Trusted Domain Support

as Active Directory Domain Controller

Stefan Metzmacher <metze@samba.org>

Samba Team / SerNet

2018-06-07

https://samba.org/~metze/presentations/2018/SambaXP/
Talks at SambaXP/SDC 2017

- Last year I gave talks about concepts and details of trusted domains
- ”The Important Details Of Windows Authentication” at SambaXP.
  https://samba.org/~metze/presentations/2017/SambaXP/
- ”Windows Authentication With Multiple Domains and Forests” at Storage Developer Conference.
  https://samba.org/~metze/presentations/2017/SDC/
Topics

- The long road to trust support (4.3.0, 4.7.0, 4.8.0, master)
- `samba-tool` domain trust commands
- `wbinfo -m -verbose` changes
- Automatic creation of foreignSecurityPrincipal objects
- Implementing SID expanding/filtering
- Forest/Domain-wide Authentication
- Selective Authentication (Cross Organization Trusts)
- Future Improvements/Open Bugs
- Questions?
The long road to trust support (Part 1, before 4.3.0)

- It started with a Red Hat project to support Forest Trusts to FreeIPA:
  - Red Hat sponsored my work (via SerNet)
  - The initial target was only Kerberos
  - NTLMSSP was not required and got deferred

- Preparation work:
  - The Windows GUI should be able to create/manage trusts
  - It was required to fix/implement several LSA and Netlogon RPC calls
  - The most challenging was the forest information conflict detection

- Our own tools:
  - `samba-tool domain trust *` commands were added
  - They use very similar network requests as the Windows GUI
  - They manage trusts for the local domain by default
  - But they can also run against remote servers
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- They use very similar network requests as the Windows GUI
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dc1:~$ samba-tool domain trust help
Usage: samba-tool domain trust <subcommand>

Domain and forest trust management.

Options:
   -h, --help   show this help message and exit

Available subcommands:
create       - Create a domain or forest trust.
delete       - Delete a domain trust.
list         - List domain trusts.
namespaces   - Manage forest trust namespaces.
show         - Show trusted domain details.
validate     - Validate a domain trust.

For more help on a specific subcommand, please type: samba-tool domain trust <subcommand> (-h|--help)
The long road to trust support (Part2, before 4.3.0)

- We added code to manage and use a trust routing table:
  - Utility (dsdb_trust_*) functions made it easier for high level code
  - They load the forest information of the local forest
  - They load the forest information of all trusted domain/forests
  - Some put everything together to form a routing table

- Implementing INCOMING and OUTGOING trust support for Kerberos:
  - The KDC was changed to use the routing table
  - AS-Requests may refer clients to the correct KDC with WRONG_REALM referrals
  - TGS-Requests may result in cross realm referral tickets

- Regression selftests:
  - We established trust relationships between several environments
  - It was relatively easy by using the new 'samba-tool domain trust' commands
  - The rest was done with some blackbox tests using kinit or smbclient
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Trusted Domain Support as AD DC

SerNet
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- It’s not possible to add users groups of a trusted domain into domain groups
- NTLMSSP and LSA LookupNames Sids were not implemented for outgoing trusts

There were also security limitations:

- No SID filtering rules are applied at all!
- Both sides of the trust need to fully trust each other!
- This means DCs of domain A can grant domain admin rights in domain B!

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- But it was still only be usable for some rare usecases
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  ▶ SerNet got more and more customers asking for trust support
  ▶ This was often the only reason they had to keep using Windows servers

Other customers had a lot of problems with trusts on member servers
  ▶ We knew that support for trusted domains on a member server faces very similar problems than on a domain controller

By selling the SAMBA+ subscriptions
  ▶ We had the opportunity to think about sponsoring our own projects
  ▶ So we decided to bring trust support for DCs to a level which is really useful for customers
  ▶ As a side effect we were also able to solve urgent problems on domain members
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The long road to trust support (Part4, 4.7.0 and more)

- The new ”map untrusted to domain = auto” option
  - Was introduced to improve member server setups
  - It lets the domain controllers of the primary domain do its job
  - The member server doesn’t have to know about trusted domains
  - There is just an outgoing transitive trust to the primary domain

- The ”map untrusted to domain” and ”auth methods” options
  - Got deprecated in 4.7.0 and removed in 4.8.0
  - The (new) default behaviour (as of 4.7.0) was kept for 4.8.0

- The ”winbind scan trusted domains” option
  - With ”map untrusted to domain” being removed there is no need to
    have a list of trusted domain available in winbindd
  - We no longer try to list all trusted domain recursively
  - The option was added in 4.8.0, but the default is still ”yes”
  - But the old (default) is only required for domain specific idmap
    backend configurations
  - As domain controller the behaviour is hardcoded to ”no”
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The long road to trust support (Part 5, 4.7.0 and more)

- The most challenging task was a rewrite of gensec processing
  - Async authentication is required for trusted domains
  - The complexity of spnego.c relied on recursing into the sync `gensec_update()` implementation

- It took a while to create a patchset for upstream inclusion:
  - In total 31 files changed, 3774 insertions(+), 1954 deletions(-)
  - It took about 150 (relatively small) commits to make auth/gensec fully async
  - 82 patches just for spnego.c
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The long road to trust support (Part6, 4.8.0)

- Trusted domain support requires winbindd in 4.8.0
  - On domain members the primary domain is also a trusted domain
  - The AD DC already required and used winbindd internally

- winbindd loads the full domain topology as AD DC
  - We also load all domains of forest trusts
  - Internally we remember a "routing domain" for transitive trusts
  - Only uses NETLOGON and LSA with Netlogon Secure Channel
  - Only anonymous DCERPC transports (tcp or unauthenticated smb)
  - No NTLMSSP, no Kerberos!
  - No SAMR, no LDAP!

- LookupNames and LookupSids are routed via winbindd as AD DC
  - There are various scopes for LookupNames/Sids
  - Predefined, Builtin, Account Domain, Trusts
  - We use abstracted view tables for this
  - At the end winbindd is the last resort routing
  - Samba member servers can make use of the trust now
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Admin visible changes in 4.8.0 (Part1)

- Previously "wbinfo -m –verbose" produced confusing results
  - It mixed the views recursively of all reachable domains
  - The trust types and directions don’t match the view of the local system

- This changed to be more useful in 4.8.0
  - The trust properties printed have been changed to correctly reflect the view of the system where wbinfo is executed (only!)
  - This is only correct with "winbind scan trusted domains" effectively "no"
  - On a domain member trusted domains are learned on the fly if used
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Admin visible changes in 4.8.0 (Part2)

▶ Example, on a AD DC (SDOM1):

```
dc1:~$ wbinfo -m --verbose

<table>
<thead>
<tr>
<th>Domain Name</th>
<th>DNS Domain</th>
<th>Trust Type</th>
<th>Transitive</th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILTIN</td>
<td></td>
<td>Local</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDOM1</td>
<td>sdom1.site</td>
<td>RWDC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WDOM3</td>
<td>wdom3.site</td>
<td>Forest</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>WDOM2</td>
<td>wdom2.site</td>
<td>Forest</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SUBDOM31</td>
<td>subdom31.wdom3.site</td>
<td>Routed (via WDOM3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBDOM21</td>
<td>subdom21.wdom2.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

▶ Indirect (transitive) trusts are shown as ”Routed” including the routing domain.
Example, on a AD DC (SDOM1):

```bash
dc1:~$ wbinfo -m --verbose
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<thead>
<tr>
<th>Domain</th>
<th>Name</th>
<th>DNS Domain</th>
<th>Trust Type</th>
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<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILTIN</td>
<td></td>
<td>Local</td>
<td></td>
<td></td>
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<td>SDOM1</td>
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<tr>
<td>WDOM3</td>
<td>wdom3.site</td>
<td>Forest</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
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<td>WDOM2</td>
<td>wdom2.site</td>
<td>Forest</td>
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<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>SUBDOM31</td>
<td>subdom31.wdom3.site</td>
<td>Routed (via WDOM3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBDOM21</td>
<td>subdom21.wdom2.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indirect (transitive) trusts are shown as "Routed" including the routing domain.
Admin visible changes in 4.8.0 (Part3)

▶ Same setup, on a member of WDOM2:

```
member1:~$ wbinfo -m --verbose

<table>
<thead>
<tr>
<th>Domain Name</th>
<th>DNS Domain</th>
<th>Trust</th>
<th>Type</th>
<th>Transitive</th>
<th>In</th>
<th>Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUILTIN</td>
<td></td>
<td>BUILTIN</td>
<td>Workstation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>TITAN</td>
<td></td>
<td>TITAN</td>
<td>Workstation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>WDOM2</td>
<td>wdom2.site</td>
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<td>Workstation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>WDOM1</td>
<td>wdom1.site</td>
<td>WDOM1</td>
<td>Routed (via WDOM2)</td>
<td>No</td>
<td>Yes</td>
<td></td>
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<td>WDOM3</td>
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<td>sdom1.site</td>
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</tr>
<tr>
<td>SUBDOM11</td>
<td>subdom11.wdom1.site</td>
<td>SUBDOM11</td>
<td>Routed (via WDOM2)</td>
<td>No</td>
<td>Yes</td>
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▶ The list of trusts may be incomplete

▶ Additional domains may appear as "Routed" if a user of an unknown domain is successfully authenticated
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<td>TITAN</td>
<td>Local</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WDOM2</td>
<td>wdom2.site</td>
<td>Workstation</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>WDOM1</td>
<td>wdom1.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WDOM3</td>
<td>wdom3.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBDOM21</td>
<td>subdom21.wdom2.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDOM1</td>
<td>sdom1.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUBDOM11</td>
<td>subdom11.wdom1.site</td>
<td>Routed (via WDOM2)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

The list of trusts may be incomplete.

Additional domains may appear as "Routed" if a user of an unknown domain is successfully authenticated.
foreignSecurityPrincipal objects (Part 1)

- Domain local (resource) groups
  - Should be able to have users/group of trusted domains as members
  - We only support one domain in our forest (yet)
  - So we have to care about just about foreignSecurityPrincipal objects (FPO)

- The ”member” attribute
  - Requires a full extended dn of an object in the local forest
  - Is an FPO-enabled attribute (as well as msDS-MembersForAzRole, msDS-NeverRevealGroup and msDS-RevealOnDemandGroup)
  - It automatically creates an FPO if a foreign extended dn SID is added
  - E.g. ’<SID=S-1-5-21-123-456-789-512>’ or ’<SID=S-1-5-11>’ does not belong to any domain in the local forest
  - CN=S-1-5-11,CN=ForeignSecurityPrincipals,DC=example,DC=com

- samba-tool group addmembers
  - Allows members to be specified as SID-string
  - E.g. ’S-1-5-21-123-456-789-512’
  - In master, will be in 4.9.0
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foreignSecurityPrincipal objects (Part 2)

Get some details of the trust

```
dc1:~$ samba-tool domain trust list
Type[Forest] Transitive[Yes] Direction[BOTH] Name[addom.samba.example.com]
```

```
dc1:$ samba-tool domain trust show addom.samba.example.com
TrustedDomain:

NetbiosName: ADDOMAIN
DnsName: addom.samba.example.com
SID: S-1-5-21-987-654-321
Type: 0x2 (UPLEVEL)
Direction: 0x3 (BOTH)
Attributes: 0x8 (FOREST_TRANSITIVE)
PosixOffset: 0x00000000 (0)
kerb_EncTypes: 0x18 (AES128_CTS_HMAC_SHA1_96,AES256_CTS_HMAC_SHA1_96)
Namespaces[4] TDO[addom.samba.example.com]:
TLN: Status[Enabled] DNS[*.ADDOM.SAMBA.EXAMPLE.COM.upn]
TLN: Status[Enabled] DNS[*.ADDOM.SAMBA.EXAMPLE.COM.spn]
TLN: Status[Enabled] DNS[*.addom.samba.example.com]
   SID[S-1-5-21-987-654-321]
```
Get some details of the trust

```bash
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Type[Forest]   Transitive[Yes] Direction[BOTH]   Name[addom.samba.example.com]

TrustedDomain:

NetbiosName:     ADDOMAIN
DnsName:        addom.samba.example.com
SID:            S-1-5-21-987-654-321
Type:           0x2 (UPLEVEL)
Direction:      0x3 (BOTH)
Attributes:     0x8 (FOREST_TRANSITIVE)
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TLN: Status[Enabled] DNS[*addom.samba.example.com]
            SID[S-1-5-21-987-654-321]
```
foreignSecurityPrincipal objects (Part 3)

How to add 'ADDOMAIN\Domain Admins' to 'SAMBA2008R2\Domain Admins'

```
dc1:$ wbinfo --name-to-sid 'ADDOMAIN\Domain Admins'
S-1-5-21-987-654-321-512 SID_DOM_GROUP (2)
```

```
dc1:$ samba-tool group listmembers 'Domain Admins'
Administrator
```

```
dc1:$ samba-tool group addmembers 'Domain Admins' S-1-5-21-987-654-321-512
Added members to group Domain Admins
```

```
dc1:$ samba-tool group listmembers 'Domain Admins'
Administrator
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Administrator
```

```
dc1:$ samba-tool group addmembers 'Domain Admins'
S-1-5-21-987-654-321-512
Added members to group Domain Admins
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S-1-5-21-987-654-321-512
```
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```

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```

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S-1-5-21-987-654-321-512
```
SID-Expanding (Part 1)

- Domain local (resource) groups
  - Need to be expanded before using the received authorization token
  - Before expanding the BUILTIN groups for local authentication
  - Before returning netr_LogonSamLogon[{WithFlags,Ex}]( )
  - Before returning CROSS-REALM Kerberos Tickets

- We have this in authsam_update_user_info_dc( )
  - Called from source4/auth/ntlm/auth_winbind.c
  - Called from source4/kdc/pac-glue.c
  - In master, will be in 4.9.0

- Some TODOs...
  - We don’t add SE_GROUP_RESOURCE yes
  - We don’t use resource group compression for Kerberos
  - We pass resource/domain local groups via the trust
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  - We don’t add SE_GROUPRESOURCE yes 
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The fully expanded token of a authentication of a user from a trusted domain

dc1:$ ldbsearch -H ldap://dc1.samba2008r2.example.com -U ADDOMAIN\Administrator" -b "" -s base tokenGroups
# record 1
dn:
tokenGroups: S-1-5-21-987-654-321-500
tokenGroups: S-1-5-21-987-654-321-513
tokenGroups: S-1-5-21-987-654-321-512
tokenGroups: S-1-5-21-987-654-321-572
tokenGroups: S-1-5-21-987-654-321-518
tokenGroups: S-1-5-21-987-654-321-519
tokenGroups: S-1-5-21-987-654-321-520
tokenGroups: S-1-5-21-123-456-789-1109
tokenGroups: S-1-5-21-123-456-789-512
tokenGroups: S-1-5-21-123-456-789-572
tokenGroups: S-1-1-0
tokenGroups: S-1-5-2
tokenGroups: S-1-5-11
tokenGroups: S-1-5-64-10
tokenGroups: S-1-5-32-544
tokenGroups: S-1-5-32-545
tokenGroups: S-1-5-32-554

Resource / domain local groups (type 4) should not be passed, needs to be fixed!

dc1:$ wbinfo --sid-to-name S-1-5-21-987-654-321-572
ADDOMAIN\Denied RODC Password Replication Group 4
The fully expanded token of a authentication of a user from a trusted domain

```
dc1:$ ldbsearch -H ldap://dc1.samba2008r2.example.com -U"ADDOMAIN\Administrator" -b "" -s base tokenGroups
# record 1
dn:
tokenGroups: S-1-5-21-987-654-321-500
tokenGroups: S-1-5-21-987-654-321-513
tokenGroups: S-1-5-21-987-654-321-512
tokenGroups: S-1-5-21-987-654-321-572
tokenGroups: S-1-5-21-987-654-321-518
tokenGroups: S-1-5-21-987-654-321-519
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Stefan Metzmachher
SID-Filtering (Part 1)

- A trusted domain could spoof an authorization token
  - Local admin privileges could be gained
  - Very critical in case of cross organization trusts
  - See [MS-PAC] 4.1.2 Authorization Validation and Filtering

- Based on the documentation (and some further thinking)
  - I added dom_sid_filter_token_sid() and dom_sid_filter_{domain,upn}_name()
  - They operate on just one sid or name
  - They take the local domain/forest information
  - They take the used secure channel type
  - They take the remote domain/forest information

- authsam_update_user_info_dc() also filters
  - We filter SIDs as well as names using the helper functions
  - Used in source4/kdc/pac-glue.c
  - source4/auth/ntlm/auth_winbind.c can't filter, uses SEC_CHAN_BDC
  - Only winbinddd has the remote domain/forest information
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SID-Filtering (Part 2)

- Filtering in winbindd...
  - netr_LogonSamLogon[{WithFlags,Ex}]() results are filtered
  - lsa_Lookup{Sids,Names}() results are filtered
  - pdb_filter_hints() and pdb_update_validation() are added
  - pdb_samba_dsdb implements this for the AD DC
  - All non AD DC roles still get local SAM, BUILTIN protection

- Work in progress...
  - git://git.samba.org/metze/samba/wip.git
  - master3-trusts-ok
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  - Planed to be ready before 4.9.0
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Forest/Domain-wide Authentication

- Forest/Domain-wide Authentication (the default) allows:
  - Authentication of each principal of the trusted forest/domain
  - Authentication to each service in the trusting forest/domain

- Authorization is handled by:
  - Using ACLs on individual resources (objects, files, ...)
  - Access might be granted just by "Authenticated Users" ACEs

- One-way trusts:
  - Often used to limit the authentication between organizations
  - Make the use of S4U2Self impossible
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Selective Authentication (Cross Organization Trusts) (Part1)

Trusts can be marked for selective authentication:
- Using LSA_TRUST_ATTRIBUTE_CROSS_ORGANIZATION
- The trusting end adds the OTHER_ORGANIZATION_SID (S-1-5-1000) to any token
- By default authentication of trusted principals to trusting services is rejected with STATUS_AUTHENTICATION_FIREWALL_FAILED

Selective authentication checking:
- Only done if the token contains S-1-5-1000
- The "AllowedToAuthenticateTo" extended access right is required on the AD object of the service

Advantages of selective authentication:
- It is much more flexible than the all or nothing of one-way trusts
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- authsam_update_user_info_info_dc() also "selects"
  - We pass 'struct ldb_dn *local_service_dn' is the target is within the local domain
  - authsam_extract_local_service_dn() gets it from auth_usersupplied_info
  - We need Heimdal changes to pass the required information to the pac [re-]generation hooks
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Future Improvements / Open Bugs

- **Open bugs...**
  - Bug 11362: GPO security filtering based on the groups in Kerberos PAC (but primary group is missing)
  - Bug 11517: Samba 4.3 GPO issue when Trust is enabled

- **TODOs...**
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  - A lot more tests to verify we construct the PAC exactly like Windows
  - A low level Kerberos testsuite (most likely as python bindings)
  - More Kerberos features from Windows 2012 and higher
  - See the last year’s slides for more topics and references
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Questions?

- Stefan Metzmacher, metze@samba.org
- https://www.sernet.com