MATERIALFLUSSGRUPPE

performing databases

# TNS Connections

# What Could Possibly Go Wrong?




Axel vom Stein – BSS Bohnenberg GmbH



Martin Klier – Performing Databases

# Speaker

- Martin Klier, Oracle ACE Director
- Performing Databases since 2014

- Solution Architect and Database Expert
- My focus:
  - Performance & Tuning
  - Highly Available Systems
  - Cluster and Replication

- Linux since 1997
- Oracle Database since 2003



Oracle ACE Director

Proud Member of symposium42

# Speaker

- Axel vom Stein, Oracle ACE Pro
- Technical Project Manager, Head of IT
- Working for BSS since 2001

- Oracle:
  - since 2001
  - started out as a developer (PL/SQL, C, C#)
  - interest moved more towards DBA topics

- My focus:
  - teaching trainees and young professionals
  - HA - concepts
  - standardization & automation





Oracle ACE Pro

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# The German Oracle Database Community

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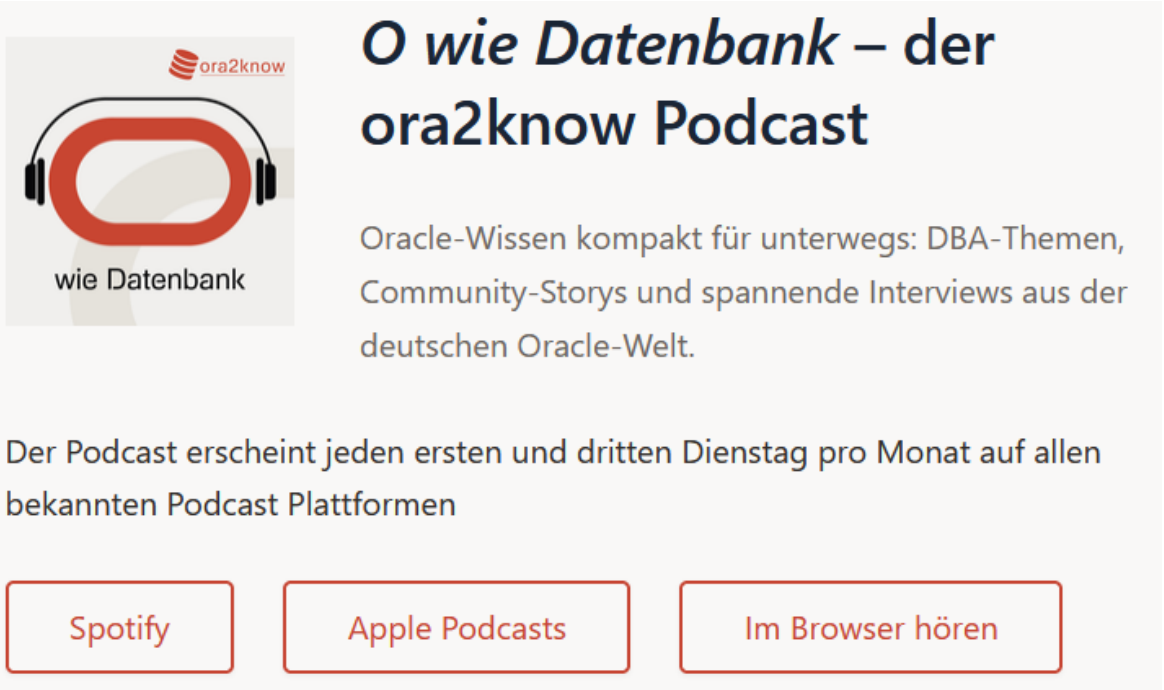


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The German Oracle Database Community

https://www.ora2know.de

# Logistics / Warehousing



# Logistics Warehousing








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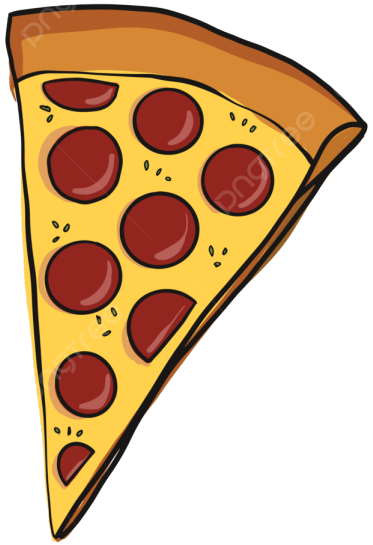
# Networking Basics

# ISO/OSI 7-Layer Model

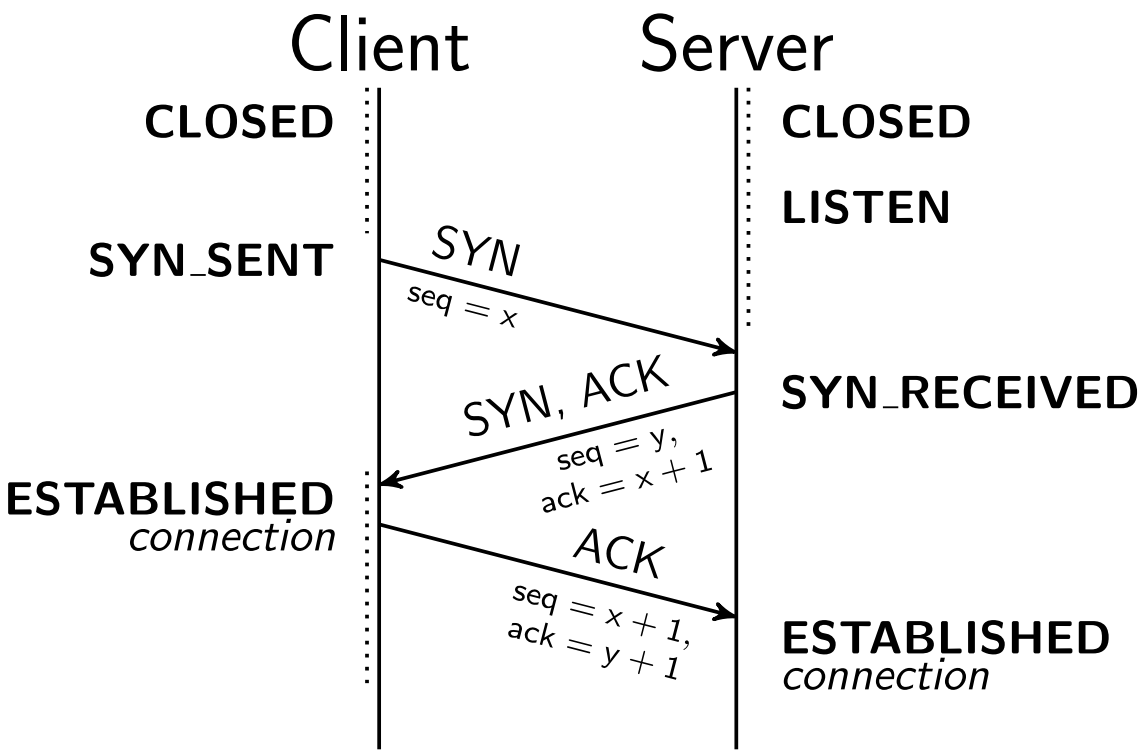


Away!
Pizza
Salami
Throw
Not
Do
Please

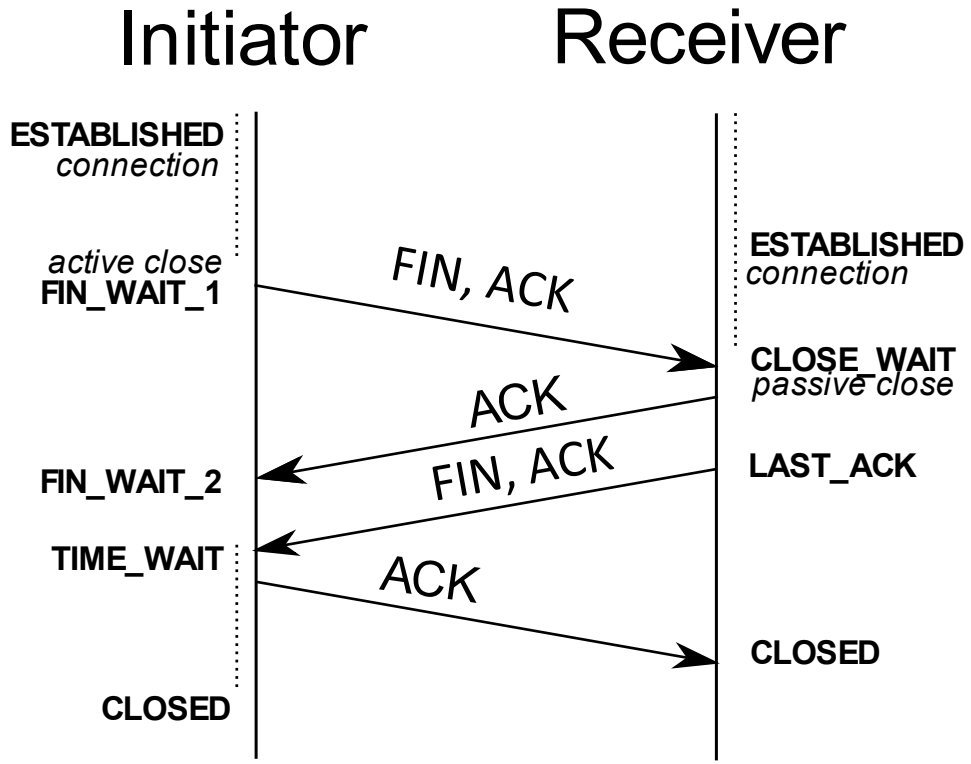
| | |
|---|---|
| Application | Database |
| Presentation | Database |
| Session | Oracle TNS |
| Transport | TCP, UDP |
| Network | IP |
| Data Link | Ethernet Proto. |
| Physical | Ethernet/Cable |

# Transport - TCP Basics: Connections

3-Way Handshake




Connection Teardown

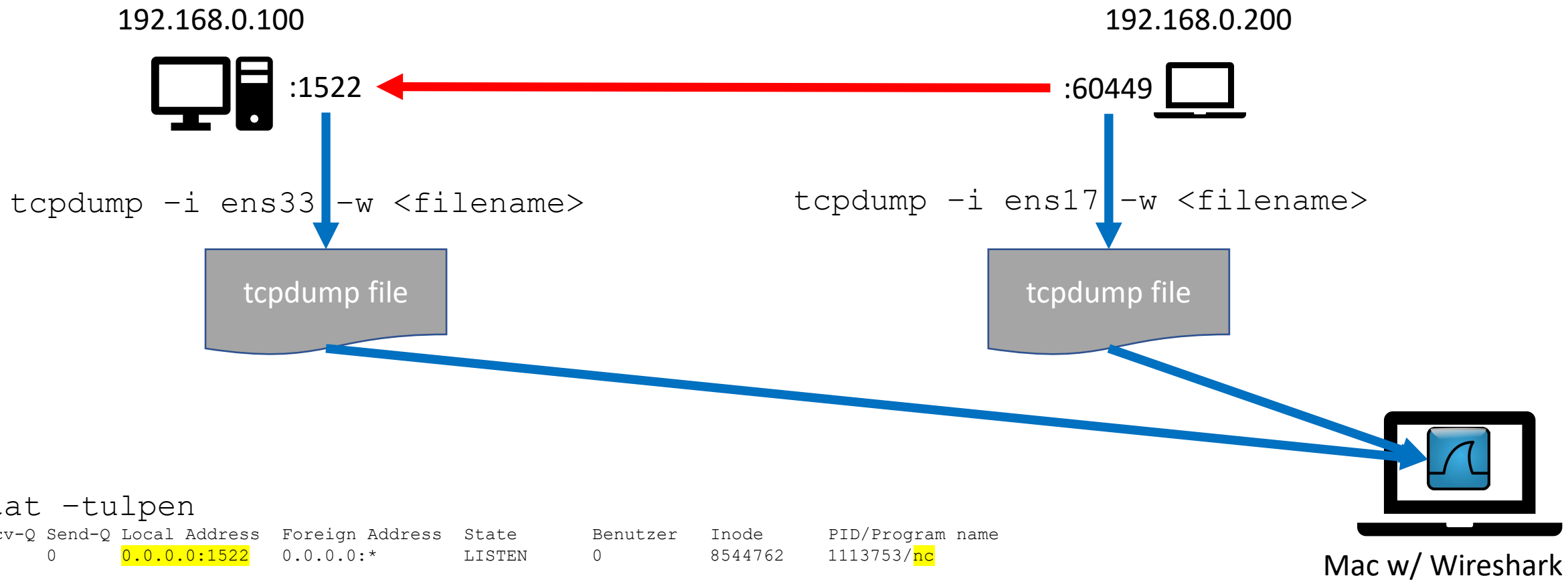



Picture: Wikimedia

# Transport – TCP Basics: netcat Example

"Server-Socket" with open netcat port
`nc -lvk 1522`
(= listen, verbose, keep open port 1522)

netcat "Client-Socket" from random port
`nc lab26ai.lab01.pdb.lan 1522`
(= connect to host lab26ai at port 1522)




`netstat -tulpen`

```
Proto Recv-Q Send-Q Local Address  Foreign Address  State       Benutzer   Inode      PID/Program name
tcp   0      0      0.0.0.0:1522   0.0.0.0:*        LISTEN      0          8544762    1113753/nc
```

# Transport - TCP Basics: netcat Example

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usn — root@lab26ai-1:~ — ssh -o StrictHostKeyChecking=no root@lab26ai-1.lab01.pdb.lan — 153×46

```
[root@lab26ai-1 ~]#
[root@lab26ai-1 ~]#
[root@lab26ai-1 ~]# nc -lvk 1522
Ncat: Version 7.92 ( https://nmap.org/ncat )
Ncat: Listening on :::1522
Ncat: Listening on 0.0.0.0:1522
Ncat: Connection from 10.22.11.45.
Ncat: Connection from 10.22.11.45:60962.
Hallo Axel!
```

**Opening Socket 10.22.21.50:1522**

usn — -bash — 137×35

```
odysseus:~ usn$ echo 'Hallo Axel!' | nc lab26ai-1.lab01.pdb.lan 1522
odysseus:~ usn$
```

**Connection from 10.22.11.45:60449 (random high port)**

(ip.src==10.22.21.50 or ip.dst==10.22.21.50) and tcp.port==1522

| No. | Time | Source | Src Port | Destination | Dest Port | Protocol | Length | Info |
|---|---|---|---|---|---|---|---|---|
| 1128 | 12:05:15.638731 | 10.22.11.45 | 60449 | 10.22.21.50 | 1522 | TCP | 68 | 60449 → 1522 [SYN, ECE, CWR] Seq=0 Win=65535 Len=0 MSS=1240 WS=64 TSval=3110016318 TSecr=0 SACK_PERM |
| 1129 | 12:05:15.660566 | 10.22.21.50 | 1522 | 10.22.11.45 | 60449 | TCP | 64 | 1522 → 60449 [SYN, ACK, ECE] Seq=0 Ack=1 Win=65160 Len=0 MSS=1460 SACK_PERM TSval=1992944886 TSecr=3110016318 WS=128 |
| 1130 | 12:05:15.660728 | 10.22.11.45 | 60449 | 10.22.21.50 | 1522 | TCP | 56 | 60449 → 1522 [ACK] Seq=1 Ack=1 Win=131456 Len=0 TSval=3110016341 TSecr=1992944886 |
| 1131 | 12:05:15.661257 | 10.22.11.45 | 60449 | 10.22.21.50 | 1522 | TCP | 68 | 60449 → 1522 [PSH, ACK] Seq=1 Ack=1 Win=131456 Len=12 TSval=3110016341 TSecr=1992944886 |
| 1132 | 12:05:15.661384 | 10.22.11.45 | 60449 | 10.22.21.50 | 1522 | TCP | 56 | 60449 → 1522 [FIN, ACK] Seq=13 Ack=1 Win=131456 Len=0 TSval=3110016341 TSecr=1992944886 |
| 1134 | 12:05:15.683092 | 10.22.21.50 | 1522 | 10.22.11.45 | 60449 | TCP | 56 | 1522 → 60449 [ACK] Seq=1 Ack=13 Win=65152 Len=0 TSval=1992944908 TSecr=3110016341 |
| 1135 | 12:05:15.683102 | 10.22.21.50 | 1522 | 10.22.11.45 | 60449 | TCP | 56 | 1522 → 60449 [FIN, ACK] Seq=1 Ack=14 Win=65152 Len=0 TSval=1992944908 TSecr=3110016341 |
| 1138 | 12:05:15.683461 | 10.22.11.45 | 60449 | 10.22.21.50 | 1522 | TCP | 56 | 60449 → 1522 [ACK] Seq=14 Ack=2 Win=131456 Len=0 TSval=3110016363 TSecr=1992944908 |

```
> Frame 1131: Packet, 68 bytes on wire (544 bits), 68 bytes captured (544 bits) on interface ppp0, id 0
> Point-to-Point Protocol
> Internet Protocol Version 4, Src: 10.22.11.45, Dst: 10.22.21.50
v Transmission Control Protocol, Src Port: 60449, Dst Port: 1522, Seq: 1, Ack: 1, Len: 12
    Source Port: 60449
    Destination Port: 1522
    [Stream index: 32]
    [Stream Packet Number: 4]
  > [Conversation completeness: Complete, WITH_DATA (31)]
    [TCP Segment Len: 12]
    Sequence Number: 1    (relative sequence number)
    Sequence Number (raw): 560682208
    [Next Sequence Number: 13    (relative sequence number)]
    Acknowledgment Number: 1    (relative ack number)
    Acknowledgment number (raw): 1347369990
```

```
0000  ff 03 00 21 45 02 00 40  00 00 40 00 40 06 06 2c   ···!E··@ ··@·@··,
0010  0a 16 0b 2d 0a 16 15 32  ec 21 05 f2 21 6b 54 e0   ···-···2 ·!··!kT·
0020  50 4f 3c 06 80 18 08 06  27 12 00 00 01 01 08 0a   PO<····· '·······
0030  b9 5f 15 55 76 c9 ec f6  48 61 6c 6c 6f 20 41 78   ·_·Uv··· Hallo Ax
0040  65 6c 21 0a                                       el!·
```

# Transport - TCP Basics: netcat Example

Establish

| Dest Port | Protocol | Length | Info |
|---|---|---|---|
| 1522 | TCP | 68 | 60449 → 1522 [SYN, ECE, CWR] Seq=0 Win=65535 Len=0 MSS |
| 60449 | TCP | 64 | 1522 → 60449 [SYN, ACK, ECE] Seq=0 Ack=1 Win=65160 Len |
| 1522 | TCP | 56 | 60449 → 1522 [ACK] Seq=1 Ack=1 Win=131456 Len=0 TSval= |
| 1522 | TCP | Data 68 | 60449 → 1522 [PSH, ACK] Seq=1 Ack=1 Win=131456 Len=12 |
| 1522 | TCP | 56 | 60449 → 1522 [FIN, ACK] Seq=13 Ack=1 Win=131456 Len=0 |
| 60449 | TCP | 56 | 1522 → 60449 [ACK] Seq=1 Ack=13 Win=65152 Len=0 TSval= |
| 60449 | TCP | 56 | 1522 → 60449 [FIN, ACK] Seq=1 Ack=14 Win=65152 Len=0 T |
| 1522 | TCP | 56 | 60449 → 1522 [ACK] Seq=14 Ack=2 Win=131456 Len=0 TSval |

Teardown

```
[PSH, ACK] Seq=1 Ack=1 Win=131456 Len=12 TSval=3110016341 TSecr=1992944886
[FIN, ACK] Seq=13 Ack=1 Win=131456 Len=0 TSval=3110016341 TSecr=1992944886
[ACK] Seq=1 Ack=13 Win=65152 Len=0 TSval=1992944908 TSecr=3110016341
[FIN, ACK] Seq=1 Ack=14 Win=65152 Len=0 TSval=1992944908 TSecr=3110016341
[ACK] Seq=14 Ack=2 Win=131456 Len=0 TSval=3110016363 TSecr=1992944908
```

```
000  ff 03 00 21 45 02 00 40  00 00 40 00 40 06 06 2c   ···!E··@ ··@·@··,
010  0a 16 0b 2d 0a 16 15 32  ec 21 05 f2 21 6b 54 e0   ···-···2 ·!··!kT·
020  50 4f 3c 06 80 18 08 06  27 12 00 00 01 01 08 0a   PO<····· '·······
030  b9 5f 15 55 76 c9 ec f6  48 61 6c 6c 6f 20 41 78   ·_·Uv··· Hallo Ax
040  65 6c 21 0a                                       el!·
```

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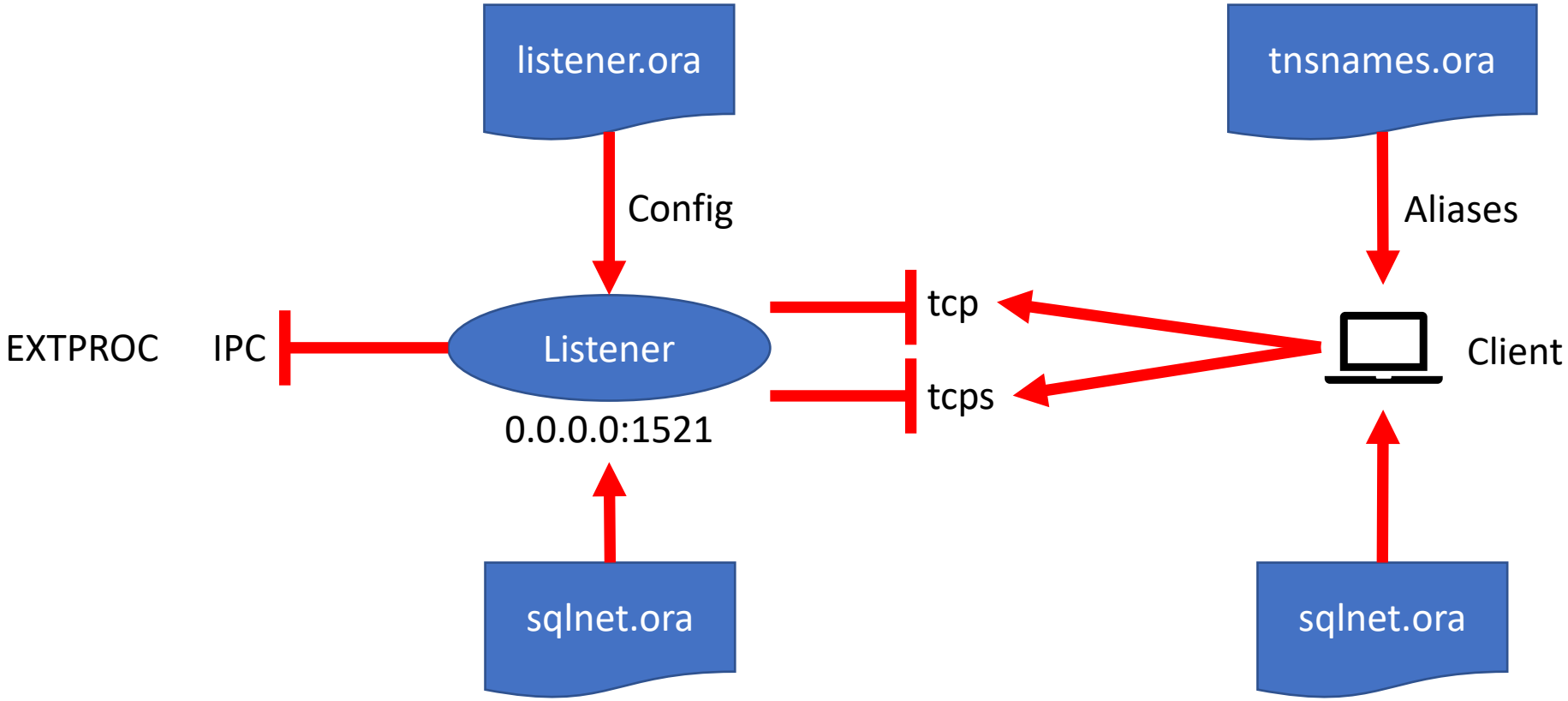
# Transparent Network Substrate “TNS”, “Oracle Net”, “Net8”

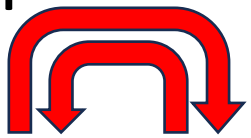
# TNS Connection Protocol Options

- PROTOCOL=TCP
  *sqlplus scott/tiger@dbhost1.example.com:1521/orclpdb1*
- PROTOCOL=TCPS
  *sqlplus scott/tiger@'tcps://dbhost1.example.com:2484/orclpdb1?ssl_server_dn_match=yes'*
- PROTOCOL=IPC ("Inter-Process Communication")
  Example: EXTPROC
- PROTOCOL=BEQ ("Bequeath")
  Example: sqlplus / as sysdba

# Listener Endpoints



# What can go wrong... sqlnet.ora



```
NAMES.DIRECTORY_PATH = (TNSNAMES, EZCONNECT, HOSTNAME)
```

listener.ora:
⇒ DEFAULT_SERVICE_LISTENER
⇒ (no service, take this service)

```
SQLNET.OUTBOUND_CONNECT_TIMEOUT = 10
```

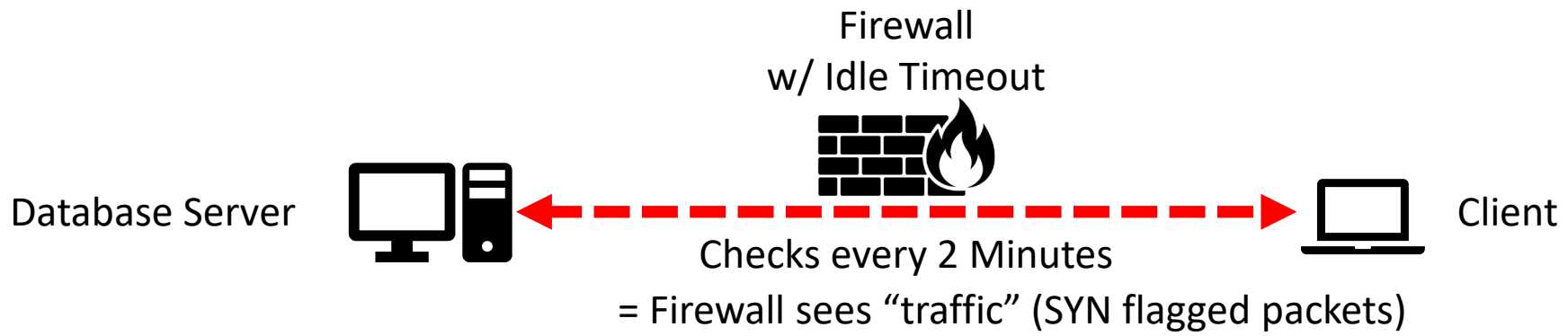
Overridden by tnsnames.ora CONNECT_TIMEOUT (local)

```
SQLNET.RECV_TIMEOUT = 30
SQLNET.SEND_TIMEOUT = 30
```

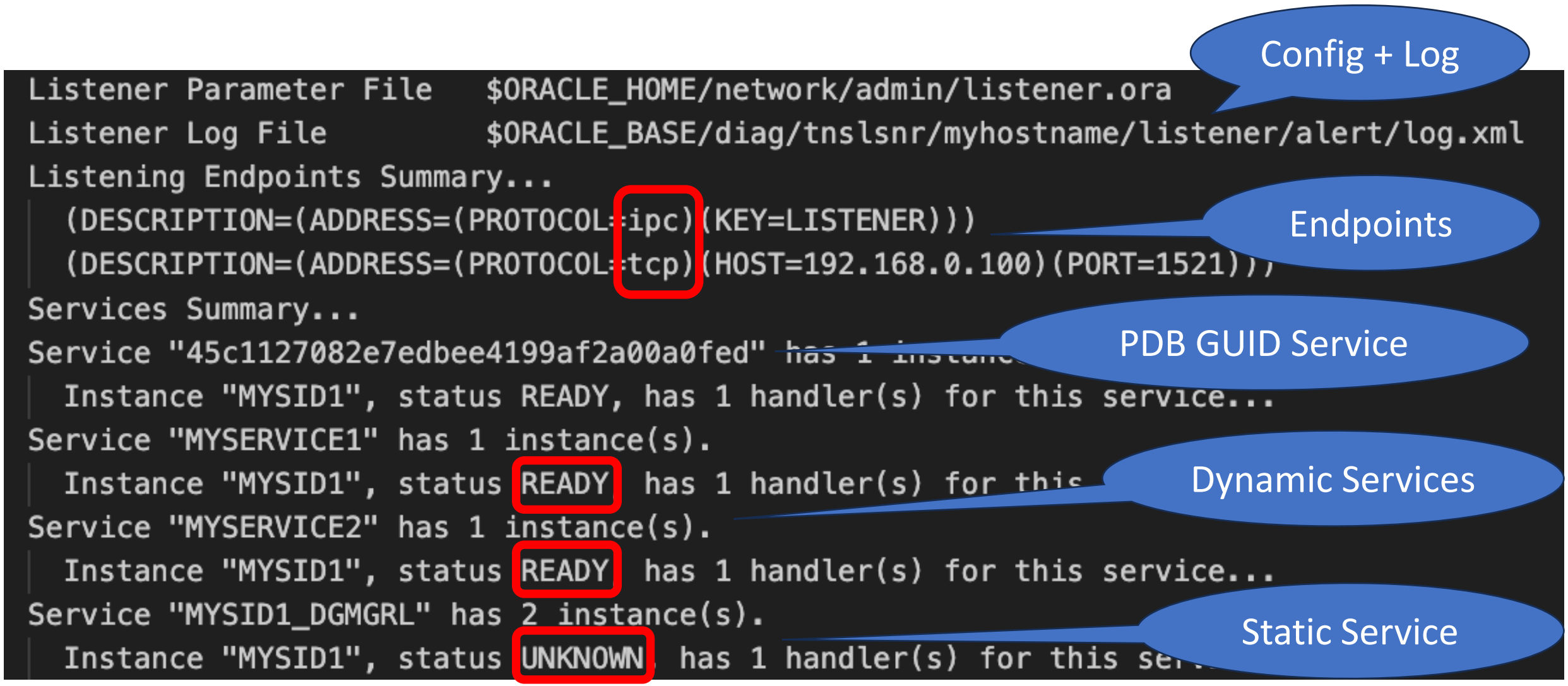
Limiting Connection Idle Time (SQL >30s will die!)

```
SQLNET.EXPIRE_TIME = 2
```

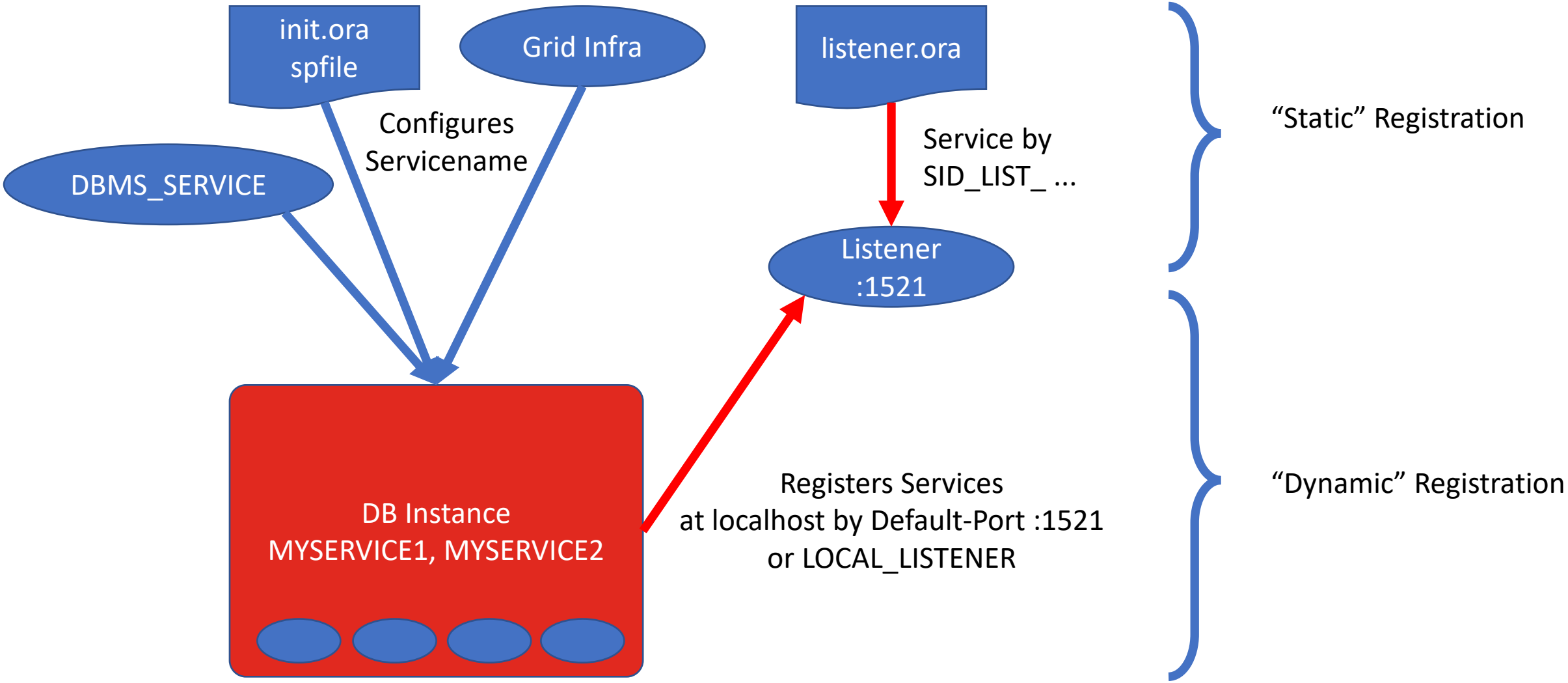
Firewall is my friend ...



# The Listener



# Instance Registration@Listener



# What can go wrong... listener.ora

HUGO ?

```
LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = TCP)(HOST = dbserver01.example.local)(PORT = 1521))
    )
  )
```

1523 ?

LOCAL_LISTENER !

HUGO !

```
SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (GLOBAL_DBNAME = TEST)
      (ORACLE_HOME = /u01/app/oracle/product/19.0.0/dbhome_1)
      (SID_NAME = TEST)
    )
  )
```

HUGO !

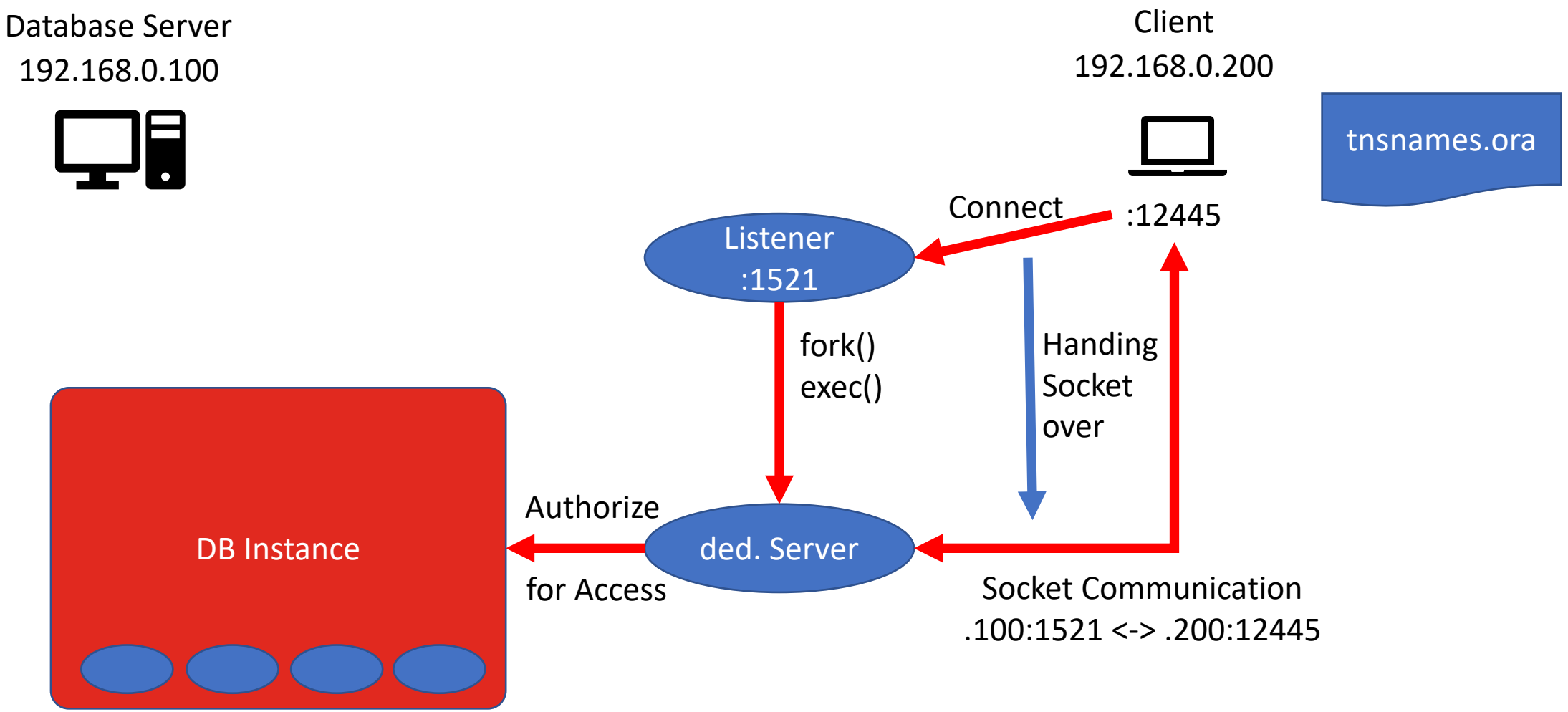
```
USE_SID_AS_SERVICE_LISTENER = ON
```

HUGO !

```
DEFAULT_SERVICE_LISTENER = MYDEFAULTSERVICE
```

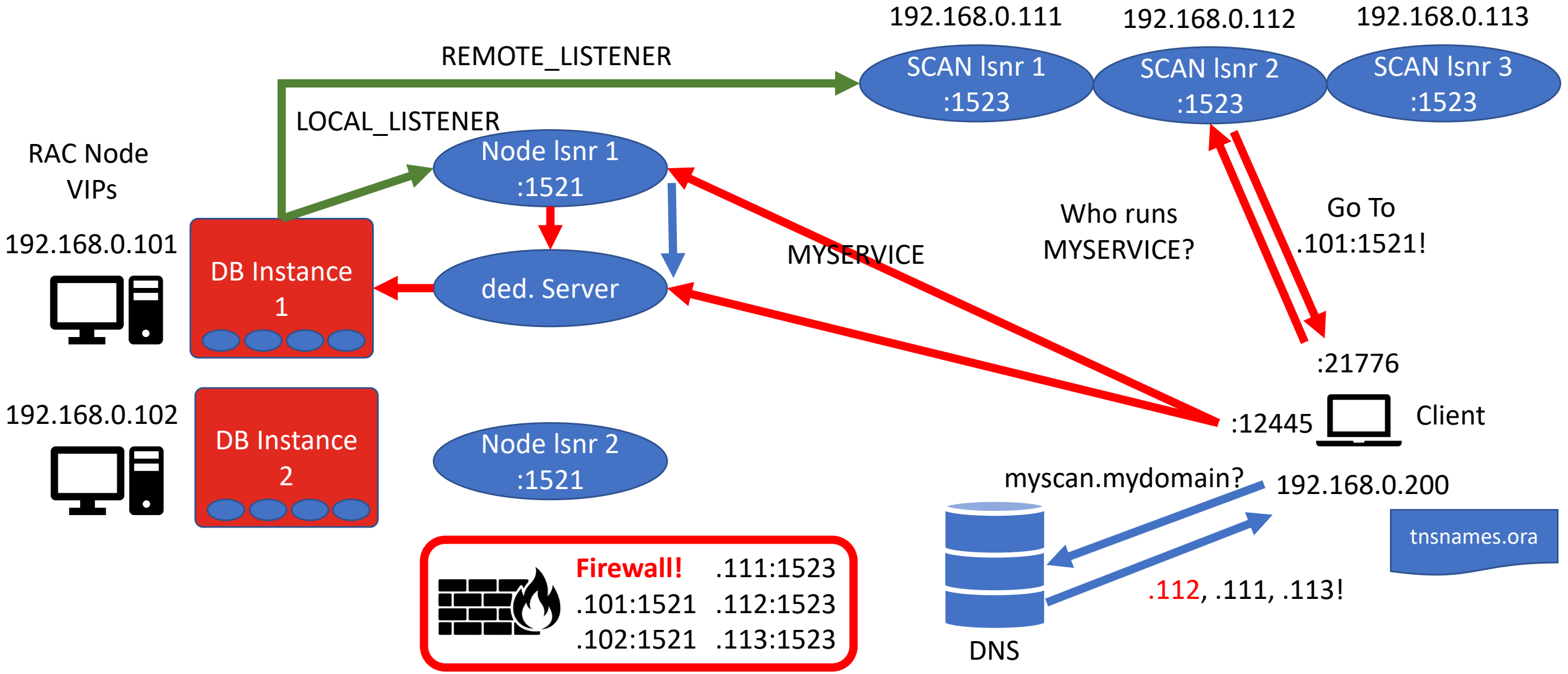
tnslsnr ... just sayin' ...

# TNS Connection via Listener (Linux/Unix)

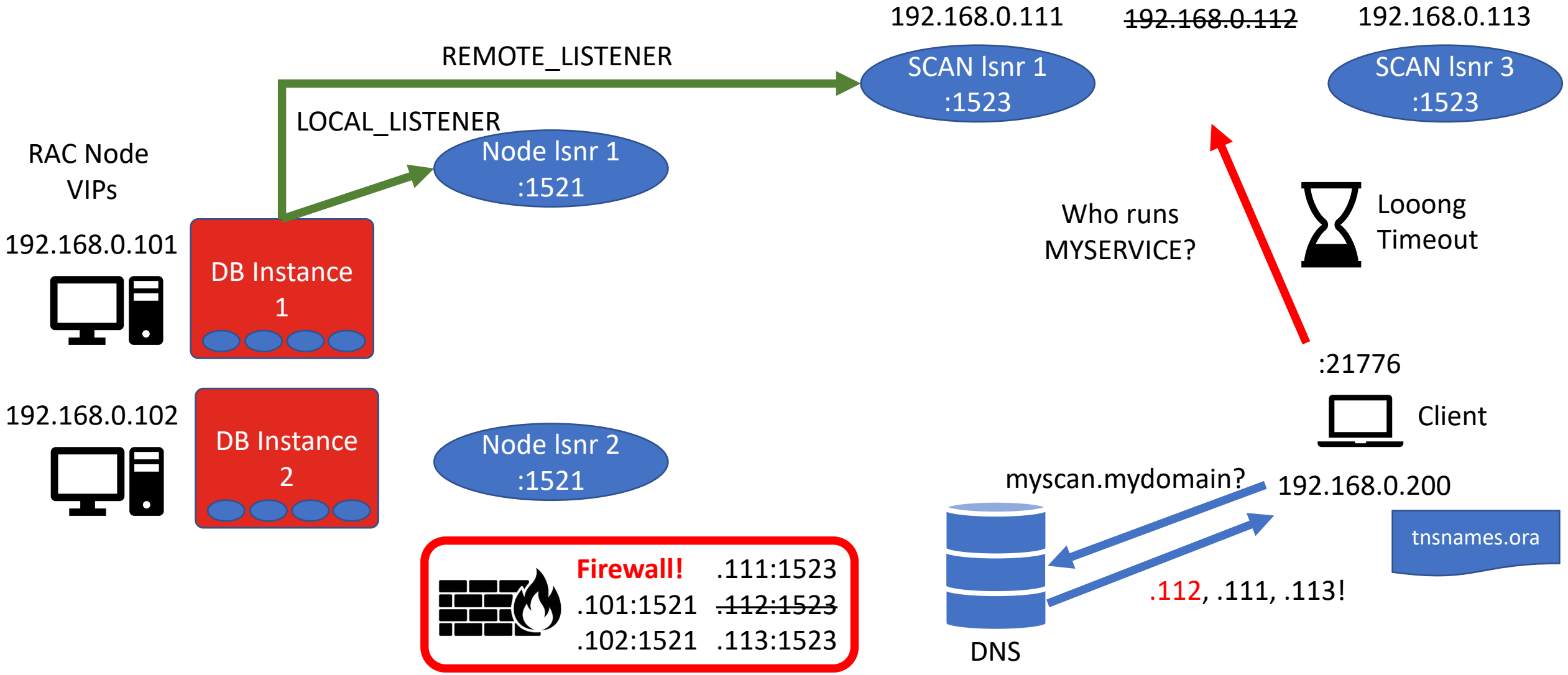



```
netstat -tulpen
```

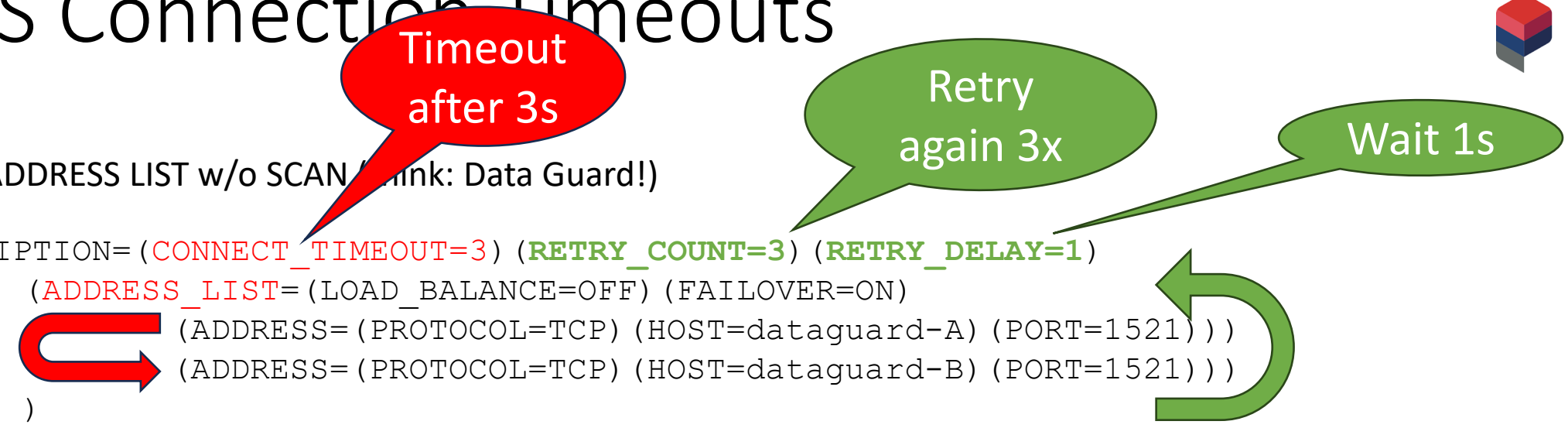
# TNS Connection via SCAN Listener



# TNS No! Connection via SCAN Listener



# TNS Connection Timeouts



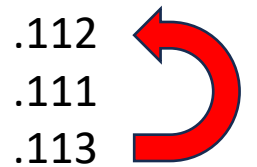

Classic ADDRESS LIST w/o SCAN (think: Data Guard!)

```
(DESCRIPTION=(CONNECT_TIMEOUT=3)(RETRY_COUNT=3)(RETRY_DELAY=1)
        (ADDRESS_LIST=(LOAD_BALANCE=OFF)(FAILOVER=ON)
          (ADDRESS=(PROTOCOL=TCP)(HOST=dataguard-A)(PORT=1521)))
          (ADDRESS=(PROTOCOL=TCP)(HOST=dataguard-B)(PORT=1521)))
        )
        (CONNECT_DATA=(SERVER=DEDICATED)(SERVICE_NAME=MYSERVICE)
        )
)
```




11gR2+ ADDRESS Syntax for SCAN Listener

```
(DESCRIPTION=
                              (RETRY_COUNT=3)(RETRY_DELAY=1)
        (ADDRESS=(PROTOCOL=TCP)(HOST=myscan.mydomain)(PORT=1521))
        (CONNECT_DATA=(SERVER=DEDICATED)(SERVICE_NAME=MYSERVICE)
)
```



# What can go wrong... tnsnames.ora

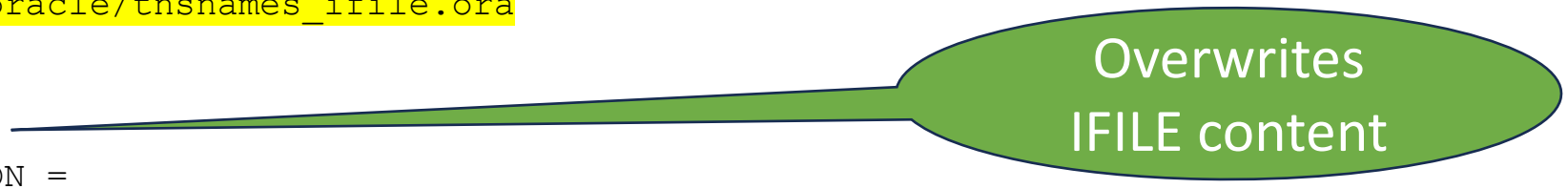
- Duplicate TNS names
  (Last always wins)
- IFILE=/path/to/myfile.ora
  Have it nested, have fun! (max. 3 levels)
- Duplicate TNS names in IFILE vs. tnsnames.ora
  Position of IFILE matters!
- IFILE also possible for listener.ora, sqlnet.ora ...

# What can go wrong... Duplicates in IFILE




```
MYDBOX =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = 192.168.0.100)(PORT     = 1521))
    )
    (CONNECT_DATA = (SERVICE_NAME = MYSERVICE))
  )

IFILE=/home/oracle/tnsnames_ifile.ora
```




```
YOURDBOX =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = 192.168.0.100)(PORT     = 1521))
    )
    (CONNECT_DATA = (SERVICE_NAME = YOURSERVICE))
  )
```

# What can go wrong... $TWO_TASK

- ”Two Task” = classic naming of Oracle for Client-Server-Communication
  Opposite: Bequeath Connect

- Can contain
  - TNS alias
  - TNS connect string
  - EZconnect string

- Is used INSTEAD OF bequeath connect
  (adds “@$TWO_TASK” to your “sqlplus user/pw”)

- In Windows: %LOCAL%

# What can go wrong... Connection Errors

```
SQL> connect sys/oracle@192.168.0.100:1521/freepdb1 as sysdba

ERROR:
ORA-12650: No common encryption or data integrity algorithm
```

# ONNE: Encryption and Hash Cipher

**Network Encryption** (protects from curious people, but not from data manipulation)

SQLNET.ENCRYPTION_{CLIENT|SERVER} → REJECTED, ACCEPTED, REQUESTED, REQUIRED

SQLNET.ENCRYPTION_TYPES_{CLIENT|SERVER} → AES128, AE192, AES256

**Network Data Integrity** (protects from altering data, but not from curious people)

SQLNET.CRYPTO_CHECKSUM_{CLIENT|SERVER} → REJECTED, ACCEPTED, REQUESTED, REQUIRED

SQLNET.CRYPTO_CHECKSUM_TYPES_{CLIENT|SERVER} → SHA256, SHA384, SHA512

Security: Min → Max

| | | SERVER SETTING | | | |
|---|---|---|---|---|---|
| | | REJECTED | ACCEPTED | REQUESTED | REQUIRED |
| CLIENT SETTING (Min → Max) | REJECTED | OFF | OFF | OFF | FAIL |
| | ACCEPTED | OFF | OFF | ON | ON |
| | REQUESTED | OFF | ON | ON | ON |
| | REQUIRED | FAIL | ON | ON | ON |

# ONNE: ezTLS (encryption-only, zero-configuration TLS)

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TLS-based Network Encryption Without Customer-Managed Certificates

SQLNET.ENCRYPTION_TYPES_{CLIENT|SERVER} → EZTLS, AES128, AE192, AES256
SQLNET.EZTLS → TRUE
SQLNET. TLS_CLIENT_AUTHENTICATION=OPTIONAL

19.33
23.26.4

Supported with client-driver versions:

| Client driver | Version |
|---|---|
| JDBC | 23.26.4 |
| python-oracledb (Thin mode) | 26.1.0 |
| OCI-C-based drivers | 19.33 and 23.26.4 |

https://docs.oracle.com/en/database/oracle/oracle-database/26/dbseg/configuring-eztls.html
https://docs.oracle.com/en/database/oracle/oracle-database/19/dbseg/configuring-eztls.html

# Analysis with SQL

```
WITH y AS (
    SELECT c.CON_ID, c.SID, c.Client_Version, c.Client_Charset, c.Authentication_Type,
           c.Client_OCI_Library, c.Client_Connection_String,
      /* Protokoll (TCP or TCPS) */
      CASE WHEN MAX(CASE WHEN c.Network_Service_Banner LIKE '%TCPS%' THEN 1 END) = 1 THEN 'TCPS' ELSE 'TCP' END AS Protocol,
      /* Encrpyption Algorithm or NONE - (26ai supported: AES128,192,256) */
      NVL(MAX(REGEXP_SUBSTR(c.Network_Service_Banner,'(AES128|AES192|AES256|3DES|DES|RC4)',1,1,'i')),'NONE') AS Encryption,
      /* Checksum Algorithmus or NONE - (26ai supported: SHA256,384,512) */
      NVL(MAX(REGEXP_SUBSTR(c.Network_Service_Banner,'(SHA256|SHA384|SHA512|MD5|SHA1)',1,1,'i')), 'NONE') AS Checksum
    FROM gv$session_connect_info c
    GROUP BY c.Con_ID, c.SID, c.Client_Version, c.Client_Charset, c.Authentication_Type,
             c.Client_OCI_Library, c.Client_Connection_String
)
SELECT * FROM (
    SELECT y.Protocol, s.Server, s.Service_Name, s.Port,
           y.Encryption, y.Checksum,
           y.Con_ID, y.SID, s.Serial#,
           y.Client_Version, y.Client_Charset, y.Authentication_Type, y.Client_OCI_Library,
           s.Username as DbUser , s.OsUser, s.Machine, s.Logon_Time, s.Status,
           s.Program,
           s.Module, s.Action, s.Client_Info, /* <== DBMS_APPLICATION_INFO */
           y.Client_Connection_String
      FROM gv$Session s, y
     WHERE y.SID = s.SID
       AND s.Type != 'BACKGROUND')
```

gv$session_connect_info

gv$session

# Analysis with SQL

26ai

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| PROTO | SERVER | SERVICE | PORT | ENCRYPTION | CHECKSUM | CID | SID | CLIENT_VER | CLIENT_CHARSET | AUTH_TYPE | OCI_LIBRARY | SERIAL# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCP | DEDICATED | SYS$USERS | 0 | NONE | NONE | 3 | 211 | 23.26.0.00.00 | Unknown | DATABASE | nknown | 17301 |
| TCP | DEDICATED | freepdb1 | 50770 | AES128 | SHA384 | 3 | 178 | 19.23.0.0.0 | US7ASCII | INTERNAL | ll Instant Client | 60970 |
| TCP | SHARED | freeXDB | 50764 | NONE | NONE | 1 | 210 | 19.23.0.0.0 | WE8MSWIN1252 | INTERNAL | F Instant Client | 43111 |
| TCP | DEDICATED | SYS$USERS | 0 | NONE | NONE | 1 | 212 | 23.26.0.00.00 | Unknown | DATABASE | Un nown | 42757 |
| TCP | DEDICATED | freepdb1 | 13432 | AES192 | SHA1 | 3 | 52 | 23.26.0.00.00 | US7ASCII | INTERNAL | Ho e-based | 48044 |
| TCP | DEDICATED | freepdb1 | 55638 | AES192 | SHA1 | 3 | 206 | 18.5.0.0.0 | AL32UTF8 | INTERNAL | Full stant Client | 46659 |
| TCP | DEDICATED | freepdb1 | 51163 | NONE | NONE | 3 | 16 | 19.23.0.0.0 | US7ASCII | INTERNAL | Full I stant Client | 43910 |
| TCP | SHARED | freeXDB | 50765 | NONE | NONE | 1 | 43 | 19.23.0.0.0 | WE8MSWIN1252 | INTERNAL | Full Ins tant Client | 4386 |
| TCP | DEDICATED | freepdb1 | 49793 | AES192 | SHA256 | 3 | 204 | 19.23.0.0.0 | US7ASCII | INTERNAL | Full Inst ant Client | 12824 |
| TCP | DEDICATED | freepdb1 | 51166 | NONE | NONE | 3 | 215 | 19.23.0.0.0 | US7ASCII | INTERNAL | Full Inst nt Client | 22026 |

| DBUSER | OSUSER | MACHINE | LOGON_TIME | STATUS | PROGRAM | MODULE | ACTION | CLIENT_INFO | CLIENT_CON_STRING |
|---|---|---|---|---|---|---|---|---|---|
| SYS | oracle | new-host-41 | 04.04.2026 18:49:17 | ACTIVE | oracle@new-host-41 (J001) | DBMS_SCHED | ORACLE_APE | | |
| SYS | myuser | mymachine | 04.04.2026 18:11:49 | INACTIVE | plsqldev.exe | PL/SQL Dev | SQL Window | | (DESCRIPTION=(ADDR |
| SYS | myuser | mymachine | 04.04.2026 18:11:10 | INACTIVE | plsqldev.exe | PL/SQL Dev | Primary Se | | (DESCRIPTION=(ADDR |
| | oracle | new-host-41 | 04.04.2026 18:51:25 | ACTIVE | oracle@new-host-41 (J002) | | | | |
| SYS | oracle | new-host-41 | 04.04.2026 12:00:17 | INACTIVE | sqlplus@new-host-41 (TNS | sqlplus@ne | | | (DESCRIPTION=(CONI |
| SYS | myuser | mymachine | 04.04.2026 18:02:40 | INACTIVE | sqlplus.exe | sqlplus.ex | | | (DESCRIPTION=(CONI |
| SYS | myuser | mymachine | 03.04.2026 18:12:57 | INACTIVE | plsqldev.exe | PL/SQL Dev | Primary Se | | (DESCRIPTION=(ADDR |
| SYS | myuser | mymachine | 04.04.2026 18:11:16 | ACTIVE | plsqldev.exe | PL/SQL Dev | SELECT * F | | (DESCRIPTION=(ADDR |
| SYS | myuser | mymachine | 04.04.2026 10:52:54 | INACTIVE | plsqldev.exe | PL/SQL Dev | SQL Window | Example | (DESCRIPTION=(ADDR |
| SYS | myuser | mymachine | 03.04.2026 18:13:09 | INACTIVE | plsqldev.exe | PL/SQL Dev | SQL Window | | (DESCRIPTION=(ADDR |

# What can go wrong... Connection Errors

```
SQL> connect sys/oracle@192.168.0.100:1521/freepdb1 as sysdba
ERROR:
ORA-28041: authentication protocol internal error
```

```
SQL> connect sys/oracle@192.168.0.100:1521/freepdb1 as sysdba
ERROR:
ORA-12699: Native service internal error occurred.
```

**ORA-28041**
authentication protocol internal error

| | |
|---|---|
| **Cause** | Authentication protocol failed with an internal error. |
| **Action** | Contact Oracle Support Services. |

**ORA-12699**
Native service internal error occurred.

| | |
|---|---|
| **Cause** | An internal error occurred in the native services component. |
| **Action** | Enable tracing to determine the exact error. Contact Oracle Support. |

**Client Version 23.5.0.24.07 => Fixed with 23.26.xx**

# War Story: Stealth Mode



Ping? No Pong.

SYN = Attack

A-Queue dead.

# CQN + Windows Firewall: One Client to rule them all

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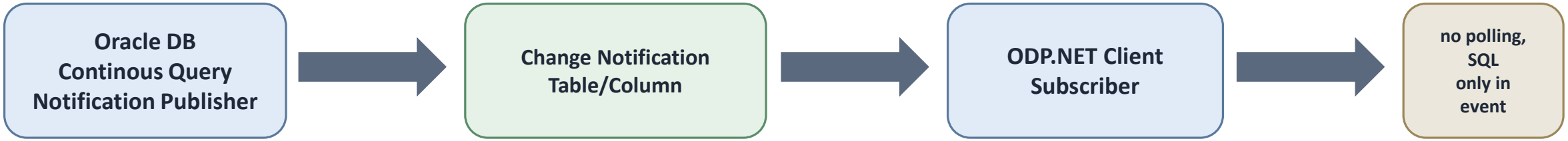
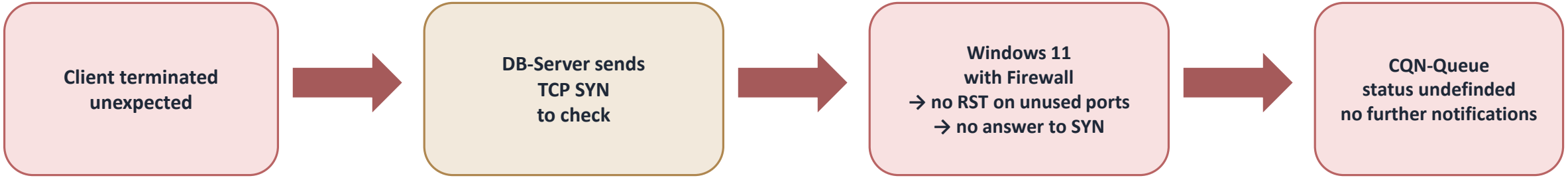
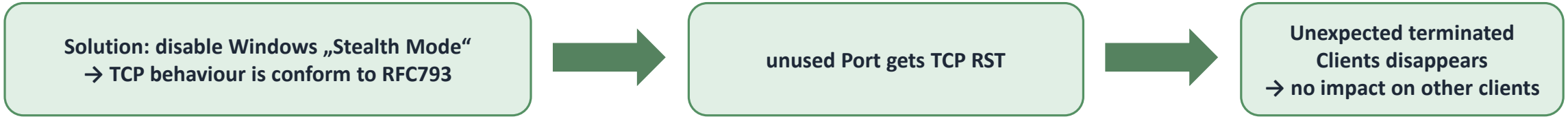



**Error**




Impact: Not only the „problem“ Client hangs, all other Clients are not able to get Change Notifications → manually intervention



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# Further reading ....

**Database Net Services Reference**

https://docs.oracle.com/en/database/oracle/oracle-database/26/netrf/index.html

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# THANK YOU VERY MUCH!

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