

Improving DCERPC Security

https://wiki.samba.org/index.php/DCERPC_Hardening

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<https://samba.org/~metze/presentations/2016/SDC/>

Agenda

- ▶ The badlock related bugs
- ▶ Scope of the urgent changes
- ▶ What is DCERPC?
- ▶ Existing Hardening
- ▶ Remaining Problems
- ▶ Proposed Solutions
- ▶ Summary/Status
- ▶ Questions?

- ▶ I gave a talk about Badlock and the related bugs at SambaXP 2016
 - ▶ <https://samba.org/~metze/presentations/2016/SambaXP/>
 - ▶ <https://sambaxp.org>
 - ▶ <http://badlock.org>
- ▶ I just give a short overview here...

CVE-2015-5370: Multiple errors in DCE-RPC code

- ▶ The first denial of service problem was found at an interop event by Jouni Knuutinen from Synopsys
- ▶ Jeremy Allison did the initial research
- ▶ While reviewing the initial patches the nightmare begun
- ▶ I found new problems day after day
- ▶ About 20 problem classes (mostly denial of service and man in the middle)
- ▶ Distributed over 4 DCERPC implementations (2 servers, 2 clients)
- ▶ I analysed these problems deeply together with Günther Deschner
- ▶ At the end I had 94 patches including an almost complete DCERPC protocol verification testsuite

CVE-2016-2118: Badlock (Part 1)

- ▶ While thinking about the CVE-2015-5370 patches I thought about possible related problems
- ▶ After a while I found that the DCERPC auth_level can be downgraded and nasty things can be done with it
- ▶ My first finding was limited to clients using ncacn_ip_tcp with SAMR
- ▶ I created a man in the middle exploit that got the full AD database including all secret keys while joining a Windows DC into a Windows domain
- ▶ NOTE THIS IS A FULL TAKEOVER: information leak and remote code execution on all domain member computers (maybe also in trusted domains)
- ▶ The attacker only needs to be able to intercept network traffic
- ▶ I guess it's really not that unlikely that someone might find exploits for an unpatched router firmware

CVE-2016-2118: Badlock (Part 2)

- ▶ After thinking a bit more I finally realized that the problem is even worse
- ▶ It is not limited to a join of a new Windows DC
- ▶ Every login as an administrator can be used by an attacker
- ▶ It is not limited to just Windows domains, also Samba domains are affected
- ▶ The problem is a generic to DCERPC over unprotected transports like ncacn_ip_tcp or ncacn_np (without SMB signing)
- ▶ Some application layer protocols (e.g. DRSUAPI) only allow secure connections using integrity or privacy protection
- ▶ Samba was missing most of these checks which were already available on Windows

CVE-2016-2110: NTLMSSP problems

- ▶ While working on CVE-2015-5370 and CVE-2016-2118 I thought a complete audit of all protocols was required
- ▶ After a while I found that NTLMSSP flags, e.g. NTLMSSP_SIGN/SEAL can be removed by a man in the middle without noticing
- ▶ This has implications on encrypted LDAP traffic
- ▶ A bit of research revealed that Microsoft already implemented downgrade detection into NTLMSSP when using NTLMv2
- ▶ I decided to implement the same in Samba in order to improve NTLMSSP authenticated connections

CVE-2016-2111: NETLOGON problems

- ▶ While researching about CVE-2016-2110 I found Microsofts CVE-2015-0005 "NETLOGON Spoofing Vulnerability"
- ▶ The problem with this was that any domain member was able to ask the domain controller for NTLM session keys of authentication sessions of all other domain members.
- ▶ The protection mechanism relies on NTLMv2 being used only via NTLMSSP
- ▶ During the research it turned out that the problems in Samba were even worse
- ▶ Anonymous attackers could ask for the session keys
- ▶ raw NTLMv2 was allowed without NTLMSSP wrapping, which allowed downgrade attacks

- ▶ Fixing the specific NTLMSSP based problems of CVE-2016-2110 is not enough
- ▶ The LDAP client and server also need to verify if the authentication (gensec/gssapi) backend negotiated the requested features
- ▶ This is required in order to prevent Kerberos replay attacks
- ▶ It was required to fix these things in the LDAP server as well as in our two LDAP client libraries
- ▶ At the same time we improved the consistency of behaviors especially regarding the usage of configuration options
- ▶ The default behavior of the LDAP server is much stricter than before

CVE-2016-2113: Missing TLS certificate validation

- ▶ While analyzing CVE-2016-2110 and CVE-2016-2112, I realized that we don't do any certificate validation
- ▶ This applies to all TLS based protocols like ldaps:// and ncacln.http with https://
- ▶ For ldaps:// it only applies to tools like samba-tool, ldbsearch, ldbedit and other ldb tools
- ▶ Typically, these protocols are not used, but if someone does use them they are expected to be protected
- ▶ So (as a client) we now verify the server certificates as much as we can

CVE-2016-2114: "server signing = mandatory" not enforced

- ▶ While working on CVE-2015-5370 and CVE-2016-2118 I thought a complete audit of all protocols was required
- ▶ As all unprotected DCERPC transports are vulnerable to man in the middle attacks it was clear that SMB signing is important
- ▶ It turned out that we didn't require SMB signing even if we are configured with mandatory signing
- ▶ This is fixed now
- ▶ As an active directory domain controller we require signing by default now

CVE-2015-2115: SMB IPC traffic is not integrity protected

- ▶ While working on CVE-2015-5370 and CVE-2016-2118 I thought a complete audit of all protocols was required
- ▶ As all unprotected DCERPC transports are vulnerable to man in the middle attacks it was clear that SMB signing is important
- ▶ We can't change the default of "client signing" and "client max protocol" in a security release, because of performance reasons
- ▶ We try to use SMB3 and required signing for IPC\$ related SMB client connections, which are used as a DCERPC transport

Scope of the urgent changes

- ▶ In order to prevent the man in the middle attacks it was required to change the (default) behavior for some protocols.
- ▶ As the Samba Team we only have resources to provide security fixes for 3 maintained branches (at the time 4.4, 4.3 and 4.2)
 - ▶ 4.4.2 had 323 patches on top of 4.4.0 (note that 4.4.1 had a regression and was superseded by 4.4.2)
 - ▶ samba-4.4.0-security-2016-04-12-final.patch
227 files changed, 14582 insertions(+), 5037 deletions(-)
 - ▶ 4.3.8 had 352 patches on top of 4.3.6 (note that 4.3.7 had a regression and was superseded by 4.3.8)
 - ▶ samba-4.3.6-security-2016-04-12-final.patch
236 files changed, 14870 insertions(+), 5195 deletions(-)
 - ▶ 4.2.11 had 440 patches on top of 4.2.9 (note that 4.2.10 had a regression and was superseded by 4.2.11)
 - ▶ samba-4.2.9-security-2016-04-12-final.patch
319 files changed, 17636 insertions(+), 7506 deletions(-)

What is DCE-RPC?

- ▶ Distributed Computing Environment / Remote Procedure Calls
 - ▶ It is an infrastructure to call a function on a remote server
 - ▶ "remote" is connected via some kind of socket (tcp/ip, named pipes, ...)
- ▶ As development environment
 - ▶ Function stubs are typically autogenerated from an Interface Definition Language (IDL)
- ▶ As network protocol defines how:
 - ▶ marshalling of payloads work - transfer syntax (NDR/NDR64)
 - ▶ marshalling of PDUs
 - ▶ PDUs are ordered
 - ▶ authentication and encryption works
- ▶ My talk from 2014 has much more details
 - ▶ <https://samba.org/~metze/presentations/2014/>

```
▼ Distributed Computing Environment / Remote Procedure Call (DCE/RPC) Bind, Fragment:
  Version: 5
  Version (minor): 0
  Packet type: Bind (11)
  ▶ Packet Flags: 0x07
  ▶ Data Representation: 10000000 (Order: Little-endian, Char: ASCII, Float: IEEE)
  Frag Length: 198
  Auth Length: 74
  Call ID: 1
  Max Xmit Frag: 5840
  Max Recv Frag: 5840
  Assoc Group: 0x00000000
  Num Ctx Items: 2
  ▶ Ctx Item[1]: Context ID:0, LSARPC, 32bit NDR
  ▶ Ctx Item[2]: Context ID:1, LSARPC, Bind Time Feature Negotiation
  ▼ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)
    Auth type: SPNEGO (9)
    Auth level: Packet integrity (5)
    Auth pad len: 0
    Auth Rsvrd: 0
    Auth Context ID: 1
  ▶ GSS-API Generic Security Service Application Program Interface
```

Existing DCERPC Hardening (PFC_SUPPORT_HEADER_SIGN)

- ▶ GSS-API based authentication is used
 - ▶ NTLMSSP, KRB5, SPNEGO
 - ▶ A custom security provider for the NETLOGON service
 - ▶ `gss_wrap.iov()` is required to support header signing
- ▶ MS-RPCE 2.2.2.3 PFC_SUPPORT_HEADER_SIGN Flag.
 - ▶ Same value as PFC_PENDING_CANCEL
 - ▶ This flag can be negotiated in the Bind/BindAck exchange
 - ▶ On Windows and modern Samba installations all security providers support it.
 - ▶ It protects the header fields of DCERPC Request/Response PDUs incl. the `sec_trailer`.


```
Version: 5
Version (minor): 0
Packet type: Bind (11)
▼ Packet Flags: 0x07
  0... .. = Object: Not set
  .0.. .. = Maybe: Not set
  ..0. .. = Did Not Execute: Not set
  ...0 ... = Multiplex: Not set
  .... 0... = Reserved: Not set
  .... 1.. = Cancel Pending: Set PFC_SUPPORT_HEADER_SIGN
  .... ..1 = Last Frag: Set
  .... ...1 = First Frag: Set
▶ Data Representation: 10000000 (Order: Little-endian, Char: ASCII, Float: IEEE)
  Frag Length: 198
  Auth Length: 74
  Call ID: 1
  Max Xmit Frag: 5840
  Max Recv Frag: 5840
  Assoc Group: 0x00000c58
  Num Ctx Items: 2
▶ Ctx Item[1]: Context ID:0, LSARPC, 32bit NDR
▶ Ctx Item[2]: Context ID:1, LSARPC, Bind Time Feature Negotiation
```

Existing DCERPC hardening (Verification Trailer)

- ▶ MS-RPCE 2.2.2.13 Verification Trailer
 - ▶ A hidden structure injected at the end of the DCERPC Request stub data
 - ▶ Identified by a 8 byte magic value (0x8a, 0xe3, 0x13, 0x71, 0x02, 0xf4, 0x36, 0x71)
 - ▶ It contains an array of optional command structures
- ▶ rpc_sec_vt_bitmask protects the PFC_SUPPORT_HEADER_SIGN negotiation
- ▶ rpc_sec_vt_header2 protects the header fields if PFC_SUPPORT_HEADER_SIGN is not available
- ▶ rpc_sec_vt_pcontext protects the negotiation of the presentation context (Interfaceld/TransferSyntax)

- ▼ Distributed Computing Environment / Remote Procedure Call (DCE/RPC) Request, Fragment:
 - Version: 5
 - Version (minor): 0
 - Packet type: Request (0)
 - ▶ Packet Flags: 0x03
 - ▶ Data Representation: 10000000 (Order: Little-endian, Char: ASCII, Float: IEEE)
 - Frag Length: 240
 - Auth Length: 16
 - Call ID: 2
 - Alloc hint: 188
 - Context ID: 0
 - Opnum: 6
 - [\[Response in frame: 66\]](#)
- ▼ Complete stub data (188 bytes)
 - Payload stub data (44 bytes)
 - ▶ Verification Trailer
 - ▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)
- ▶ Local Security Authority, Lsa_OpenPolicy

Wireshark DCERPC Verification Trailer

- ▼ Complete stub data (104 bytes)
 - Payload stub data (44 bytes)
 - ▼ Verification Trailer
 - SEC_VT_SIGNATURE: 8ae3137102f43671
 - ▼ Command: BITMASK_1
 - ▶ Command: 0x0001, Cmd: BITMASK_1
 - Length: 4
 - ▶ rpc_sec_vt_bitmask: 0x00000001, CLIENT_SUPPORT_HEADER_SIGNING
 - ▼ Command: PCONTEXT, END
 - ▶ Command: 0x4002, Cmd: PCONTEXT, SEC_VT_COMMAND_END
 - Length: 40
 - ▼ pcontext
 - Abstract Syntax: LSARPC
 - Version: 0x00000000
 - Transfer Syntax: 32bit NDR
 - Version: 0x00000002

- ▶ MS-RPCE 2.2.2.14 BindTimeFeatureNegotiationBitmask
 - ▶ A way to negotiate new features
- ▶ Current defined features:
 - ▶ SecurityContextMultiplexingSupported
 - ▶ KeepConnectionOnOrphanSupported

Wireshark DCERPC Bind Time Features (BIND)

- ▶ Ctx Item[1]: Context ID:0, LSARPC, 32bit NDR
- ▼ Ctx Item[2]: Context ID:1, LSARPC, Bind Time Feature Negotiation
 - Context ID: 1
 - Num Trans Items: 1
 - ▶ Abstract Syntax: LSARPC V0.0
 - ▼ Transfer Syntax[1]: Bind Time Feature Negotiation V1
 - Transfer Syntax: Bind Time Feature Negotiation UUID:6cb71c2c-9812-4540-0300-000000000000
 - ▶ Bind Time Features: 0x0003, Security Context Multiplexing Supported, Keep Connection On Orphan Supported
 - ver: 1

- ▼ Ctx Item[1]: Acceptance, 32bit NDR
 - Ack result: Acceptance (0)
 - Transfer Syntax: 32bit NDR
 - Syntax ver: 2
- ▼ Ctx Item[2]: Negotiate ACK, NULL
 - Ack result: Negotiate ACK (3)
 - ▶ Bind Time Features: 0x0003, Security Context Multiplexing Supported, Keep Connection On Orphan Supported
 - Transfer Syntax: NULL
 - Syntax ver: 0

Design problems of current DCERPC implementations

- ▶ DCERPC Fault, Cancel and Orphan PDUs don't include any integrity nor privacy protection.
- ▶ DCERPC_NCA_S_OP_RNG_ERROR is typically used to indicate that a specific opnum is not implemented by the server
- ▶ DCERPC_NCA_S_FAULT_INVALID_TAG is typically used to indicate that a specific information level is not supported
- ▶ There are higher level protection against downgrades required.
- ▶ The most important protocols don't have known downgrade problems.
- ▶ But it would be good to have real protection at the DCERPC layer.

- ▶ SMB 3.x has support for generic encryption and downgrade detection
 - ▶ It wraps SMB 2/3 PDUs inside an SMB2 TRANSFORM_HEADER PDU.
 - ▶ FSCTL_VALIDATE_NEGOTIATE_INFO was a nice try, but does not protect everything.
- ▶ SMB 3.1.1 has finally a working downgrade protection
 - ▶ A SHA512 preauth hash is calculated over the Negotiate and SessionSetup PDUs.
- ▶ BindTimeFeatureNegotiation and Verification Trailer should be able to build a backward compatible solution for DCERPC.
 - ▶ DCERPC_BIND_TIME_SUPPORT_PREAUTH
 - ▶ DCERPC_BIND_TIME_PROTECT_ALL_PDUS
 - ▶ DCERPC_BIND_TIME_SUPPORT_WRAP

DCERPC_BIND_TIME_SUPPORT_PREAUTH

- ▶ DCERPC_BIND_TIME_SUPPORT_PREAUTH is negotiated in the Bind/BindAck exchange.
 - ▶ The DCERPC_BIND_ACK_RESULT_NEGOTIATE_ACK element is filled with a random transfer_syntax value as salt (16 bytes).
- ▶ All DCERPC Bind, BindAck, AlterContext, AlterContextResp and Auth3 PDUs update a rolling preauth hash.
 - ▶ These are triggered by the client and are strictly ordered.
 - ▶ Client and Server start with a zero preauth hash.
 - ▶ The preauth hash is updated when sending or receiving an unprotected PDU.
 - ▶ $\text{PREAUTH_SHA512} = \text{SHA512}(\text{PREAUTH_SHA512}, \text{PDU})$.
- ▶ DCERPC_SEC_VT_COMMAND_PREAUTH is added to the verification trailer of the first request.
 - ▶ DCERPC_SEC_VT_COMMAND_PREAUTH contains a 16 byte SALT.
 - ▶ It also contains the result of $\text{SHA512}(\text{PREAUTH_SHA512} + \text{SALT})$.

Wireshark DCERPC Bind Time Features (PREAUTH Bind)

```
Num Ctx Items: 2
▶ Ctx Item[1]: Context ID:0, LSARPC, 32bit NDR
▼ Ctx Item[2]: Context ID:1, LSARPC, Bind Time Feature Negotiation
  Context ID: 1
  Num Trans Items: 1
  ▶ Abstract Syntax: LSARPC V0.0
  ▼ Transfer Syntax[1]: Bind Time Feature Negotiation V1
    Transfer Syntax: Bind Time Feature Negotiation UUID:6cb71c2c-9812-4540-0700-000000000000
    ▼ Bind Time Features: 0x0007,
      .... = Security Context Multiplexing Supported: True
      .... = Keep Connection On Orphan Supported: True
      .... = Support SHA512 PREAUTH Verification: True
      .... = Support protection of all PDUs: False
    ver: 1
  ▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)
```

Wireshark DCERPC Bind Time Features (PREAUTH Ack)

```
Num results: 2
▼ Ctx Item[1]: Acceptance, 32bit NDR
  Ack result: Acceptance (0)
  Transfer Syntax: 32bit NDR
  Syntax ver: 2
▼ Ctx Item[2]: Negotiate ACK, ad6a9956-cce7-45d2-801a-ca2d0d3c4216
  Ack result: Negotiate ACK (3)
  ▼ Bind Time Features: 0x0004, Support SHA512 PREAUTH Verification
    .... = Security Context Multiplexing Supported: False
    .... = Keep Connection On Orphan Supported: False
    .... = Support SHA512 PREAUTH Verification: True
    .... = Support protection of all PDUs: False
  Transfer Syntax: ad6a9956-cce7-45d2-801a-ca2d0d3c4216
  Syntax ver: 0
  ▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)
```

- ▼ Complete stub data (188 bytes)
 - Payload stub data (44 bytes)
- ▼ Verification Trailer
 - SEC_VT_SIGNATURE: 8ae3137102f43671
 - ▶ Command: BITMASK_1
 - ▶ Command: PCONTEXT
 - ▼ Command: PREAUTH, END
 - ▶ Command: 0x4004, Cmd: PREAUTH, SEC_VT_COMMAND_END
 - Length: 80
 - ▼ preauth
 - Salt: 5cf16b4a22602a6c10fd7678de2c235f
 - SHA512 Hash: 96a9bd8be3572ade794b5cad6e4371dc23d87296f1f5c2c9...

Wireshark DCERPC Bind Time Features (PROTECT_ALL_PDUs Bind)

- Num Ctx Items: 2
- ▶ Ctx Item[1]: Context ID:0, LSARPC, 32bit NDR
- ▼ Ctx Item[2]: Context ID:1, LSARPC, Bind Time Feature Negotiation
 - Context ID: 1
 - Num Trans Items: 1
 - ▶ Abstract Syntax: LSARPC V0.0
 - ▼ Transfer Syntax[1]: Bind Time Feature Negotiation V1
 - Transfer Syntax: Bind Time Feature Negotiation UUID:6cb71c2c-9812-4540-0f00-000000000000
 - ▼ Bind Time Features: 0x000f,
 -1 = Security Context Multiplexing Supported: True
 -1. = Keep Connection On Orphan Supported: True
 -1.. = Support SHA512 PREAUTH Verification: True
 -1... = Support protection of all PDUs: True
 - ver: 1
 - ▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)

Wireshark DCERPC Bind Time Features (PROTECT_ALL_PDUs Ack)

```
Num results: 2
▼ Ctx Item[1]: Acceptance, 32bit NDR
  Ack result: Acceptance (0)
  Transfer Syntax: 32bit NDR
  Syntax ver: 2
▼ Ctx Item[2]: Negotiate ACK, d38da7fa-a8a8-4ee8-9069-f840f6752401
  Ack result: Negotiate ACK (3)
  ▼ Bind Time Features: 0x000c, Support SHA512 PREAUTH Verification, Support protection of all PDUs
    .... ..0 = Security Context Multiplexing Supported: False
    .... ..0 = Keep Connection On Orphan Supported: False
    .... ..1 = Support SHA512 PREAUTH Verification: True
    .... ..1 = Support protection of all PDUs: True
  Transfer Syntax: d38da7fa-a8a8-4ee8-9069-f840f6752401
  Syntax ver: 0
▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)
```

Wireshark DCERPC Fault PDU

```
▼ Distributed Computing Environment / Remote Procedure Call (DCE/RPC) Fault, Fragment:
  Version: 5
  Version (minor): 0
  Packet type: Fault (3)
  ▶ Packet Flags: 0x03
  ▶ Data Representation: 10000000 (Order: Little-endian, Char: ASCII, Float: IEEE)
  Frag Length: 32
  Auth Length: 0
  Call ID: 2
  Alloc hint: 32
  Context ID: 0
  Cancel count: 0
  ▶ Fault flags: 0x00
  ▶ Status: nca_s_fault_access_denied (0x00000005)
  Reserved: 00000000
  [Opnum: 6]
  [Request in frame: 65]
  [Time from request: 0.000296000 seconds]
  Fault stub data (0 bytes)
```


- ▼ Distributed Computing Environment / Remote Procedure Call (DCE/RPC) Fault, Fragment:
 - Version: 5
 - Version (minor): 0
 - Packet type: Fault (3)
 - ▶ Packet Flags: 0x03
 - ▶ Data Representation: 10000000 (Order: Little-endian, Char: ASCII, Float: IEEE)
 - Frag Length: 68
 - Auth Length: 28
 - Call ID: 2
 - Alloc hint: 24
 - Context ID: 0
 - Cancel count: 0
 - ▶ Fault flags: 0x00
 - ▶ Status: nca_s_fault_access_denied (0x00000005)
 - Reserved: 00000000
 - [Opnum: 45]
 - [\[Request in frame: 55\]](#)
 - [Time from request: 0.002011000 seconds]
 - Fault stub data (0 bytes)
 - ▶ Auth Info: SPNEGO, Packet integrity, AuthContextId(1)

IDL definition the DCERPC (ncacn) PDU

The ncacn pdu IDL description in Samba:

```
typedef [public] struct {
    uint8 rpc_vers;           /* RPC version */
    uint8 rpc_vers_minor;    /* Minor version */
    dcerpc_pkt_type ptype;    /* Packet type */
    dcerpc_pfc_flags pfc_flags; /* Fragmentation flags */
    uint8 drep[4];           /* NDR data representation */
    uint16 frag_length;      /* Total length of fragment */
    uint16 auth_length;      /* authenticator length */
    uint32 call_id;          /* Call identifier */
    [switch_is(ptype)] dcerpc_payload u;
} ncacn_packet;
```

IDL definition of the Payload union

The ncacn payload desription union:

```
typedef [nodiscard] union {
    [case(DCERPC_PKT_REQUEST)] dcerpc_request request;
    [case(DCERPC_PKT_RESPONSE)] dcerpc_response response;
    [case(DCERPC_PKT_FAULT)] dcerpc_fault fault;
    [case(DCERPC_PKT_BIND)] dcerpc_bind bind;
    [case(DCERPC_PKT_BIND_ACK)] dcerpc_bind_ack bind_ack;
    [case(DCERPC_PKT_BIND_NAK)] dcerpc_bind_nak bind_nak;
    [case(DCERPC_PKT_ALTER)] dcerpc_bind alter;
    [case(DCERPC_PKT_ALTER_RESP)] dcerpc_bind_ack alter_resp;
    [case(DCERPC_PKT_SHUTDOWN)] dcerpc_shutdown shutdown;
    [case(DCERPC_PKT_CO_CANCEL)] dcerpc_co_cancel co_cancel;
    [case(DCERPC_PKT_ORPHANED)] dcerpc_orphaned orphaned;
    [case(DCERPC_PKT_AUTH3)] dcerpc_auth3 auth3;
    [case(DCERPC_PKT_RTS)] dcerpc_rts rts;
    /* WRAP packets used to improve privacy */
    [case(DCERPC_PKT_WRAP)] dcerpc_wrap wrap;
} dcerpc_payload;
```

dcerpc_wrap (work in progress) definition

The IDL function definition (in Samba):

```
typedef [public] struct {
    //TODO/DISCUSS:
    // - add random confounder at the beginning
    // - add explicit verification traller
    // - allow extra preauth hash check PDU
    // - callid random?
    // - flags?
    // - How to detect downgrades on the client
    //   without breaking against old servers

    /* this contains the real ncacn_packet blob and the auth verifier */
    [flag(NDR_REMAINING)] DATA_BLOB pdu_and_verifier;
} dcerpc_wrap;
```

- ▶ The specific numbers for flags and types need to be agreed on
 - ▶ It would be good if Microsoft could assign them in MS-RPCE
 - ▶ Are other vendors also interested to implement (at least parts of) this?
- ▶ Bind Time Features:
 - ▶ DCERPC_BIND_TIME_SUPPORT_PREAUTH = 0x0004
 - ▶ DCERPC_BIND_TIME_PROTECT_ALL_PDUS = 0x0008
 - ▶ DCERPC_BIND_TIME_SUPPORT_WRAP = 0x0010
- ▶ Verification Trailer Command:
 - ▶ DCERPC_SEC_VT_COMMAND_PREAUTH = 0x0004
- ▶ PDU Type:
 - ▶ DCERPC_PKT_WRAP = 21

New DCERPC testing infrastructure

- ▶ Low-level protocol testing
 - ▶ python/samba/tests/dcerpc/raw_protocol.py
 - ▶ This uses our python bindings to marshal PDUs and use raw sockets
 - ▶ This becomes a full DCERPC testsuite exploring almost each bit in the protocol
 - ▶ Windows 2012R2 is the current reference implementation
 - ▶ Samba as AD DC also passes
 - ▶ Currently 75 tests in master and 50 more waiting for review

Calling the raw protocol testsuite (in a Samba source tree):

```
$ export SMB_CONF_PATH=/dev/null
$ export SERVER=w2012r2-188.w2012r2-16.base
$ export USERNAME=administrator
$ export PASSWORD=A1b2C3d4
$ python/samba/tests/dcerpc/raw_protocol.py -v -f TestDCERPC_BIND
```

Application level problems (LSA and SAMR)

- ▶ Some LSA and SAMR functions use an SMB application session key
 - ▶ This implies that they only work on ncacn_np
 - ▶ They can't use DCERPC level authentication (integrity/privacy)
 - ▶ They rely on SMB signing/encryption
- ▶ There're used to be a wellknown transport session key for authenticated DCERPC
 - ▶ It was the constant "SystemLibraryDTC"
 - ▶ All recent versions of Samba and Windows return NT_STATUS_NO_USER_SESSION_KEY instead
 - ▶ DCERPC_AUTH_LEVEL_CONNECT is not supported anymore
- ▶ `samr_Connect5()` and `lsa_OpenPolicy2()` can be used to negotiate a new behaviour
 - ▶ It's possible to avoid application level encryption
 - ▶ It could rely on DCERPC_AUTH_LEVEL_PRIVACY
 - ▶ I need to continue the discussion with Microsoft about that

Summary/Status

- ▶ DCERPC_BIND_TIME_SUPPORT_PREAUTH
 - ▶ The code is ready to be merged in to Samba master
 - ▶ Just needs some more tests
- ▶ DCERPC_BIND_TIME_PROTECT_ALL_PDUS
 - ▶ The code is ready to be merged in to Samba master
 - ▶ Just needs some more tests
- ▶ DCERPC_BIND_TIME_SUPPORT_WRAP
 - ▶ Needs a bit more thinking to get the design robust
 - ▶ There's some work in progress prototype
- ▶ The LSA and SAMR improvements
 - ▶ They need more discussion

https://wiki.samba.org/index.php/DCERPC_Hardening

- ▶ Please contact me if you're a vendor and are interested in implementing this in your product.
- ▶ Stefan Metzmacher, metze@samba.org
- ▶ <http://www.sernet.com>

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