Database Applied Cryptography

Anti-forensics techniques/Data Protection

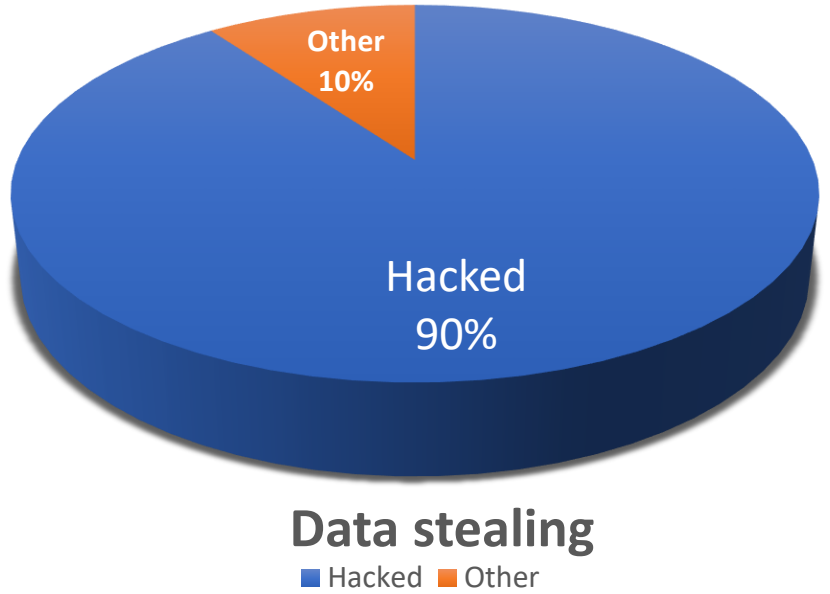
Case study: SQL Server 2022

Content

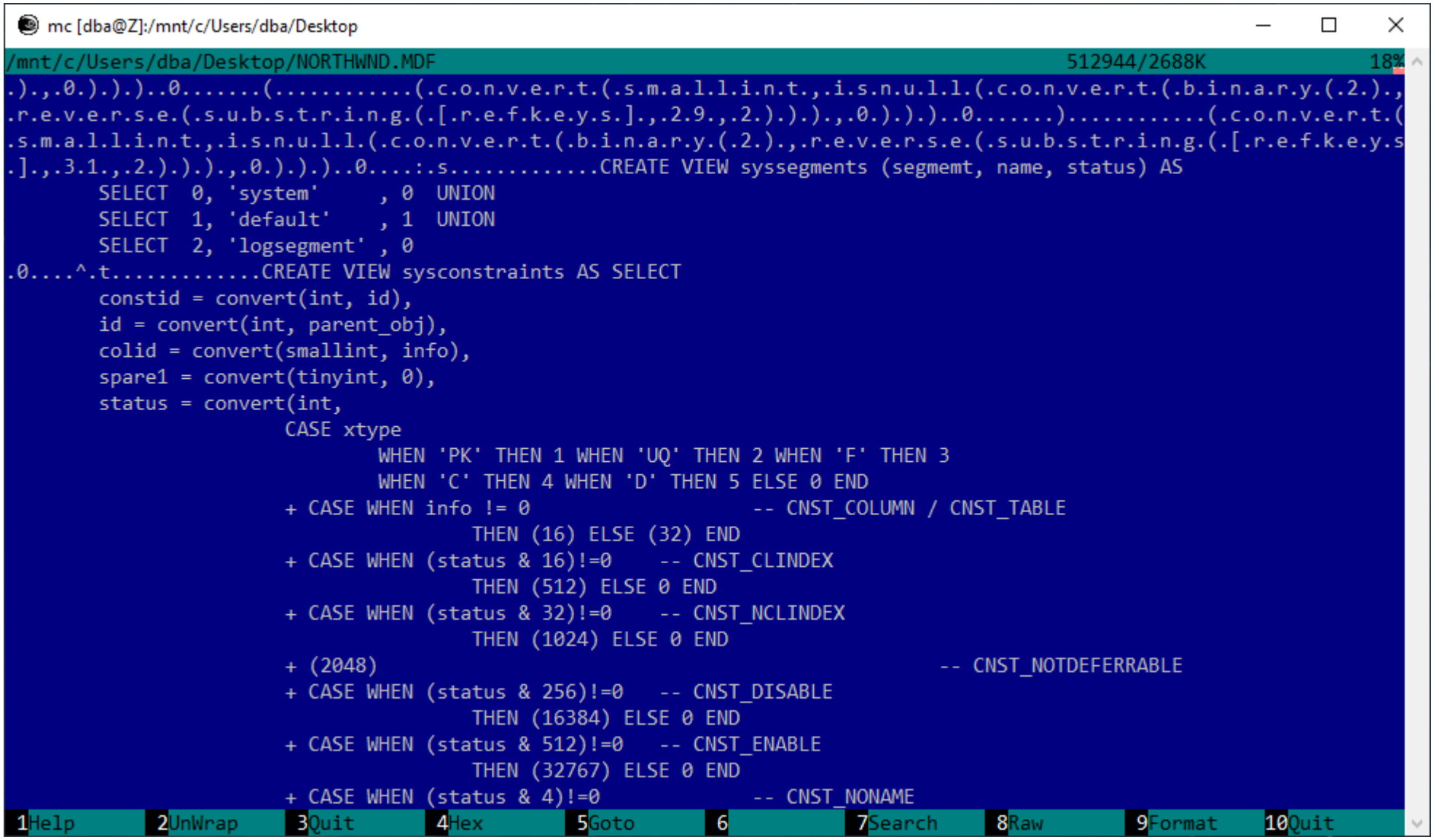
Intro

01_Intro

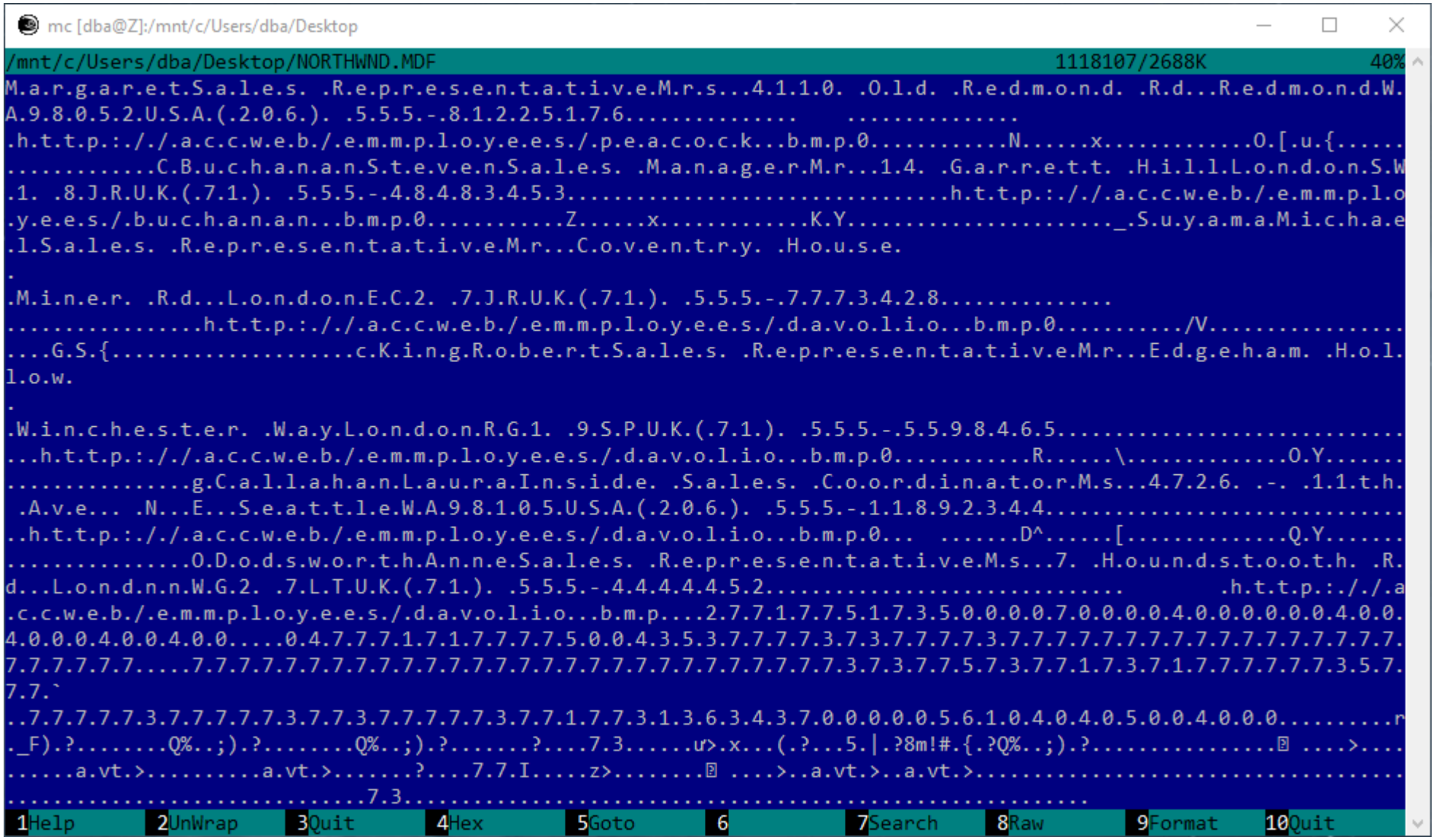
- Back Up files
- Data and Log files
- Oversized database permissions
- Copy/Paste from apps.
- Export options
- SQL injection
- Backdoors
- Phishing
- Social engineering
- Hacking
- etc.



Low level file acess

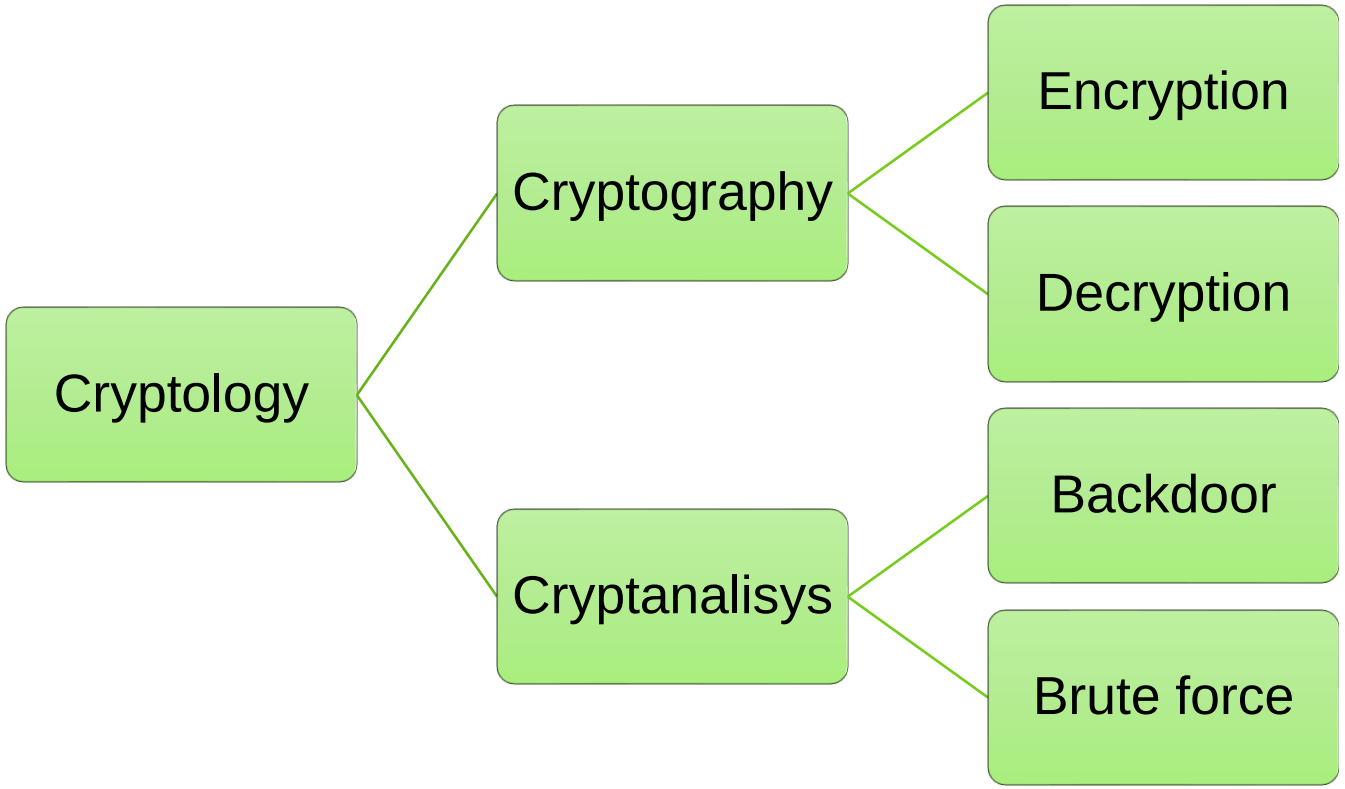


Low level file access



SQL Server Applied Cryptography

02_What is Cryptography



02_Types of Cryptography

- Symmetric cryptography
  - the sender and recipient share a key that is used to perform encryption and decryption
  - common symmetric algorithms are: Rijndael (AES) and Triple DES (3DES).
- Asymmetric cryptography
  - the sender encrypts data with one key, and the recipient uses another key for decryption
  - commonly used asymmetric algorithm is the RSA algorithm

02_SQL Server Applied Cryptography

SQL Server Encryption Hierarchy

SQL Server Encryption Algorithms

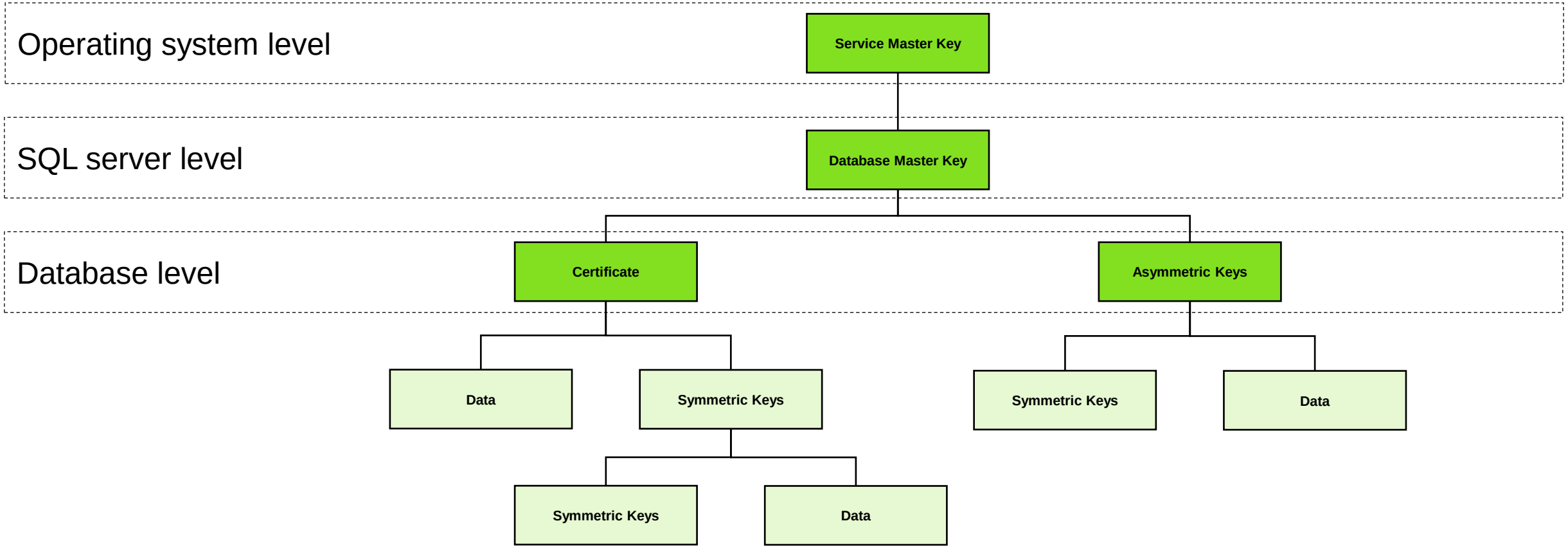
Pre-breach cryptography

- Symmetric key column encryption
- Always Encrypted
- Always Encrypted : Secure Enclaves

Post-breach cryptography

- Transparent Data Encryption
- Back Up encryption

02_SQL Server Encryption Hierarchy



02_SQL Server Encryption Algorithms

Beginning with SQL Server 2016 (13.x), all algorithms other than AES_128, AES_192, and AES_256 are deprecated. To use older algorithms (not recommended) you must set the database-to-database compatibility level 120 or lower.

Symmetric Encryption Algorithms

Keyword	Algorithm	Key Length (Bits)
AES_256	AES	256
AES_192	AES	192
AES_128	AES	128
~~TRIPLE_DES_3KEY~~	~~Triple DES (3-Key)~~	~~112~~

Asymmetric Algorithms

Keyword	Algorithm	Key Length (Bits)
RSA_2048	RSA	2048
RSA_1024	RSA	1024
RSA_512	RSA	512

02_Symmetric key column encryption

Symmetric Keys are created in a database, and they are always in that database

What can you encrypt/decrypt?

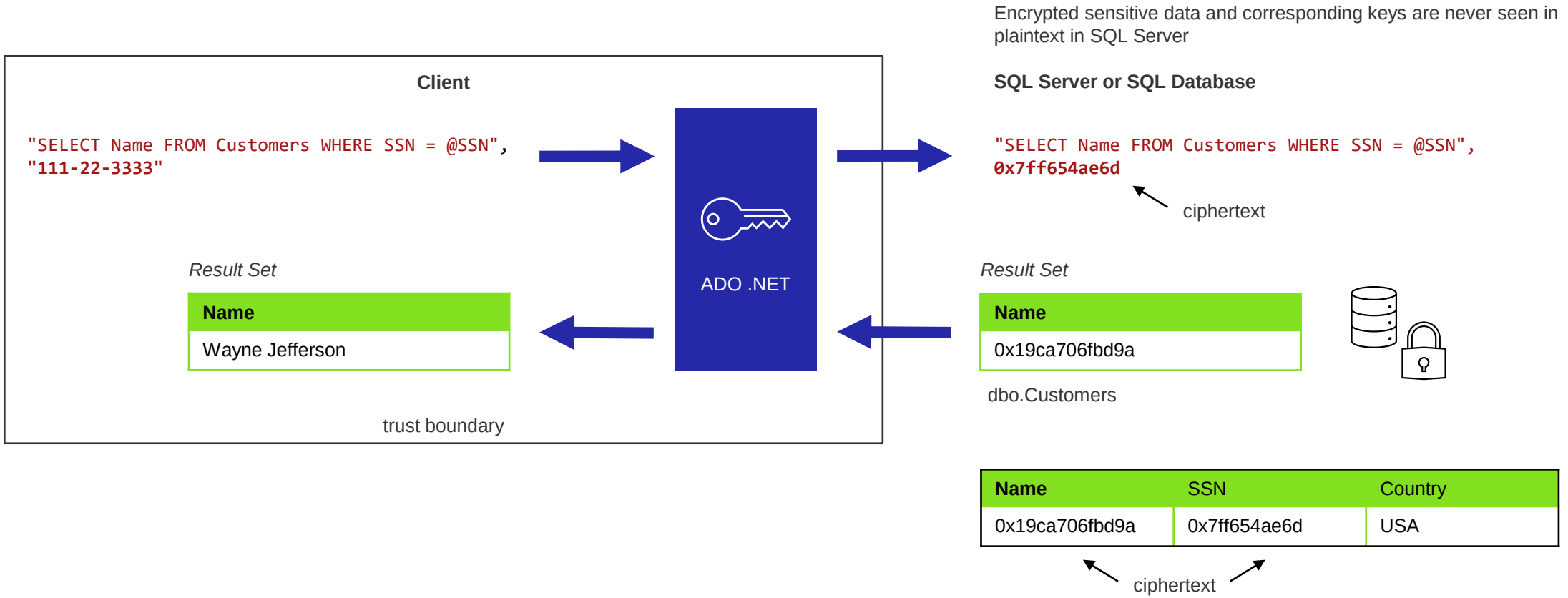
- Data in tables (column level)

Encryption require an additional CPU load from their use.

Results | Messages

	FirstName
1	0x008EA7B31E68C4B8CA3307A5AA41CBCE010000007CD2971D4429634F322549A5563B3E90DB0B6388CEECB3A37533F1160CB043D9
2	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000F2DCB70922F8B65231122AF2A4F9C41B919F704AFD75C0EE9D41325041D08C5851D8B311C5120BC7EDBE992A719670FA
3	0x008EA7B31E68C4B8CA3307A5AA41CBCE0100000026A5F8C367E9C4524BFD880BA586457D65B4B7571B69D325E9AAB848CD4043C008A3D47A4454D3054ED6DBD6D861AB56
4	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000B8BCD196FE4DB5124C6E3224FA2C0AC4715E053248B14DE399552082E1C864DA
5	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000BC41B4D968C9233FB989558B4BCE6DD1553DBEBFF62E6E1EC01D76F818C8BEB71C9A23CAB8BC669A742738AE94F26D8E
6	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000F071CFDBB17339A9528F5DD34599E5E3F48409D4B033A37F4C4AABFD8690D10CEC2A48F4F464F20ED49C91F40F92EFEA
7	0x008EA7B31E68C4B8CA3307A5AA41CBCE010000000311B39CFB51BB66CC6669C62A44EE0F2C9DE3633DE51E5AD173F54FCD9C3CCB6432E52309062AEAD50716E8421BFD31
8	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000CBFF8899034BFF048DC23C23C51D83720CAD717D456EDE5AF2546D4EBF44B591D2D19BF8E524C52FDFBDA6C83014F7EF
9	0x008EA7B31E68C4B8CA3307A5AA41CBCE01000000F08B158296356D5BC2EE5EF151A8A7A40BBF7E032BDC5B220EE171411B35D48B712C0599491CD59395500D055517F8E1
10	0x008EA7B31E68C4B8CA3307A5AA41CBCE010000000047EF032AA4ADC5314E7CC79D227DD5DC4B97134F028F6BAE3E5F763F7922B2898D6DF1E2A4F6B33451872DFFAF76947

02_Always Encrypted - facts



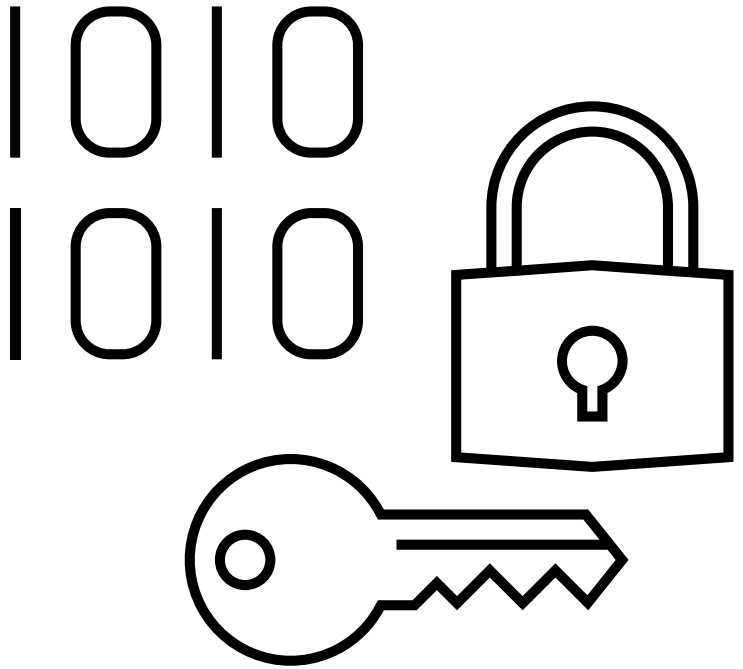
02_Always Encrypted - facts

Randomized encryption

- Encrypt ('123-45-6789') = 0x17cfd50a
- Repeat: Encrypt ('123-45-6789') = 0x9b1fcf32
- Allows for transparent retrieval of encrypted data but NO operations
- More secure

Deterministic encryption

- Encrypt('123-45-6789') = 0x85a55d3f
- Repeat: Encrypt('123-45-6789') = 0x85a55d3f
- Allows for transparent retrieval of encrypted data AND equality comparison
- E.g., in WHERE clauses and joins, distinct, group by



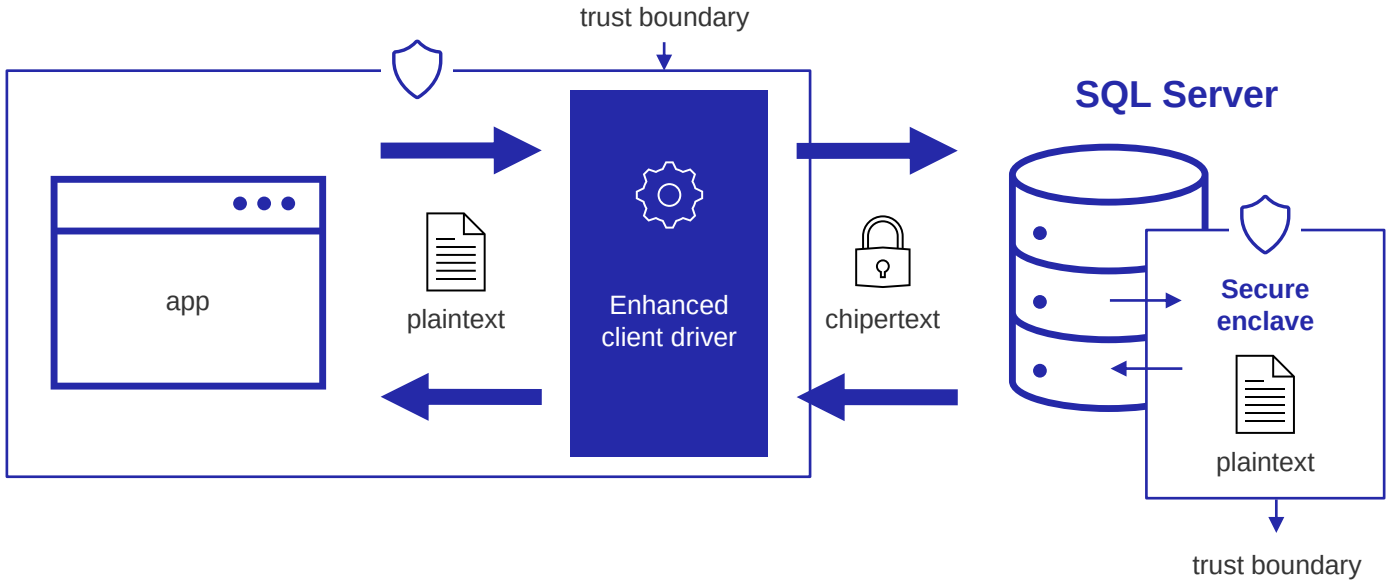
02_Always Encrypted - Secure Enclaves

Current implementation : encrypt/decrypt at client

Great for security, but…
Rich computations impossible or expensive

Secure Enclaves

Protected, isolated area of memory (fast!) on the SQL Server machine; allowing…
Encrypt in place (e.g., key rotation), range queries, pattern matching – even on random



02_Transparent Data Encryption

Protects the data at rest by encrypting the data on disk.

The transaction log is encrypted

Backups are encrypted

Tempdb is encrypted for all operations.

Replication data is not encrypted

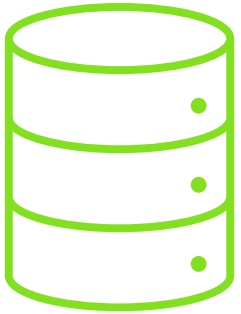
Filestream data is not encrypted

TDE does not provide encryption across communication channels

02_Backup encryption

Increase security of backups stored separate from the instance (another environment such as the Cloud)

Encryption keys can be stored on-premises while backup files in the cloud



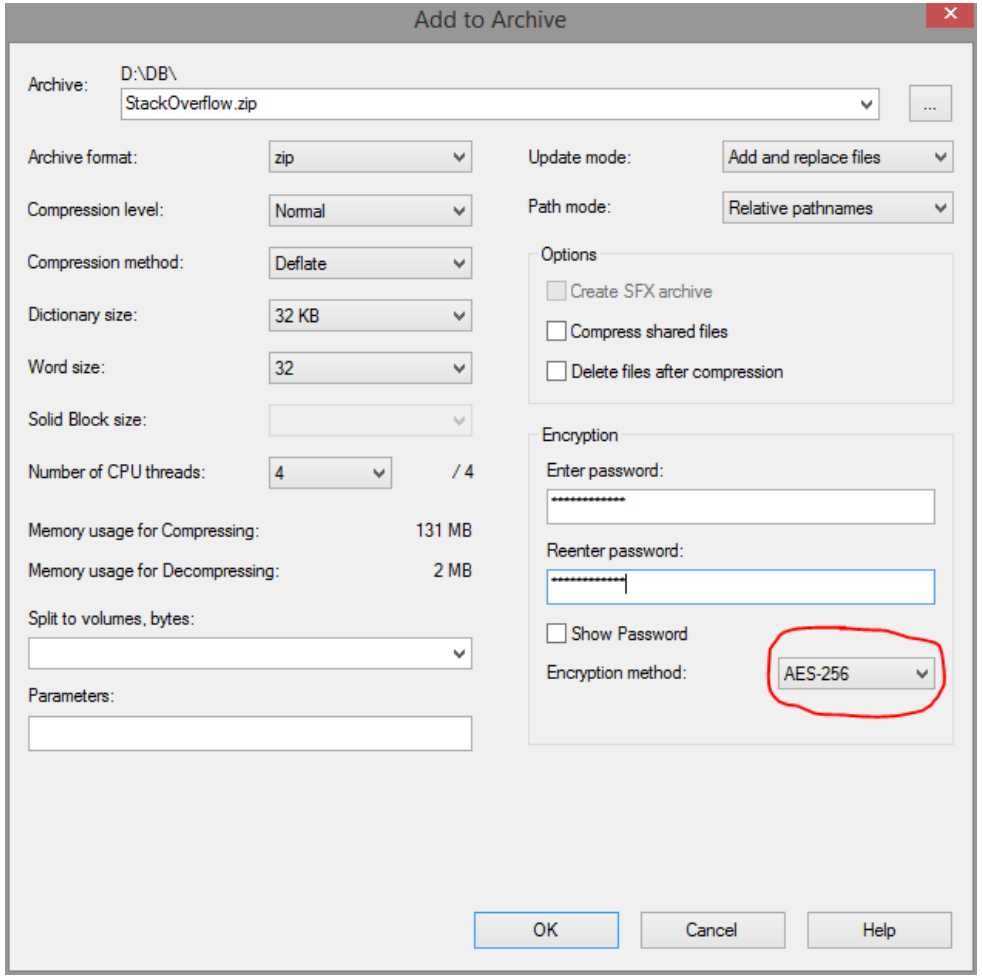
Support non-encrypted databases (don’t need to turn on TDE anymore)

02_Better then nothing

7ZIP

WinRAR

Another tools



Demo section

- Column encryption symmetric key – **Live Demo**
- Column encryption asymmetric key – **Live Demo**
- Always encrypted – **3:15 min (Recording)**
- Transparent Database Encryption (TDE) – **2:20 min (Recording)**
- Backup encryption – **2 min (Recording)**

Additional resources

https://learn.microsoft.com/en-us/sql/relational-databases/security/encryption/sql-server-encryption

https://github.com/jasminazemovic/Book-Securing-Sql-Server

https://www.sqlshack.com/sql-server-confidential-part-crypto-basics-sql-server-cryptographic-features/

https://www.sqlshack.com/sql-server-confidential-part-ii-sql-server-cryptographic-features/

Time for questions