# PostgreSQL 9 High Availability With Linux-HA

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StormDB

# Agenda

- Introduction
- HA considerations
- PostgreSQL HA evolution
- Linux HA – components
- PostgreSQL streaming replication + Linux HA recipe
- Summary

# Who am I?

- Nikhil Sontakke
  - Architect and Founding member at StormDB
  - Responsible for the HA aspects of the StormDB product
  - PostgreSQL/Postgres-XC community member/contributor
  - Stints earlier at Veritas, EnterpriseDB

# HA - Definition

- What is High Availability (HA):
  - HA is a “concept”
  - A percentage of time that a given system is providing service since it has been deployed
  - For example: A system is 99% available if the downtime is 4 days in a year
  - Everyone craves for the five 9s (downtime of less than 5 minutes in a year – 99.999%)
  - HA is NOT designed for high performance
  - HA is NOT designed for high throughput (aka load balancing)

# HA – Why does it matter?

- Why do we bother with HA:
  - Downtime is expensive
  - You miss out on earnings due to the downtime
  - You bother because your boss might complain ;)
  - Users might not return!

# HA – wish our sysadmin is like this ;)

WE TOOK THE HOSTAGES, SECURED THE BUILDING, AND CUT THE COMMUNICATION LINES LIKE YOU SAID.
EXCELLENT.
BUT THEN THIS GUY CLIMBED UP THE VENTILATION DUCTS AND WALKED ACROSS BROKEN GLASS, KILLING ANYONE WE SENT TO STOP HIM.
AND HE RESCUED THE HOSTAGES?
NO, HE IGNORED THEM. HE JUST RECONNECTED THE CABLES WE CUT, MUTTERING SOMETHING ABOUT "UPTIME".
SHIT, WE'RE DEALING WITH A SYSADMIN.

xkcd.com/705

# PostgreSQL – HA evolution

- Log Shipping and Point In Time Recovery
  - PostgreSQL 8.1
  - Base backup of the database
  - Write Ahead Logs (WAL) sent to the standby

- Warm Standby
  - PostgreSQL 8.2
  - Continuously apply WAL on the standby

# PostgreSQL – HA evolution (contd...)

- HA using Logical Replication
  - Trigger/Event based replication systems
  - Slony (PG 7.3 onwards), Londiste, Bucardo

- HA using statement based replication
  - Pgpool-II (PG 6.4 onwards)
  - Intercept SQL queries and send to multiple servers

# PostgreSQL – HA evolution (contd...)

- HA using Shared Storage
  - Sharing disk array between two servers
  - SAN environment needed (very expensive)

- HA using Block-Device replication
  - All changes to a filesystem residing on a block device are replicated to a block device on another system
  - DRBD pretty popular

# PostgreSQL – HA latest...

- HA using Streaming Replication
  - Standby can be a HOT one to serve read only queries as well
  - Synchronous streaming available to have almost zero lag with the primary

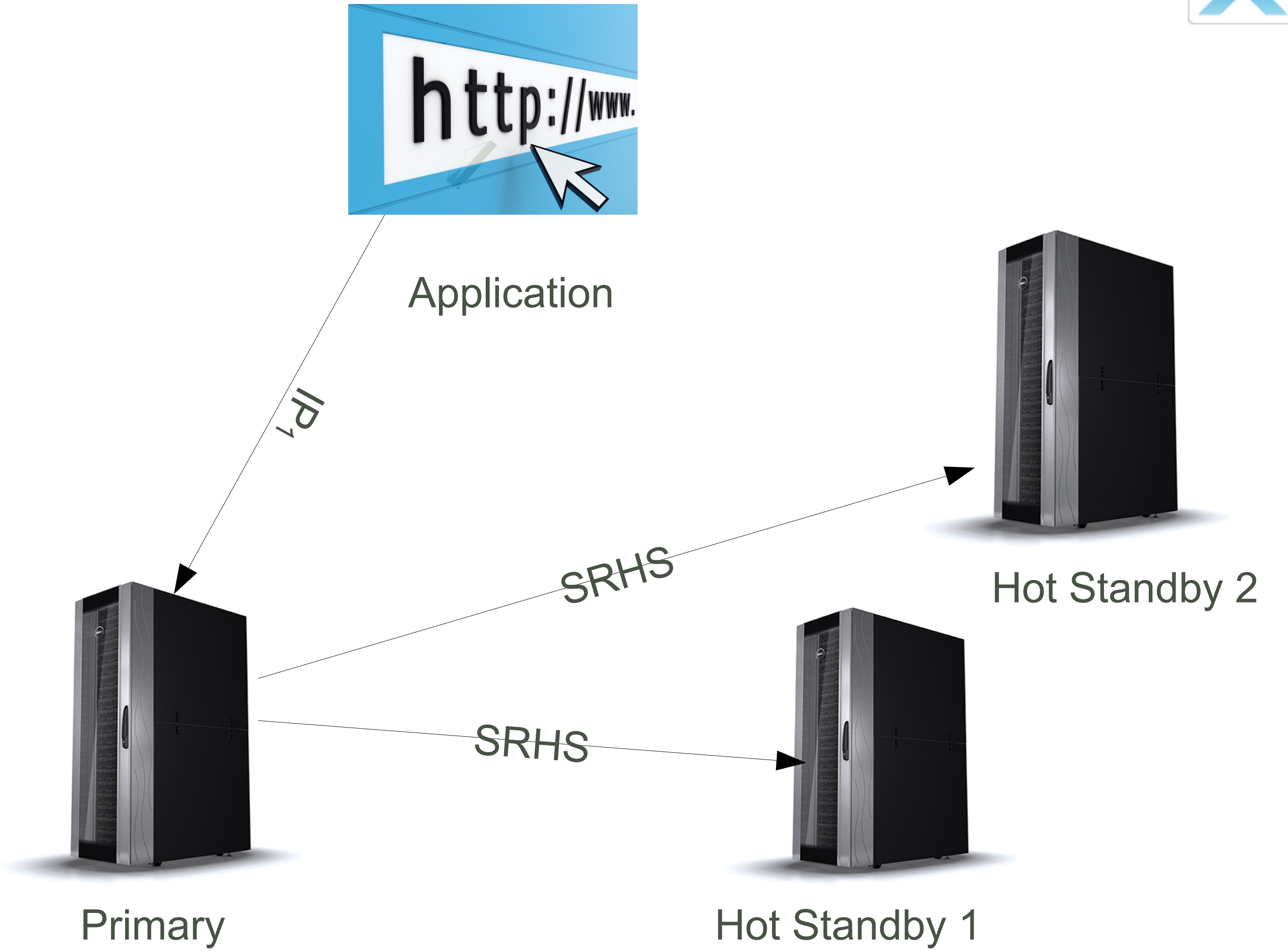
- HA using Multi-master clusters
  - Postgres-XC coordinator and datanodes

- All solutions mentioned need an “external” HA infrastructure to manage failover

# PostgreSQL – HA not in-built

- HA not in-built/in-core in PostgreSQL
- PostgreSQL provides the means, mechanisms and building blocks to get a HA system in place
- External monitoring and cluster management tools needed to come up with a “working” HA solution

# PostgreSQL – Streaming Replication Scenario



Application

IP$_1$

SRHS

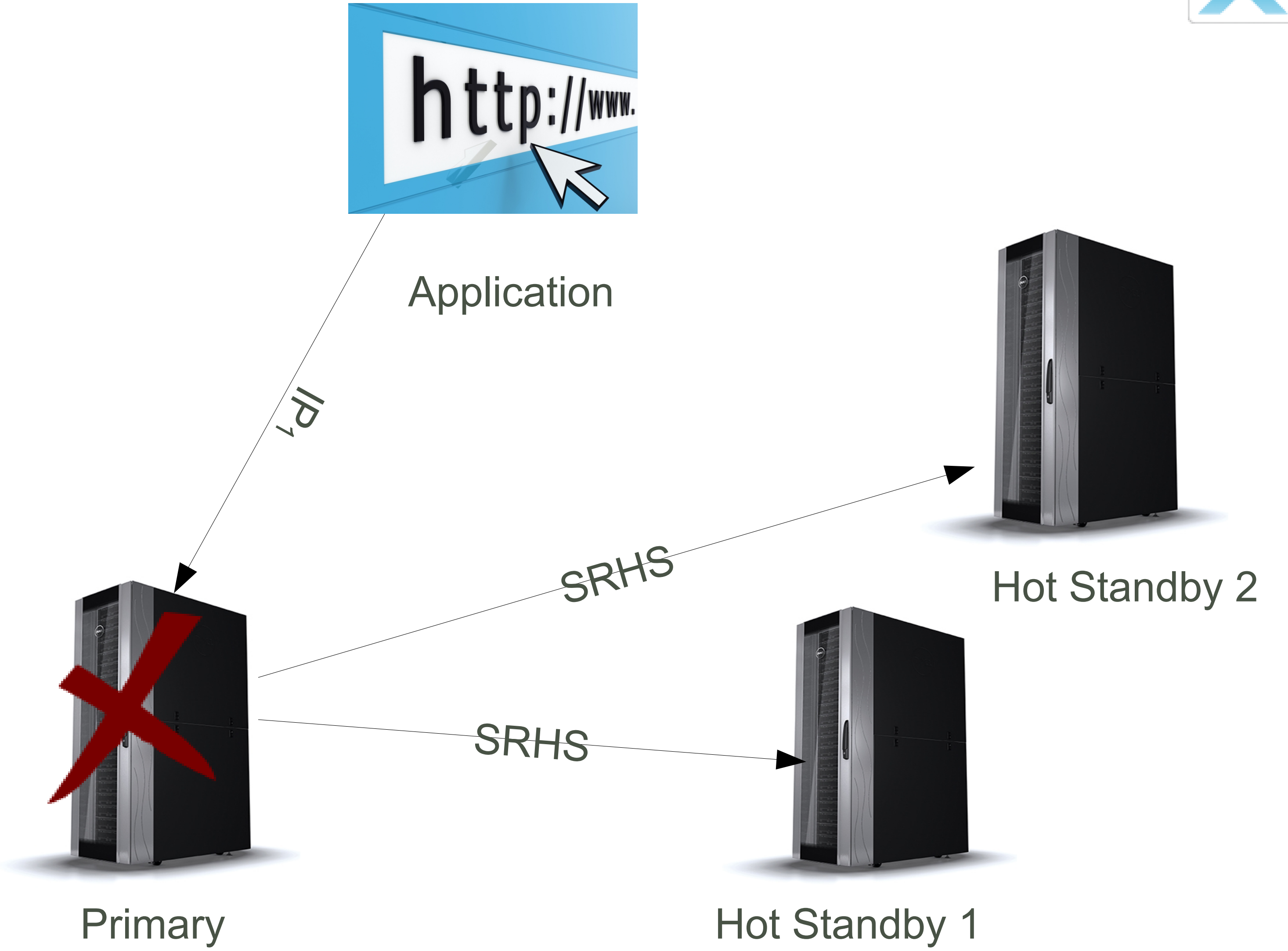
SRHS

Primary

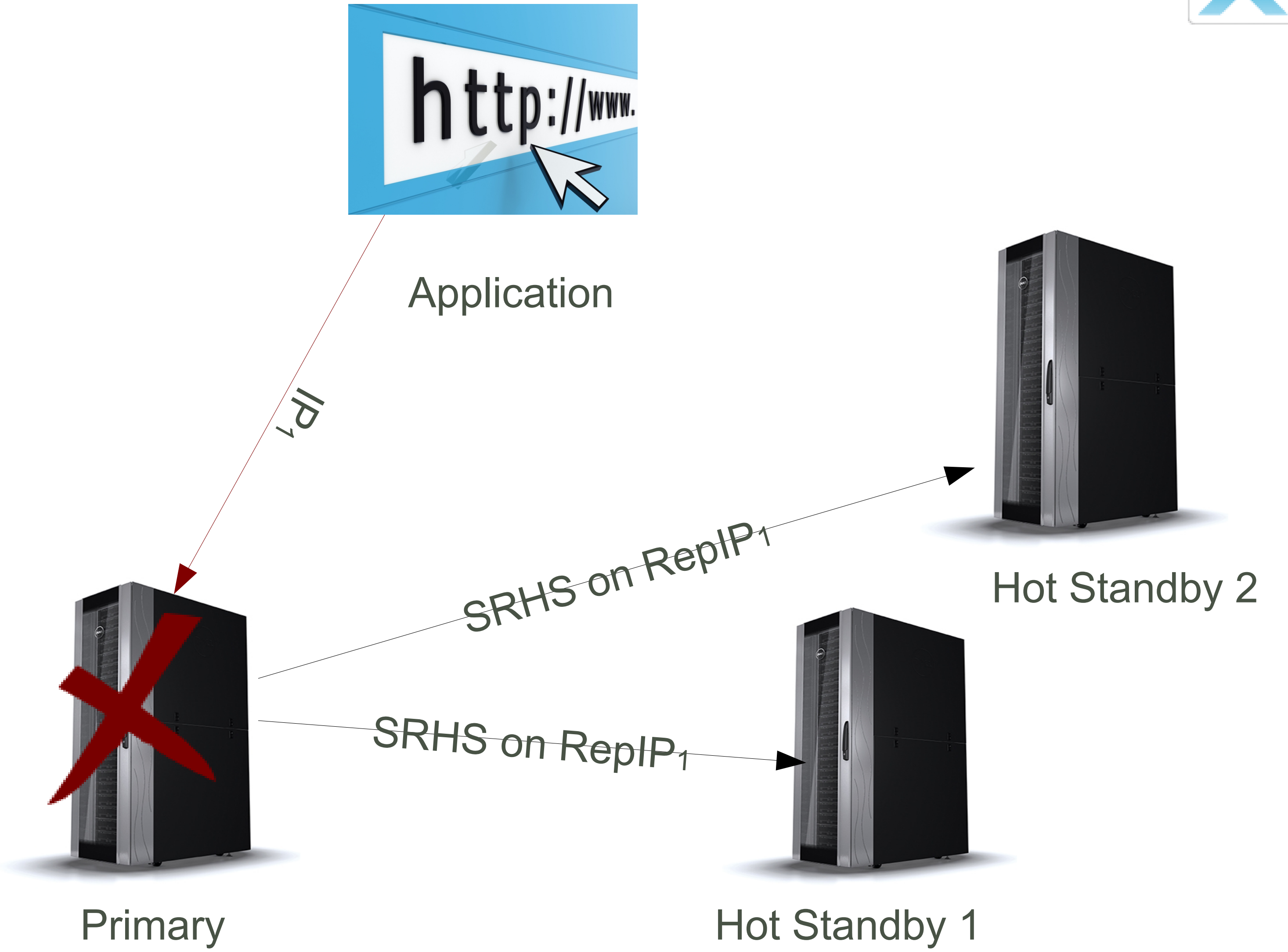
Hot Standby 1

Hot Standby 2

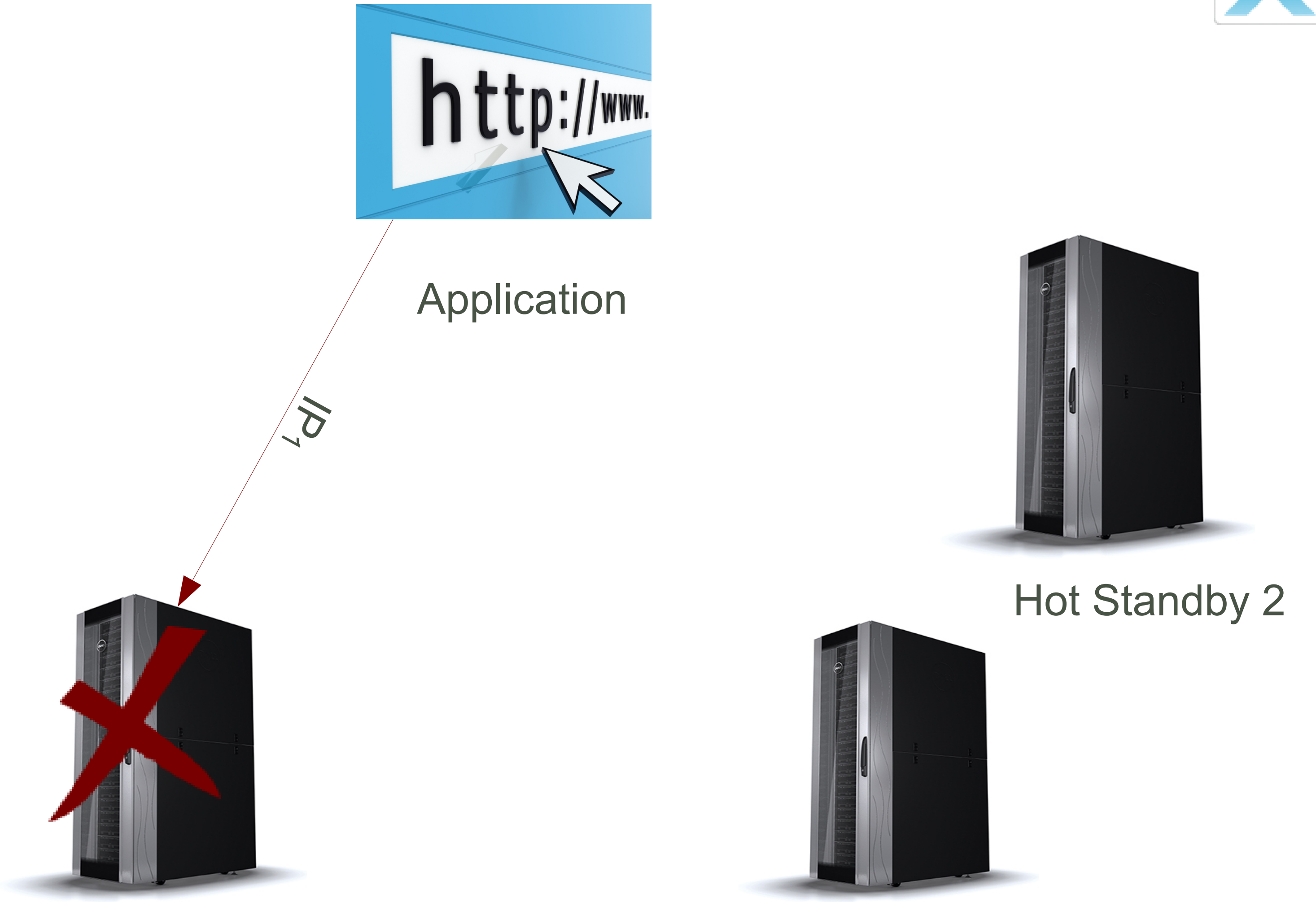
# PostgreSQL – Streaming Replication Scenario



# PostgreSQL – Streaming Replication Scenario



# PostgreSQL – Streaming Replication Scenario



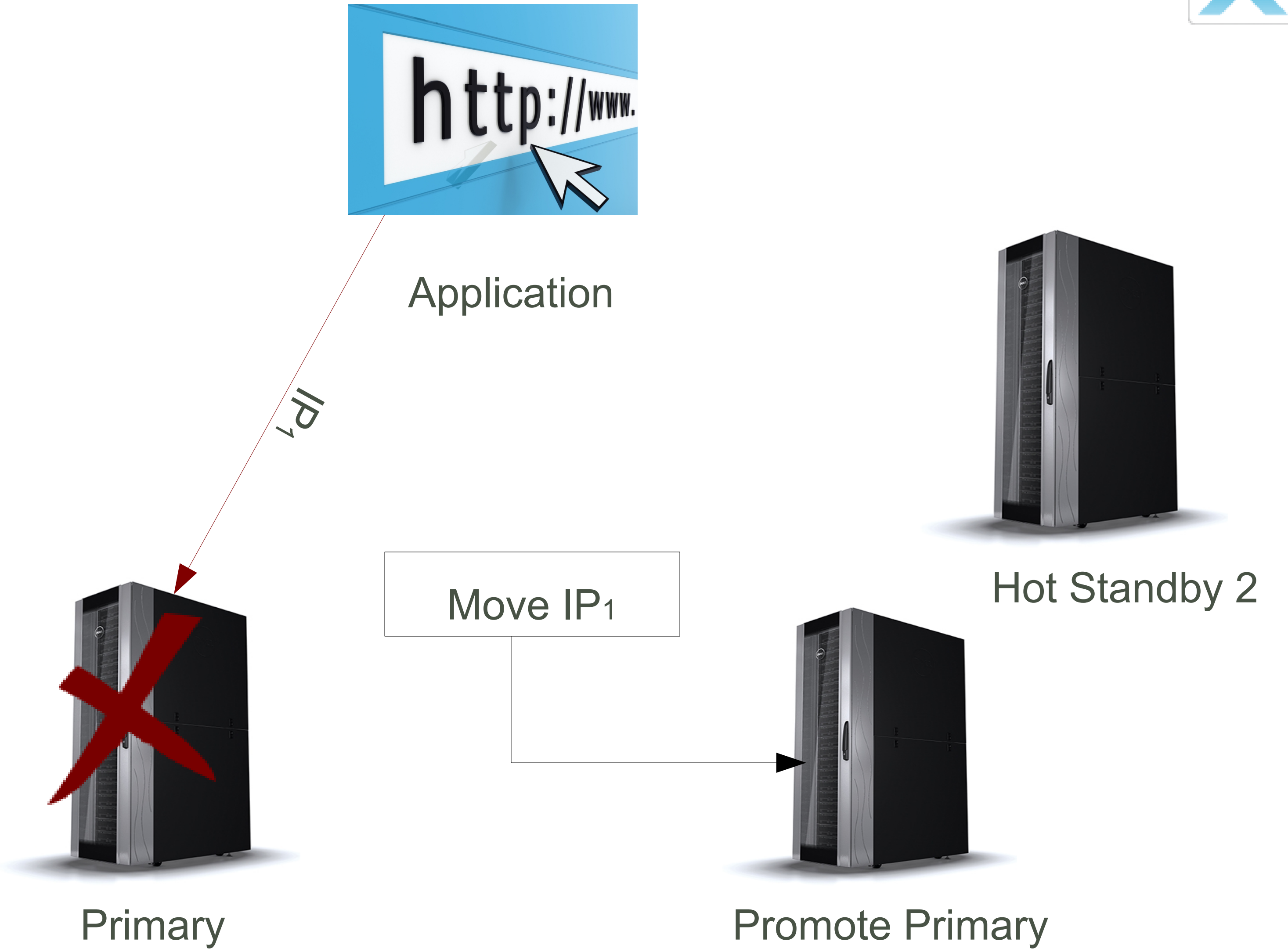
Application

Hot Standby 2

Primary

Promote Primary

# PostgreSQL – Streaming Replication Scenario



Application

IP1

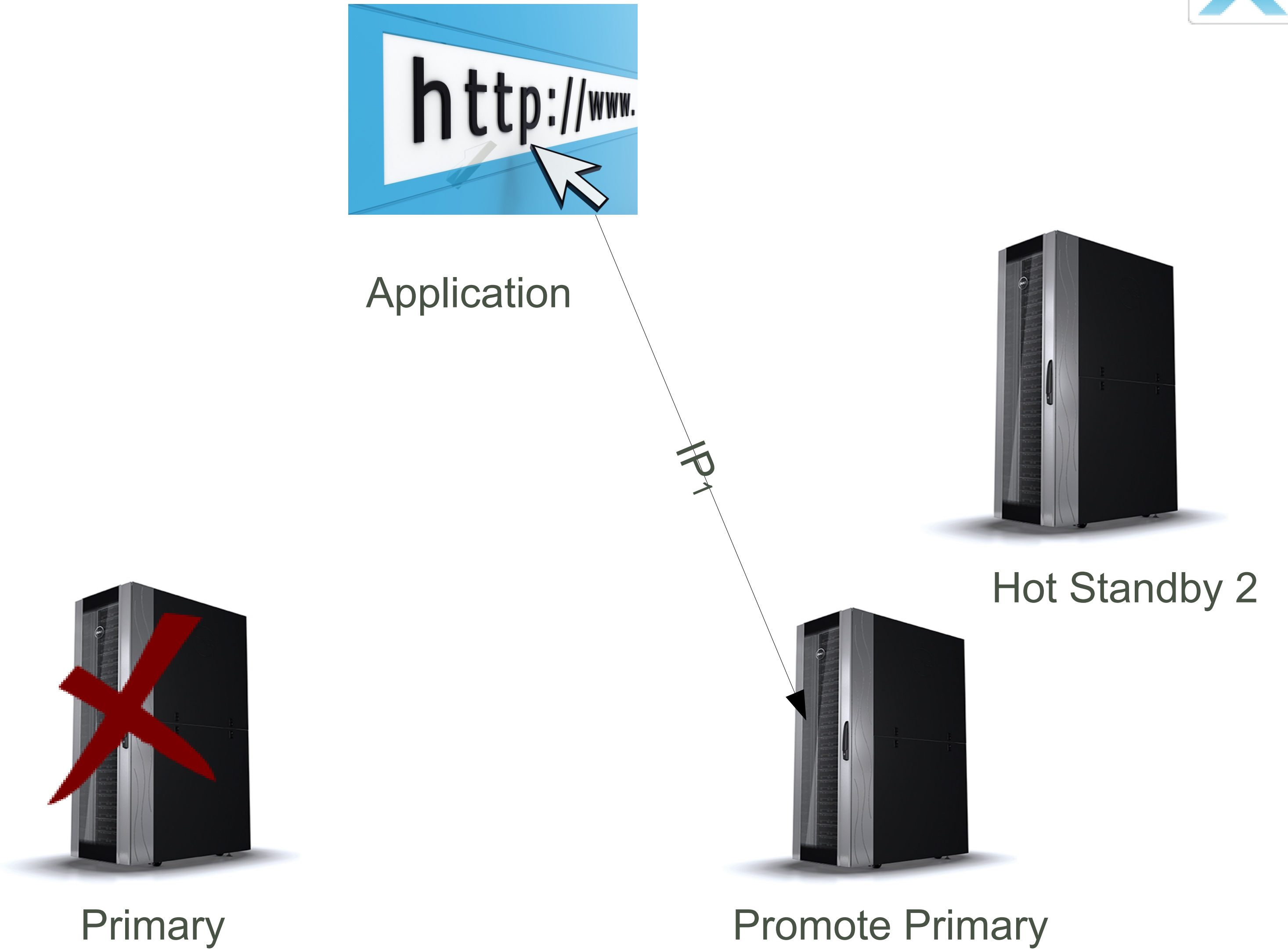
Hot Standby 2

Move IP1

Primary

Promote Primary

# PostgreSQL – Streaming Replication Scenario



Application

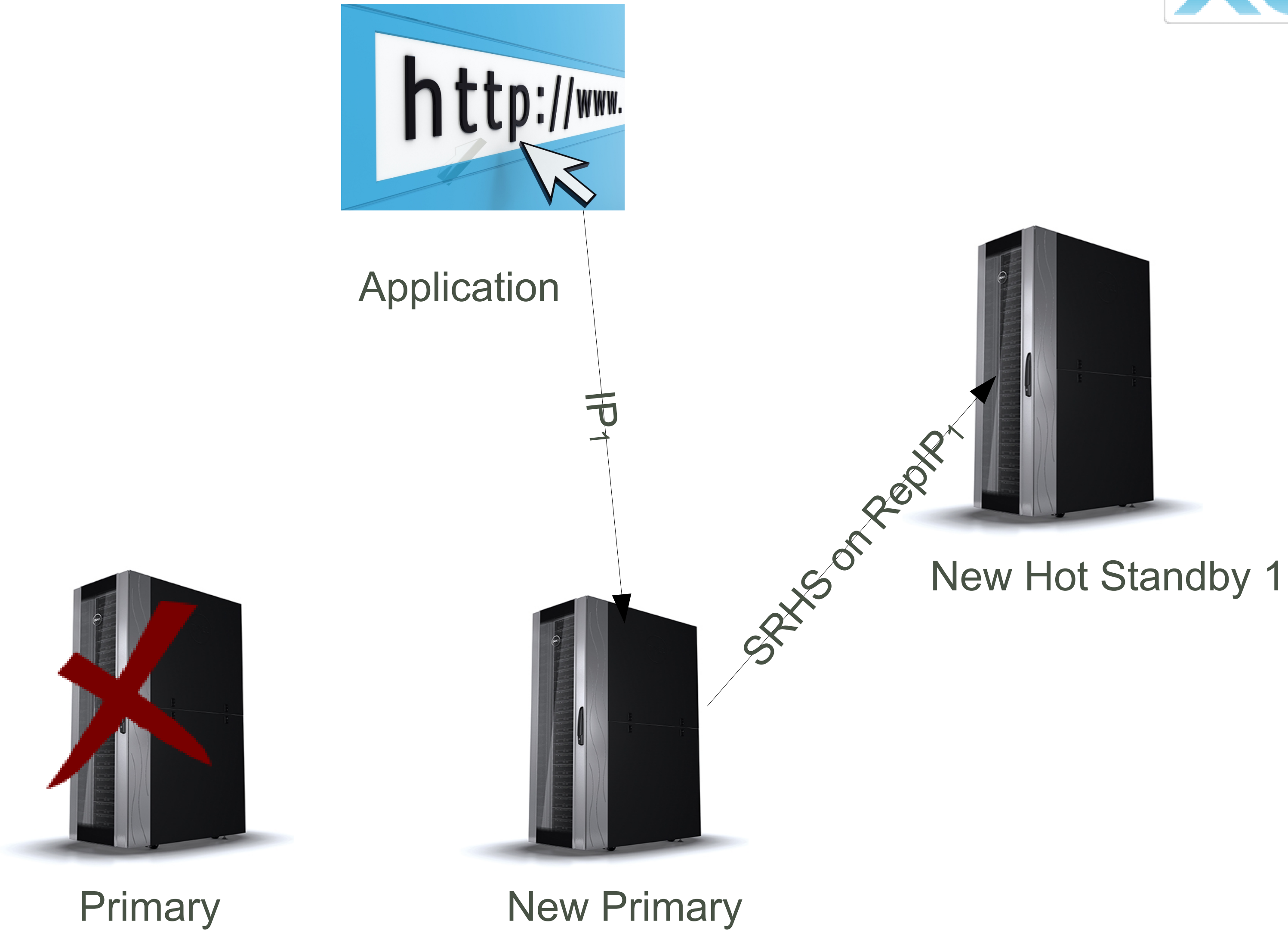
IP$_1$

Hot Standby 2

Primary

Promote Primary

# PostgreSQL – Streaming Replication Scenario – Bonus!



Application

$IP_1$

SRHS on $RepIP_1$

New Hot Standby 1

Primary

New Primary

# PostgreSQL SR – HA requirements

- The Application should be able to connect to the database on a fixed IP address
- There should be a monitor running on the Primary and Standby nodes checking for running PG processes
- The monitor should first try to re-start PG if not running on the nodes configurable by a failure count
- In case if the node running the primary goes down for whatever reason exactly one of the Standby nodes should be promoted to Primary

# PostgreSQL SR – HA requirements (contd)

- The IP address should move to the new node only after it has been promoted to be the new master
- It will be good to have the surviving standby connect to the new master and re-start the replication process
- Obviously all of the above should be done “automatically” without manual intervention via the clustering infrastructure :)

# Introducing Linux-HA!

- The Linux-HA project is a high-availability clustering solution for Linux, FreeBSD, Solaris, etc.
- It has been around since quite a while (1999) and is increasingly gaining traction in Linux environments
- Suse Linux Enterprise Server (SLES) uses it as default clustering layer. RedHat also warming up to it in recent releases. Rpms available for Fedora, RHEL, Ubuntu etal

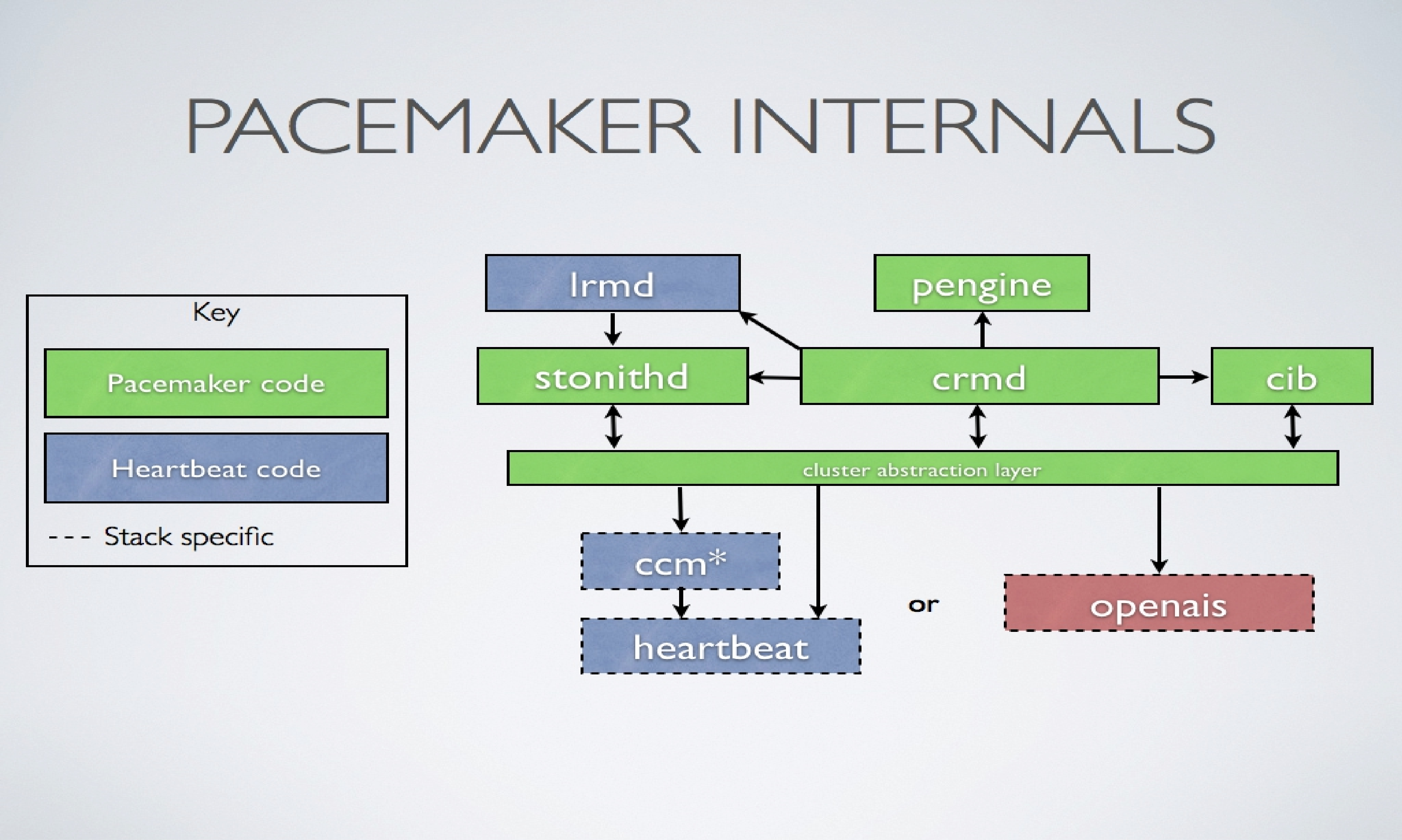
# Linux-HA – Latest Version Components

- Messaging Layer via Heartbeat/Corosync:
  - Node membership and notifications of nodes joining/leaving
  - Messaging between the nodes
  - A quorum system
- Cluster resource manager (crm) via Pacemaker:
  - Stores the configuration of the cluster
  - Uses the messaging layer to achieve maximum availability of your resources
  - Extensible: Anything that can be scripted can be managed by Pacemaker

# Linux-HA – Latest Version Components

- Cluster Glue
  - Stuff that is neither cluster messaging (Corosync) nor CRM (Pacemaker)
  - Local node resource manager to interface with resource agents
  - STONITH daemon to provide fencing
- Resource Agents
  - Agent to manage a cluster resource
  - Support operations like start, stop, monitor, promote, demote etc.
  - Readymade agents available to manage resources like Apache, PostgreSQL, drbd etc

# Linux-HA – The BIG picture (Whoops!)



PACEMAKER INTERNALS

Key

Pacemaker code

Heartbeat code

--- Stack specific

lrmd

pengine

stonithd

crmd

cib

cluster abstraction layer

ccm*

heartbeat

or

openais

# Linux-HA – PostgreSQL resource agent

- The latest PostgreSQL resource agent is available at:

  https://raw.github.com/ClusterLabs/resource-agents/master/heartbeat/pgsql

  **CAUTION: this is a bleeding edge, BETA agent. Used here JUST as an example for the talk. YMMV!**

- It follows the OCF (Open Cluster Framework) specifications

- The latest version is a Master/Slave resource agent supporting streaming replication (added by Takatoshi Matsuo)

# Linux-HA – Warning! Eyes will HURT ;) :P

https://i.chzbgr.com/maxW500/6591864832/hC8B27BD6/

# Linux-HA – Planning

- Create data directory on one node
- Setup the postgresql.conf, pg_hba.conf configuration files for replication
  - wal_level = hot_standby
  - max_wal_senders, wal_keep_segments
  - hot_standby = on, etc..
- Do a basebackup onto the other node
- No need to create recovery.conf file for the Standby. The RA creates it itself
- Check https://github.com/t-matsuo/resource-agents/wiki/Resource-Agent-for-PostgreSQL-9.1-streaming-replication for inspiration

# Linux-HA – Resource definitions

- The Linux HA configuration can be specified using the crm cli
  - crm configure edit (as root)
- Define a master public IP resource to which applications will connect to:

```
primitive vip-master ocf:heartbeat:IPaddr2 \
    params ip="192.168.168.108" nic="eth0"
    cidr_netmask="24" \
    op start interval="0s" timeout="60s" on-fail="stop" \
    op monitor interval="10s" timeout="60s" on-fail="restart" \
    op stop interval="0s" timeout="60s" on-fail="block"
```

# Linux-HA – Resource definitions (contd...)

- Define a replication IP resource to which slaves will connect to:

```
primitive vip-rep ocf:heartbeat:IPaddr2 \
    params ip="192.168.168.109" nic="eth0"
    cidr_netmask="24" \
    op start interval="0s" timeout="60s" on-fail="stop" \
    op monitor interval="10s" timeout="60s" on-fail="restart" \
    op stop interval="0s" timeout="60s" on-fail="block"
```

- You can create an additional IP resource to allow reads to be queried from Standby nodes as well

# Linux-HA – Resource definitions (contd...)

- The IP used for replication will shift along with the master IP whenever a standby is promoted.
- This allows other existing standbys to re-connect on this replication IP to the new Master.
- We use a “group” to keep them together:

```
group master-group vip-master vip-rep \
        meta ordered="false"
```

# Linux-HA – Resource definitions (contd...)

- Define the resource to control the PostgreSQL servers on the node:

```
primitive pgsql ocf:heartbeat:pgsql \
    params repuser="stormdb" pgdba="stormdb" pgport="5472"
    pgctl="/opt/PostgreSQL/bin/pg_ctl" psql="/opt/PostgreSQL/bin/psql"
    pgdata="/data/PostgreSQL/data/" start_opt="-p 5472"
    rep_mode="sync" node_list="stormtest1 stormtest3"
    master_ip="192.168.168.109" stop_escalate="0" \
    op start interval="0s" timeout="60s" on-fail="restart" \
    op monitor interval="7s" timeout="60s" on-fail="restart" \
    op monitor interval="2s" role="Master" timeout="60s" on-fail="restart" \
    op promote interval="0s" timeout="60s" on-fail="restart" \
    op demote interval="0s" timeout="60s" on-fail="stop" \
    op stop interval="0s" timeout="60s" on-fail="block" \
    op notify interval="0s" timeout="60s"
```

# Linux-HA – Resource definitions (contd...)

- Create a master/slave configuration using the just specified pgsql resource

```
ms msPostgresql pgsql \
        meta \
        master-max="1" \
        master-node-max="1" \
        clone-max="2" \
        clone-node-max="1" \
        notify="true"
```

# Linux-HA – Resource definitions (contd...)

- The “group” of the IP resources should always co-locate with the Master. Specify that

```
colocation rsc_colocation-1 \
    inf: master-group  msPostgresql:Master
```

- The IP addresses should be started ONLY after a MASTER has been chosen properly. We specify the same via resource ordering:

```
  order rsc_order-1 0: msPostgresql:promote master-
group:start symmetrical=false
```

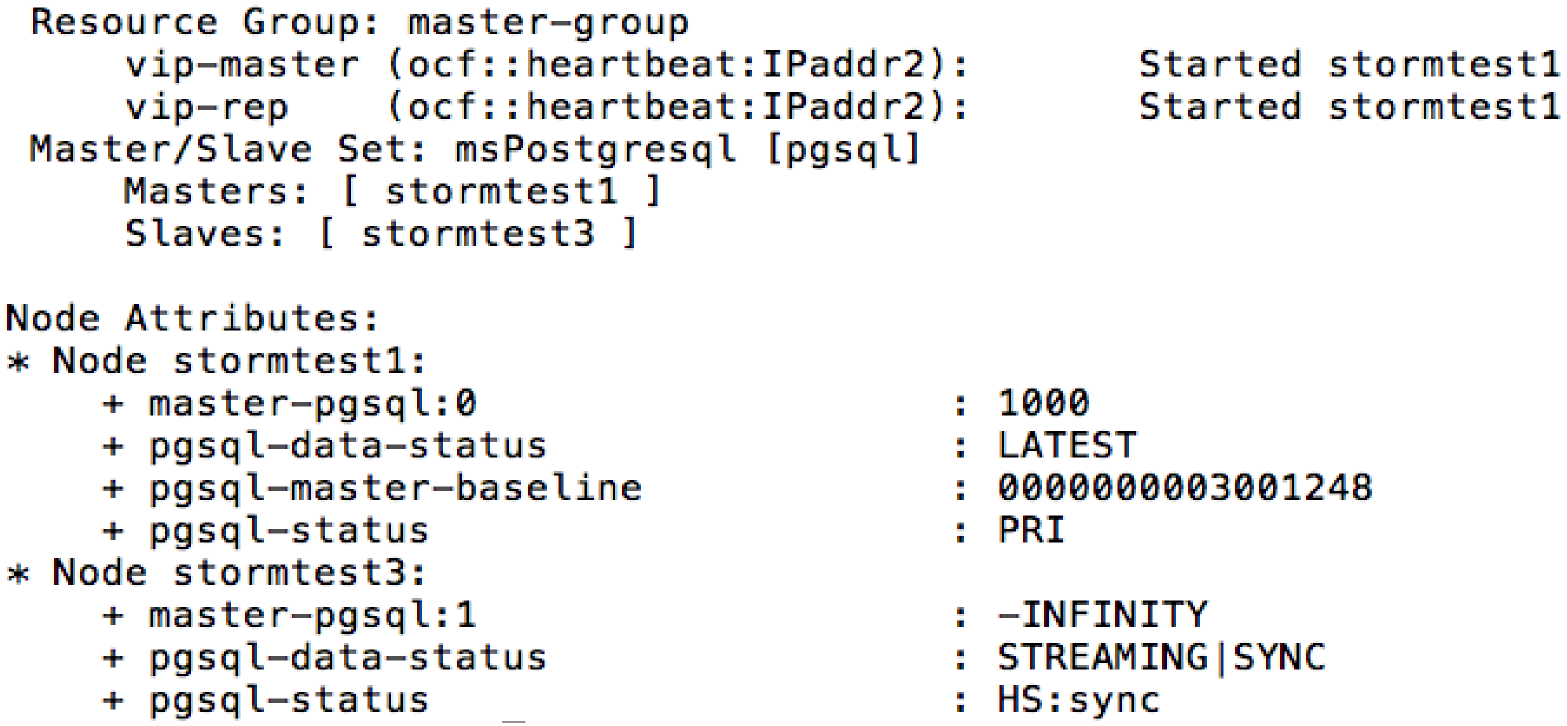
# Linux-HA – Resource definitions (contd...)

- Done!!
- Save the configuration by quitting the 'crm configure edit' window
- Check that there are no syntax or other errors while quitting
- Now take a deep breath, wipe off the sweat of your brow and invoke the command to start the cluster:

```
crm resource start msPostgresql
```

# Linux-HA - Results

- Check if the HA cluster is up and running properly by issuing “crm_mon -1r -A”



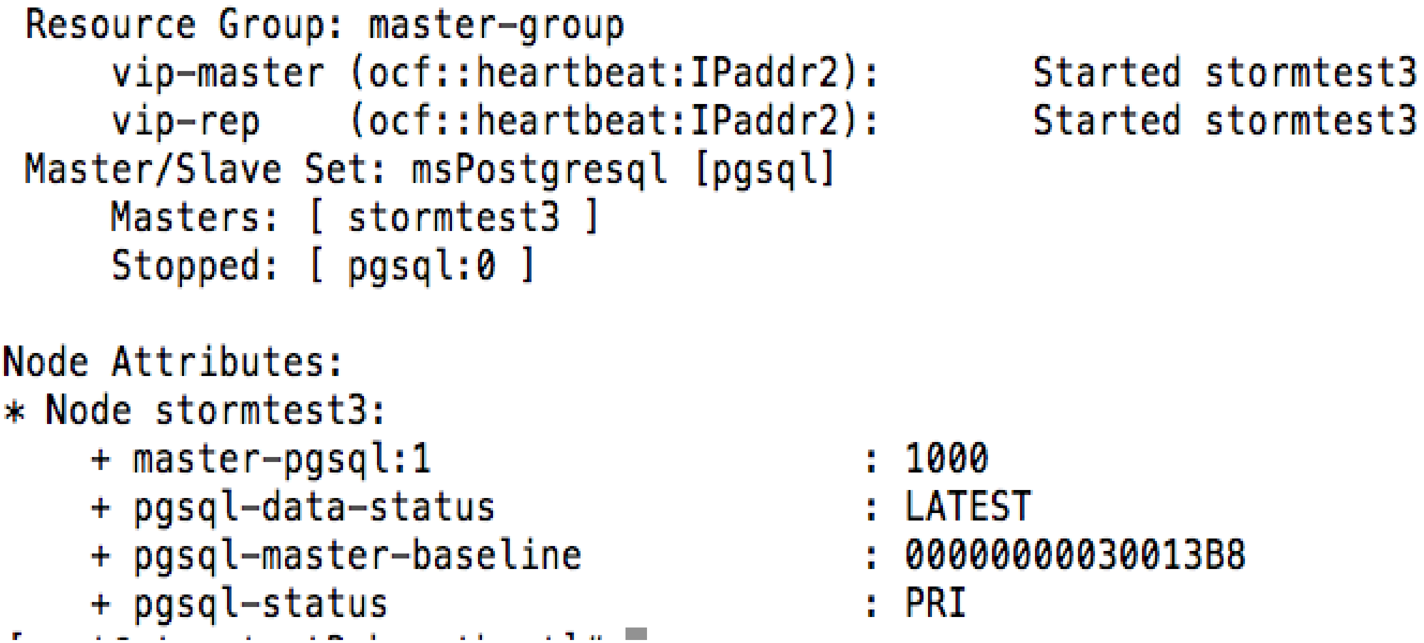
```
 Resource Group: master-group
     vip-master (ocf::heartbeat:IPaddr2):        Started stormtest1
     vip-rep    (ocf::heartbeat:IPaddr2):        Started stormtest1
 Master/Slave Set: msPostgresql [pgsql]
     Masters: [ stormtest1 ]
     Slaves: [ stormtest3 ]

Node Attributes:
* Node stormtest1:
    + master-pgsql:0                    : 1000
    + pgsql-data-status                 : LATEST
    + pgsql-master-baseline             : 0000000003001248
    + pgsql-status                      : PRI
* Node stormtest3:
    + master-pgsql:1                    : -INFINITY
    + pgsql-data-status                 : STREAMING|SYNC
    + pgsql-status                      : HS:sync
```

# Linux-HA – Test!!

- Test, Test, TEST!
- Pull out network cables
- Power off nodes
- Use iptables to cause networking split brains

# Linux-HA – Test Failover

- Stop the “corosync” service on one node. Check on the other node “crm_mon -1r -A”:



```
 Resource Group: master-group
     vip-master (ocf::heartbeat:IPaddr2):       Started stormtest3
     vip-rep    (ocf::heartbeat:IPaddr2):       Started stormtest3
 Master/Slave Set: msPostgresql [pgsql]
     Masters: [ stormtest3 ]
     Stopped: [ pgsql:0 ]

Node Attributes:
* Node stormtest3:
    + master-pgsql:1                            : 1000
    + pgsql-data-status                         : LATEST
    + pgsql-master-baseline                     : 00000000030013B8
    + pgsql-status                              : PRI
```

It works!

# PostgreSQL 9.x + Linux-HA == WIN!

- PostgreSQL 9.x provides the super cool streaming replication feature

- Linux HA has all the bells and whistles to provide a comprehensive HA infrastructure

- This gives you a full blown HA solution in place using purely awesome Open Source components

- Sure brings you closer to the 99.999% desired availability!

# Further reading

- http://www.linux-ha.org (Linux HA homepage)
- http://clusterlabs.org/ (for Pacemaker)
- http://corosync.github.io/corosync/ (Corosync)
- http://www.linux-ha.org/wiki/Resource_Agents (various supported resource agents)
- https://github.com/t-matsuo/resource-agents/wiki/Resource-Agent-for-PostgreSQL-9.1-streaming-replication

# Questions?

Questions?!

Thanks,

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