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PostgreSQL access control using an external authentication provider

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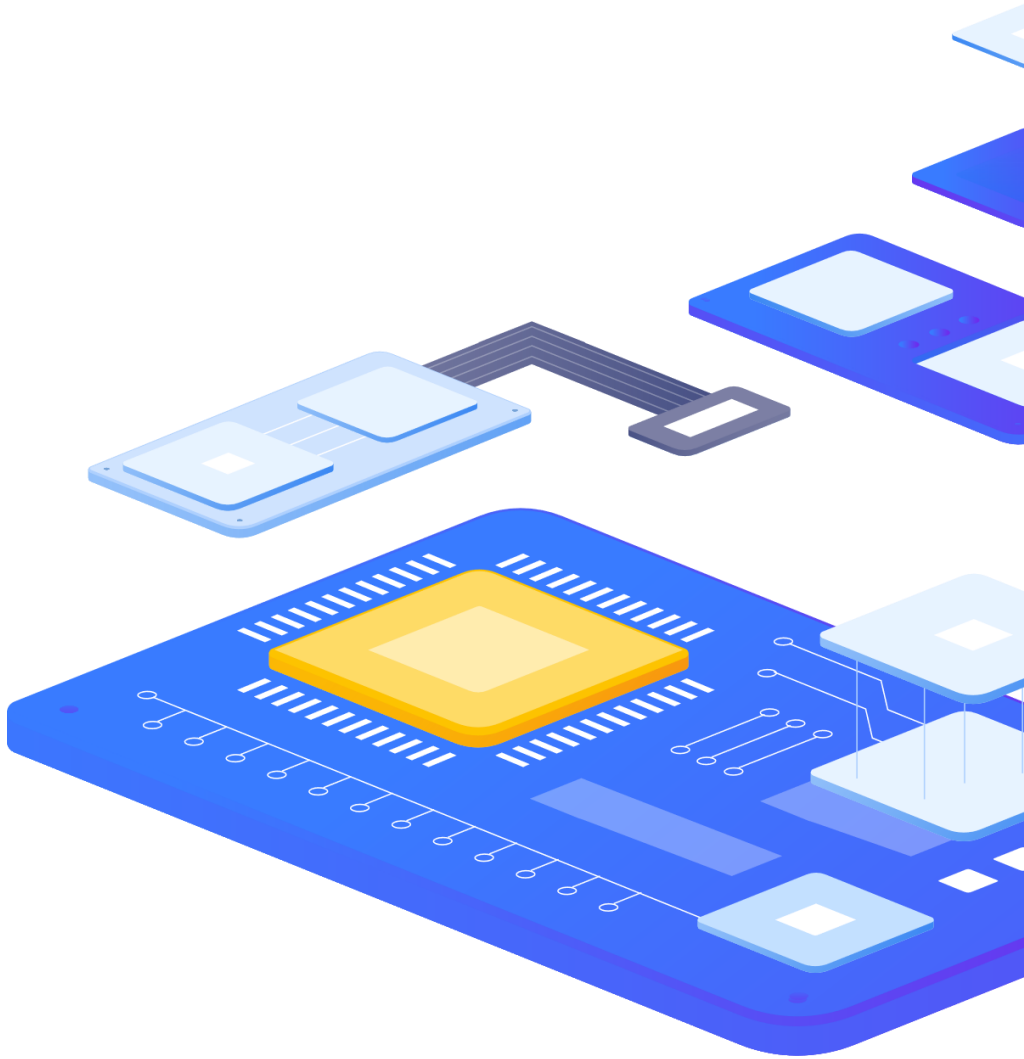
Introduction

- PostgreSQL supports 11 authentication methods, the basic ones include:
  - **Trust authentication**, which simply trusts that users are who they say they are.
  - **Password Authentication,** which requires users to authenticate with a password.
  - **LDAP Authentication**, which relies on an LDAP authentication server.
  - **PAM authentication,** which relies on PAM (Pluggable Authentication Modules) library.
  - **Certificate authentication**, which requires an SSL connection and authenticates the user by checking the received SSL certificate.
  - **GSSAPI authentication**, which relies on a GSSAPI-compatible library. It is typically used to access an authentication service such as FreeIPA or Microsoft Active Directory and uses the Kerberos protocol. .



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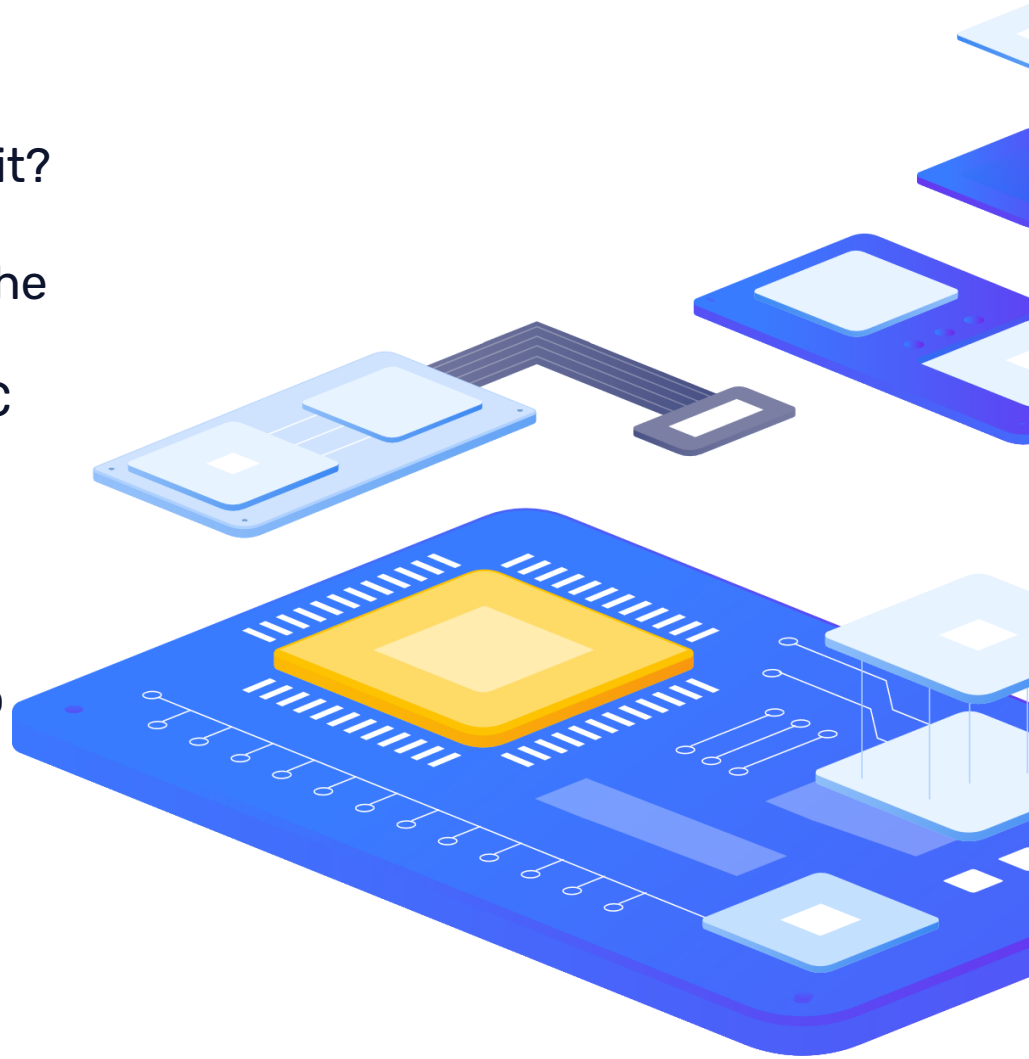
Introduction

- What is Kerberos, how does it work and why is it good to use it?
  - Kerberos is a network authentication protocol, which serves for secure authentication of both the client and the server
  - The client authenticates itself against a third party - KDC (Key Distribution Center)
  - No passwords are sent over the network, nor are they stored locally on the client
  - Strong encryption algorithms are used
  - The KDC is a central element and can provide services to many applications and clients
  - Access can be controlled from one place
  - **Failure of the central authentication service may affect the operation of multiple systems**



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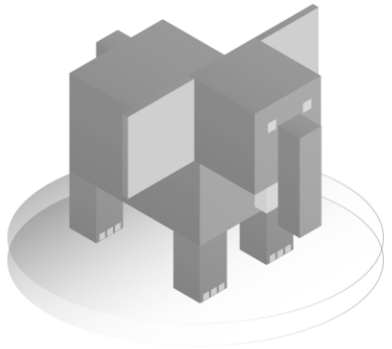
1. Autentizace a žádost o ticket

2. Odeslání Session Key a TGT

3. Žádost o ServiceTicket

4. ServiceTicket



PostgreSQL Client

6. Ověření

PostgreSQL Server

5. ServiceTicket a požadavek na autentizaci

7. Potvrzení a navázání spojení

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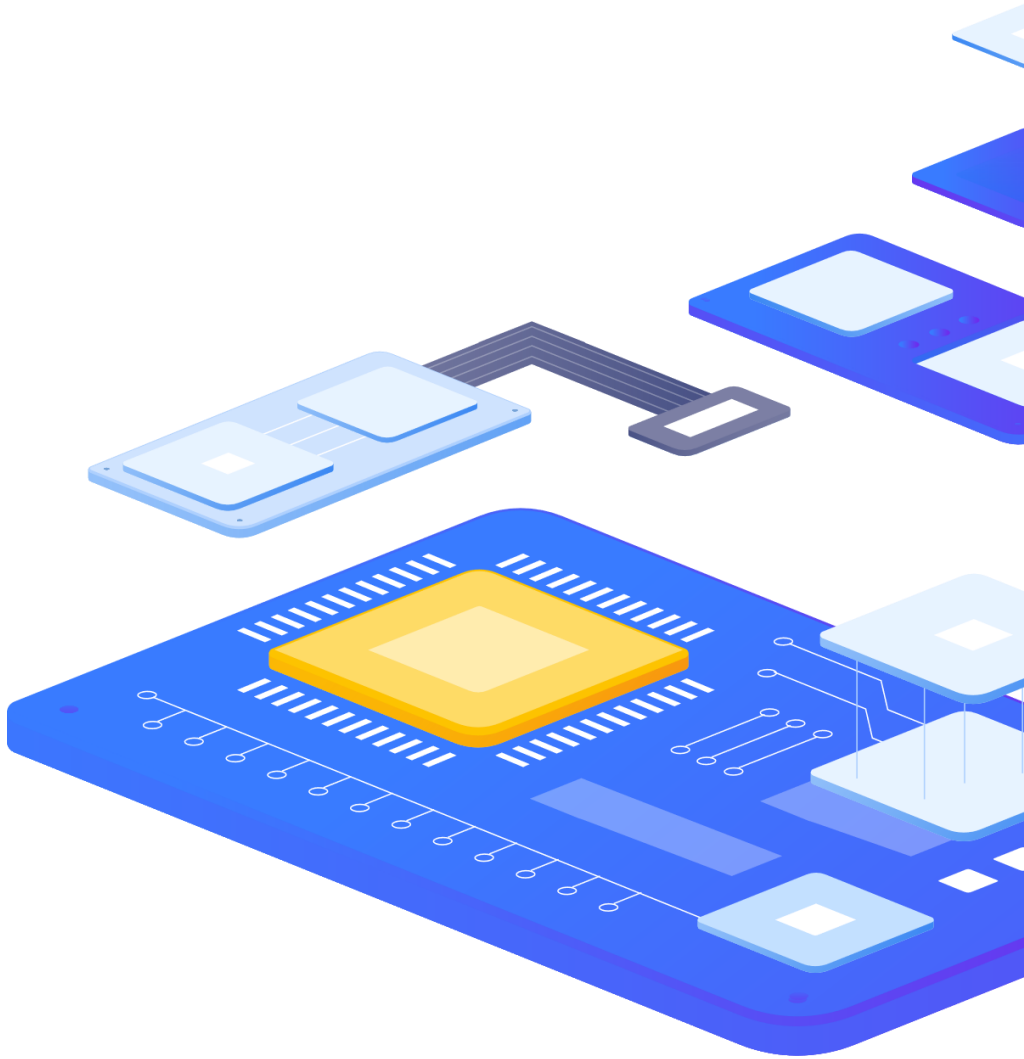
Basic requirements

- Installed PostgreSQL server
- Kerberos support and configuration
  - krb5-workstation & krb5-server
  - /etc/krb5.conf
- User account for PostgreSQL in Active Directory
- Generated keytab for the DB server
- PostgreSQL configuration
  - pg_hba.conf
  - postgresql.conf
- User account in PostgreSQL with required privileges
- Kerberos ticket for DB user (Active Directory or kinit)



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Kerberos support and configuration

- The necessary libraries must be installed on the server and support for Kerberos must be set up
- Installation of required packages

```
dnf install krb5-server krb5-workstation
```

- Configuring Kerberos support for the client
  - Editing the file /etc/krb5.conf (see example)
  - Editing must be done by the root user

```
[logging]
    default = /var/log/krb5libs.log
    kdc = /var/log/krb5kdc.log
    admin_server = /var/log/kadmind.log

[libdefaults]
    default_realm = DEMO.INITMAX.CZ
    dns_lookup_realm = false
#    ticket_lifetime = 24h
#    renew_lifetime = 7d
    forwardable = true
    udp_preference_limit = 1
    default_ccache_name = KEYRING:persistent:%{uid}

[realms]
DEMO.INITMAX.CZ = {
     kdc = demo.initmax.cz
     admin_server = demo.initmax.cz
}

[domain_realm]
.demo.initmax.cz = DEMO.INITMAX.CZ
demo.initmax.cz = DEMO.INITMAX.CZ
```

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User account for DB server in AD and keytab

- In Active Directory, create a service account for the database server - for example pg_db_srv01
- Next, you need to generate a **Kerberos keytab** linked to the account from the previous step on the Active Directory server

```
ktpass –princ POSTGRES/pgsql.demo.initmax.cz@DEMO.INITMAX.CZ –pass heslo –mapuser pg_db_srv01
-crypto ALL –ptype KRB5_NT_Principal –out pgsql.demo.initmax.cz.keytab
```

- We copy the keytab obtained in this way to the DB server, for example in the /etc folder
- And we can verify its functionality on the PotgreSQL server

```
kinit -k -t /etc/pgsql.demo.initmax.cz.keytab POSTGRES/pgsql.demo.initmax.cz@DEMO.INITMAX.CZ -V
Using existing cache: 0
Using principal: POSTGRES/pgsql.demo.initmax.cz@DEMO.INITMAX.CZ
Using keytab: /etc/pgsql.demo.initmax.cz.keytab
Authenticated to Kerberos v5
```

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PostgreSQL configuration

- In the configuration file of the PostgreSQL server, modify the parameter **krb_server_keyfile**

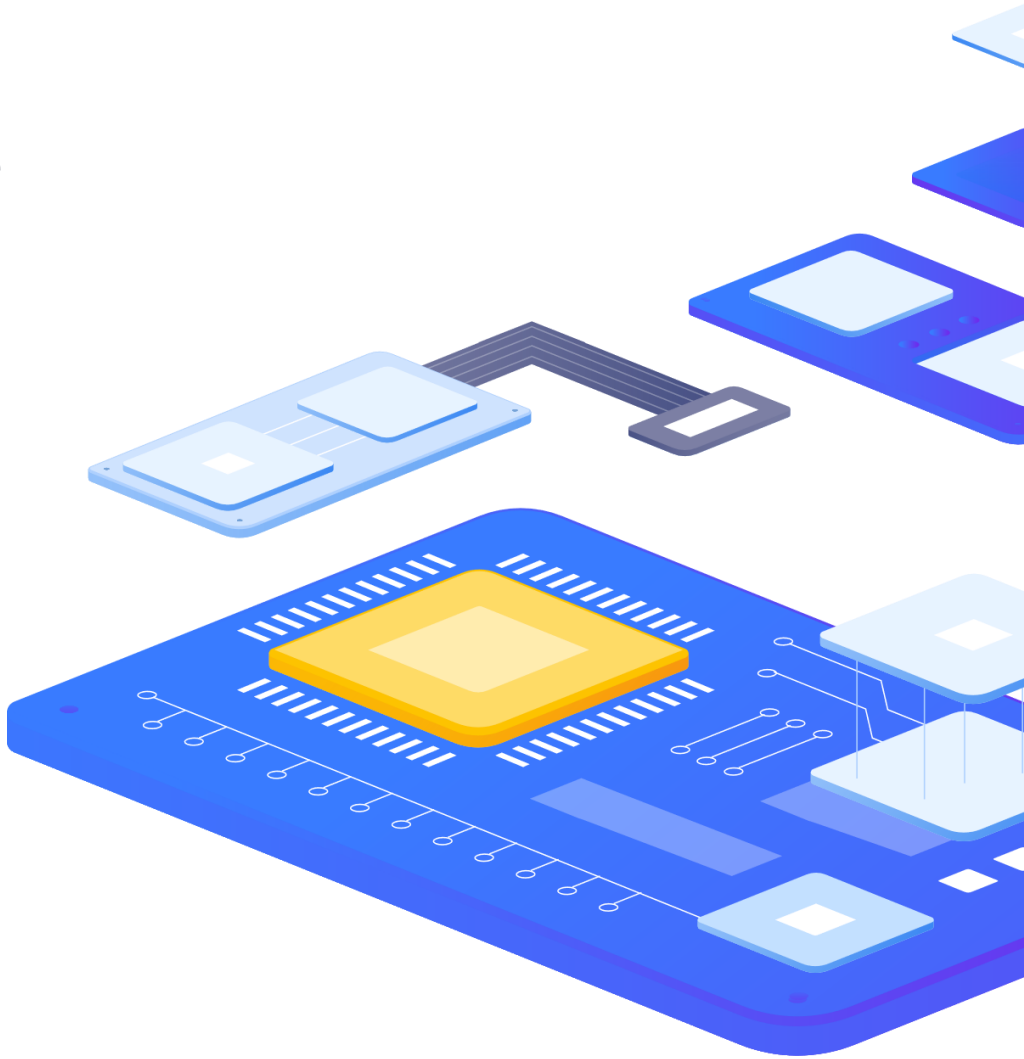
```
krb_server_keyfile=/etc/pgsql.demo.initmax.cz.keytab
```

- In the **pg_hba.conf** file, enable login using the GSSAPI method

```
# IPv4 local connections:
#host   all   all   127.0.0.1/32   ident
host   all   all   0.0.0.0/0      gss include_realm=0 krb_realm=DEMO.INITMAX.CZ
```

- And create a user in PostgreSQL
  - The user must match a real user in AD

```
pgsqldemo=# create user "ad_user" superuser;
```



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Login to PostgreSQL

- Getting a ticket from Active Directory

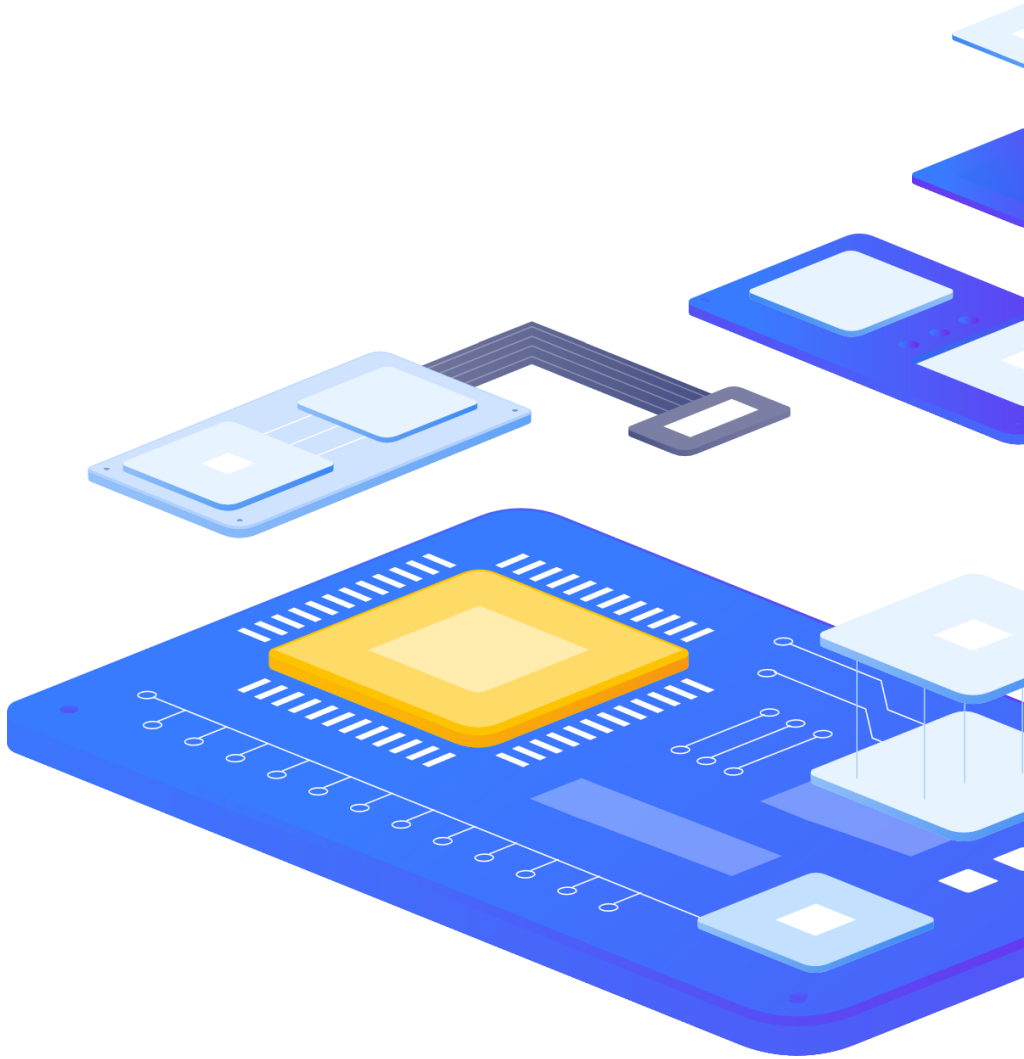
```
kinit ad_user
```

- Login to PostgreSQL

```
psql -U "ad_user" -h csas-pgsql.win.initmax.cz postgres
```

- In larger environments, user creation can be automated
- For example, a combination of the following can be used
  - LDAP (Active Directory, FreeIPA, OpenLDAP,…)

  and
  - ldap2pg



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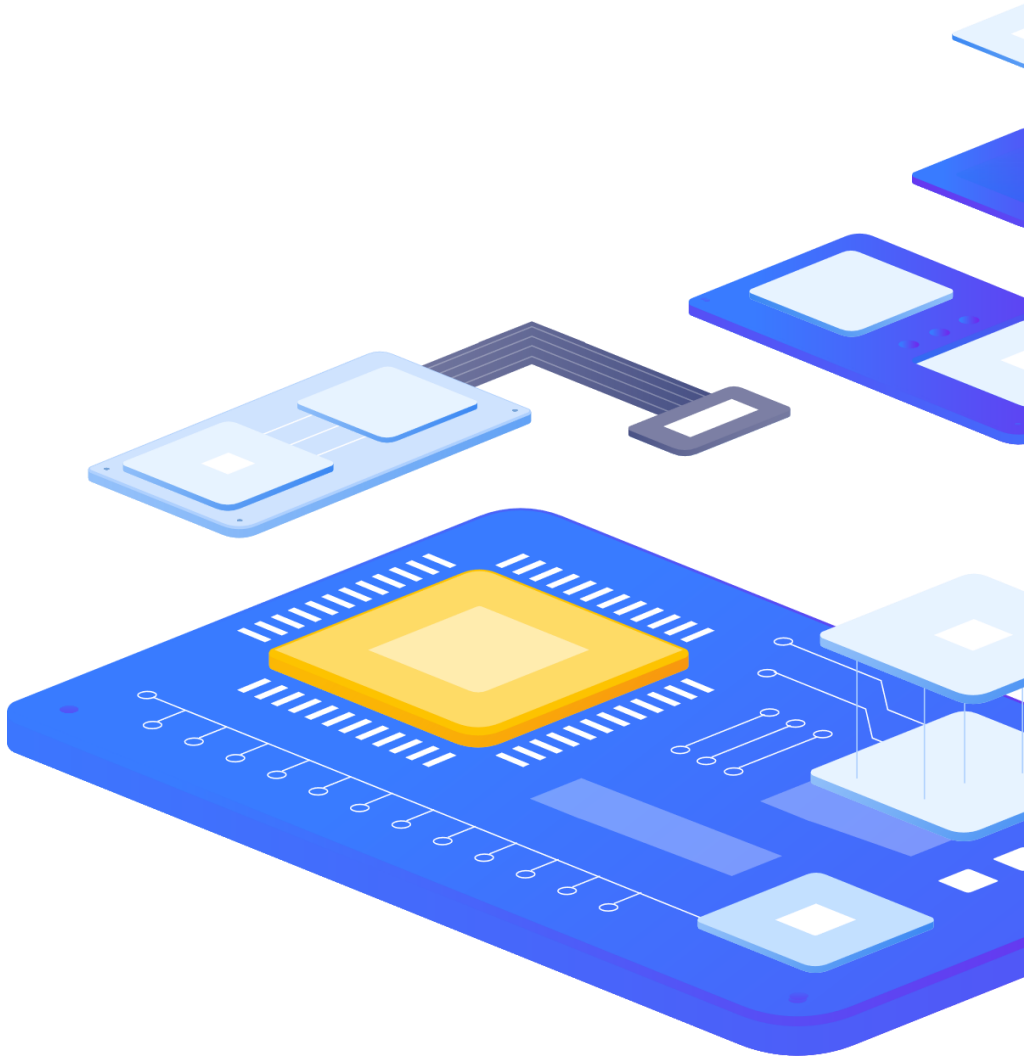
ldap2pg

- ldap2pg automates the creation, update and removal of PostgreSQL roles and users
- A YAML file is used for configuration
- Creates, changes and deletes roles in PostgreSQL according to settings in LDAP
- Can set or remove permissions statically or according to LDAP settings
- Can manage role membership
- It can perform validation of settings before its deployment using parameters `--dry` and `--check`



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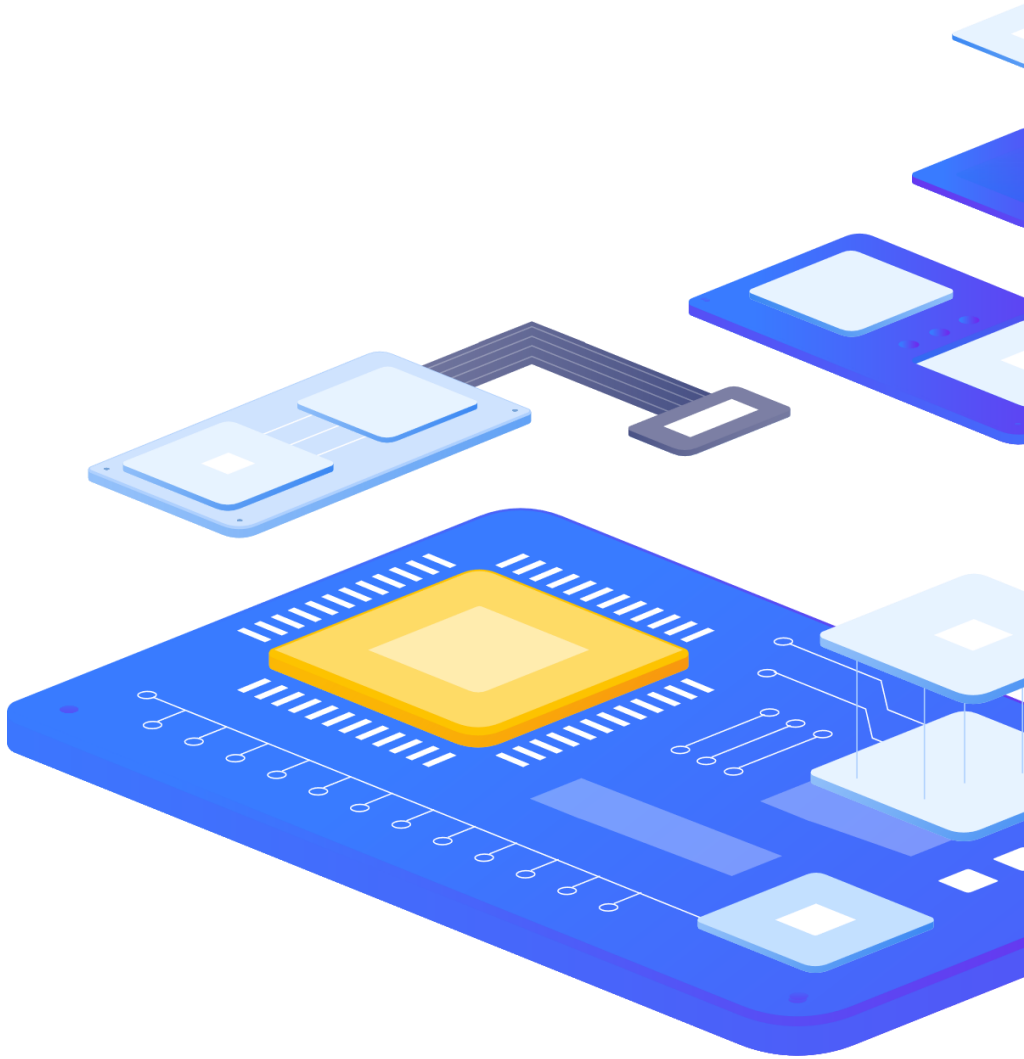
ldap2pg - installation

- ldap2pg is available as a Python package
- ldap2pg requires:
  - Python 2.6+ or Python 3.4+
  - Pyyaml
  - python-ldap
  - python-psycopg2
- The authors recommend using distribution packages both for installing dependencies and for ldap2pg itself, if available.



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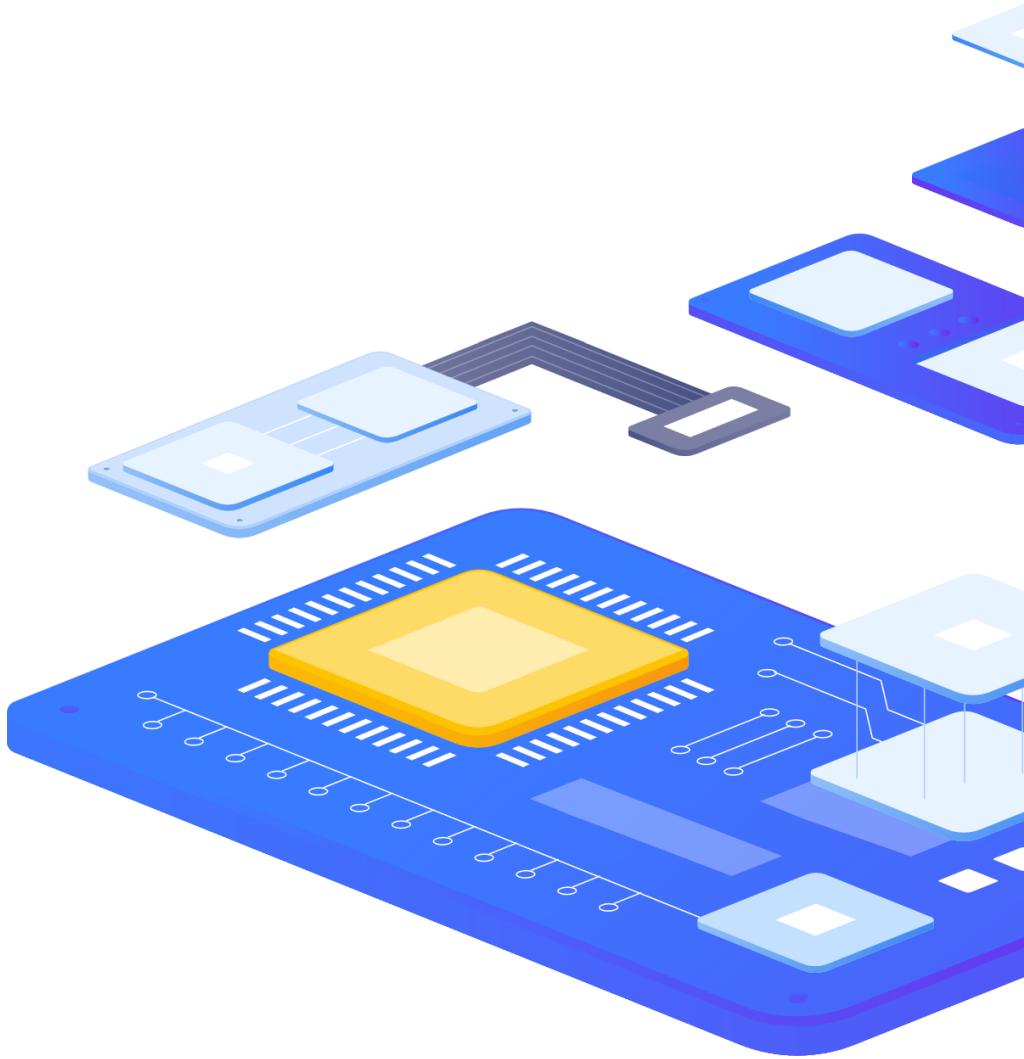
ldap2pg - installation

- Installation on RHEL 6/7/8/9 compatible OS
  - Two repositories are available
    - PGDG YUM repository
      - the official PostgreSQL repository
      - You may already have it available on a server with PostgreSQL
    - Dalibo Labs YUM repository
      - upstream
      - Packages are more current
- Debian 8/9/10/11
  - It is necessary to install using pip



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ldap2pg - installation

- Guide for RHEL 6/7/8/9 compatible and Dalibo Labs YUM repository
  - Install the repository and refresh dnf cache

```
dnf install -y https://yum.dalibo.org/labs/dalibo-labs-4-1.noarch.rpm
dnf makecache fast
```

  - The repository can also be added manually

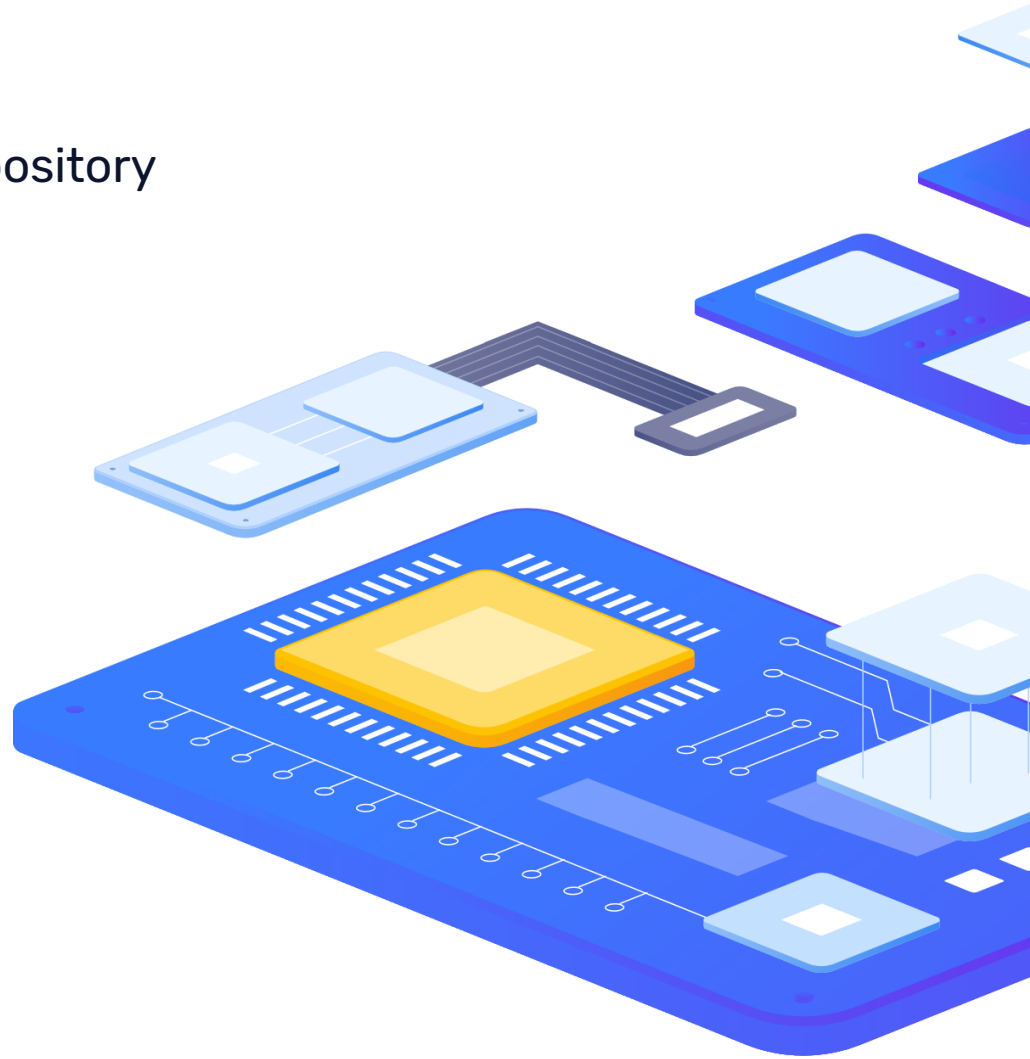
```
vi /etc/yum.repos.d/dalibolabs.repo

# do souboru vložit
[dalibolabs]
name = Dalibo Labs - RHEL/CentOS/Rockylinux $releasever - $basearch
baseurl = https://yum.dalibo.org/labs/RHEL$releasever-$basearch
gpgcheck = 1
enabled = 1

# uložit a obnovit dnf cache
dnf makecache fast
```

  - Install ldap2pg itself

```
dnf install ldap2pg
```



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ldap2pg – verifying the installation

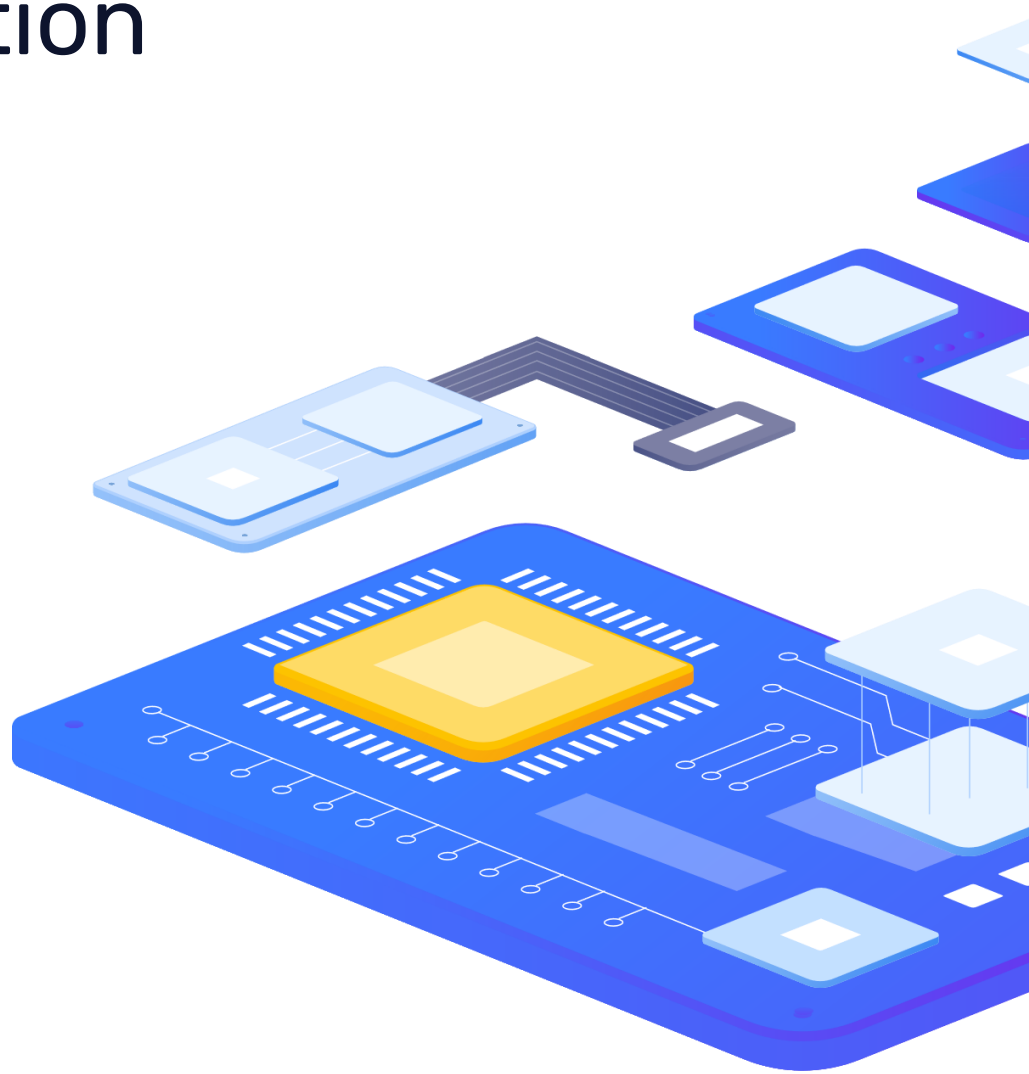
```
ldap2pg -V
ldap2pg 5.8
psycopg2 2.8.6 (dt dec pq3 ext lo64) libpq 12.4
python-ldap 3.3.1
Python 3.6.8 (default, Nov  9 2021, 14:44:26)
[GCC 8.5.0 20210514 (Red Hat 8.5.0-3)]ld
```

```
ldap2pg --help
usage: ldap2pg [-c PATH] [-C] [-n] [-N] [-q] [-v] [--color] [--no-color] [-?]
               [-V]

PostgreSQL roles and privileges management.

optional arguments:
  -c PATH, --config PATH
                        path to YAML configuration file (env: LDAP2PG_CONFIG).
                        Use - for stdin.
  -C, --check           check mode: exits with 1 on changes in cluster
  -n, --dry             don't touch Postgres, just print what to do (env:
                        DRY=1)
  -N, --real            real mode, apply changes to Postgres (env: DRY='')
  -q, --quiet           decrease log verbosity (env: VERBOSITY)
  -v, --verbose         increase log verbosity (env: VERBOSITY)
  --color               force color output (env: COLOR=1)
  --no-color            force plain text output (env: COLOR='')
  -?, --help            show this help message and exit
  -V, --version         show version and exit

ldap2pg requires a configuration file to describe LDAP searches and role
mappings. See https://ldap2pg.readthedocs.io/en/latest/ for further details.
By default, ldap2pg runs in dry mode.
```



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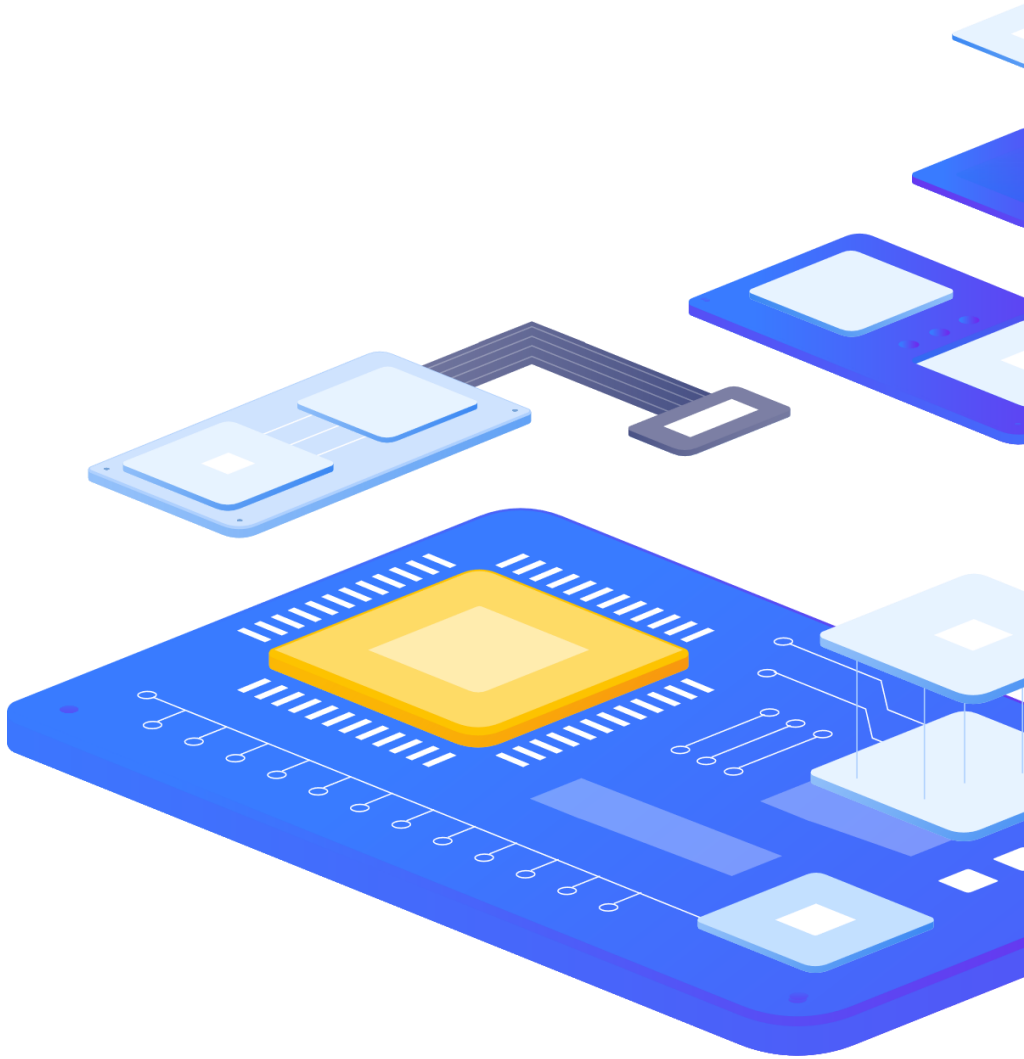
ldap2pg - configuration

- Configuration of ldap2pg is saved in the ldap2pg.yml file
- Configuration is done in YAML format – watch out for syntax
- It can contain everything needed to run ldap2pg
- The configuration file is searched for in these standard locations:
  - ldap2pg.yml in current working directory
  - ~/.config/ldap2pg.yml
  - /etc/ldap2pg.yml
- If the LDAP2PG_CONFIG variable or the --config <path to configuration> parameter is set, ldap2pg will skip searching the default file locations
- It is also possible to specify ldap2pg - (with a dash) to read the configuration from standard input



PostgreSQL access control using an external authentication provider

ldap2pg – example configuration

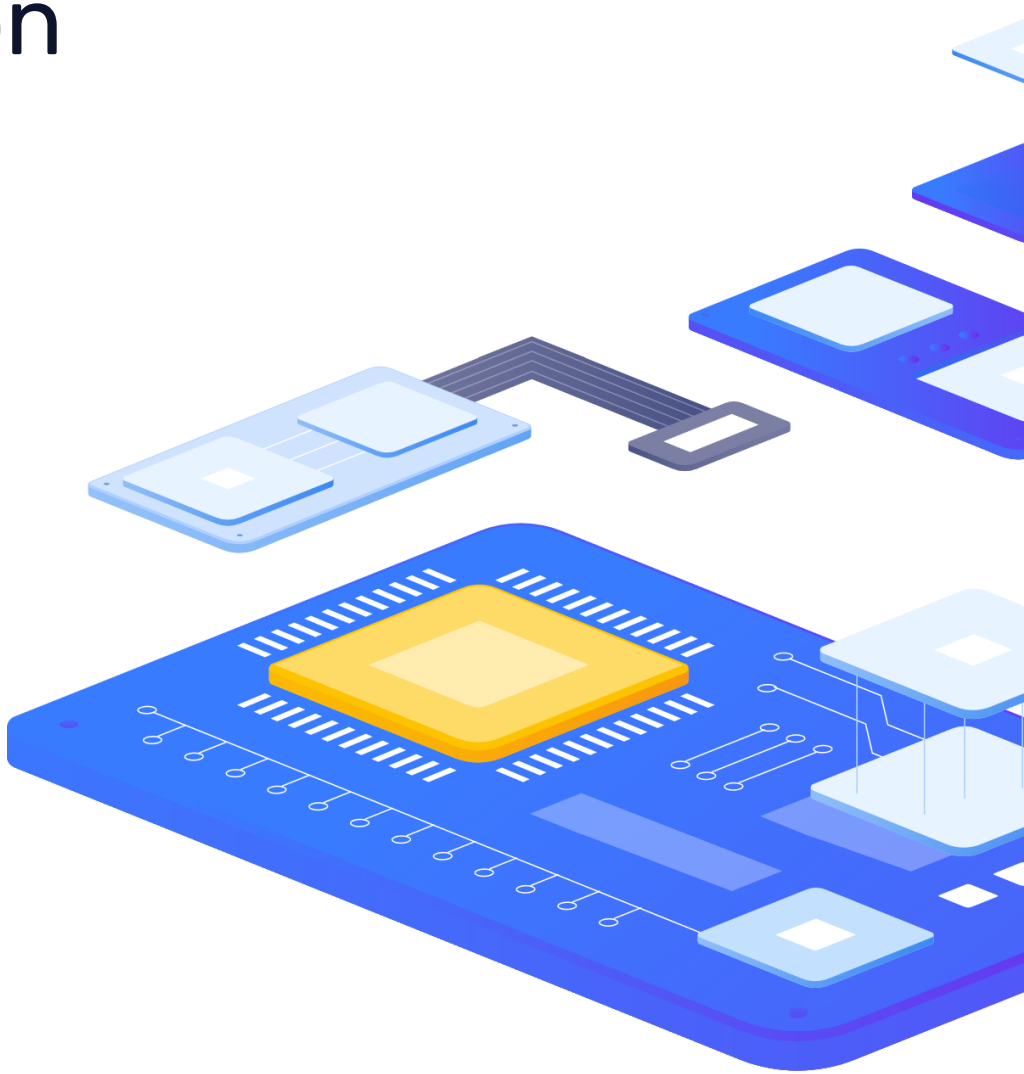
```
postgres:
  dsn: postgres://alfa@csas-pgsql.win.initmax.cz:5432/postgres
  roles_blacklist_query:
    - postgres
    - "pg_*"
    - "rds_*"

ldap:
  uri: ldap://dc1.win.initmax.cz
  binddn: CN=Test User Alfa,OU=Users,OU=testAcounts,DC=win,DC=initmax,DC=cz
  password: "heslo"

sync_map:
- role:
    name: alfa
    options: LOGIN SUPERUSER
    names:
     - ad_roles
    comment: "LDAP role managed by ldap2pg."

- ldapsearch:
    base: CN=pg_DBA_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz
  role:
    name: 'dba_{member.samaccountname}'
    options: LOGIN SUPERUSER
    parent: ad_roles
    comment: "Synced from AD: {dn}"


- ldapsearch:
    base: CN=pg_RO_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz
  role:
    name: '{member.samaccountname}'
    options: LOGIN
    parent: ad_roles
    comment: "Synced from AD: {dn}"
```



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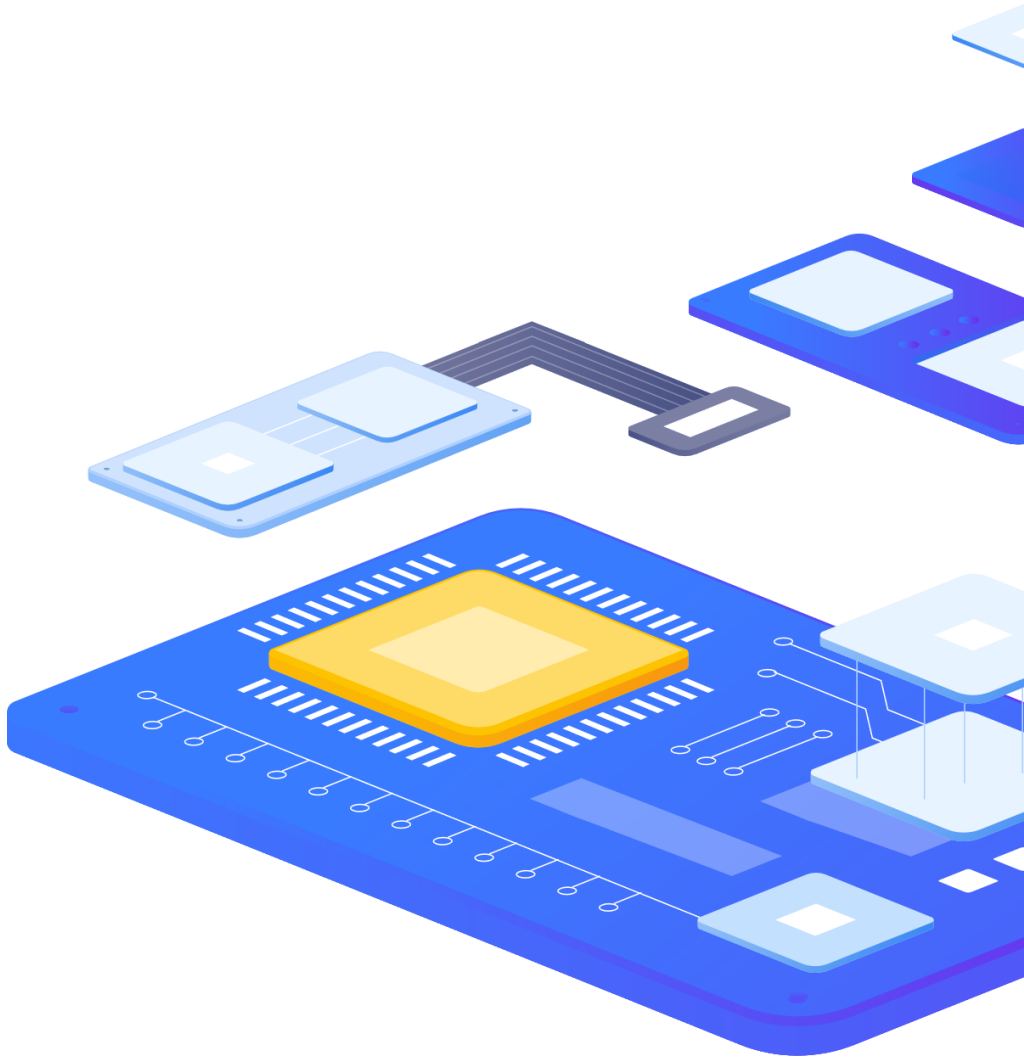
ldap2pg - usage

```
# ldap2pg --dry
Starting ldap2pg 5.8.
Using /root/ldap2pg.yml.
Connecting to LDAP server ldap://dc1.win.initmax.cz.
Trying simple bind.
Running in dry mode. Postgres will be untouched.
Inspecting roles in Postgres cluster...
Querying LDAP CN=pg_DBA_users,OU=Group... (objectClass...
Missing 'member' from CN=pg_DBA_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz.
Considering it as an empty list.
Querying LDAP CN=pg_RO_users,OU=Groups... (objectClass...
Missing 'member' from CN=pg_RO_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz. Considering
it as an empty list.
Nothing to do.
Comparison complete.
```

```
$ ldap2pg --real
Starting ldap2pg 5.8.
Using /root/ldap2pg.yml.
Connecting to LDAP server ldap://dc1.win.initmax.cz.
Trying simple bind.
Running in real mode.
Inspecting roles in Postgres cluster...
Querying LDAP CN=pg_DBA_users,OU=Group... (objectClass...
Missing 'member' from CN=pg_DBA_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz. Considering
it as an empty list.
Querying LDAP CN=pg_RO_users,OU=Groups... (objectClass...
Missing 'member' from CN=pg_RO_users,OU=Groups,OU=testAcounts,DC=win,DC=initmax,DC=cz. Considering
it as an empty list.
Nothing to do.
Synchronization complete.
```



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Demonstration

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