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SMB over QUIC

Obaid Farooqi
Microsoft

What I am going to cover

- SMB over a new transport QUIC
- AES-GMAC Signing

Problems fixed by SMB over QUIC

- SMB uses TCP port 445
- Port 445 is blocked by firewalls on the Internet
- SMB over Internet either requires VPN
- Or requires port 445 to be opened in firewall

SMB over QUIC Details

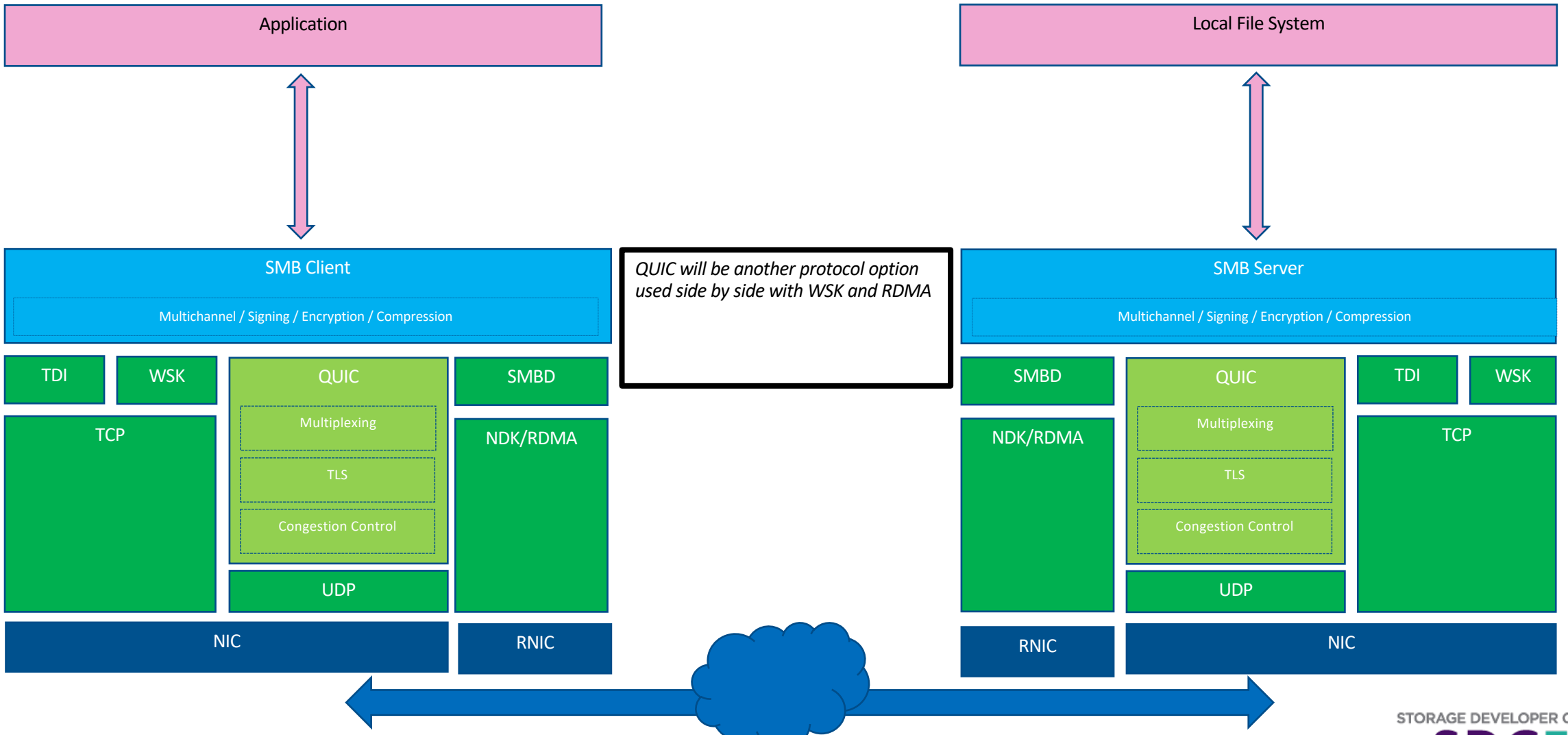
What is SMB over QUIC?

- QUIC is a new **transport** for SMB
- Available in Windows 10 21H1 and Windows Server 2022 and later
- Offers all the SMB goodness to remote workers and cloud users (VPN not needed!)
- Encapsulates every single SMB message so no malicious actor can sniff the file data and authentication payloads
- Makes NTLM more secure
- QUIC selected seamlessly; no user configuration required

A quick overview of QUIC

- Secure networking **transport** leveraging UDP
- Faster connection set up compared to TLS on TCP
  - 1 Round Trip(1-RTT) for initial connections.
  - 0-RTT for resumed connections.
  - No TCP Handshake
- Built in TLS1.3 security
- Provides mutual authentication
- Mitigates MITM attacks
- No TCP head-of-line blocking

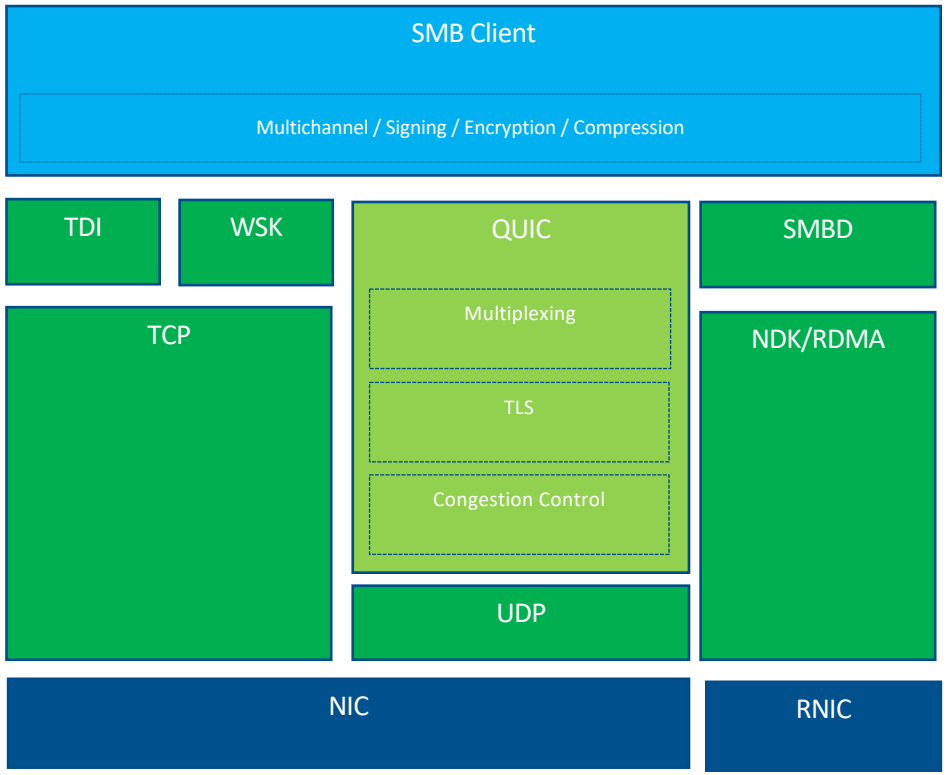
SMB/QUIC: Components



SMB-over-QUIC: What's different?

- SMB will be layered on top of the QUIC stack.
- Multichannel works as usual
- No SMB signing/encryption by default
- No changes to SMB authentication

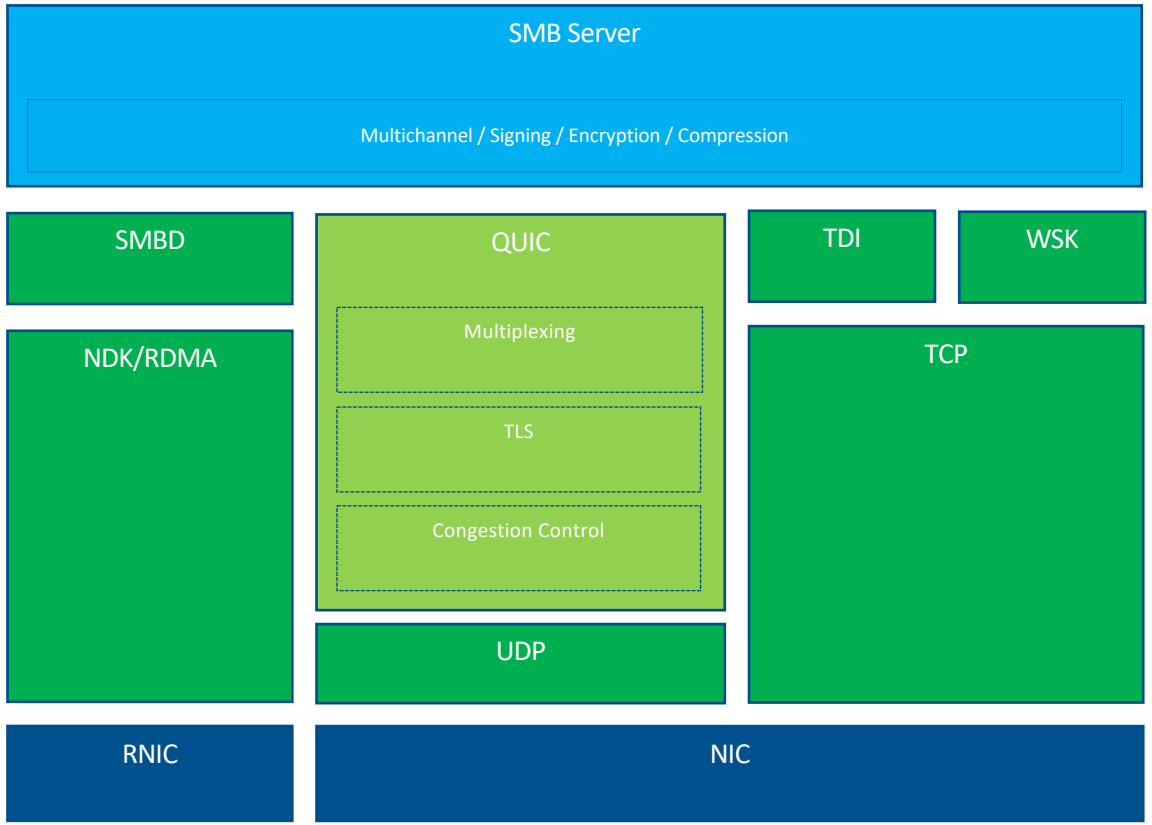
SMB/QUIC: Client



1. *Client opens \\ServerName\Share\foo.tst*
2. *Client resolves ServerName using DNS*
3. *Client attempts TCP and QUIC simultaneously**
4. *Client will start using whichever connects first*
5. *Client's multichannel will negotiate interfaces with server and will select most optimal protocols*
6. *Client sends SMB messages*

- Client does not know if server supports QUIC at all or supports only TCP or only QUIC so it attempts both.
- *TCP/IP is given a bit of head start to establish a connection.

SMB/QUIC: Server



1. *Server opens endpoints listening on UDP 443*
2. *Server receives new QUIC connection requests*
3. *Server finds the certificate for the QUIC connection*
4. *Server accept the connection*
5. *Server receives QUIC streams/SMB messages*

- Server starts both TCP/IP and QUIC listeners by default.
- Server can selectively start TCP/IP or QUIC listeners or both.

SMB Encryption on QUIC

- QUIC provides built-in TLS 1.3 encryption
- SMB over QUIC has two types of encryptions
  - Encryption offered by SMB
  - Encryption offered by QUIC transport
- Technically, both can be present simultaneously
- Double encryption imposes performance penalty

Disabling SMB Encryption on QUIC

- When client connects over QUIC
  - Client sends a negotiate transport context (NTC)
  - This indicates that client will accept QUIC encryption instead
  - Server must accept transport security
  - Server and client will not use SMB encryption over QUIC
- There are configuration options that control this behavior
- By default, SMB encryption is disabled on QUIC
- If ForceSMBEncryptionOverQUIC is set, client will skip NTC which will result in SMB encryption on QUIC

SMB2_TRANSPORT_CAPABILITIES

- Defined in MS-SMB2 section 2.2.3.1.5
- Contains flag
  - SMB2_ACCEPT_TRANSPORT_LEVEL_SECURITY
- Only possible value for this flag is 0x00000001
- Indicating that client will accept QUIC encryption and SMB encryption is not needed
- SMB encryption will be disabled over QUIC

Certificate Management

Server Certificate for QUIC

- QUIC comes with TLS1.3 built-in
- TLS requires certificates to function
- Certificate acquisition and installation is an explicit step
- Self signed certificate can be used but not recommended.

Additions to `net use` command

- **`net use /transport:quic`**
  - Forces client to use QUIC even if TCP is also available
- **`net use /transport:quic /skipcertcheck`**
  - Disables cert validation

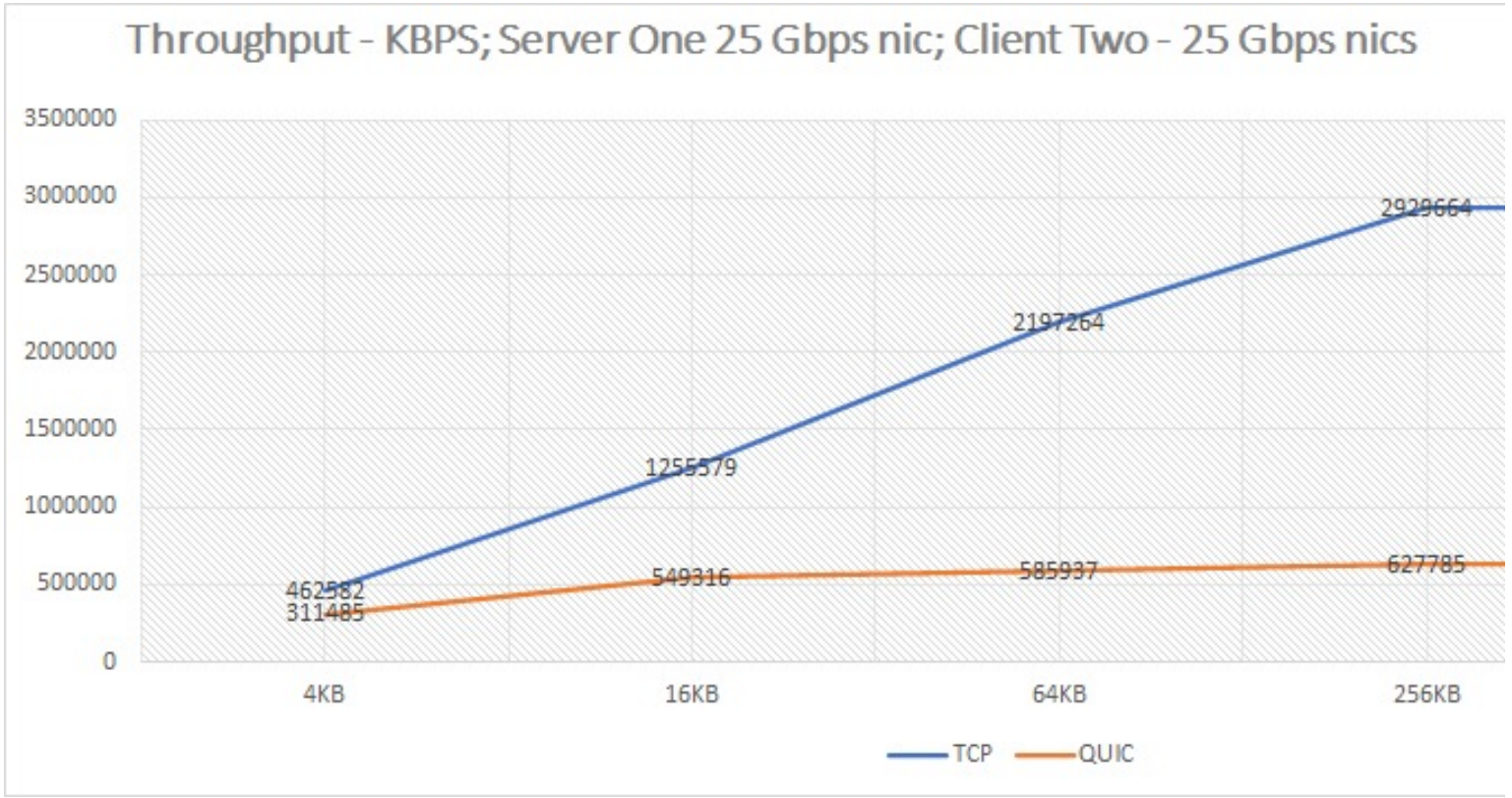
Performance

Performance comparison

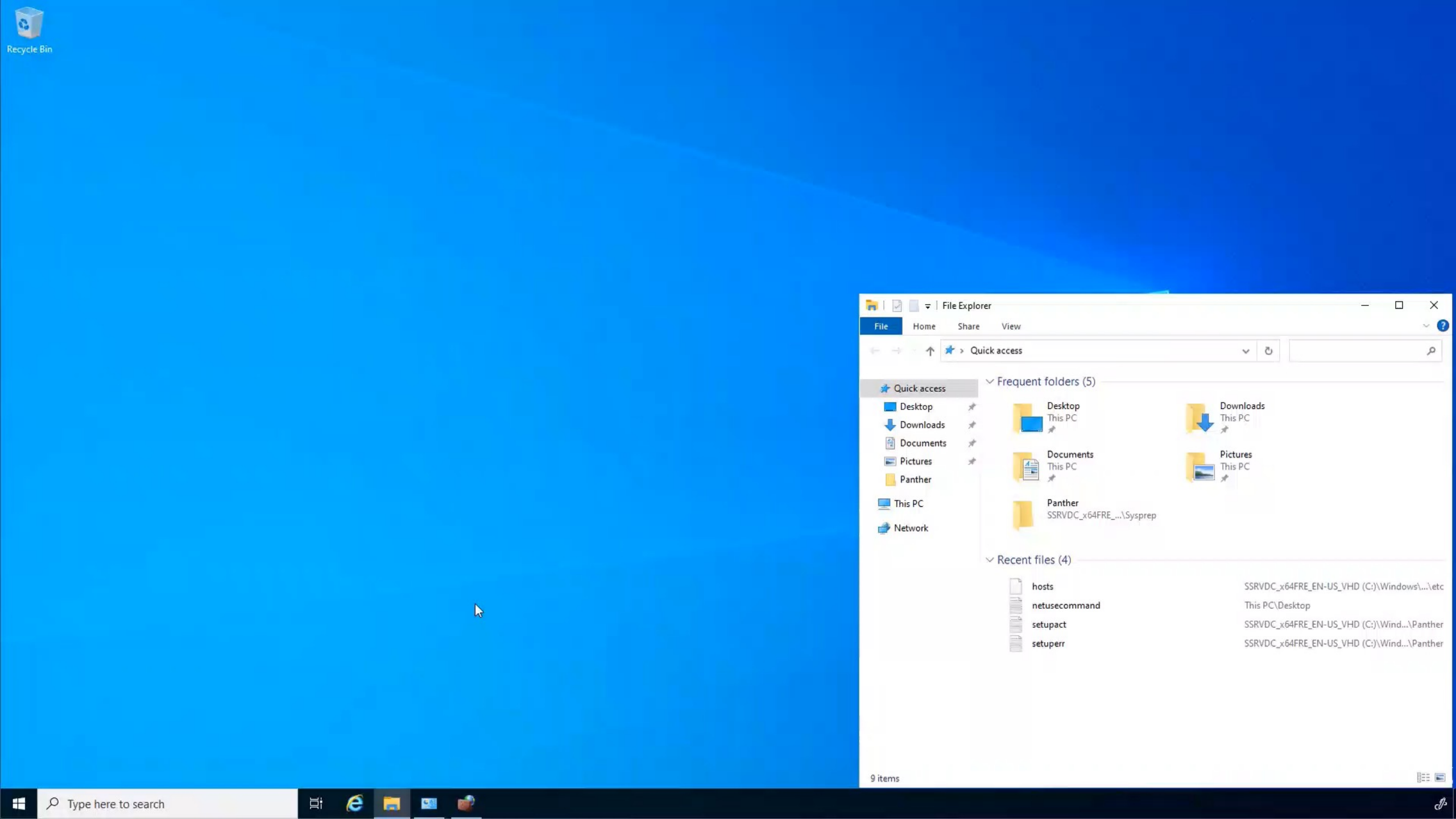
- The standard is Encrypted SMB over TCP (ESOT)
- SMB over QUIC is slower than ESOT
- The reason is in the encryption/decryption layer
- SMB encryption is asynchronous
- SMB encryption utilizes multiple processors

Performance comparison with TCP

- TCP with SMB Encryption turned on.



Demo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Share
View
Quick access
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Desktop
Downloads
Documents
Pictures
Panther
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Network
Frequent folders (5)
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This PC
Downloads
This PC
Documents
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Pictures
This PC
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SSRVDC_x64FRE_...\Sysprep
Recent files (4)
hosts
SSRVDC_x64FRE_EN-US_VHD (C:)\Windows\...\etc
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AES-GMAC Signing

New Signing Algorithm: AES-GMAC

- Supported in Window 10 v21H1 and Windows Server 2022 and later
- Most preferred algorithm for signing
- Id for AES-GMAC is 0x0002 in SMB2_SIGNING_CAPABILITIES context
- Nonce (IV) for AES-GMAC is derived from MessageId (more on next slide)

Construction of IV (Nonce)

- Following struct is used for IV value:

```
typedef struct SMB_CRYPTO_IV_128
{
    ULONGLONG MessageId;
    ULONG ServerToClient : 1;
    ULONG CancelRequest : 1;
    ULONG Reserved1 : 30;
    ULONG Reserved2;
}
```

- The value for Reserved1 and Reserved2 is zero
- ServerToClient is 0 for request and 1 for response
- CancelRequest is 1 for CancelRequest, otherwise 0

AES-GMAC Signing: things to note

- Windows sets only first 12 bytes of Nonce
- No check is made for Nonce overflow

Questions?

- For questions about SMB-over-QUIC, please contact nedpyle@microsoft.com
- For any follow up question on this presentation or any question on open specifications, please contact: dochelp@microsoft.com

References

- [MS-SMB2]: Server Message Block (SMB) Protocol Versions 2 and 3
  [MS-SMB2]: Server Message Block (SMB) Protocol Versions 2 and 3 | Microsoft Docs

- Ned Pyle Blog entry on SMB-over-QUIC:
  SMB over QUIC: Files Without the VPN (microsoft.com)

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