
Hacking SQL Server
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GroupBy

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Hacking?

This is a SECURITY session.

All software is perfect, but…

… configuration is done by humans ☹

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NSA Secrets



Disclaimer:

No actual state secrets were be revealed.

Please do not send agents to my house again

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Requirements for demos

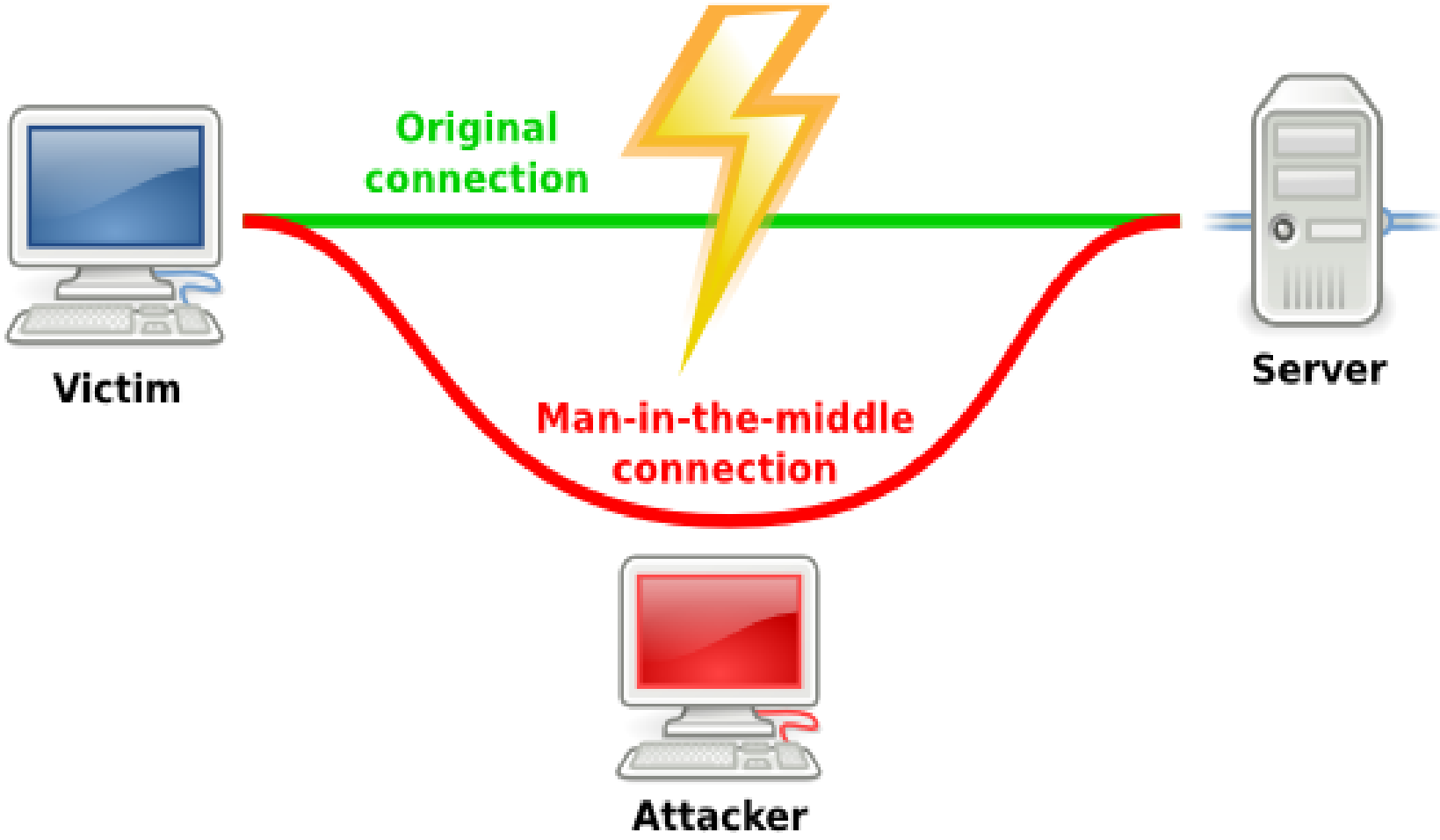
- To run the demos in this session you'll need:
  - SQL Server 2016 (for RLS and DDM), 2012 for the rest
  - Visual Studio 2015 (for the TCP Proxy)
- You'll also need to know what this means:

```
SELECT *
FROM Community.Online.GroupBy
WHERE ID = 201704
```

- (In other words, this is a introductory level security session for DBAs and developers, assuming you already know all basic database concepts)

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Man-In-The-Middle



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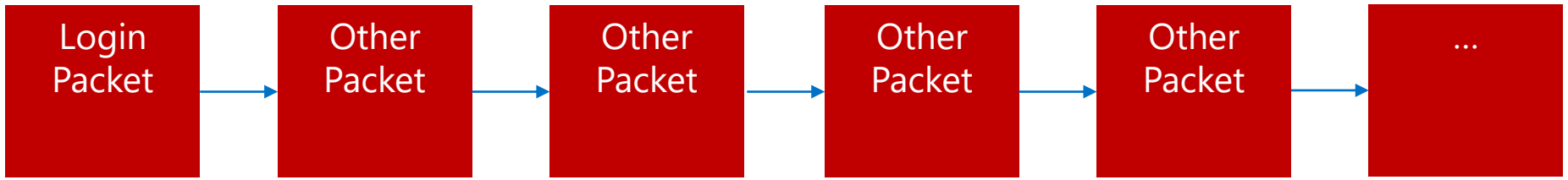
Man-In-The-Middle

- SQL Server uses TDS (Tabular Data Stream)
  - https://en.wikipedia.org/wiki/Tabular_Data_Stream
  - https://msdn.microsoft.com/en-us/library/dd304523.aspx
    - [MS-TDS]: Tabular Data Stream Protocol
  - https://msdn.microsoft.com/en-us/sqlserver/gg415738.aspx
    - Getting Started with SQL Server Protocol
- TDS was originally created by Sybase in the 1980s
- Default port: TCP 1433 (default instance)
  - Is it a good ideia to change it?
  - Changing to a higher value protects from port scan attacks?
  - Is this a problem in Azure?
  - NO!

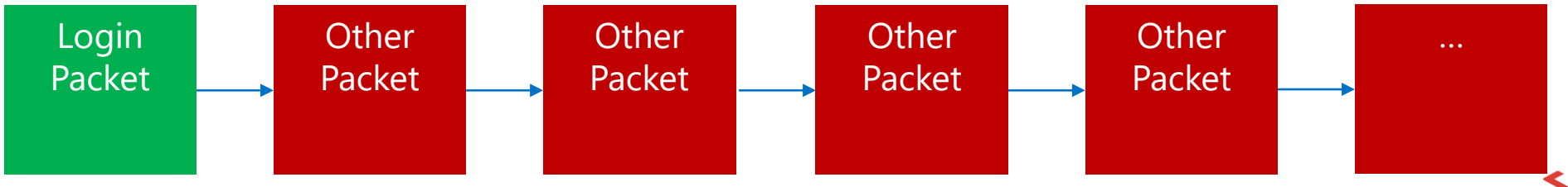
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Man-In-The-Middle

- Up to SQL Server 2000, the login/password packet was NOT encrypted.
- Plain text login, weak hash password



- SQL Server 2005 solves this, but the other packets are unencrypted by default!



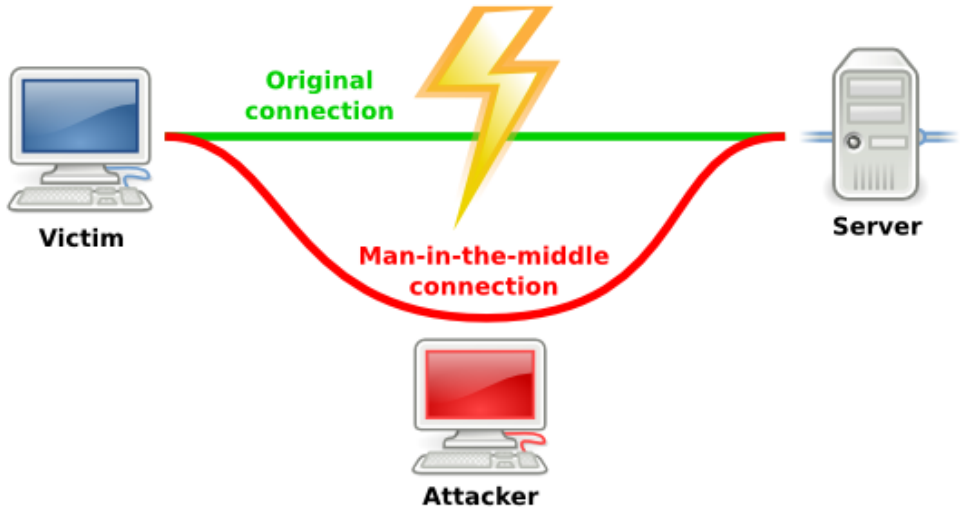
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Man-In-The-Middle

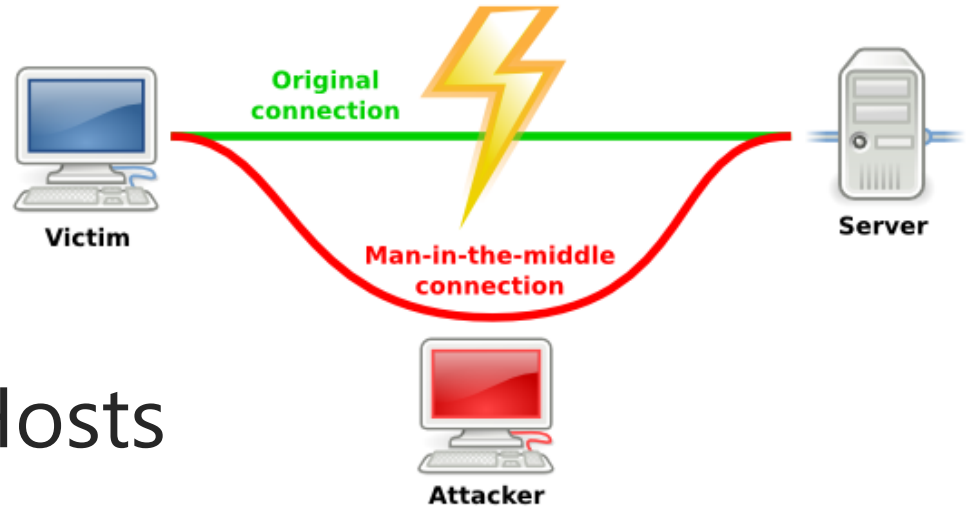
MITM, the hard way:

- Physical network tampering
- Configure/crack the router/switch
- ARP Spoofing
- DNS Poisoning
- Etc.



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Man-In-The-Middle



MITM, the easy way:

- Change the "hosts" file
  - %windir%\System32\Drivers\Etc\Hosts
- Change SQL Server "alias"
  - SQL Server Configuration Manager
  - %windir%\System32\CliConfg.EXE
  - Registry:
    - HKLM\Software\Microsoft\MSSQLServer\Client\ConnectTo (32bit)
    - HKLM\Software\WOW6432Node\Microsoft\MSSQLServer\Client\ConnectTo (64bit)

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Man-In-The-Middle

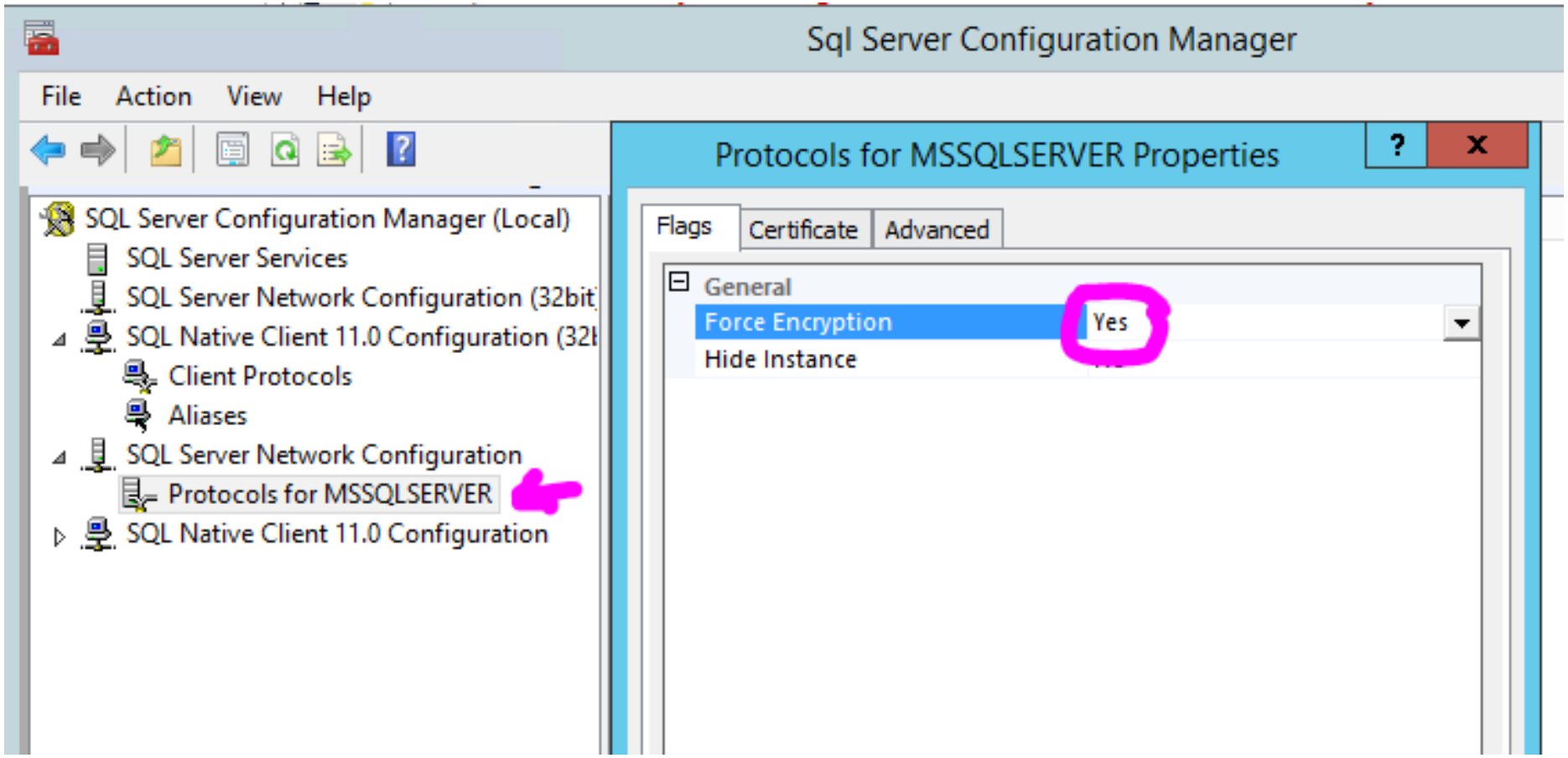
ONLY TRY
THIS AT HOME!



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Man-In-The-Middle

Always enable encryption on the SERVER:



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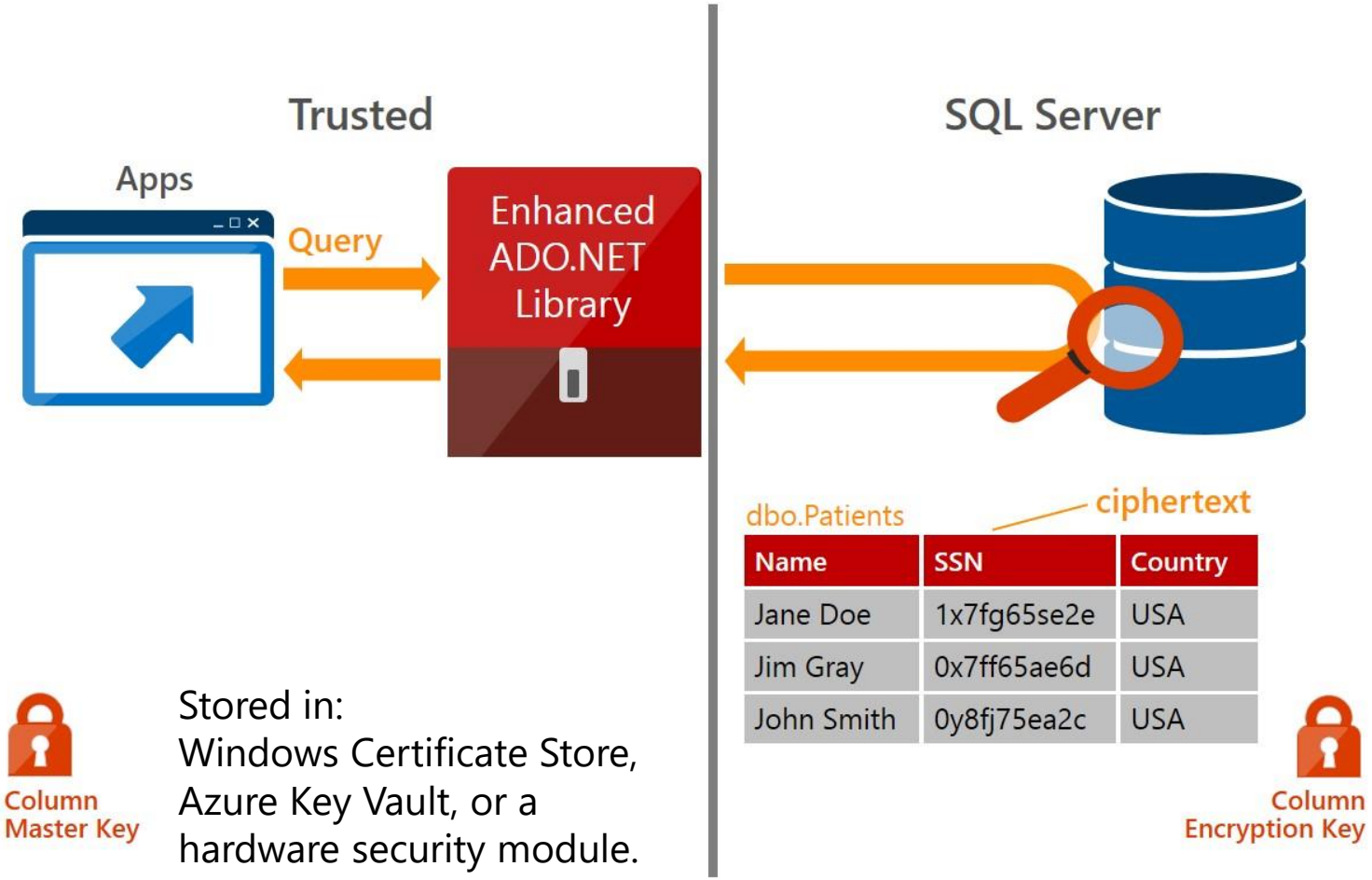
Man-In-The-Middle

Always enable encryption on the SERVER:

- https://msdn.microsoft.com/en-us/library/ms191192.aspx
  - Enable Encrypted Connections to the Database Engine
- https://msdn.microsoft.com/en-us/library/ms131691.aspx
  - Using Encryption Without Validation
- https://msdn.microsoft.com/en-us/library/ms130822.aspx
  - Using Connection String Keywords with SQL Server Native Client
    - Encrypt
    - TrustServerCertificate

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Always Encrypted



Stored in:
Windows Certificate Store, Azure Key Vault, or a hardware security module.

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Always Encrypted

- Everything over the wire is encrypted
- Data is stored encrypted in the database files
- Only the App (client) side has the decryption key
- Encryption is by Column, not Table
- Options:
  - Deterministic (allows equality lookups)
  - Random
- Drivers already available for Linux clients

More info:
https://blogs.msdn.microsoft.com/sqlsecurity/2015/06/04/getting-started-with-always-encrypted
https://msdn.microsoft.com/en-us/library/mt708953.aspx - Overview of Key Management for Always Encrypted

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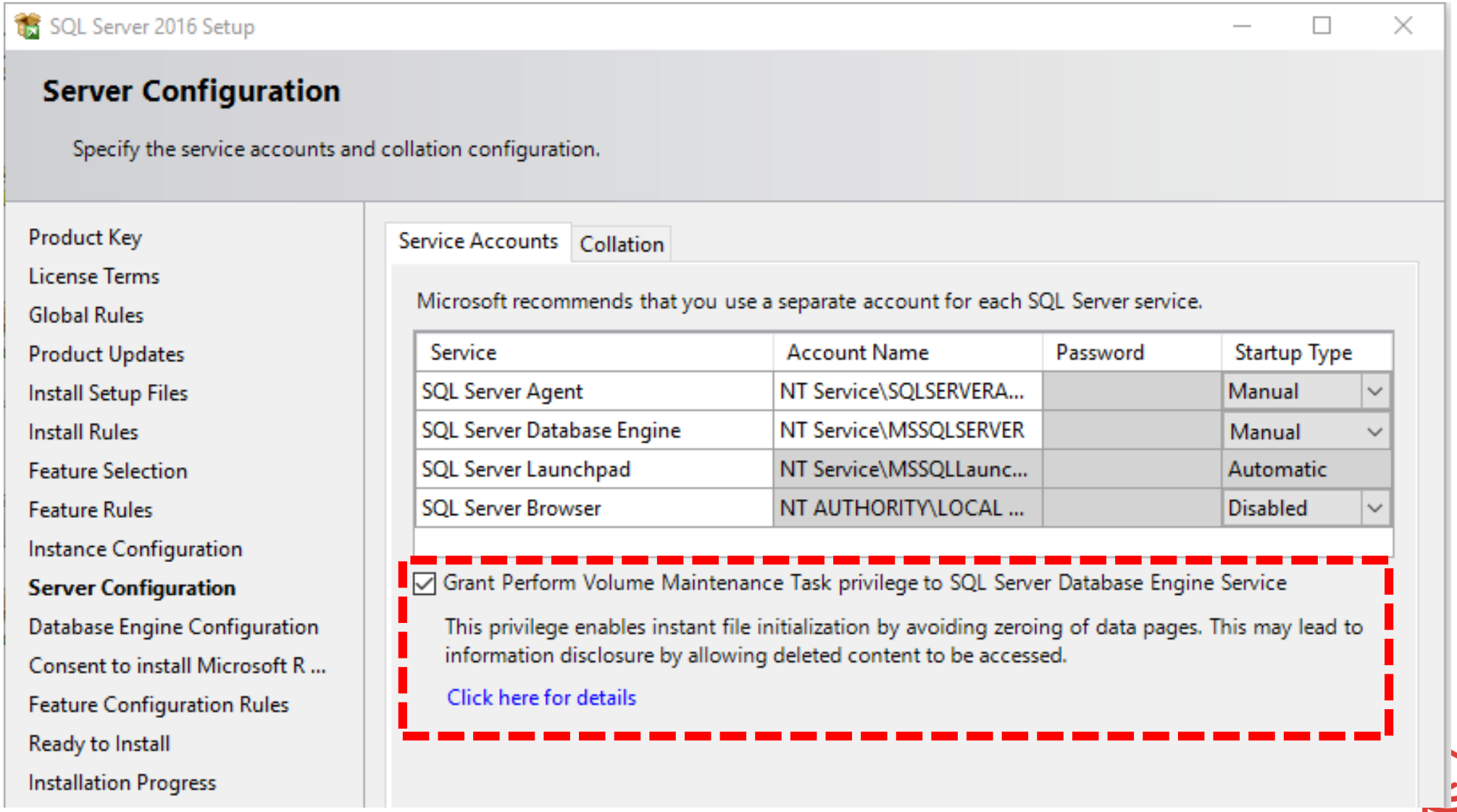
Always Encrypted

Hack it?

ID	Name	Country	Country [AE-Deterministic]	Country [AE-Random]
1	Client 1	PT	0x28DA20...	0x334523...
2	Client 2	PT	0x28DA20...	0x4d3133...
3	Client 3	PT	0x28DA20...	0x42D320...
4	Client 4	PT	0x28DA20...	0x24ABD0...
5	Client 5	UK	0x9723AC...	0xCD3289...
6	Client 6	UK	0x9723AC...	0x9CD293...
7	Client 7	UA	0x127A2A...	0xA4387A...
8	Client 8	UA	0x127A2A...	0x1999BA...
9	Client 9	UA	0x127A2A...	0x729F2A...
10	Client 10	UA	0x127A2A...	0x89478A...
11	Client 11	RU	0xF0122E...	0xFE349A...
12	Client 12	PL	0xEAB53E...	0xFA100E...
13	Client 13	DE	0x00A3D1...	0x11AFB1...

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Instant File Initialisation



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Instant File Initialisation

Hack it?

- Just copy the MDF/NDF files you created with IFI…
- … and all the previous information from the disk is there…

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Transparent Data Encryption (TDE)

- Encrypts the whole Database
- Data is stored encrypted in the storage disks
  - Page level encryption
- Decrypted in RAM on the server (on demand)
  - **Server has the keys!!!**
- Recommended: store the keys and the data in separate storage disks
- Transparent to the Apps
  - **Data is decrypted before leaving the server**

More info: https://msdn.microsoft.com/en-us/library/bb934049.aspx

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Transparent Data Encryption (TDE)

Hack it?

- Remember… "Server has the keys!!!"
- So… Get the keys from someone's backup…
- Also… Backups and network communication are not encrypted by TDE

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Backup Encryption (TDE)

- Data is stored encrypted in the backup media
- Works with
  - TDE
  - Managed Backup to Azure

More info: https://msdn.microsoft.com/en-us/library/dn449489.aspx

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Dynamic Data Masking

```
CREATE TABLE Membership
(
  MemberID  int          IDENTITY PRIMARY KEY,
  FirstName varchar(66) MASKED WITH (FUNCTION = 'partial(1,"XXXXXXX",0)')     NULL,
  LastName  varchar(66)                                                    NOT NULL,
  Phone     varchar(66) MASKED WITH (FUNCTION = 'default()')                   NULL,
  Email     varchar(66) MASKED WITH (FUNCTION = 'email()'  )                   NULL
);


Original:
1    Roberto     Tamburello    555.123.4567    RTamburello@contoso.com

Masked:
1    RXXXXXXX    Tamburello    xxxx            RXXX@XXXX.com
```

More info: https://msdn.microsoft.com/en-us/library/mt130841.aspx

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Dynamic Data Masking

- By Column
- SELECT permission shows masked data
  - To see the data you need UNMASK permission
- Does not prevent UPDATEs to masked columns
- Using SELECT INTO or INSERT INTO doesn't work
  - Output is masked text (trash)
- Backups are also masked text (trash),
  - Unless the backup user has UNMASK permission
- Hacks?

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Dynamic Data (Un)Masking – Demo!

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SQL Server 2016 SP1 changes

Feature	RTM				SP1			
	Standard	Web	Express	Local DB	Standard	Web	Express	Local DB
Row-level security	Yes	No	No	No	Yes	Yes	Yes	Yes
Dynamic Data Masking	Yes	No	No	No	Yes	Yes	Yes	Yes
Change data capture*	No	No	No	No	Yes	Yes	No*	No*
Database snapshot	No	No	No	No	Yes	Yes	Yes	Yes
Columnstore	No	No	No	No	Yes	Yes	Yes	Yes
Partitioning	No	No	No	No	Yes	Yes	Yes	Yes
Compression	No	No	No	No	Yes	Yes	Yes	Yes
In Memory OLTP	No	No	No	No	Yes	Yes	Yes	No**
Always Encrypted	No	No	No	No	Yes	Yes	Yes	Yes
PolyBase	No	No	No	No	Yes	Yes	Yes	No
Fine grained auditing	No	No	No	No	Yes	Yes	Yes	Yes
Multiple filestream containers	No	No	No	No	Yes	Yes	Yes	No**

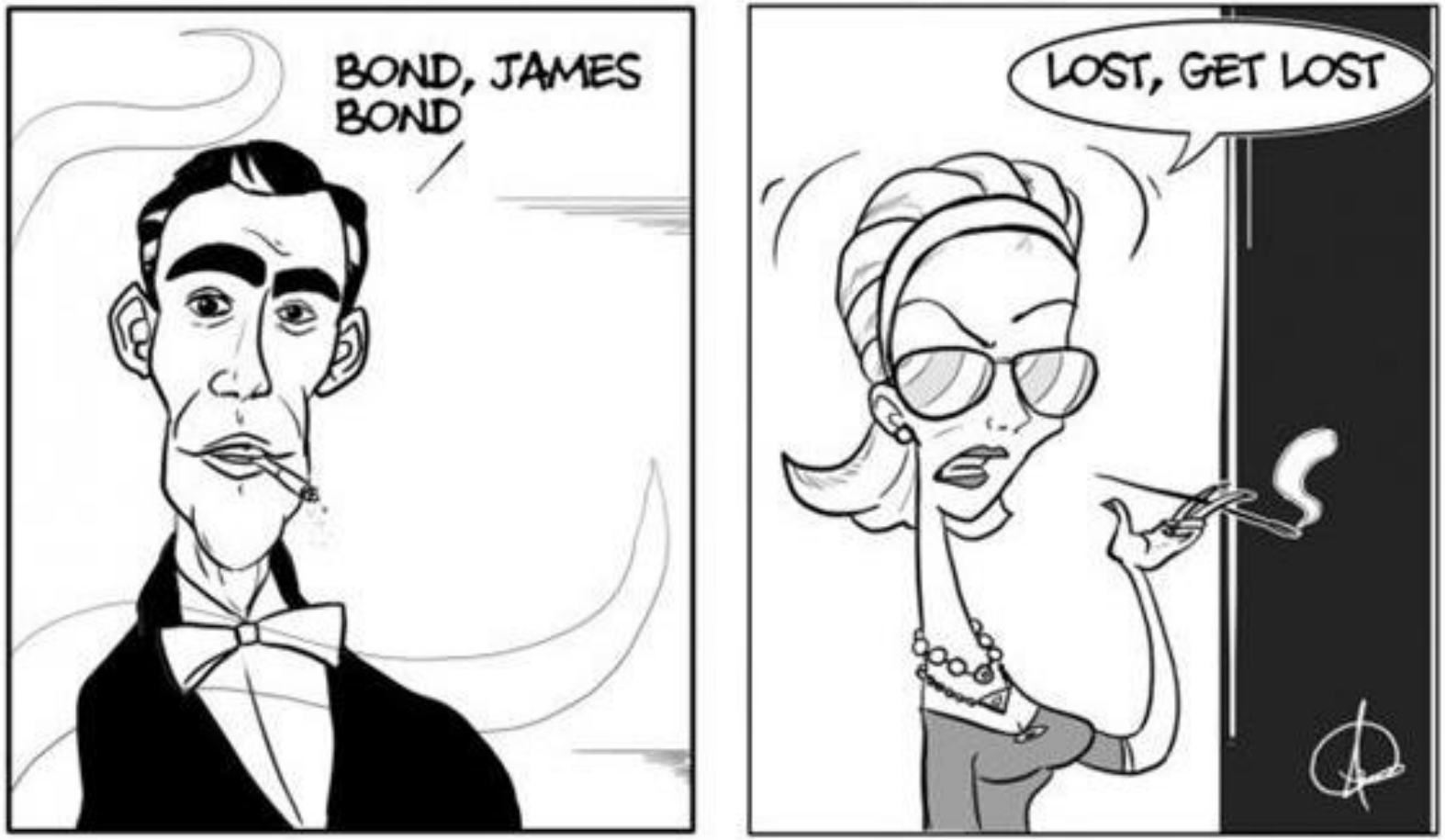
* Requires SQL Server agent which is not part of SQL Server Express Editions

** Requires creating filestream file groups which is not possible in Local DB due to insufficient permissions.

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Row Level (In)Security

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Row Level Security (RLS)

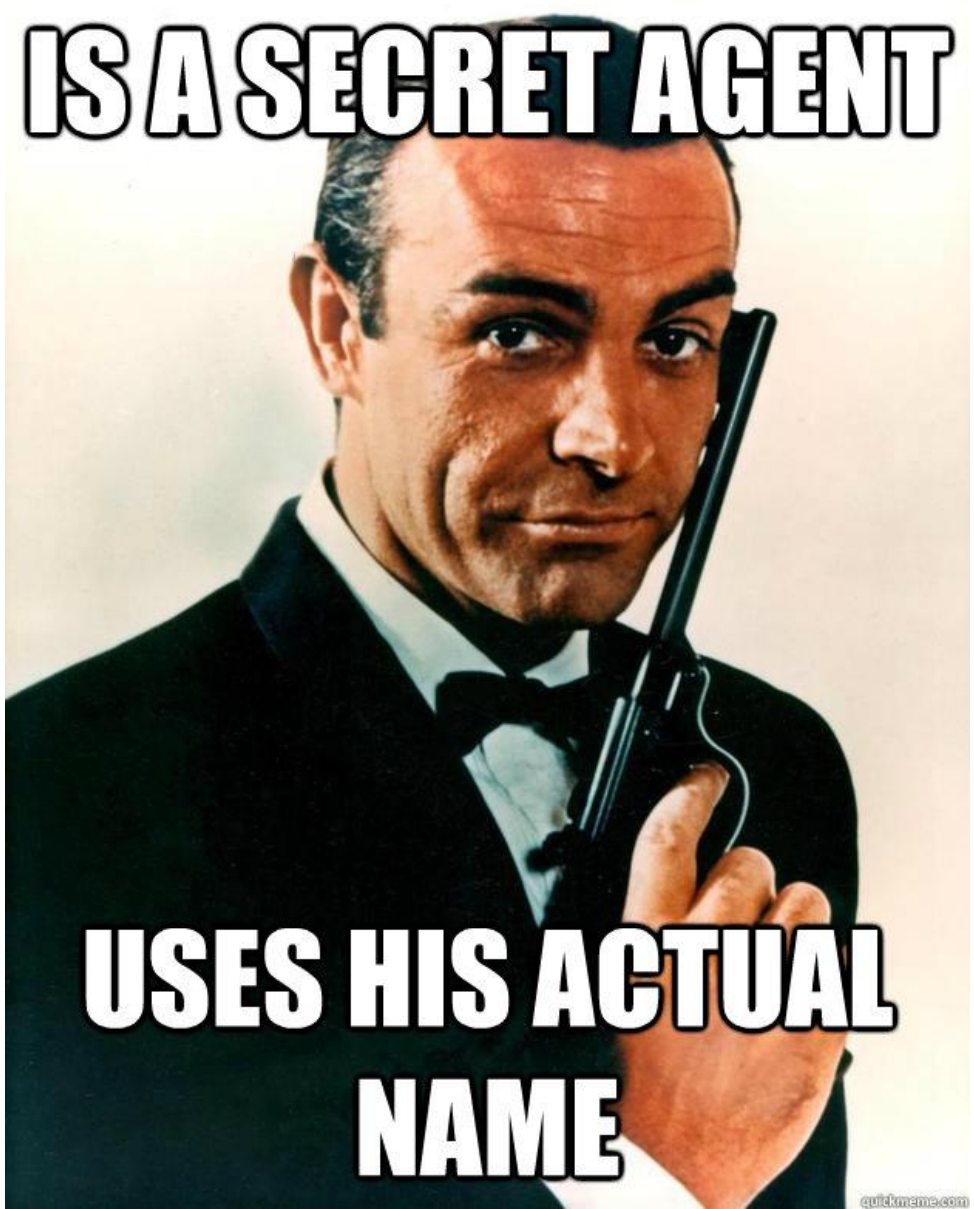
- Function Predicate
  - Defines Business logic/rules/access
  - User defined inline table valued-function (reusable)
- Security Policy
  - Collection of Predicates
  - Predicates added as FILTER or BLOCK

More info: https://msdn.microsoft.com/en-us/library/dn765131.aspx

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Never Say DEMO Again…

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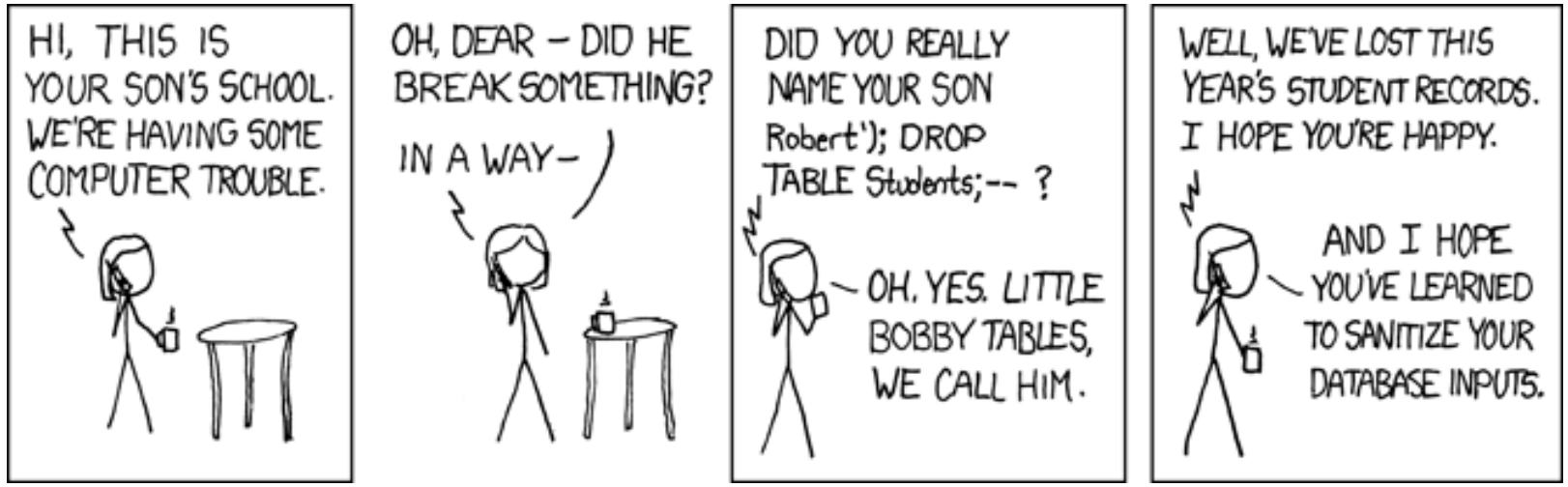
SQL Injection

- We get the Category parameter in a web page…

```
http://Example.COM/?Cat=trash'; DROP TABLE TopSecretStuff; --
```

```
SQL = " SELECT *          "
    + " FROM TableX       "
    + " WHERE FieldZ = '" + Category + "'; ";
```

- Executing this is NOT SAFE!



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SQL Injection

In the Apps/Libs, use prepared statements:

- Available in most languages
  - .Net, PHP, Java, etc.
- Prevents SQL Injection
- Validates Data Types
- Usually integrated into app classes

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SQL Injection

Prepared Statement example:

```
SqlConnection connection = new
sqlConnection(connectionString))

SqlCommand cmd              = new SqlCommand();
cmd.Connection              = SomeConnection;
cmd.CommandText             = "SP_SalesByCategory";
cmd.CommandType             = CommandType.StoredProcedure;

SqlParameter parameter  = new SqlParameter();
parameter.ParameterName = "@CategoryName";
parameter.SqlDbType     = SqlDbType.NVarChar;
parameter.Direction     = ParameterDirection.Input;
parameter.Value         = ThatFunnyParameter;
cmd.Parameters.Add (parameter);
```





More info: https://msdn.microsoft.com/en-us/library/yy6y35y8(v=vs.110).aspx

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Permissions

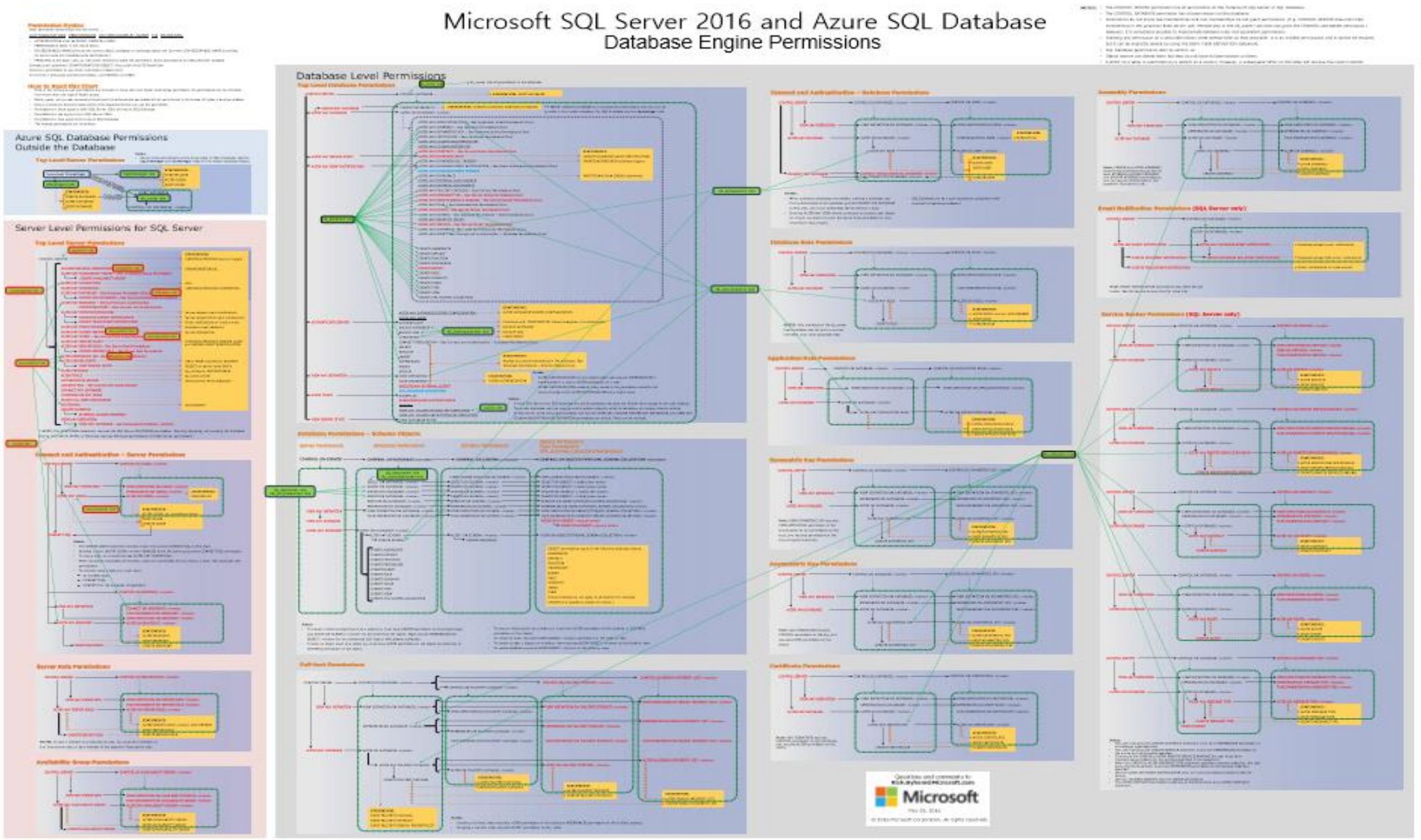
- By SQL Server login (e.g. "sa")
- By AD/Windows login (domain or local)
- By AD group

- By DB user

- By server role
- By database role
- By application role

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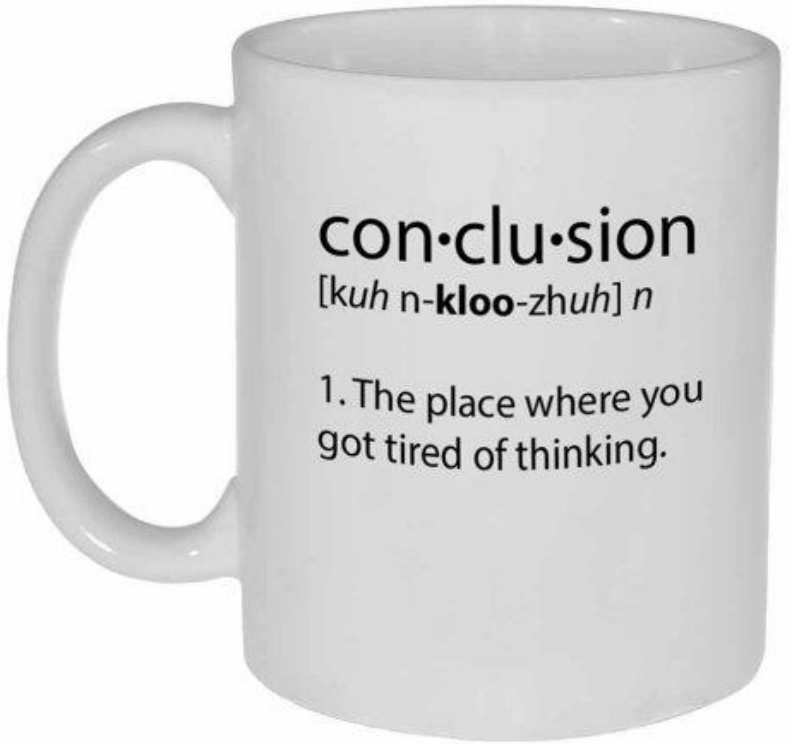
Permissions poster by Rick Byham



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Recommendations

- ALWAYS encrypt traffic!
- Don't expose TCP 1433, UDP 1434 (and others) directly on the Internet
  - Use a VPN or other options
- Always assign the least amount of permissions possible!
- Use prepared statements to avoid SQL Injection



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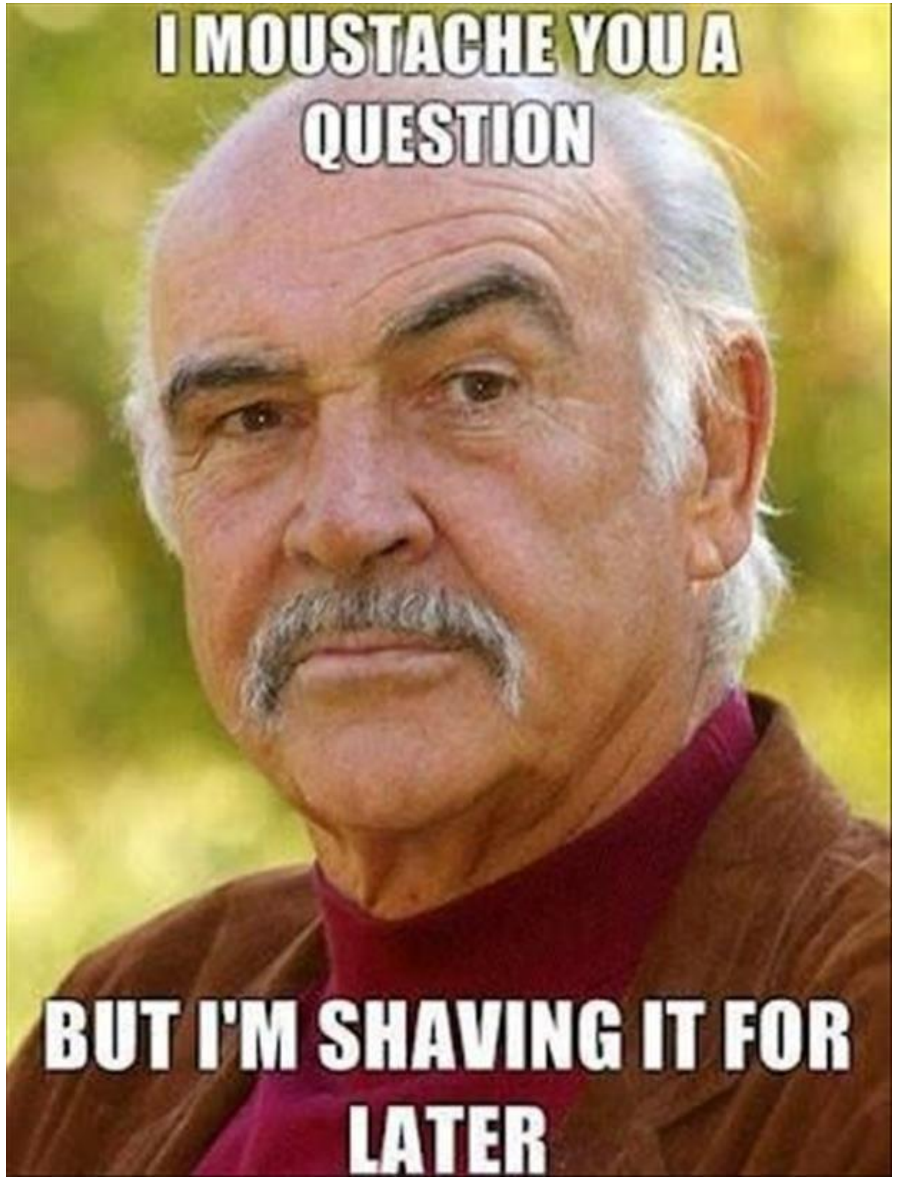
Even if you can't get the Bond Girl, remember...

- SQL Server 2016 has a lot of new features...
  - But they're not perfect!
- ALWAYS,
- ALWAYS,
- ALWAYS,
- Install the latest Service Packs and patches!

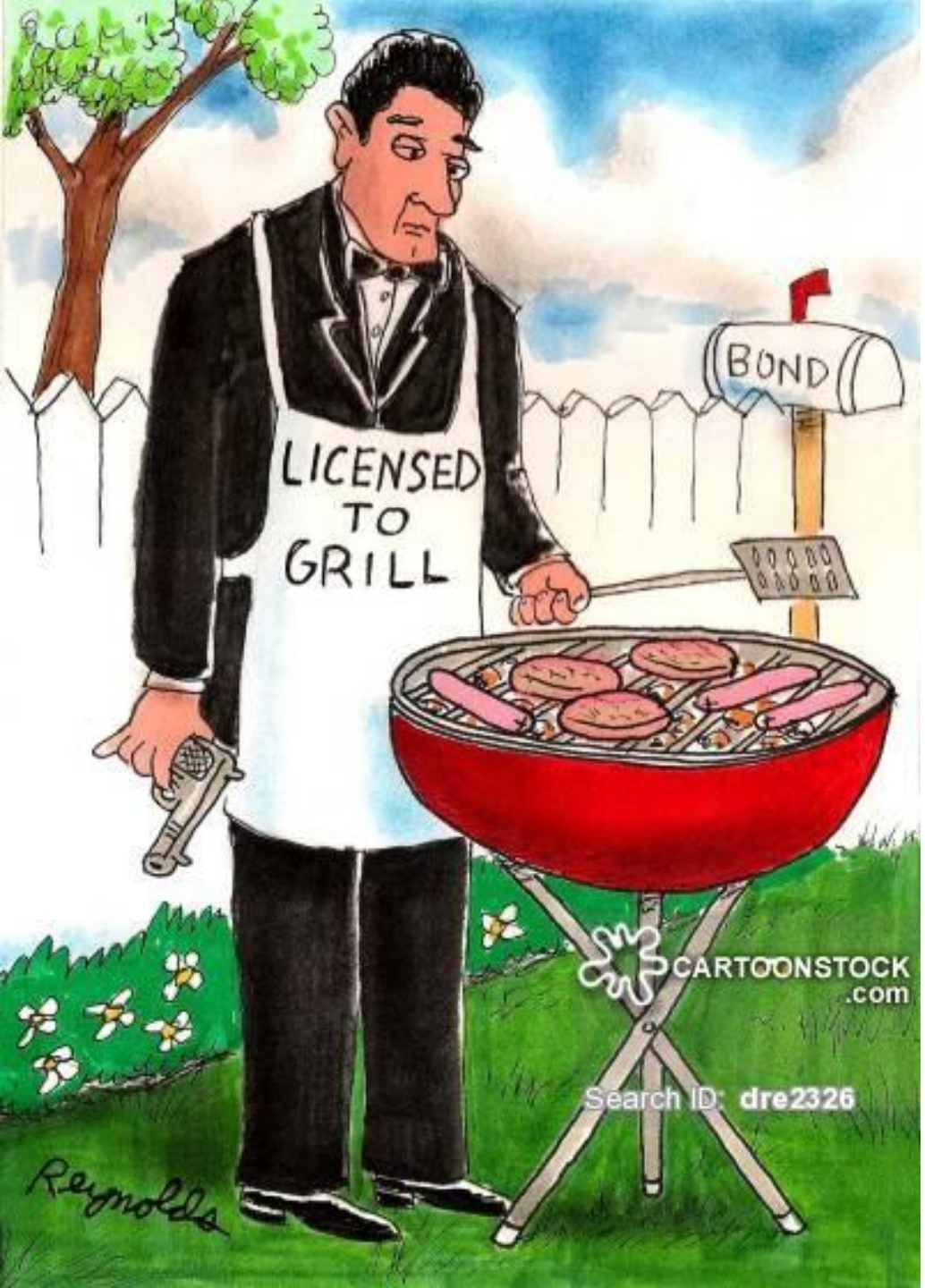


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Receive-Questions –Input "Speech"



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THANK YOU!

TAKK!

Obrigado!

Дуже дякую!

Dziękuję!

Merci beaucoup!

Dank je!

Go raibh maith agaibh!

Danke!

Děkuju!

Diolch!

¡Gracias!

Arigato!



André Melancia

http://Andy.PT

http://LunarCat.PT

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