Security Soup

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Now with instant ~~Simple~~ plus wholesome protocols !

What are we trying to do with security protocols ?

- Security protocols are not an end in and of themselves.
  - We just want to add them to existing useful protocols.
- The idea is to add privacy (encryption), non-repudiation (signing) on top of clent/server and peer to peer protocols.
  - This needs to be done in such a way as to interface transparently with existing authentication mechanisms (everyone wants single-sign on).
- Ideally this is done transparently to existing protocols so client/server writers get the benefits without having to understand the details.

Why is Samba concerned with this ?

- Samba, and the Windows directory services it provides are where the rubber meets the road for many “standard” security protocols.
  - Plus a few extra suprises Microsoft cooked up on it's own (they're the stones in the soup :-).
- “Standard” security protcols are SASL, SPNEGO, Kerberos5, GSSAPI.
- Microsoft “stones” are LM, NTLM, NTLMv2, LMv2, NTLMSSP, SMB Signing, DCE/RPC security and SChannel.
- Cyptographic standards such as MD4, MD5-HMAC, DES and RC4 are also in the broth.

Integration with Authentication

- All of these protocols in the SMB/CIFS world are designed to integrate with symmetric key encryption, not public key.
  - No SSL or certificates to deal with, thank goodness :-).
  - Designed for “password” style authentication mechanisms (cryptographic hashes).
  - Client and server both have knowledge of the “secret password” used to create the secure communications protocols.

“That Word. I do not think it means what you think it means”

- Many of the “standard” protocols are described as “simple”.
  - They even have this in the name !
  - SPNEGO = Simple and Protected GSS-API Negotiation mechanism.
  - SASL = Simple Authentication and Security Layer.
- These protocols are not simple :-). They are designed to be generic so any authentication mechanism can be slotted in below this level.
  - This leads to unbelievable complexity in trying to figure this stuff out.....

An example of “simple”….

- Security Blob: 60820B6206062B0601050502A0820B56...
  - GSS-API
    - OID: 1.3.6.1.5.5.2 (SPNEGO (Simple Protected Negotiation))
    - SPNEGO
      - negTokenInit
        - mechType
          - OID: 1.2.840.48018.1.2.2 (MS KRB5 (Microsoft Kerberos 5))
          - OID: 1.3.6.1.4.1.311.2.2.10 (NTLMSSP (Microsoft NTLM Security Support Provider))
        - mechToken
          - krb5_blob: 60820B2B06092A864886F71201020201...
            - OID: 1.2.840.113554.1.2.2 (KRB5 (Kerberos 5))
            - krb5_tok_id: KRB5_AP_REQ (0x0001)
            - Kerberos
              - Version: 5
              - MSG Type: AP-REQ
              - APOptions: 0020000000
              - Ticket
              - Encrypted Data: Authenticator

Basic Authentication Protocols – LM and NTLM (challenge response)

Client

Hello from client !

Server

Challenge (BLOB)

Password Hash
+ Challenge

Response

Request to logon :
Username + Response
(BLOB)

Password Hash
+ Challenge

Response

Logon successful or
error message.

More complex Authentication Protocols – NTLMv2 and LMv2

Client

Server

Request to logon (client workstation identifier)

Challenge (BLOB)

Response + Client blob + (optional data)

Start of communication
or error message.

Password Hash
+ Challenge
+ Server name
+ Username
+ Client blob

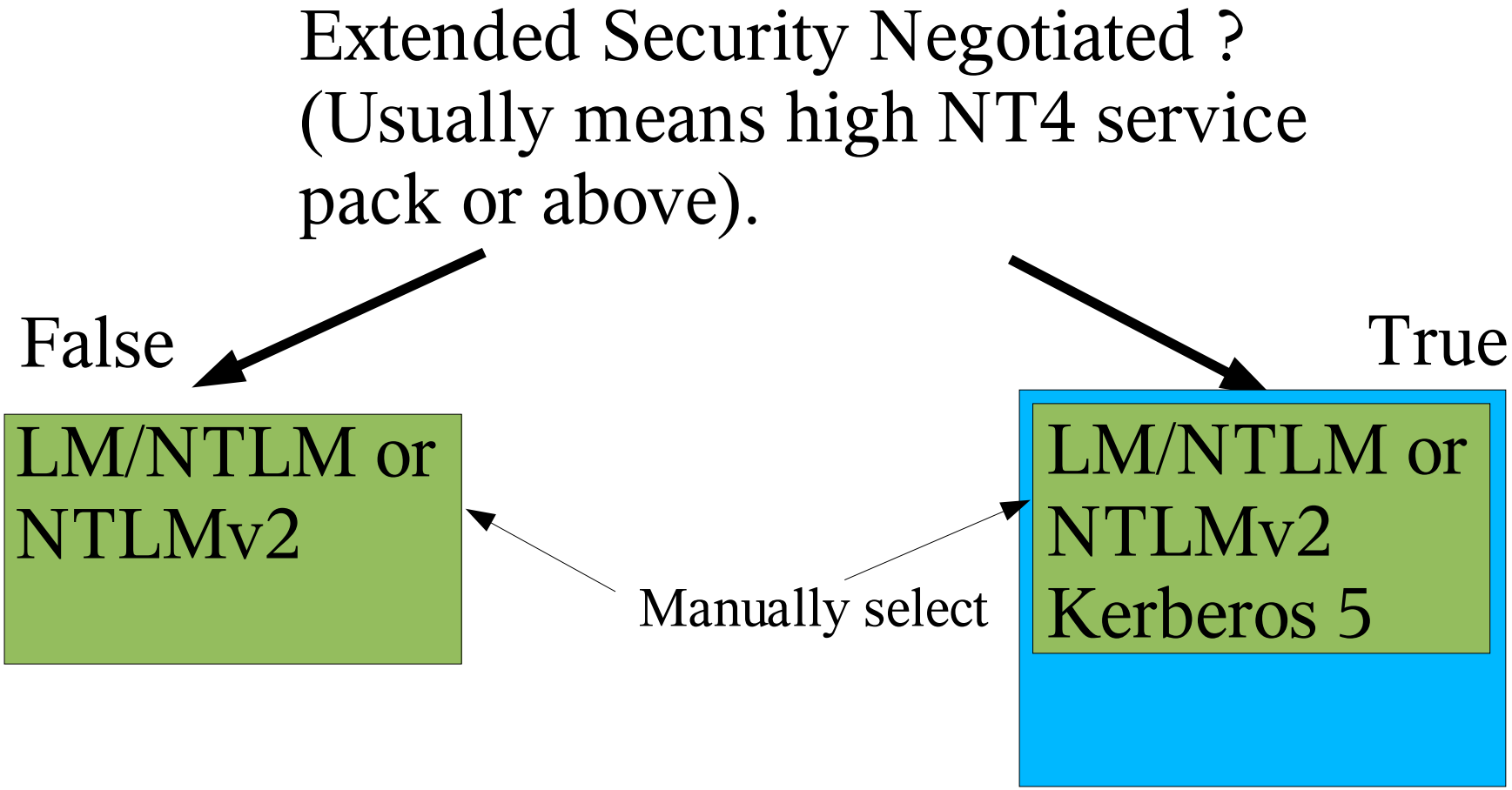
Response

Password Hash
+ Challenge
+ Server name
+ Username
+ Client blob

Response

Selecting NTLM or NTLMv2 ?

- This isn't intuative. Extended security can be negotiated, but NTLM or NTLMv2 must be selected by hand (registry on Windows, smb.conf in Samba).

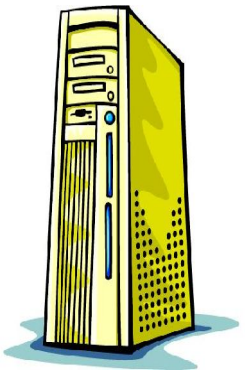


Kerberos 5 Authentication – Part 1
TGT and Server Ticket

Client

Please send me a ticket-granting-ticket for user “foo”(with proof I know foo's password)

Ok, here is a TGT for user “foo” (encrypted with foo's password)



Kerberos KDC

Contains master passwords for all users and servers (services).

Please send me a service ticket for server “BAR”. Here's my TGT as proof I can ask this

Ok, here is a ticket for server “BAR”, with an authenicator encrypted in BAR's password

Kerberos 5 Authentication – Part 2
Using the Server ticket

Client

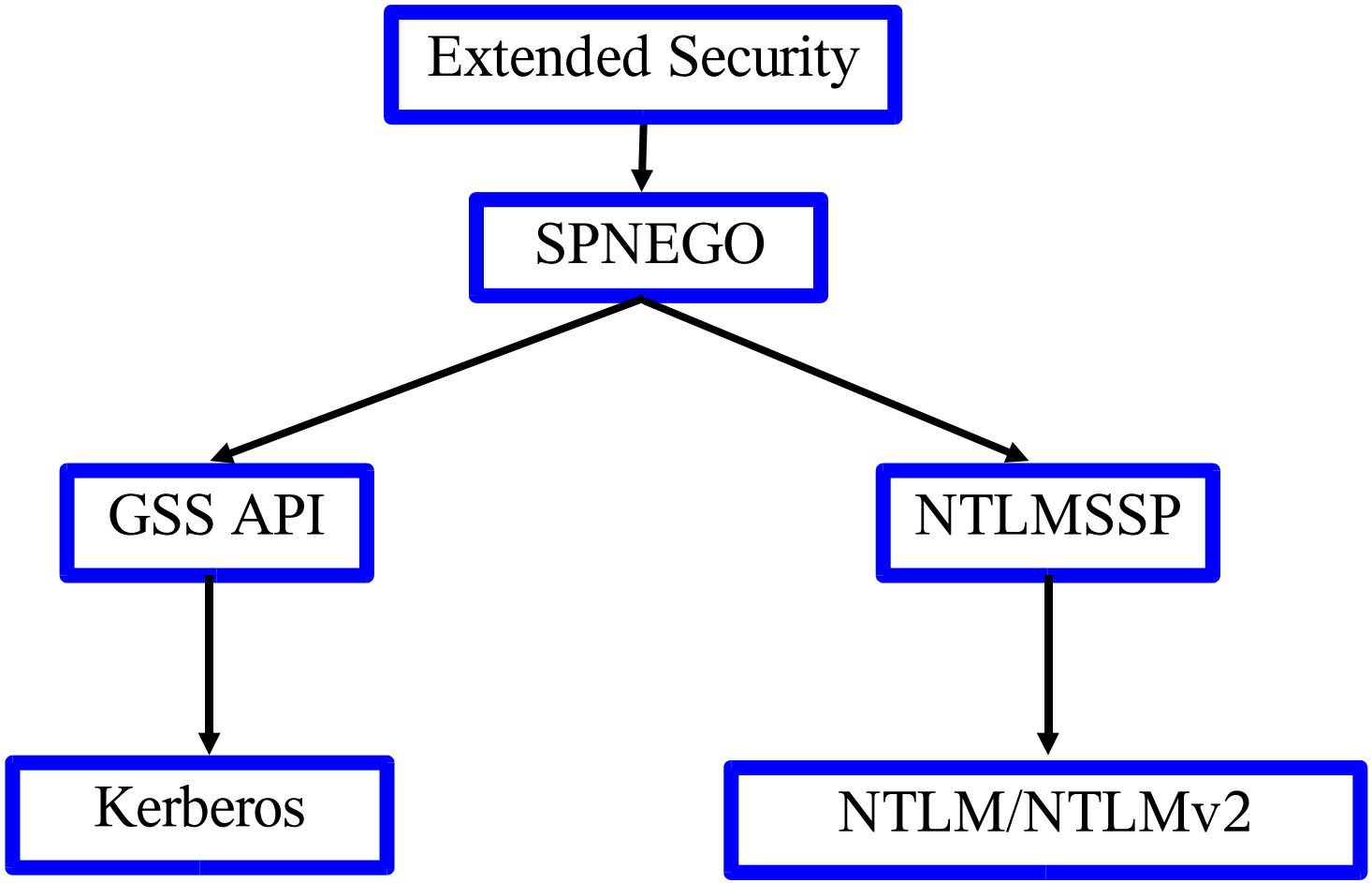
Server
"BAR"

Request to logon to server "BAR" as user "foo".
Here is the kerberos server ticket.

Logon successful or error.

- More secure than the Microsoft proprietary NTLM and NTLMv2 protocols.
- Depends on synchronised clocks. If clocks not synchronised Windows clients silently drop back to NTLM/NTLMv2 !

How do we decide whether to use NTLM or Kerberos ?



Simple and Protected GSS-API Negotiation Mechanism

- SPNEGO (rfc2478) is a framing around GSS-API.
  - Uses the same on-the-wire protocol description (ASN.1) as GSS-API, Kerberos 5 and LDAP.
  - Designed to allow lower level selection of a security protocol (or authentication mechanism).
  - Used in SMB/CIFS to select either NTLMSSP or Kerberos.
  - Initial message contains a list of client supported protocols with optional data blob for the preferred protocol (the first one).
  - Windows (and Samba) clients appear to be the only users of SPNEGO to select any other protocol than Kerberos 5 (NTLMSSP).

GSS-API – Needless complexity ?

- GSS-API (rfc2743) is actually an API that descibes how applications can negotiate a security protocol.
  - I have only ever seen this used with kerberos 5 (rfc1964 covers how the GSS-API framing of kerberos 5 is marshalled on the wire).
- What this essentially means is that we have a stack of three protocols (SPNEGO/GSS-API/Kerberos 5) where one would have done (with an out of band mechanism).
- I'm not aware of any other multi-protocol use of SPNEGO or GSS-API.

Simple Authentication and Security Layer (SASL)

- SASL (rfc2222) is another method of selecting between different underlying security protocols (called "mechanisms" in SASL).
  - SASL mechanisms are represented by text strings (actually simple :-).
  - Each client/server protocol using SASL is responsible for passing the SASL blobs in a way specific to that protocol (many internet text-based protocols encode the blobs in base64).
  - SASL represents a framework for naming different security protocols and describing their use in a client/server protocol.
  - SASL has more than one protocol defined (unlike SPNEGO :-).

In the mouth of Madness...

- SASL is used within SMB/CIFS for LDAP lookups to Active directory servers.

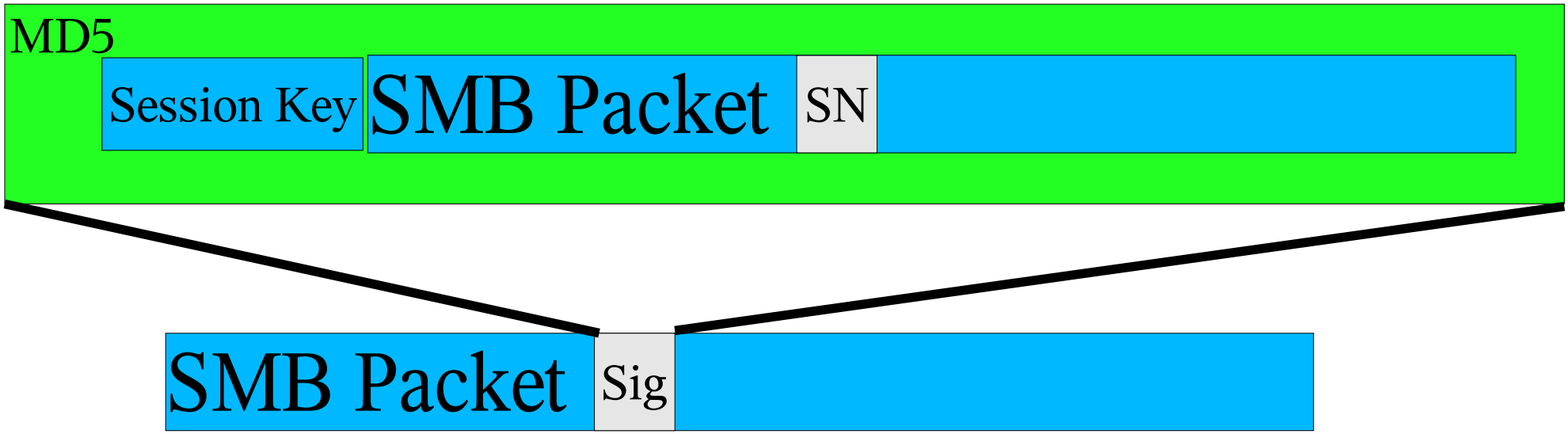
SASL can also wrap
SPNEGO
and GSS-API of
course.....

Beyond Authentication – Session Keys

- After authenticating the users long term password should not be used for any further cryptographic keys.
  - Basic security principles, don't expose passwords more than you have to.
- A random session key can be generated as part of the authentication protocols.
  - Kerberos is rather better in that the KDC generates a random session key for futher use and adds it to the ticket.
  - For NTLMSSP the session key can be one derived from the hashes in the authentication protocol (bad) or the client can propose a session key and ship it to the server encrypted by the derived session key (better maybe ?).

SMB Signing – Using session keys

- SMB signing is used to prevent TCP session hijacking of a CIFS/SMB data stream.
- It uses the previously described session key to “sign” each SMB/CIFS message, using an incrementing sequence number synchronised between client and server.
- The MD5 signature replaces the sequence number in the packet sent on the wire.



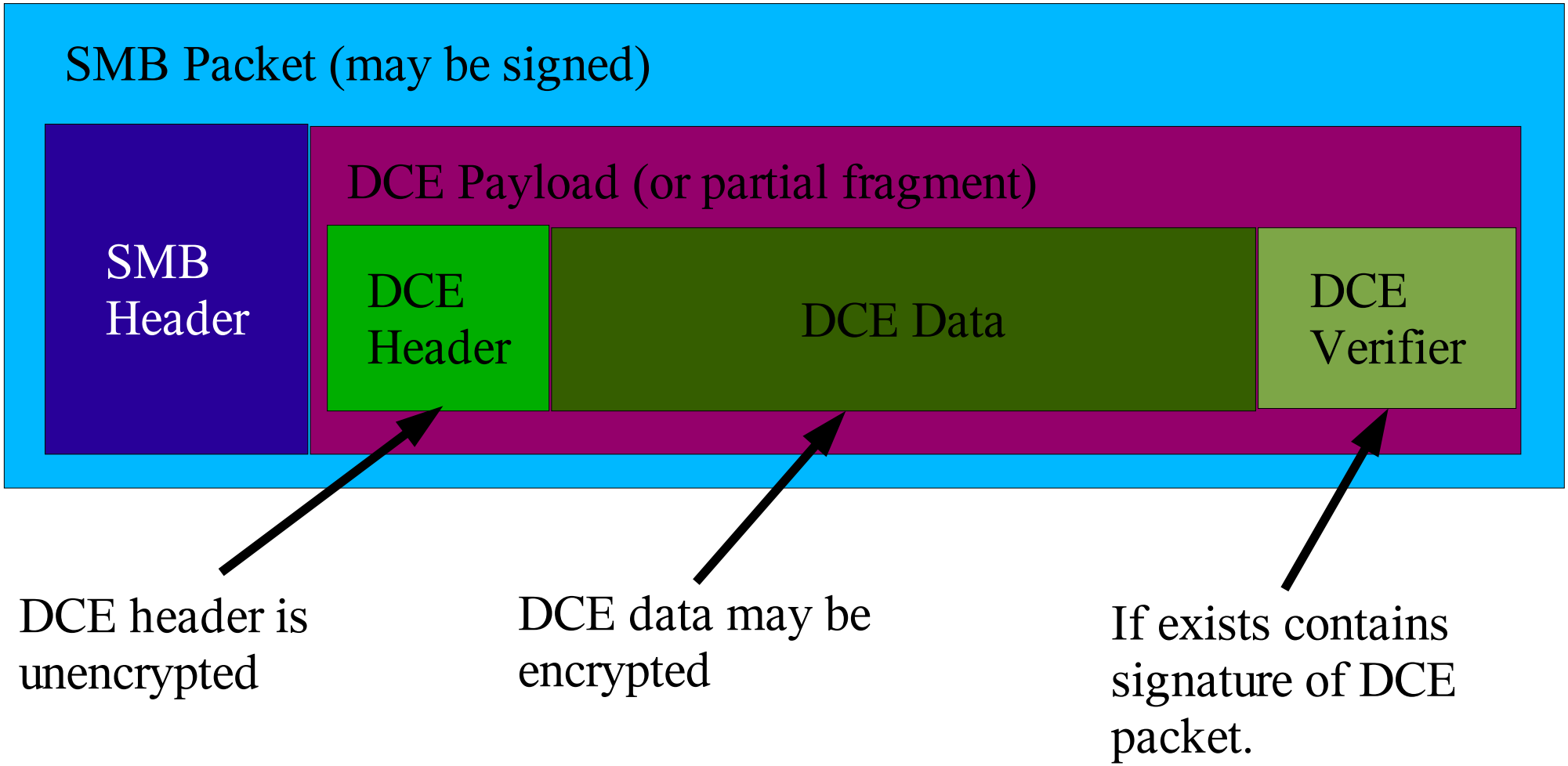
SMB Signing Problems

- The above sounds simple enough to implement from the description (like most Microsoft “documentation”).
- It doesn't take into account asynchronous messages from server to client like oplock breaks.
- It also doesn't document how to cope with partial message fragments (SMBtrans calls).
  - Turns out the sequence number must remain constant over each part of the streamed message.
- Getting this right is non-trivial. Microsoft currently is battling a “data corruption when SMB signing is turned on” bug reported into the press by a disgruntled Windows software vendor.

DCE/RPC Security with Windows Clients

- Windows RPC protocol (DCE) can be transported over “raw” TCP or layered over SMB packets (via end-points called “named pipes” such as \\PIPE\SPOOLSS).
- DCE/RPC can negotiate security on a connection and has protocol specifications for adding packet “signing” (like SMB signing) and packet “sealing” (bulk encryption).
- Microsoft don't use the published DCE security mechanism but instead used NTLMSSP and now Kerberos 5.
- An unauthenticated (guest) SMB connection can then bootstrap itself into an authenticated pipe connection by using DCE/RPC security negotiation.

DCE/RPC Encapsulation in SMB



Microsoft SChannel

- SChannel is used to secure Windows Domain Controller to Domain controller communications.
  - Could be used as a generic Microsoft DCE/RPC encryption mechanism.
- Uses signing and sealing with an incrementing sequence number as part of the signing check.
- Probably only Samba needs to worry about this protocol, I doubt it will bleed out into the generic security protocol community.

Conclusions

- NTLMSSP is widely used by Microsoft clients as a SASL negotiated mechanism.
  - Web browsers, mail clients and others will use this if available.
  - Kerberos 5 support is useful but not yet enough to provide secure single sign-on in all circumstances.
  - Open Source/Free Software projects need to be able to cope with NTLMSSP protocols.
  - Samba can help here, with the ntlm_auth helper used by squid and other projects.
  - Unfortunately this means setting up Samba correctly :-).

Questions and Comments ?

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Opening Windows to a Wider World