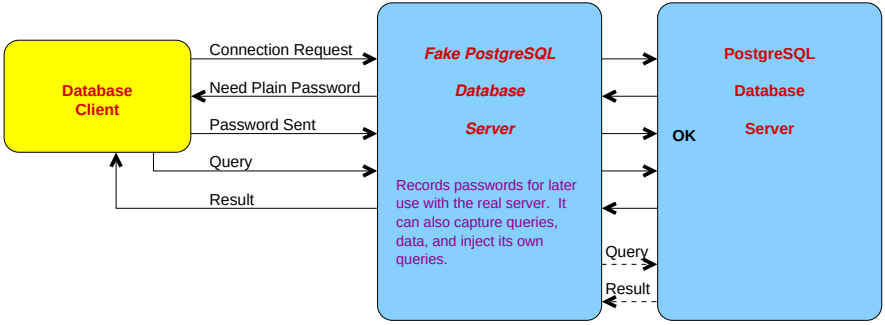
The server controls the choice of 'password' instead of 'md5'.

Network Spoofing



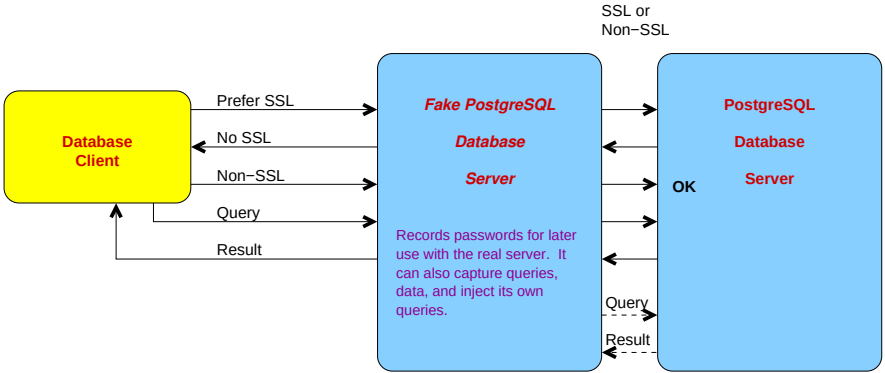
Without SSL 'root' certificates there is no way to know if the server you are connecting to is a legitimate server.

Network Spoofing Pass-Through



Without SSL 'root' certificates there is no way to know if the server you are connecting to is a legitimate server.

SSL 'Prefer' Is Not Secure



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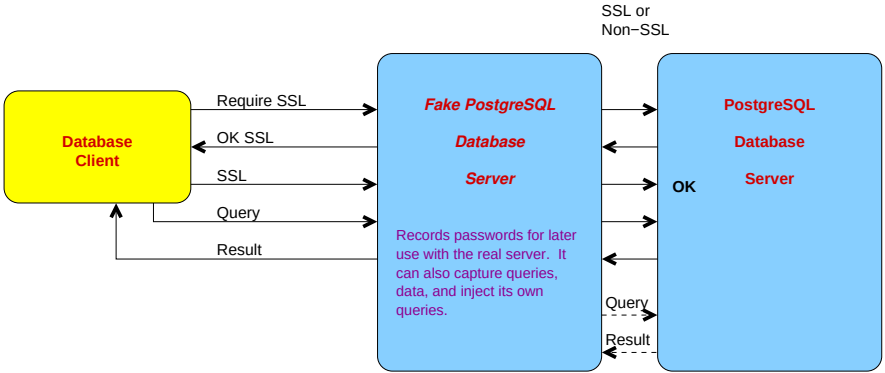
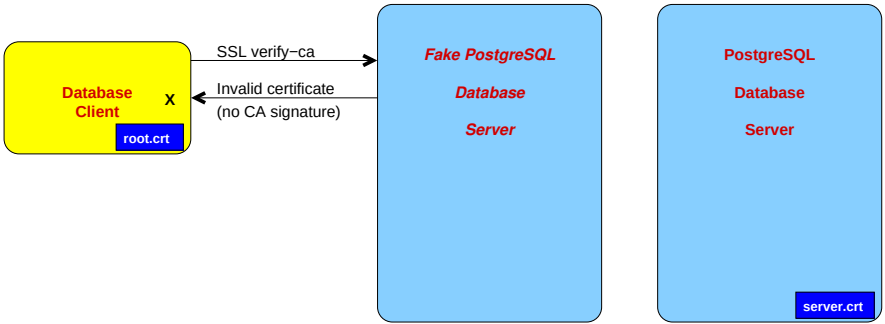
SSL 'Require' Is Not Secure From Spoofing

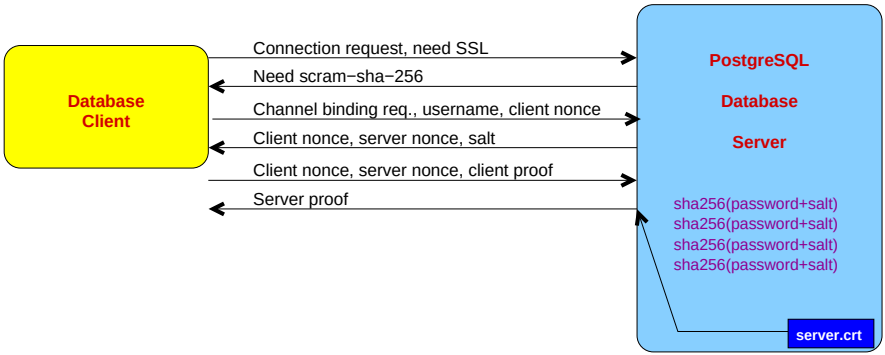


Without SSL 'root' certificates there is no way to know if the server you are connecting to is a legitimate server.

SSL 'Verify-CA' Is Secure From Spoofing

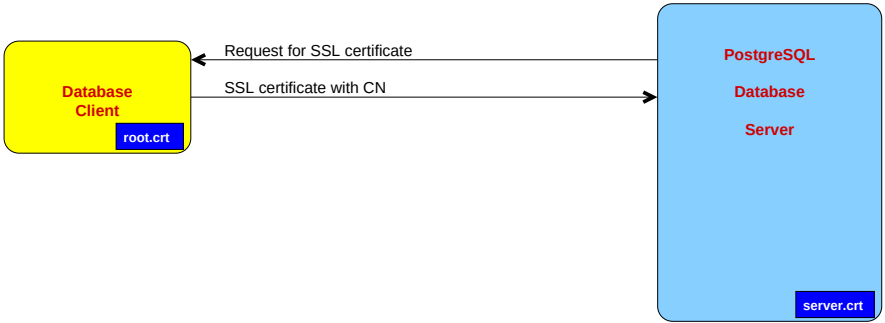


Channel Binding



Certificates are sent to peers as part of the TLS handshake. Later the certificate hash is hashed with the password hash to prove the TLS peer knows the password hash. This is tls−server−end−point channel binding.

SSL Certificates for Authentication



The *pg_hba.conf* option *clientverify* forces clients to use certificates signed by a trusted certificate authority, even if certificate authentication is not being used.

Data Encryption To Avoid Data Theft

https://www.youtube.com/watch?v=ybkkiGtJmkM

https://www.flickr.com/photos/debarshiray/

Disk Volume Encryption

This helps prevent stolen storage devices from being read, and helps with secure media destruction.

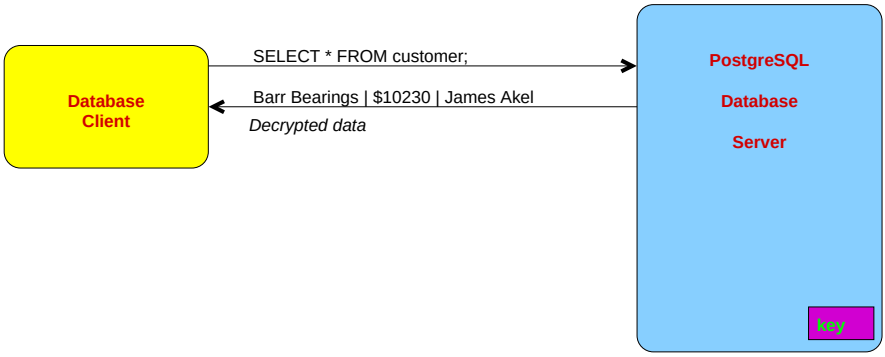
https://www.flickr.com/photos/icebrkr/

Column Encryption

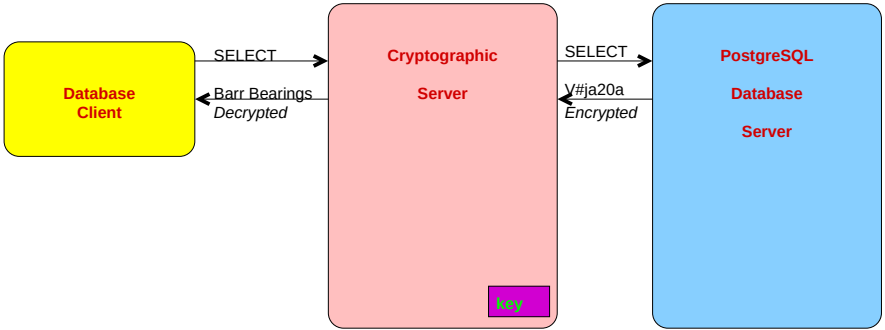
```
  id    |        name        |         credit_card_number
--------+--------------------+-----------------------------
 428914 | Piller Plaster Co. | \xc30d04070302254dc045353f28
                             ; 456cd241013e2d421e198f3320e8
                             ; 41a7e4f751ebd9e2938cb6932390
                             ; 5c339c02b5a8580663d6249eb24f
                             ; 192e226c1647dc02536eb6a79a65
                             ; 3f3ed455ffc5726ca2b67430d5
```

Encryption methods are decryptable (e.g., AES), while hashes are one-way (e.g., MD5). A one-way hash is best for data like passwords that only need to be checked for a match, rather than decrypted.

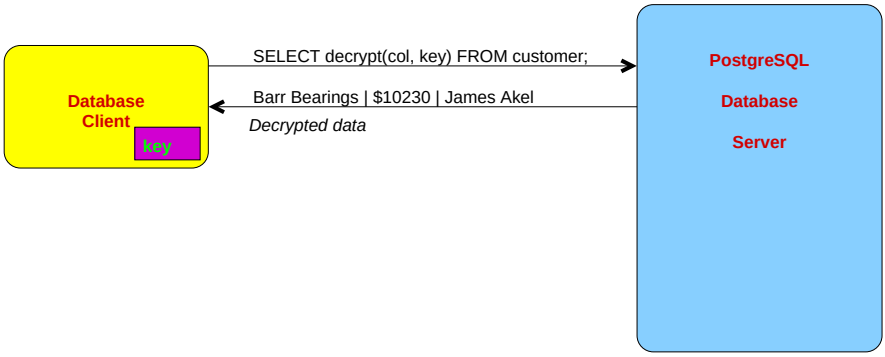
Where to Store the Key? On the Server



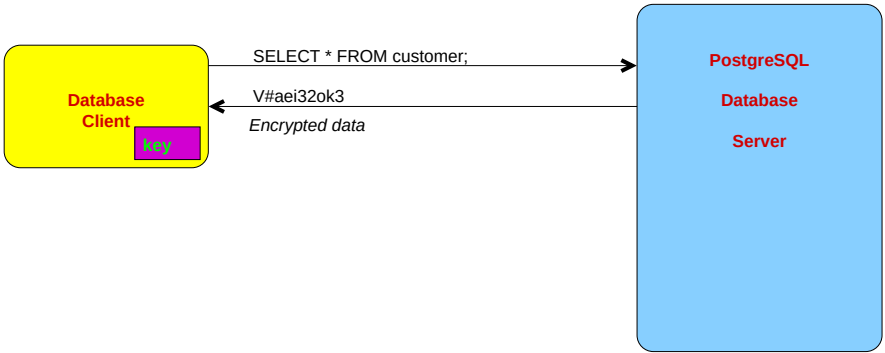
Store the Key on an Intermediate Server



Store the Key on the Client and Encrypt/Decrypt on the Server

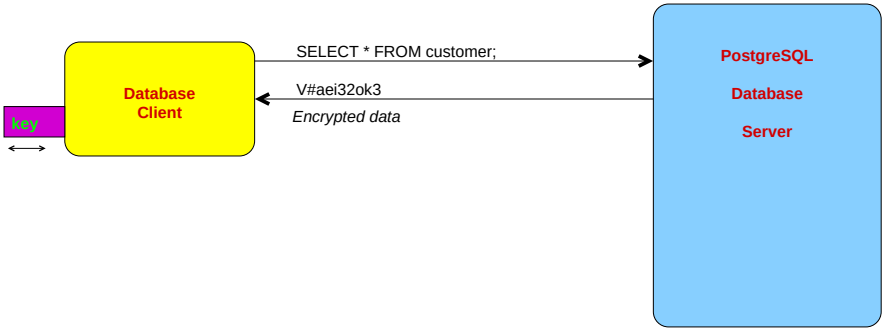


Encrypt/Decrypt on the Client



This prevents server administrators from viewing sensitive data.

Store the Key on a Client Hardware Token



This prevents problems caused by client hardware theft.

Conclusion

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