

Cloud based Media Files Storage Service – Detailed Project Specification - Web

A full, practical spec you can hand to a team or use solo. It covers goals, scope, user stories, architecture, schema, APIs, security, deployment, and a milestone plan. Tailored for a Next.js frontend, Node/Express backend, PostgreSQL (via Supabase) and object storage (Supabase Storage or S3).

1) Executive Overview

A cloud file storage and sharing web app with auth, folders, file upload/download, search, and granular sharing. Think “Google Drive core” with a clean UI, strong access controls, and scalable storage. The MVP focuses on reliability and simplicity; advanced features (versioning, previews, activity logs) are staged for later sprints.

Primary stakeholders: end users (individuals/teams), admin (platform owner).

Non-goals (MVP): Office editors, real-time doc co-editing, complex org hierarchy, desktop sync client.

2) Feature Scope

2.1 Core (MVP)

- Email/OAuth authentication, sessions, and profile.
- Folder CRUD (create, rename, move, delete), hierarchical tree, breadcrumbs.
- File upload (drag & drop, picker), download, rename, move, delete.
- Share to users (Viewer/Editor), revoke, list who has access.
- Public share links with expiry (optional password).
- Search by name/type/owner, sort and filters.

- Recent files, Starred/Favorites. (Optional)
- Trash with retention window (e.g., 30 days) and restore.

2.2 Phase 2+ (Nice-to-have)

- Version history (keep current pointer + archived versions).
 - File previews (images, PDFs, basic text) with thumbnails.
 - Activity/audit log.
 - Tags/labels, bulk actions, keyboard shortcuts.
 - Advanced search (content indexing later), shared drives/teams.
 - Quotas and usage dashboard.
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3) User Roles & Permissions

- **Owner:** full control over their files/folders.
- **Editor:** upload, edit metadata, move, delete within shared items.
- **Viewer:** read/download only.
- **Public link holder:** constrained by link settings (view-only by default), optional password, expiry.

Permission checks run **server-side** for every operation, enforced at API and storage-layer policy.

4) User Stories (selected)

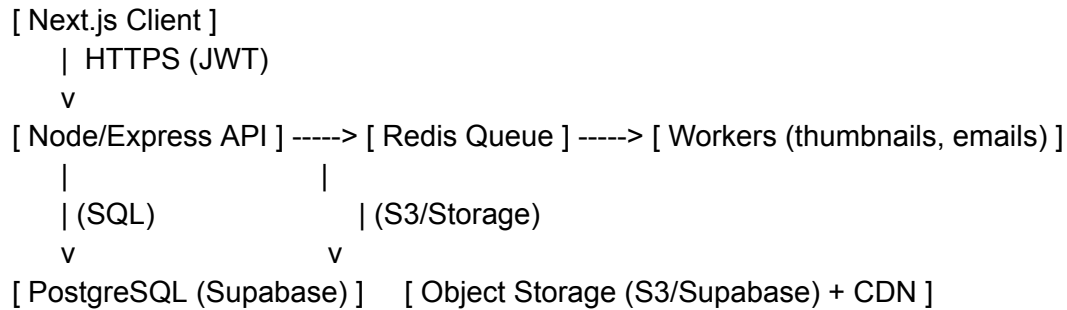
- As a user, I can sign up/sign in and stay logged in securely.
 - As a user, I can upload files via drag & drop and see progress.
 - As a user, I can create folders, move items, and navigate with breadcrumbs.
 - As a user, I can share a folder with a teammate as Viewer/Editor.
 - As a user, I can generate a public link with expiry to share a file.
 - As a user, I can search across my files and sort by name/date/size.
 - As a user, I can star important items and find them quickly.
 - As a user, I can restore a deleted item from Trash within 30 days.
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5) System Architecture

5.1 Recommended Stack

- **Frontend:** Next.js (App Router), React, Tailwind CSS, TanStack Query, React DnD, Upload library (Uppy/Tus or native + presigned URLs).
- **Backend:** Node.js + Express.js (REST), Multer (small uploads) or presigned URL flow for large uploads.
- **Database:** PostgreSQL (Supabase managed) for metadata, relations, ACL, and search indices.
- **Object Storage:** Supabase Storage (RLS policies) or Apprite or Convex or Firebase
- **Auth:** Supabase Auth or Clerk/NextAuth (JWT + refresh, httpOnly cookies).
- **CDN:** Supabase CDN or CloudFront for file delivery.
- **Background tasks:** lightweight queue (BullMQ + Redis) for thumbnails, virus scan (optional), email invites.

5.2 High-Level Diagram (ASCII)



5.3 Key Flows (Sequence)

Upload (presigned/multipart):

1. Client requests upload-init → API checks auth/ACL → creates DB placeholder row (status: "uploading"), returns key + presigned URLs (or upload token for Supabase Storage).
2. Client uploads parts directly to storage (progress tracked client-side).
3. Client calls upload-complete → API verifies parts/etag → finalizes DB row (status: "ready"), enqueues thumbnail job.

Download: Client requests → API checks ACL → returns short-lived signed URL → client downloads from CDN.

Share: Owner POST /shares → create ACL entry (user_id/role or link token with expiry/password hash).

Search: GET /search?q=...&filters=... → uses indexed columns and Postgres full-text/trigram for fast results.

6) Data Model (PostgreSQL ERD)

6.1 Tables

users

- id (uuid, pk)
- email (text, unique, indexed)
- name (text)
- image_url (text, nullable)
- created_at (timestampz, default now())

folders

- id (uuid, pk)
- name (text, indexed)
- owner_id (uuid → users.id, indexed)
- parent_id (uuid → folders.id, nullable, indexed)
- is_deleted (bool, default false)
- created_at (timestampz)
- updated_at (timestampz)

files

- id (uuid, pk)
- name (text, indexed)
- mime_type (text)
- size_bytes (bigint)
- storage_key (text, unique) // path in bucket

- owner_id (uuid → users.id, indexed)
- folder_id (uuid → folders.id, nullable, indexed)
- version_id (uuid → file_versions.id, nullable) // pointer to current
- checksum (text, nullable) // md5/sha256
- is_deleted (bool, default false)
- created_at, updated_at (timestamp tz)

file_versions

- id (uuid, pk)
- file_id (uuid → files.id, indexed)
- version_number (int)
- storage_key (text)
- size_bytes (bigint)
- checksum (text, nullable)
- created_at (timestamp tz)

shares (per-user ACL)

- id (uuid, pk)
- resource_type (enum: 'file' | 'folder')
- resource_id (uuid)
- grantee_user_id (uuid → users.id)
- role (enum: 'viewer' | 'editor')
- created_by (uuid → users.id)

- created_at (timestampz)
- unique(resource_type, resource_id, grantee_user_id)

link_shares (public links)

- id (uuid, pk)
- resource_type (enum)
- resource_id (uuid)
- token (text, unique, indexed)
- role (enum: 'viewer')
- password_hash (text, nullable)
- expires_at (timestampz, nullable)
- created_by (uuid)
- created_at (timestampz)

stars

- user_id (uuid)
- resource_type (enum)
- resource_id (uuid)
- pk (user_id, resource_type, resource_id)

activities

- id (uuid, pk)
- actor_id (uuid)
- action (enum: 'upload'|'rename'|'delete'|'restore'|'move'|'share'|'download')

- resource_type (enum)
- resource_id (uuid)
- context (jsonb)
- created_at (timestampz, indexed)

indexes to add: files(name, owner_id), folders(name, owner_id), files using gin (to_tsvector('simple', name)), activities(created_at desc), shares(resource_type, resource_id), link_shares(token).

6.2 Hierarchy Notes

- Use **adjacency list** via `parent_id` for folders. For path/breadcrumbs, query recursively (CTE) or cache `path` string. Add **constraint** preventing cycles.
- Moving a folder updates `parent_id`. Consider a unique constraint (`owner_id`, `parent_id`, `name`) to avoid duplicates at the same level.

7) Storage Design

- **Key format:**
`tenants/{owner_id}/folders/{folder_id}/files/{file_uuid}-{slug}.{ext}` (versions: append `v{n}`)
- **Multipart uploads:** S3 multipart (5MB+ parts) or Supabase's resumable via Tus/Uppy. Track `upload_id`, `part_numbers`, `etag` per part.
- **Validation:** allowlist mime-types (images/pdf/txt/docx/xlsx), max size per plan.
- **Integrity:** compute MD5/SHA-256 client-side (optional) to detect duplicates; store checksum.
- **Thumbnails/Previews:** background worker uses ImageMagick/PDFium to generate previews into `previews/` prefix.
- **Retention:** Trash = soft delete (`is_deleted = true`) + scheduled purge after N days.

8) Security & Compliance Checklist

- **Auth:** httpOnly cookies, short-lived access token + refresh rotation. OAuth providers (Google/GitHub) optional.
- **ACL:** enforce at API and storage (Supabase RLS policies or S3 presigned checks). Never expose raw storage keys.
- **Links:** signed URLs (short TTL). Public link tokens are long, random; optional password with rate limiting.
- **Validation:** Zod/Yup schema on all inputs. Filenames sanitized; no path traversal.
- **Rate limits:** IP + user-based (e.g., 100 req/5 min). Upload init stricter.
- **Headers:** CSP, X-Content-Type-Options, Referrer-Policy, CORS (allow only your origins), download **Content-Disposition**.
- **Secrets:** managed via environment (Vercel/Render), never in repo.
- **Logging:** auth events, share creations, admin actions; PII minimal.
- **Backups:** daily DB backups; lifecycle policies for storage.

9) API Design (REST, JSON)

Conventions: snake_case in DB, camelCase in JSON; **createdAt** ISO 8601; pagination via **limit, cursor**.

9.1 Auth

- **POST /api/auth/register** → { email, password, name }
- **POST /api/auth/login** → { email, password } → Set cookie tokens
- **POST /api/auth/logout**

- `GET /api/auth/me` → current session user

9.2 Folders

- `POST /api/folders` → { name, parentId|null }
- `GET /api/folders/:id` → { folder, children: { folders[], files[] }, path[] }
- `PATCH /api/folders/:id` → { name?, parentId? }
- `DELETE /api/folders/:id` → soft-delete

9.3 Files

- `POST /api/files/init` → { name, mimeType, sizeBytes, folderId|null } → { fileId, upload:{method:'multipart', parts:[{partNumber, url}], storageKey }
- `POST /api/files/complete` → { fileId, parts:[{partNumber, etag}] } → 200; background preview job
- `GET /api/files/:id` → { file, signedUrl }
- `PATCH /api/files/:id` → { name?, folderId? }
- `DELETE /api/files/:id` → soft-delete

9.4 Shares

- `POST /api/shares` → { resourceType, resourceId, granteeUserId, role }
- `GET /api/shares/:resourceType/:resourceId` → list shares
- `DELETE /api/shares/:id`

9.5 Public Links

- `POST /api/link-shares` → { resourceType, resourceId, expiresAt?, password? }

- `GET /api/link/:token` → resolves (with optional password)
- `DELETE /api/link-shares/:id`

9.6 Search & Stars & Trash

- `GET /api/search?q=&type=&owner=&starred=`
- `POST /api/stars` → { resourceType, resourceId }
- `DELETE /api/stars` → { resourceType, resourceId }
- `GET /api/trash` → list deleted
- `POST /api/trash/restore` → { resourceType, resourceId }
- Purge job: cron clears > N days

Error format: { error: { code: 'FORBIDDEN', message: '...' } } with proper HTTP status codes.

10) Frontend UX Details

- **Layout:** sidebar (My Drive, Shared, Starred, Recent, Trash), toolbar (New, Upload, Share, Sort, Grid/List toggle), main grid list.
 - **Components:** breadcrumb, upload dropzone with progress, context menus (right-click), modals for share/link, details panel (owner, size, activity).
 - **State/Data:** TanStack Query for server cache; optimistic rename/move; skeleton loaders; infinite scroll.
 - **Accessibility:** keyboard shortcuts (A11y), focus rings, ARIA on menus/modals, color contrast.
 - **Internationalization:** key strings externalized for future i18n.
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11) Search Strategy

- MVP: name + type + owner filters using B-Tree indexes.
 - Enhanced: Postgres full-text (`tsvector(name)`), trigram (`pg_trgm`) for fuzzy matches; optional tags.
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12) Versioning Model

- `files.version_id` points to the current row in `file_versions`.
 - New upload to same logical file → create `file_versions` row, update pointer.
 - UI exposes version list with `createdAt` and `size`; allow revert.
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13) Activity Log

- Append-only `activities` with `actor_id`, `action`, `resource`, `context` (e.g., { `oldName`, `newName` }).
 - Show recent activity in a side panel for selected item.
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14) Performance & Scale

- Use CDN for downloads; caching headers on signed URLs.
- DB: add composite indexes, avoid N+1 via batch queries, use pagination with cursors.
- Background workers for heavy tasks (previews, virus scan, emails).

- Storage lifecycle: move cold previews to cheaper tier; set retention for Trash.
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15) Deployment & DevOps

- **Environments:** dev, staging, prod (separate DBs/buckets).
 - **CI/CD:** GitHub Actions to lint, test, build; preview deploys on PRs (Vercel). Run migrations on deploy.
 - **Hosting:**
 - Frontend: Vercel.
 - Backend: Render/Fly.io/Heroku.
 - DB & Storage: Supabase (Postgres + Storage) or AWS (RDS + S3).
 - **Monitoring:** Sentry (frontend/backend), Logtail/Datadog logs, Uptime checks.
 - **Backups:** daily automated DB backups; restore drills quarterly.
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16) Milestone Plan (4 Sprints)

Sprint 1 (Auth & Base UI)

- Auth (email/password, OAuth optional), protected routes, layout, folder tree, create folder.

Sprint 2 (Files Core)

- Upload init/multipart, progress, list, rename, move, delete, download via signed URLs.

Sprint 3 (Sharing & Search)

- Per-user shares, public links, stars, search and filters, recent.

Sprint 4 (Polish & Ops)

- Trash + restore, activity log, thumbnails/previews, rate limits, monitoring, docs.
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17) Skills You Will Learn (Detailed)

- Designing relational schemas for hierarchical data and ACL.
 - Implementing secure, resumable multipart uploads.
 - Building REST APIs with robust validation, pagination, and error handling.
 - Enforcing RLS/ACL both at DB and storage layer (Supabase policies or S3 presigned checks).
 - Building a performant React UI with drag-drop, optimistic updates, and infinite scroll.
 - Operating a small cloud app: CI/CD, logs, alerts, backups, cost control.
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18) Cost Awareness (indicative)

- Supabase Starter (DB/Auth/Storage) for dev; scale to Pro as MAU/storage grows.
 - CDN egress dominates cost at scale; prefer regional users close to storage.
 - Thumbnails/previews increase compute/storage modestly; batch and cache.
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19) Resources (Carefully Curated)

Frontend

- Next.js: <https://nextjs.org/docs>

- TanStack Query: <https://tanstack.com/query/latest>
- React DnD Kit: <https://dndkit.com/>
- Uppy (uploads): <https://uppy.io/docs/>

Backend & Validation

- Express: <https://expressjs.com/>
- Zod: <https://zod.dev/>

Database & Search

- Supabase Postgres: <https://supabase.com/docs>
- Postgres Full Text: <https://www.postgresql.org/docs/current/textsearch.html>
- pg_trgm (fuzzy): <https://www.postgresql.org/docs/current/pgtrgm.html>

Storage

- Supabase Storage: <https://supabase.com/docs/guides/storage>
- AWS S3 multipart:
<https://docs.aws.amazon.com/AmazonS3/latest/userguide/mpuoverview.html>

Auth

- Supabase Auth: <https://supabase.com/docs/guides/auth>
- NextAuth: <https://authjs.dev/>

Security

- OWASP Cheat Sheets: <https://cheatsheetseries.owasp.org/>

DevOps

- GitHub Actions: <https://docs.github.com/actions>
 - Render: <https://render.com/docs>
 - Fly.io: <https://fly.io/docs/>
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20) Appendix

20.1 Example .env (adjust per provider)

```
# Backend
PORT=8080
NODE_ENV=development
DATABASE_URL=postgres://USER:PASSWORD@HOST:5432/drive
JWT_SECRET=super-long-random
REFRESH_SECRET=another-long-random
CORS_ORIGIN=https://your-frontend-domain.com
```

```
# Supabase (if used)
SUPABASE_URL=...
SUPABASE_ANON_KEY=...
SUPABASE_SERVICE_ROLE_KEY=...
SUPABASE_STORAGE_BUCKET=drive
```

```
# AWS (if S3 used)
AWS_ACCESS_KEY_ID=...
AWS_SECRET_ACCESS_KEY=...
AWS_REGION=ap-south-1
S3_BUCKET=drive-bucket
```

20.2 Suggested Repo Structure (separate frontend/backend)

```
root/
  apps/
    web/      # Next.js app (App Router)
    api/      # Express app
  packages/
    ui/       # shared UI components (optional)
    config/   # eslint, tsconfig, prettier
  infra/     # IaC, docker, compose, migrations
  .github/workflows/
```


20.3 Sample SQL (Postgres)

```
create extension if not exists pg_trgm;
```

```
create table if not exists users (  
  id uuid primary key default gen_random_uuid(),  
  email text unique not null,  
  name text,  
  image_url text,  
  created_at timestamptz default now()  
);
```

```
create table folders (  
  id uuid primary key default gen_random_uuid(),  
  name text not null,  
  owner_id uuid references users(id) on delete cascade,  
  parent_id uuid references folders(id) on delete set null,  
  is_deleted boolean default false,  
  created_at timestamptz default now(),  
  updated_at timestamptz default now()  
);
```

```
create unique index on folders(owner_id, parent_id, name) where is_deleted = false;
```

```
create table files (  
  id uuid primary key default gen_random_uuid(),  
  name text not null,  
  mime_type text,  
  size_bytes bigint,  
  storage_key text unique not null,  
  owner_id uuid references users(id) on delete cascade,  
  folder_id uuid references folders(id) on delete set null,  
  version_id uuid, -- set after first version  
  checksum text,  
  is_deleted boolean default false,  
  created_at timestamptz default now(),  
  updated_at timestamptz default now()  
);
```

```
create index on files(owner_id);  
create index on files using gin (name gin_trgm_ops);
```

```
create table file_versions (  

```

```

id uuid primary key default gen_random_uuid(),
file_id uuid references files(id) on delete cascade,
version_number int not null,
storage_key text not null,
size_bytes bigint,
checksum text,
created_at timestamptz default now()
);

create table shares (
id uuid primary key default gen_random_uuid(),
resource_type text not null check (resource_type in ('file','folder')),
resource_id uuid not null,
grantee_user_id uuid references users(id) on delete cascade,
role text not null check (role in ('viewer','editor')),
created_by uuid references users(id) on delete set null,
created_at timestamptz default now(),
unique(resource_type, resource_id, grantee_user_id)
);

create table link_shares (
id uuid primary key default gen_random_uuid(),
resource_type text not null check (resource_type in ('file','folder')),
resource_id uuid not null,
token text not null unique,
role text not null default 'viewer' check (role = 'viewer'),
password_hash text,
expires_at timestamptz,
created_by uuid references users(id) on delete set null,
created_at timestamptz default now()
);

create table stars (
user_id uuid references users(id) on delete cascade,
resource_type text not null check (resource_type in ('file','folder')),
resource_id uuid not null,
primary key (user_id, resource_type, resource_id)
);

create table activities (
id uuid primary key default gen_random_uuid(),
actor_id uuid references users(id) on delete set null,
action text not null check (action in
('upload','rename','delete','restore','move','share','download')),

```

```
resource_type text not null check (resource_type in ('file','folder')),
resource_id uuid not null,
context jsonb,
created_at timestamptz default now()
);
```

20.4 Example RLS (Supabase) – idea sketch (not exhaustive)

- Bucket policy: objects are private by default.
- Row-Level Security on `files`, `folders`, `shares`, `link_shares` ensures:
 - Owners can read/write their items.
 - Grantees can read (and write if role=editor).
 - Link tokens resolve via RPC that validates token/expiry/password.

20.5 Testing Matrix (samples)

- Auth: register/login/logout, refresh rotation, role checks.
 - Files: init/complete upload, rename/move, soft delete/restore, signed download.
 - Shares: grant/revoke, link expiry, password, access via token.
 - Search: by name, filters, pagination, case/fuzzy.
 - Rate limits: burst tests.
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21) How to Implement (Step-by-step)

1. **Scaffold** repos (frontend & backend), add linting/formatting, CI skeleton.
2. **Auth** with provider of choice; protect API routes; set cookies.

3. **Folders** CRUD + UI (tree + breadcrumbs), unique name per parent.
 4. **Uploads**: implement init → multipart → complete; show progress.
 5. **Listing**: folder contents (folders first, then files), sort & grid/list view.
 6. **File ops**: rename, move (drag-drop), delete → Trash; restore.
 7. **Shares**: user ACL + public links with expiry/password; share dialog in UI.
 8. **Search** + Starred + Recent.
 9. **Previews** + thumbnails (images/PDF), activity log.
 10. **Hardening**: rate limits, CSP, logs, backups, docs; staging → prod.
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22) What You'll Learn (Mapped to Tasks)

- **Schema & ACL** → designing `shares`, `link_shares`, and enforcing in API.
 - **Uploads at scale** → resumable multipart + presigned URLs.
 - **Optimistic UX** → fast rename/move with rollback on failure.
 - **Caching** → TanStack Query patterns, pagination, and invalidation.
 - **Observability** → tracing slow queries, error budgets, and alerts.
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23) Glossary

- **ACL**: Access Control List.
- **RLS**: Row-Level Security (Postgres/Supabase).

- **Multipart:** breaking large files into parts to upload in parallel.
 - **Signed URL:** time-limited URL granting access to an object.
-