Hacking SQL Server

André Melancia

SQL Saturday #657
Göteborg
2017-09-23

PASS
SQLSATURDAY
GOTHENBURG | 23 SEP 2017

Sponsors!

SQLSERVICE

dbWatch
DATABASE CONTROL

ACANDO

PASS

EVRY

SentryOne™

Microsoft

Informator
A SOPRANO COMPANY

SolidQ

Profisee®

Wedham Solutions AB

Get-NSASpyInfo "André Melancia"

- Food devouring expert
- Lunar Cat
  - Owner / Principal Consultant
  - Meow us at http://LunarCat.PT
- Microsoft Certified Trainer (MCT)
- Microsoft Data Platform MVP
- Contacts
  - http://Andy.PT
  - Andy@Andy.COM.PT
  - https://LinkedIn.COM/in/AndreMelancia
  - https://Facebook.COM/Andy.COM.PT
  - https://Twitter.COM/AndyPT
- Volunteer and/or Speaker at:
  - SQL Saturdays, SQLBits, SQLRelay, SQLDay, MCT Summit Europe, Programar Saturday
  - GroupBy, 24Hop (Data Security & Portuguese), PASS Global Portuguese VG, Channel9
  - Data Community Portugal, PowerShell Portugal, IT Pro Portugal, IoT Portugal, other crazy user groups...
  - IPv6 Portugal, DNSSec Portugal, Windows Development Portugal, etc.

Microsoft CERTIFIED Trainer

MVP Microsoft® Most Valuable Professional

Hacking?

This is a SECURITY session.

All software is perfect, but…

… configuration is done by humans ☹

NSA Secrets

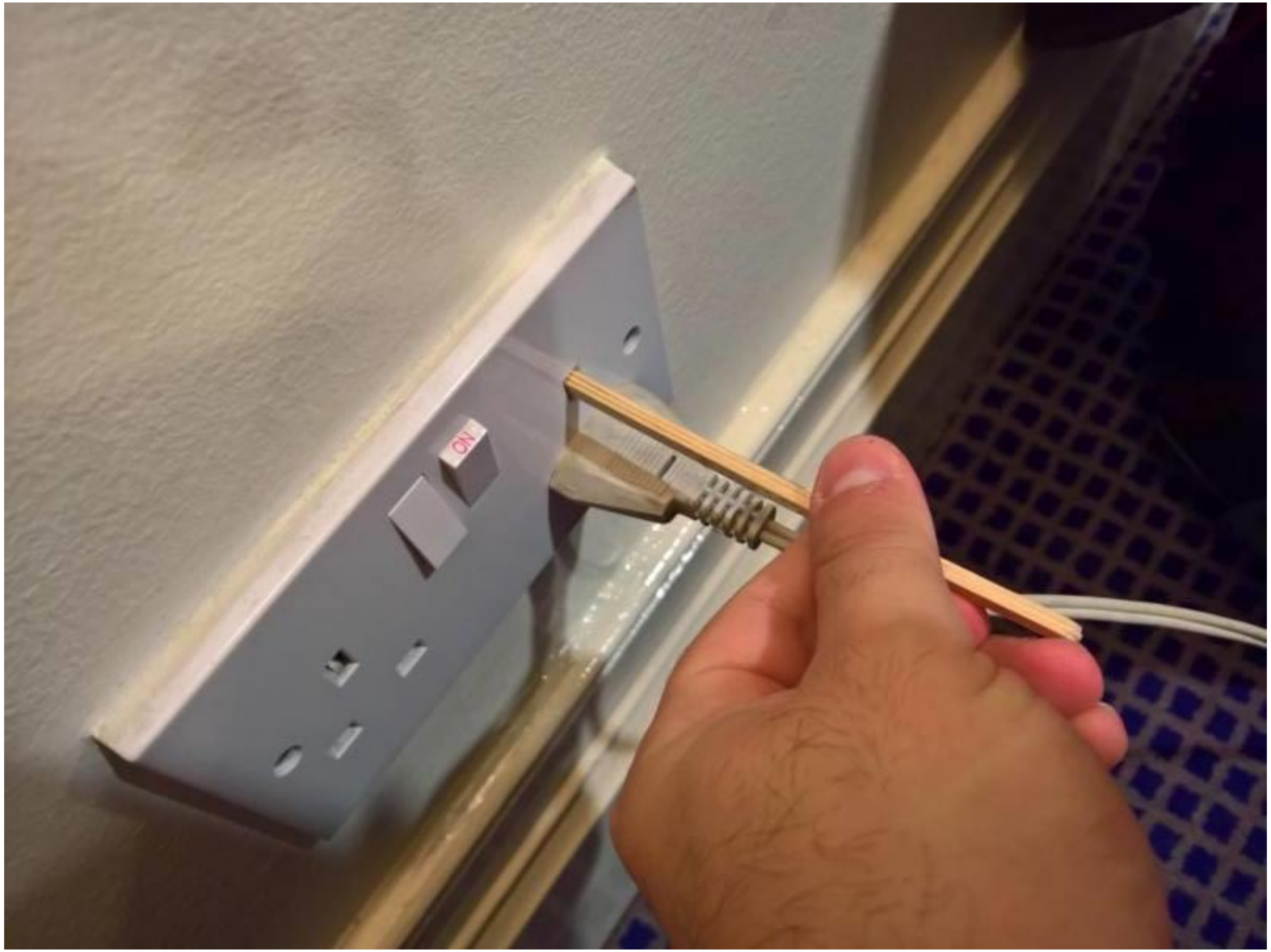
Disclaimer:

No actual state secrets will be revealed.

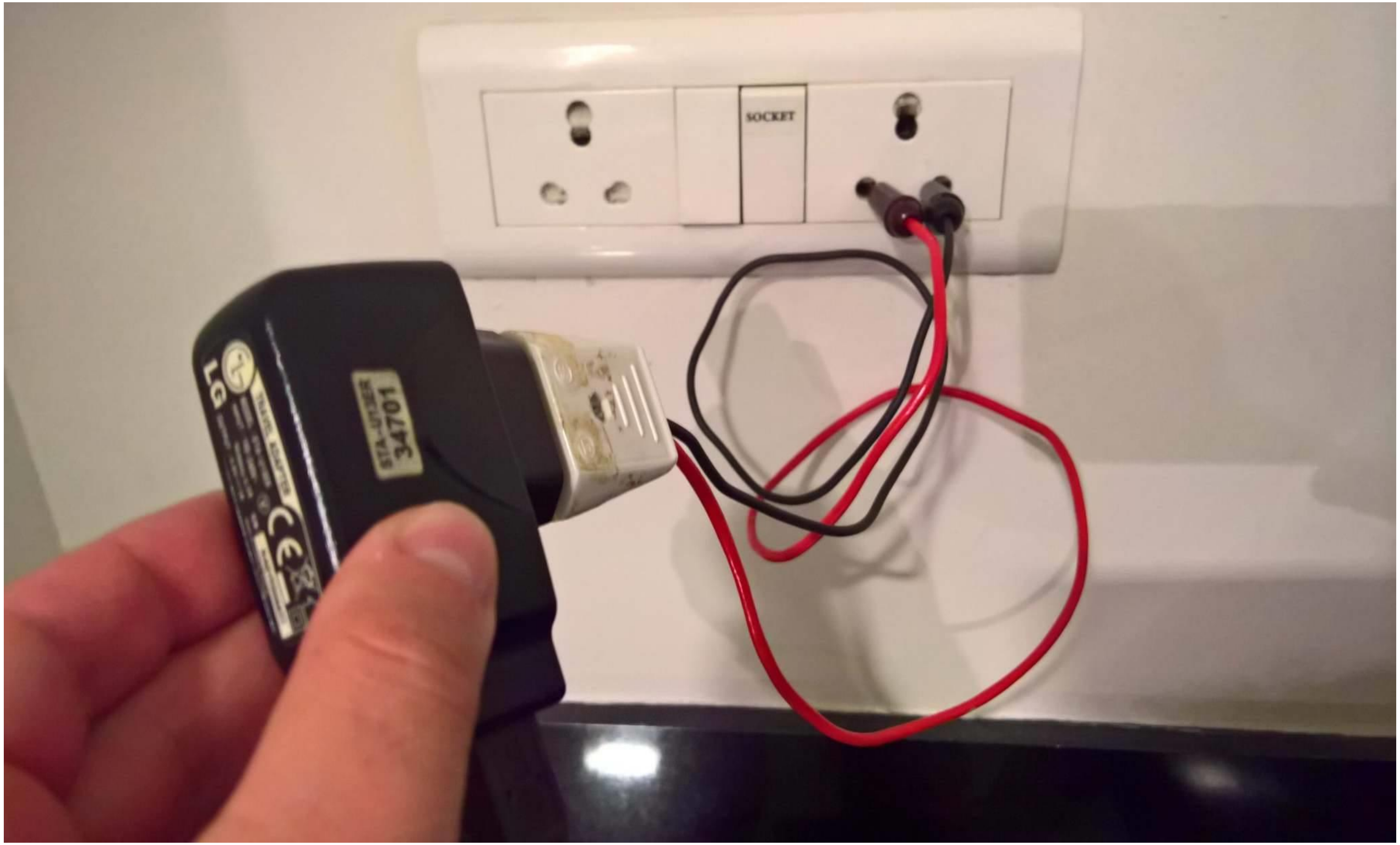
Please do not send agents to my house again…

Varning:
Inga faktiska statshemligheter kommer att avslöjas.
Vänligen skicka inte agenter till mitt hus igen…

Hacking British plug sockets



Hacking Indian plug sockets



Requirements for demos

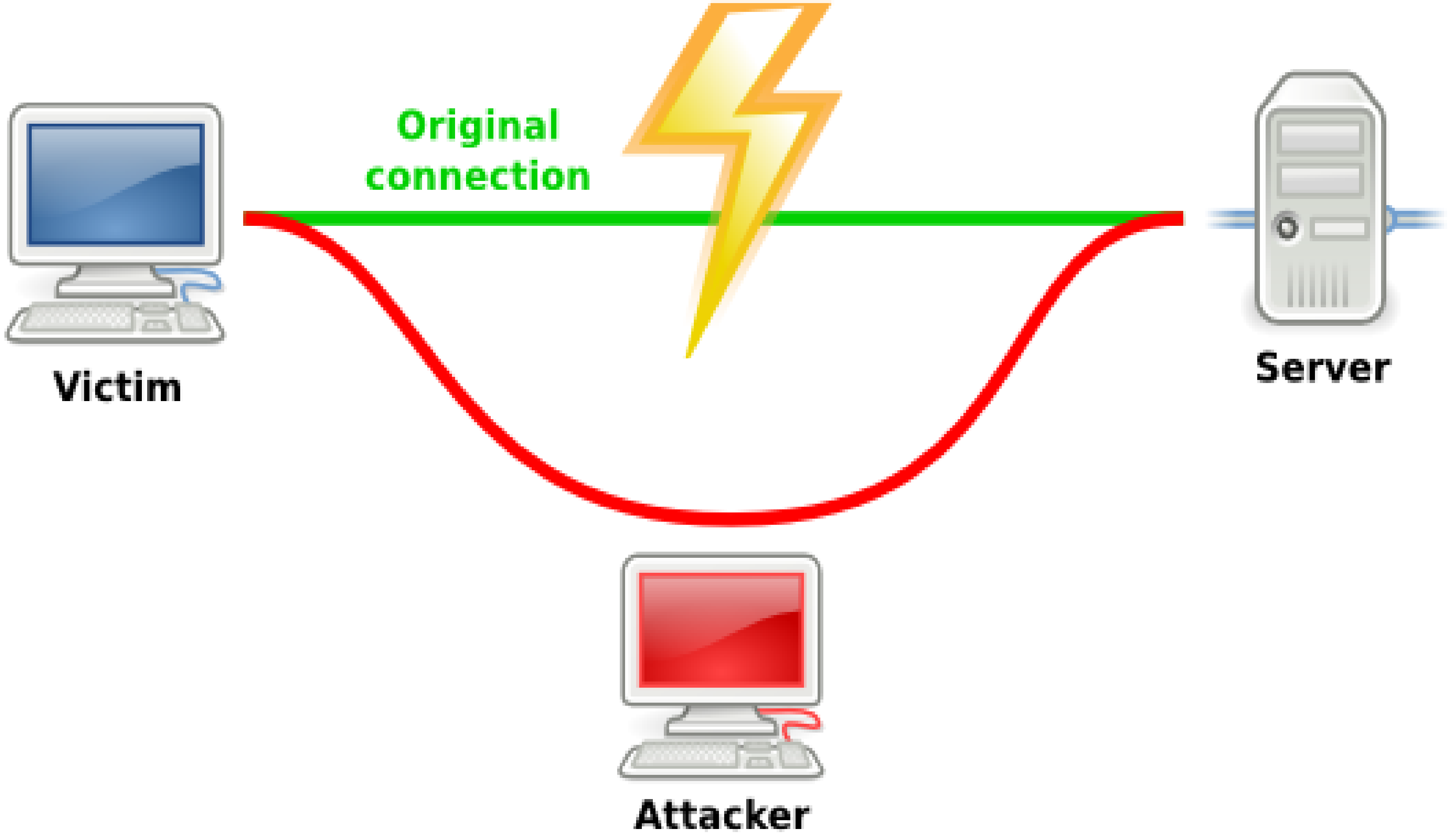
- To run the demos in this session you'll need:
  - SQL Server 2016 (for RLS and DDM), 2012 for the rest
  - Visual Studio 2015 (for the TCP Proxy)
- You'll also need to know what this means:

```
SELECT *
FROM PASS.SQLSaturday.[Göteborg]
WHERE ID = 657;
```

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

Man-~~In-The-Mi~~ddle

Person-In-The-Middle

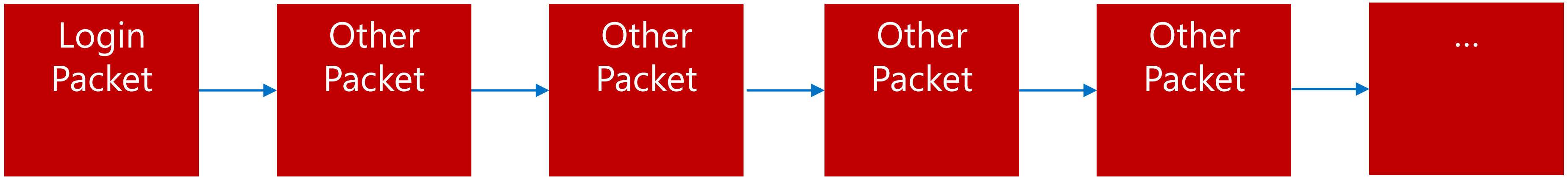


Man-In-The-Middle

- 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!

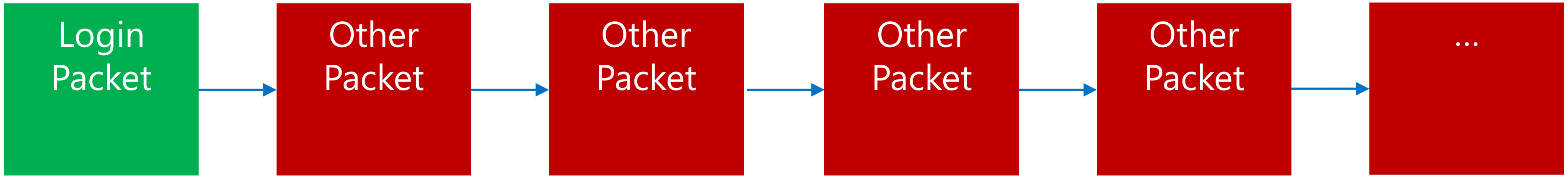
Man-In-The-Middle

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



Login Packet → Other Packet → Other Packet → Other Packet → Other Packet → …

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

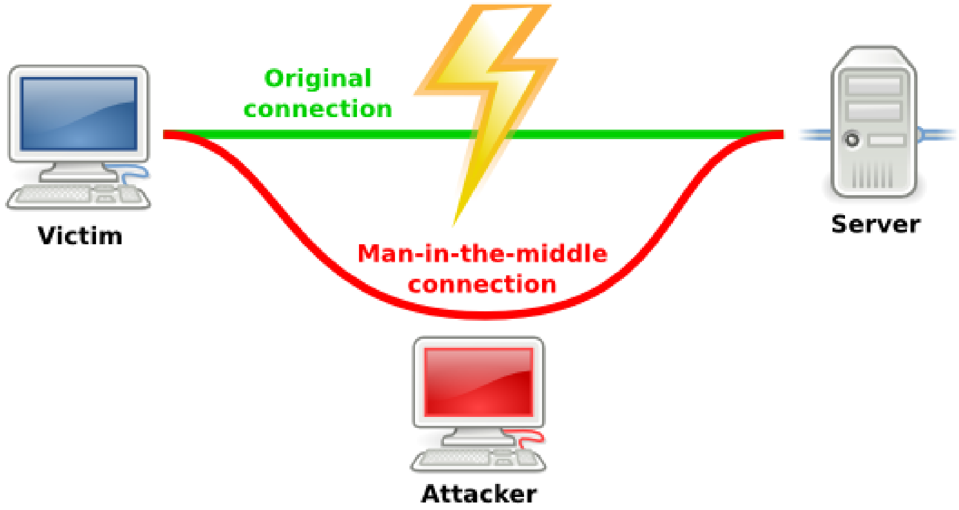


Login Packet → Other Packet → Other Packet → Other Packet → Other Packet → …

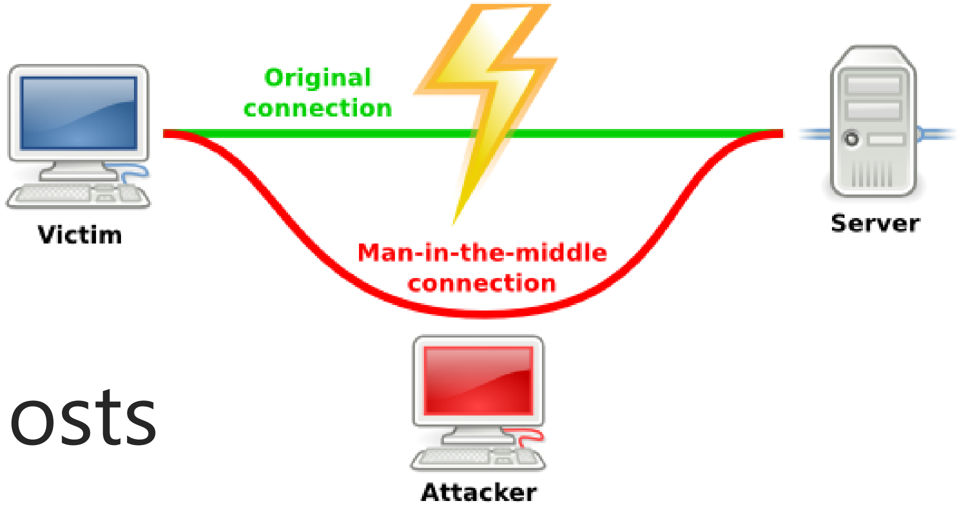
Man-In-The-Middle

MITM, the hard way:

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



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)

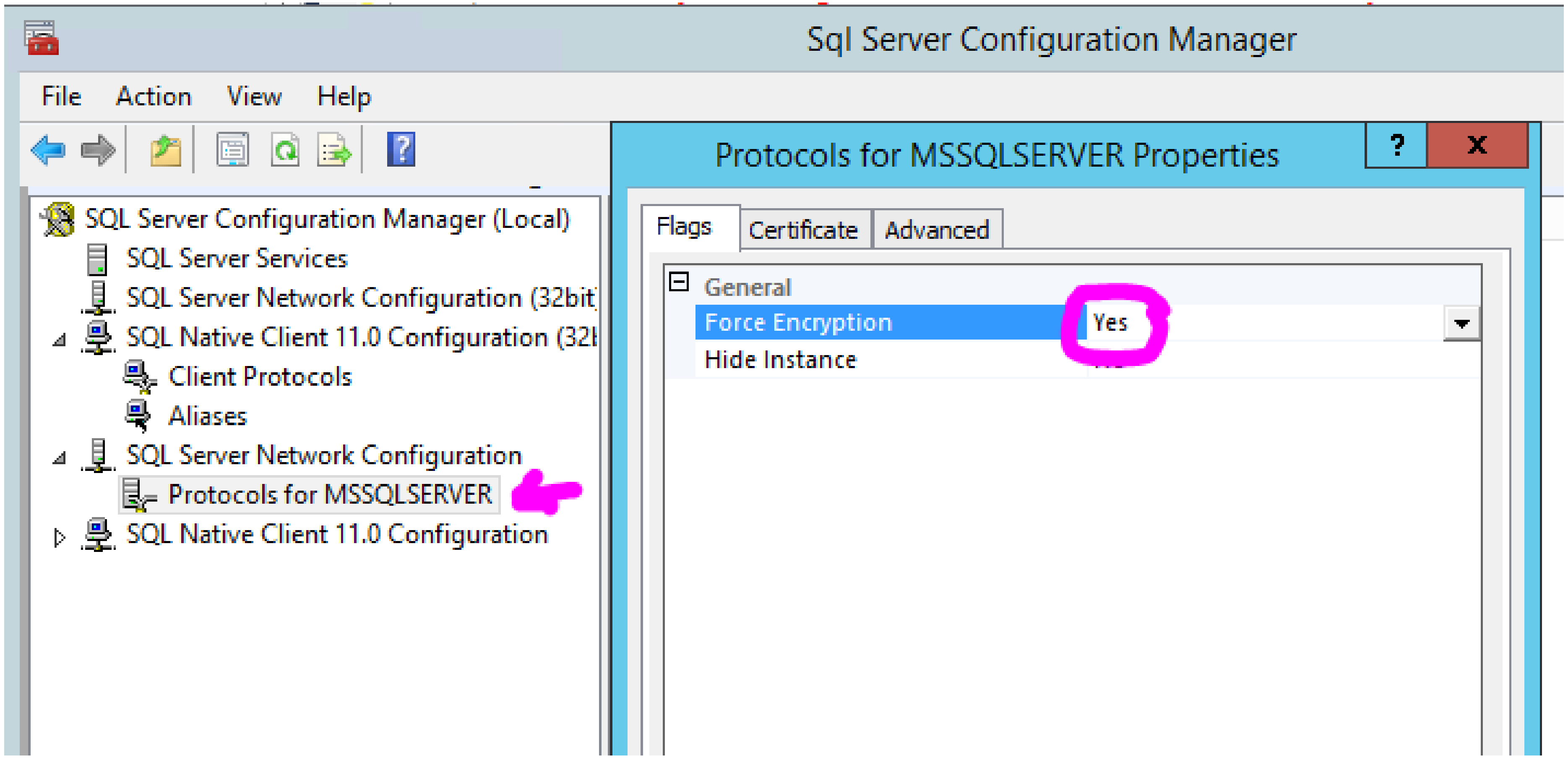
Man-In-The-Middle

ONLY TRY
THIS AT HOME!

PROVA ENDAST
DET HÄR HEMMA!

Man-In-The-Middle

Always enable encryption on the SERVER:


Sql Server Configuration Manager
File
Action
View
Help
SQL Server Configuration Manager (Local)
SQL Server Services
SQL Server Network Configuration (32bit
SQL Native Client 11.0 Configuration (32I
Client Protocols
Aliases
SQL Server Network Configuration
Protocols for MSSQLSERVER
SQL Native Client 11.0 Configuration
Protocols for MSSQLSERVER Properties
?
X
Flags
Certificate
Advanced
General

Force Encryption: Yes

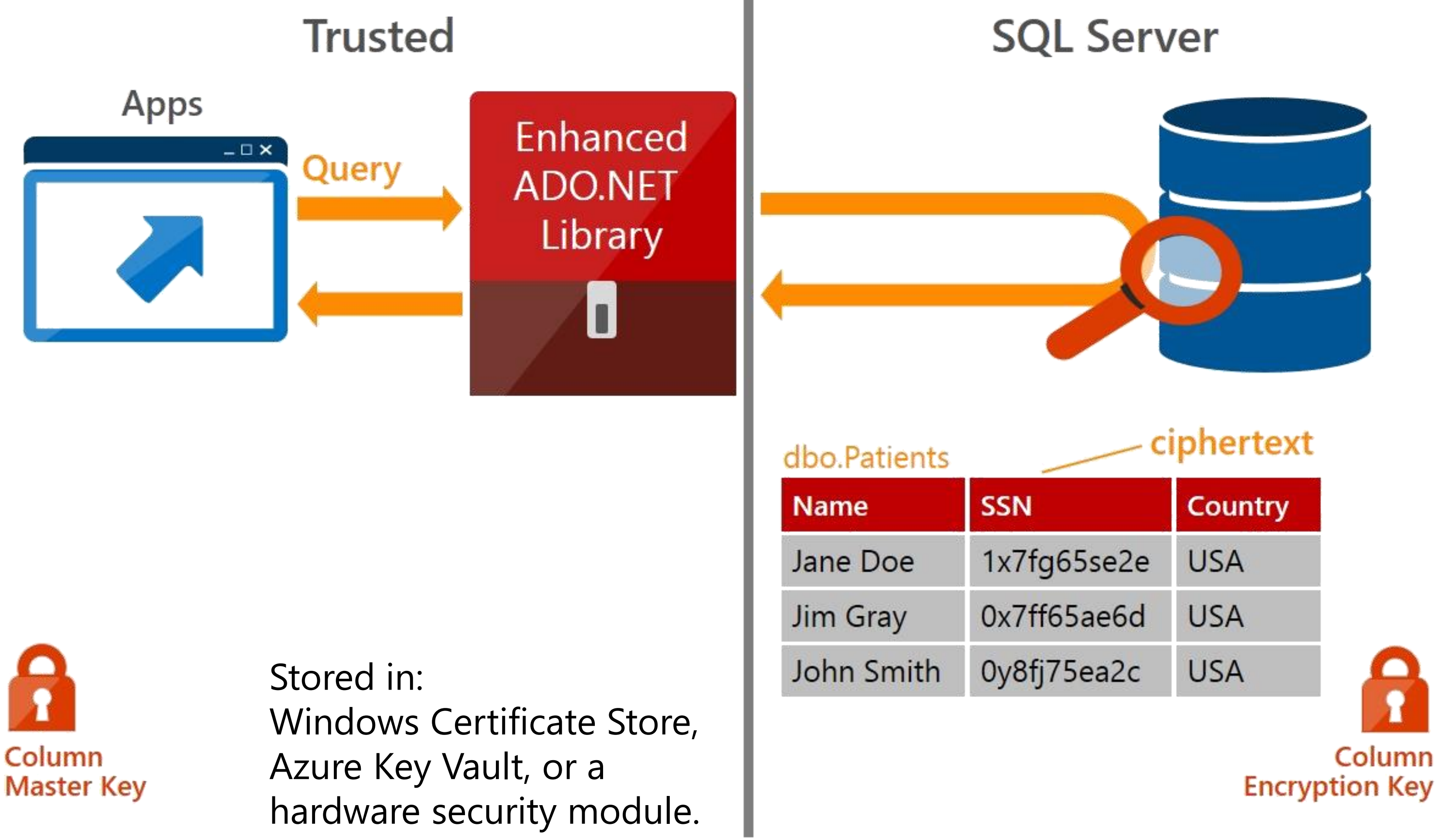
Hide Instance

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

Always Encrypted



dbo.Patients

ciphertext

Name	SSN	Country
Jane Doe	1x7fg65se2e	USA
Jim Gray	0x7ff65ae6d	USA
John Smith	0y8fj75ea2c	USA

Column Master Key

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

Column Encryption Key

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

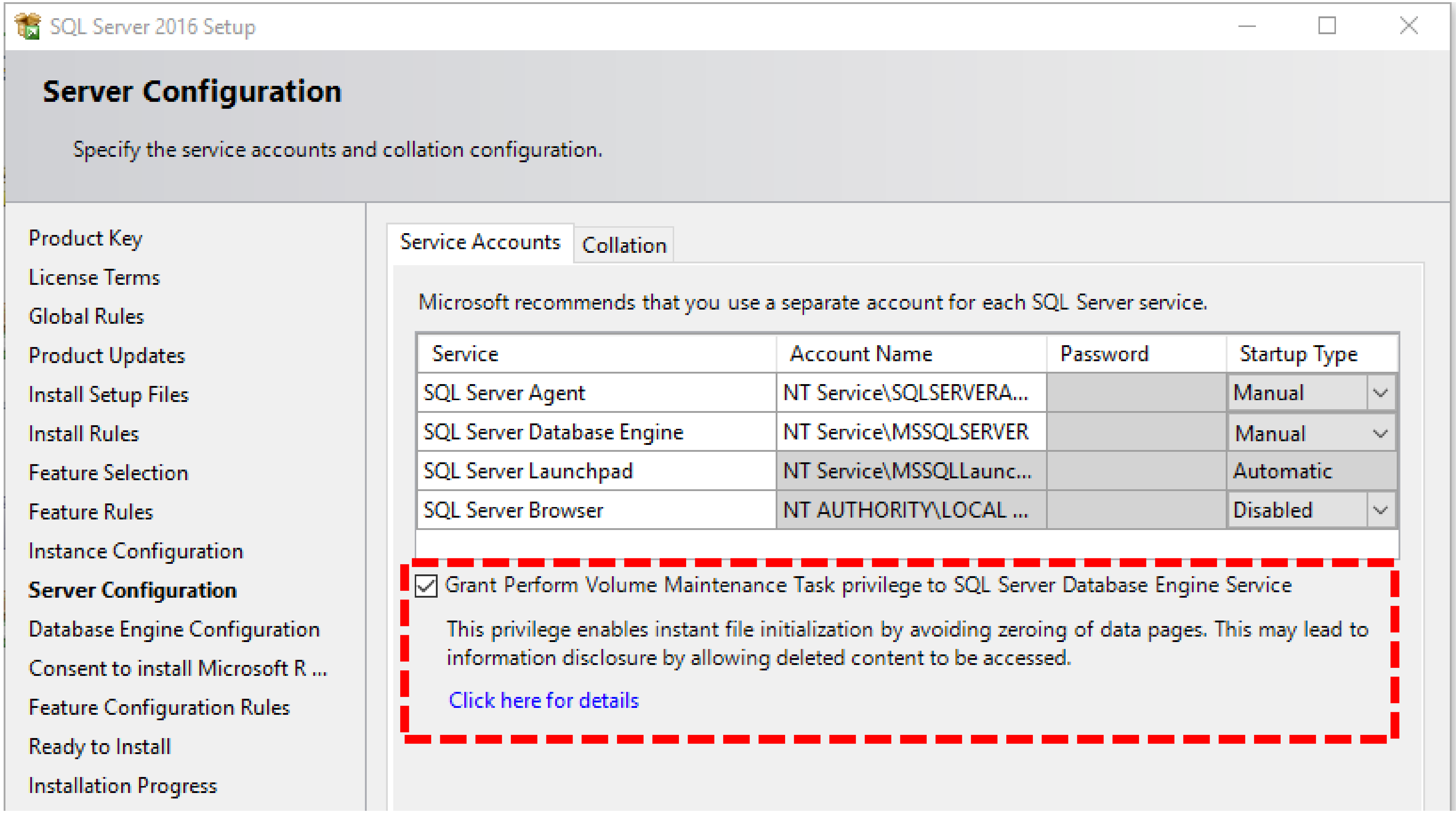
More info:
https://blogs.msdn.microsoft.com/sqlsecurity/2015/06/04/getting-started-with-always-encrypted
https://msdn.microsoft.com/en-us/library/mt708953.aspx - Overview of Key Management for Always Encrypted

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…

Instant File Initialisation



SQL Server 2016 Setup

Server Configuration

Specify the service accounts and collation configuration.

- Product Key
- License Terms
- Global Rules
- Product Updates
- Install Setup Files
- Install Rules
- Feature Selection
- Feature Rules
- Instance Configuration
- **Server Configuration**
- Database Engine Configuration
- Consent to install Microsoft R ...
- Feature Configuration Rules
- Ready to Install
- Installation Progress

Microsoft recommends that you use a separate account for each SQL Server service.

Service	Account Name	Password	Startup Type
SQL Server Agent	NT Service\SQLSERVERA...		Manual
SQL Server Database Engine	NT Service\MSSQLSERVER		Manual
SQL Server Launchpad	NT Service\MSSQLLaunc...		Automatic
SQL Server Browser	NT AUTHORITY\LOCAL ...		Disabled

☑ Grant Perform Volume Maintenance Task privilege to SQL Server Database Engine Service

This privilege enables instant file initialization by avoiding zeroing of data pages. This may lead to information disclosure by allowing deleted content to be accessed.

Click here for details

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…

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

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

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

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

Dynamic Data Masking

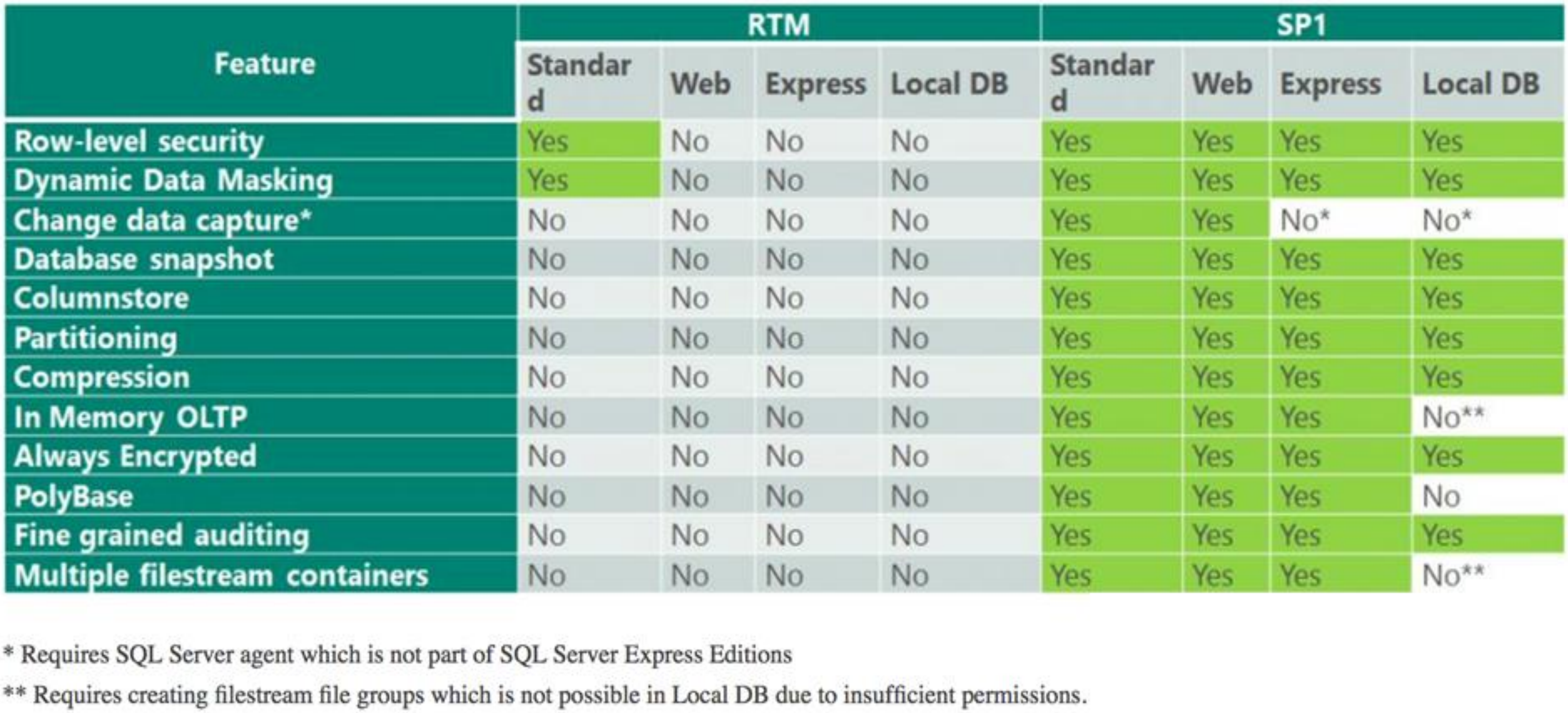
- By Column
- SELECT permission shows masked data
  - To see the data you need UNMASK permission
- Does not prevent UPDATEs to masked columns
- Using SELECT INTO or INSERT INTO doesn't work
  - Output is masked text (trash)
- Backups are also masked text (trash),
  - Unless the backup user has UNMASK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

Dynamic Data (UN)Masking

ONLY TRY
THIS AT HOME!

PROVA ENDAST
DET HÄR
HEMMA!

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.

Row Level (In)Security – Demo!

<u>ONLY</u> TRY
THIS AT HOME!

PROVA <u>ENDAST</u>
DET HÄR
HEMMA!

Row Level Security (RLS)

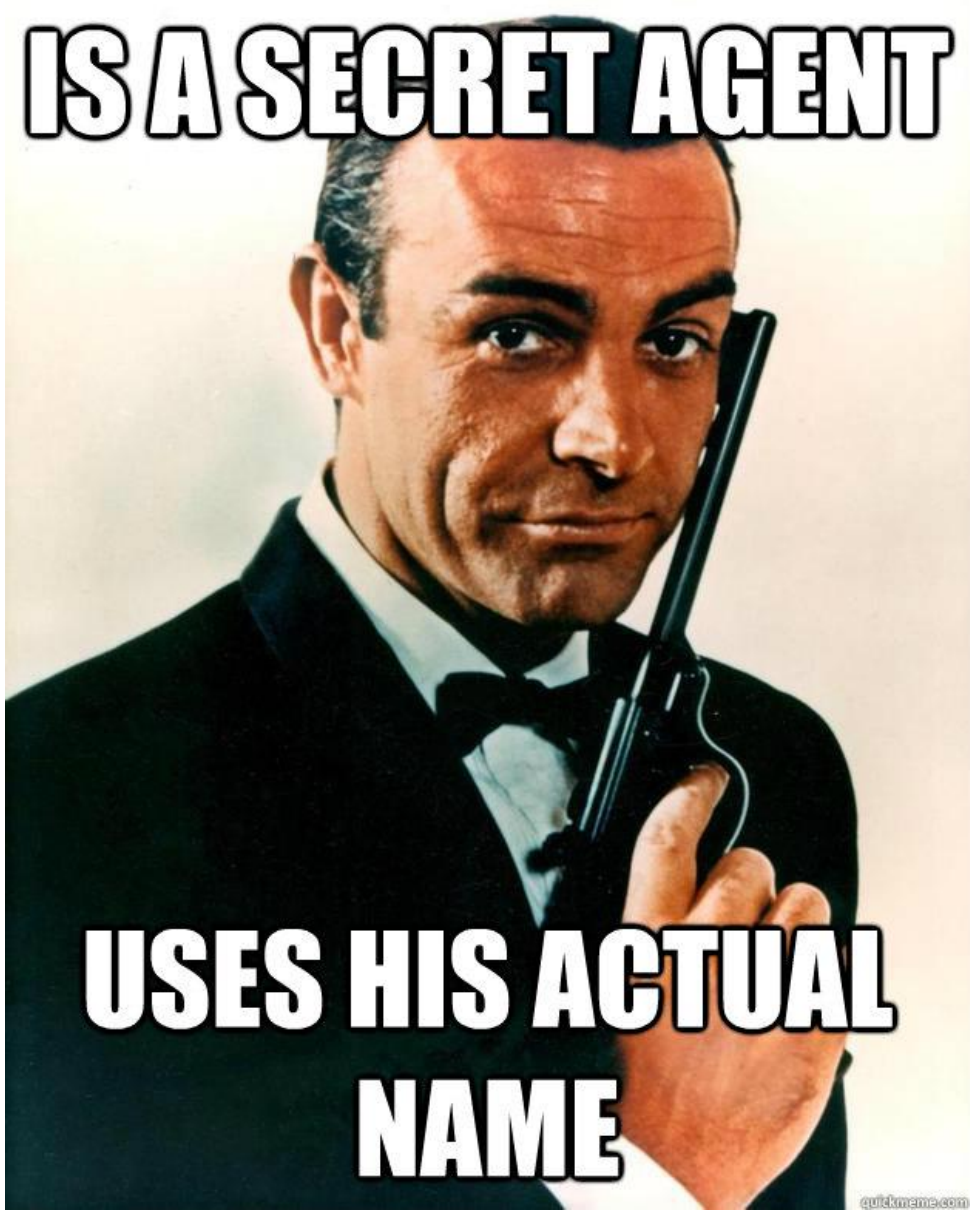
- Function Predicate
  - Defines Business logic/rules/access
  - User defined inline table valued-function (reusable)
- Security Policy
  - Collection of Predicates
  - Predicates added as FILTER or BLOCK

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

Never Say DEMO Again…

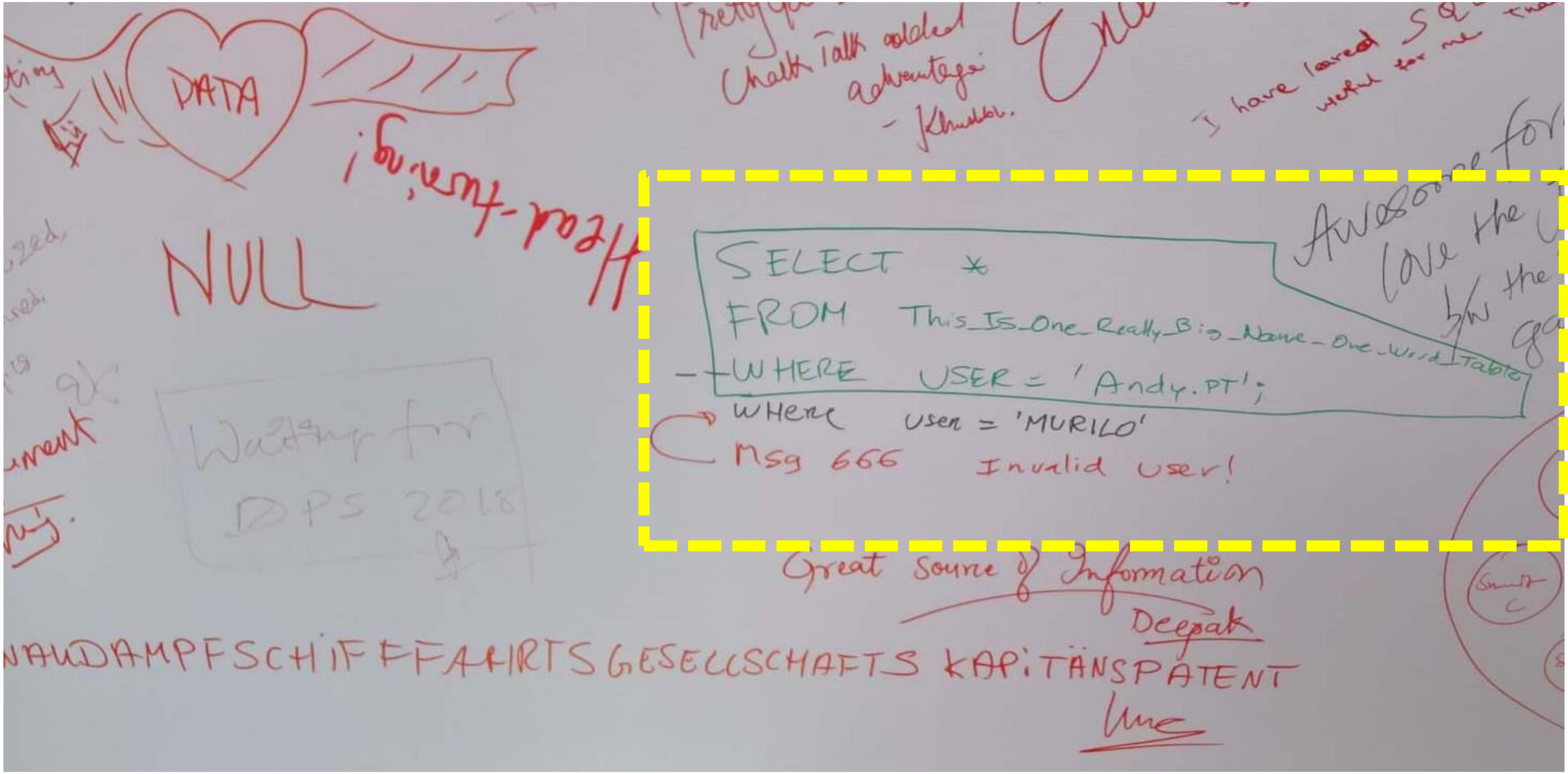
ONLY TRY
THIS AT HOME!

PROVA ENDAST
DET HÄR
HEMMA!



"Write one word about..."

Data Platform Summit 2017



```
SELECT *
FROM This_Is_One_Really_Big_Name_One_Word_Table
--WHERE USER = 'Andy.PT';
WHERE User = 'MURILO'
Msg 666 Invalid user!
```

PASS SQLSATURDAY GOTHENBURG | 23 SEP 2017

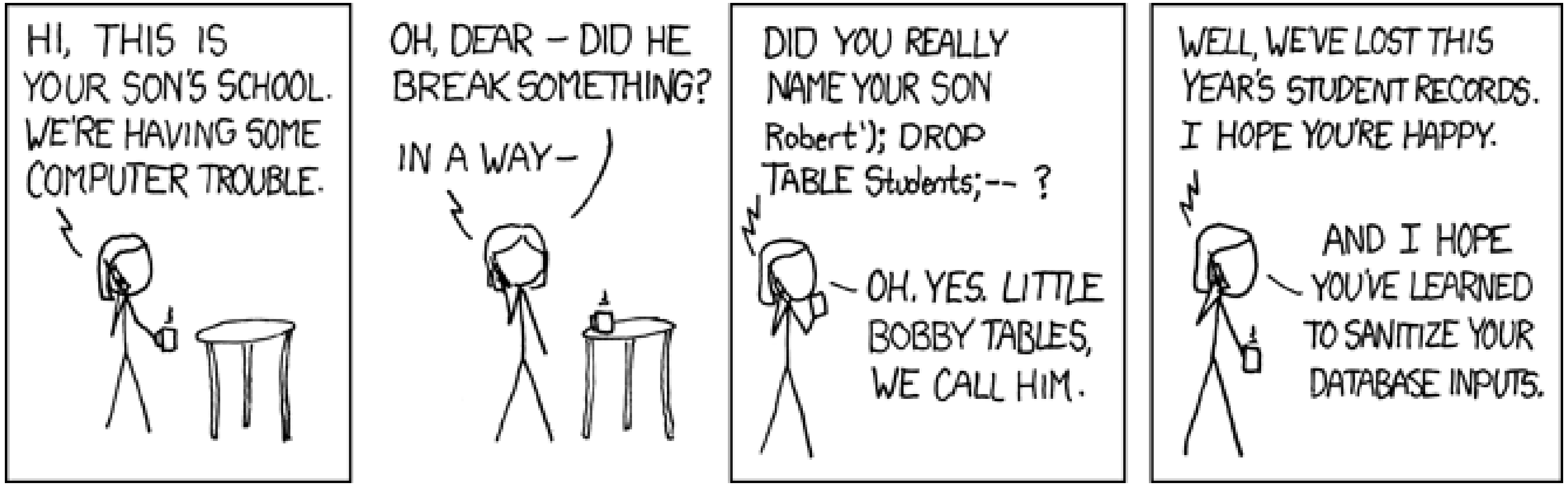
SQL Injection

- 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!


HI, THIS IS YOUR SON'S SCHOOL. WE'RE HAVING SOME COMPUTER TROUBLE.
OH, DEAR – DID HE BREAK SOMETHING?
IN A WAY–
DID YOU REALLY NAME YOUR SON Robert'); DROP TABLE Students;-- ?
OH. YES. LITTLE BOBBY TABLES, WE CALL HIM.
WELL, WE'VE LOST THIS YEAR'S STUDENT RECORDS. I HOPE YOU'RE HAPPY.
AND I HOPE YOU'VE LEARNED TO SANITIZE YOUR DATABASE INPUTS.

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

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

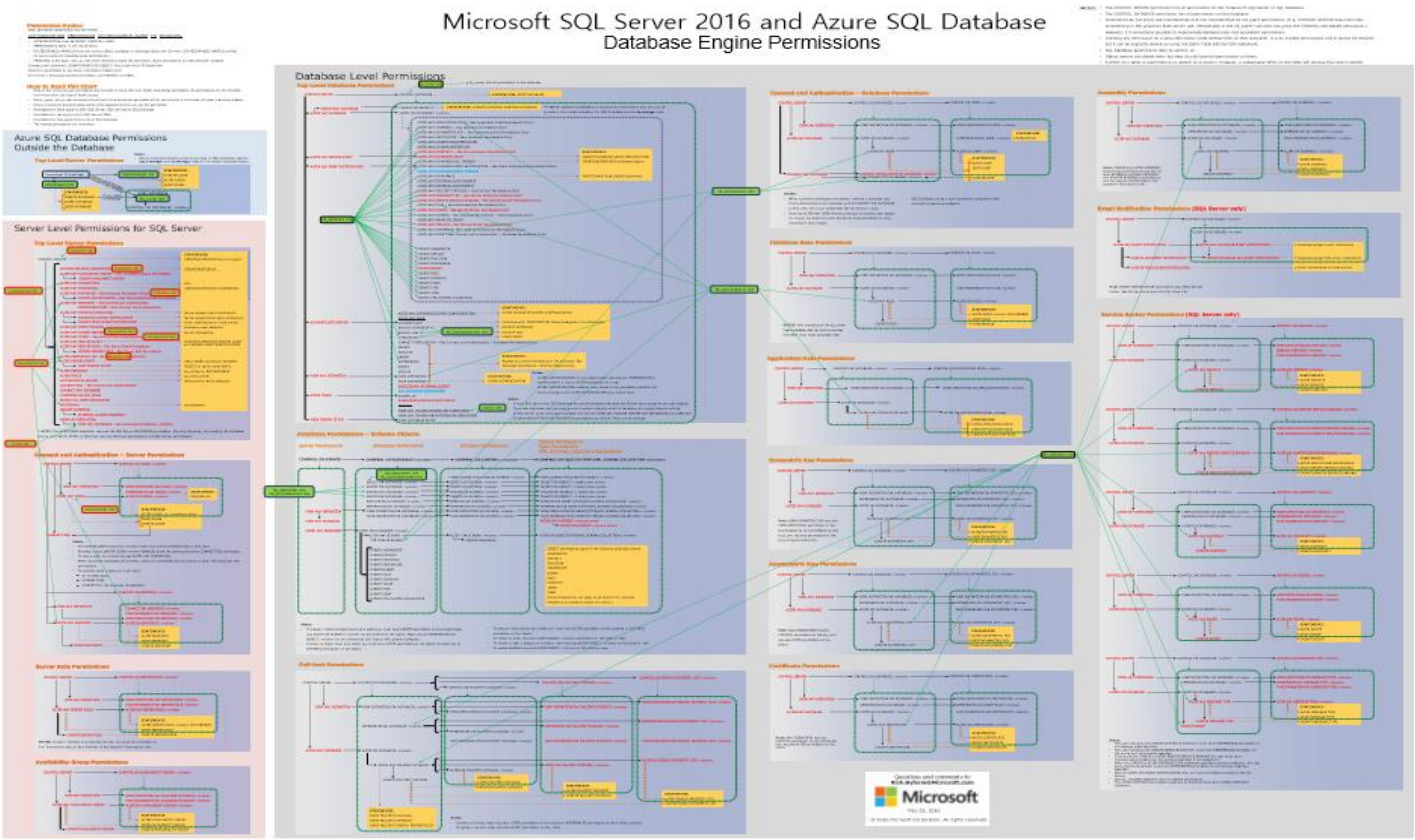
Permissions

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

- By DB user

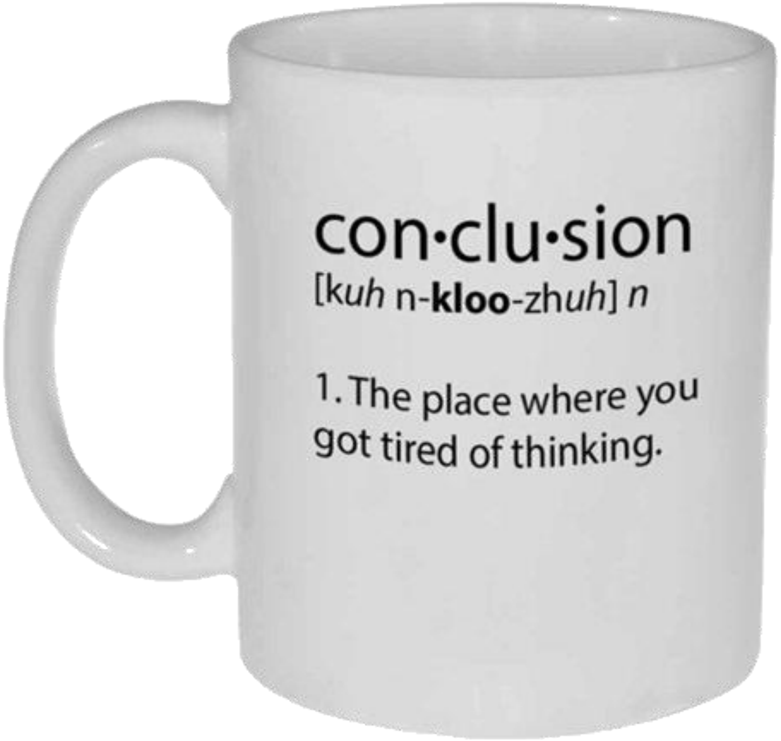
- By server role
- By database role
- By application role

Permissions poster by Rick Byham


Microsoft SQL Server 2016 and Azure SQL Database
Database Engine Permissions
Database Level Permissions
Azure SQL Database Permissions Outside the Database
Server Level Permissions for SQL Server
Microsoft

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

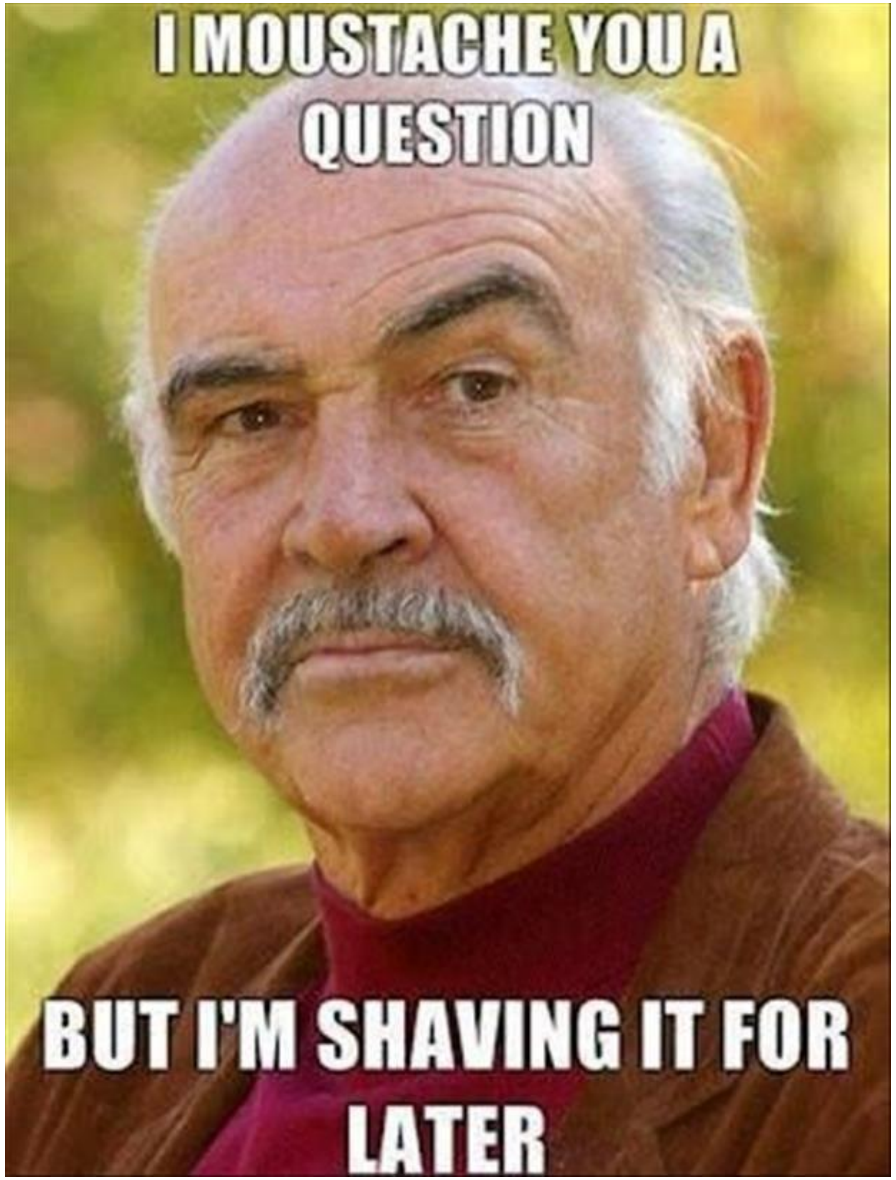


Even if you can't get the Bond Girl, remember...

- SQL Server 2016 and 2017 have a lot of new features...
  - But they're not perfect!

- ALWAYS,
- ALWAYS,
- ALWAYS,
- Install the latest Service Packs and patches!

Receive-Questions –Input "Speech"



TACK SÅ MYCKET!

Thank you!

Obrigado!

Takk!

धन्यवाद्

Благодаря!

Дуже дякую!

Köszönöm!

Dziękuję!

Merci beaucoup!

Dank je!

Go raibh maith agaibh!

Danke!

Děkuju!

Diolch!

André Melancia

http://Andy.PT

http://LunarCat.PT