Efficiently Backing up Terabytes of Data with pgBackRest

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Crunchy Data

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Agenda

Why Backup?

- Hardware Failure:
  - No amount of redundancy can prevent it.
- Replication:
  - WAL archive for when async streaming gets behind.
  - Sync replica from backup instead of master.
- Corruption:
  - Can be caused by hardware or software.
  - Detection is, of course, a challenge.

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- Accidents:
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  - Deleted your most important account?
- Development:
  - No more realistic data than production!
  - May not be practical due to size / privacy issues.
- Reporting:
  - Use backups to standup an independent reporting server.
  - Recover important data that was removed on purpose.

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Schrödingers Backup

The state of any backup is unknown until a restore is attempted.

Making Backups Useful

- Find a way to use your backups
  - Syncing / New Replicas
  - Offline reporting
  - Offline data archiving
  - Development
- Unused code paths will not work when you need them unless they are tested
  - Regularly scheduled automated failover using backups to restore the old primary
  - Regularly scheduled disaster recovery (during a maintenance window if possible) to test restore techniques

pgBackRest Design

- Rsync powers many database backup solutions but it has some serious limitations:
  - Single-process.
  - One second timestamp resolution.
  - Incremental backups require previous backup to be uncompressed.
- pgBackRest does not use rsync, tar or other typical backup tools:
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Multi-Process Backup & Restore

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Full, Incremental, & Differential Backups

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  - Full
  - Differential
  - Incremental
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Backup Rotation & Archive Expiration

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- WAL retention for all backups or configure number of recent backups.
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Backup Integrity

- PostgreSQL page checksums are validated if present ($\geqslant$ 9.3).
- Checksums are calculated for every file in the backup and rechecked during a restore.
- After a backup required WAL segments are checked in the repository.
- Simple backup format:
  - Backup directories have the same format as a PostgreSQL cluster.
  - Clusters can be brought up in place with snapshots if compression is disabled.
  - Advantageous for terabyte-scale databases.
- All operations utilize file and directory level fsync to ensure durability.

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Delta Restore

- Backup manifest contains checksum and size for every file.
- On delta restore all files not present in the backup or with a different size are removed from PGDATA.
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Advanced Parallel Archiving

- Dedicated commands are included for both pushing WAL to the archive and retrieving WAL from the archive.
- Push command automatically detects WAL segments that are pushed multiple times and de-duplicates when the segment is identical, otherwise an error is raised.
- Push and get commands both ensure that the database and repository match by comparing PostgreSQL versions and system identifiers to prevent misconfiguration.
- Asynchronous parallel archiving allows compression and transfer to be offloaded to another process which maintains continuous connections to the remote server, improving throughput significantly.
    - Critical feature for databases with extremely high write volume.

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Tablespace & Link Support

- Tablespaces are fully supported and on restore tablespaces can be remapped to any location.
- Remap all tablespaces to one location with a single command which is useful for development restores.
- File and directory links are supported for any file or directory in the PostgreSQL cluster.
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Compatibility with PostgreSQL $\geqslant$ 8.3

- Support for versions down to 8.3, since older versions of PostgreSQL are still regularly utilized.

Performance

Parameters	pgBackRest	rsync
processes: 1 network compression: l3 destination compression: none	141 Seconds	124 Seconds (.13X Faster)
processes: 2 network compression: l3 destination compression: none	84 Seconds (1.48X Faster)	N/A
processes: 1 network compression: l6 destination compression: l6	334 Seconds (1.52X Faster)	510 Seconds
processes: 2 network compression: l6 destination compression: l6	174 Seconds (2.93X Faster)	N/A

Changes to Core

- Completed
  - Exclude files/directories reset or rebuilt on recovery.
  - Make pg_stop_backup() wait optional.
  - Non-exclusive backups (Magnus Hagander).
  - Archive timeout fix (Michael Paquier).
- Planned
  - More exclusions.
  - Allow group read on $PGDATA.
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Questions?

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email: david@pgbackrest.org
email: david@crunchydata.com

releases: `https://github.com/pgbackrest/pgbackrest/releases`

slides & demo: `https://github.com/dwsteele/conference/releases`