**Radiology Scheduler — MVP Technical Specification**

Next.js + Postgres + NextAuth | Two-Month Generator | Config-Driven

Prepared: August 13, 2025

# 1. Executive Summary

Goal: Deliver a multi-tenant, config-driven scheduling MVP that onboards a radiology group, collects ranked vacation weeks, and generates the next two months of assignments while honoring eligibility and fairness.

Scope: Authentication (NextAuth), Org configuration (subspecialties, shift types, eligibility, vacation policy), roster import, vacation intake, schedule generation (2 months), publish & email notices, master & personal calendars, CSV export, basic audit.

Out of Scope (v1+): Swaps/giveaways, PT-day selection UI, Google Calendar push, payouts & PDFs, OR-Tools optimizer, billing.

# 2. Roles & RBAC

Roles: Super Admin, Admin, Chief, Radiologist.

RBAC: Role and orgId stored in NextAuth session; middleware protects routes; server APIs enforce org scoping and role checks.

# 3. Architecture & Tech Stack

Frontend: Next.js (App Router), TypeScript, Tailwind.

Backend: Next.js API routes / server actions; Postgres (Prisma ORM).

Auth: NextAuth (Email magic link; Google optional later).

Email: Nodemailer via a provider (Resend).

Jobs: Cron for reminders; generation invoked by admin.

Logging & Audit: pino logs, audit table for key actions.

# 4. MVP Features & Deliverables

The table below enumerates MVP features and later-phase items with descriptions and dependencies.

### Features/Deliverables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feature / Deliverable | Description | Included in MVP | Included in v1 / later | Dependencies / Notes |
| Year-long schedule generation | Generate an entire year respecting vacations, FTE/PT rules, eligibility, and fairness. | MVP |  | Requires roster, shift catalog, vacation/PT inputs. |
| Month-only generation | Support month-by-month generation for testing or incremental rollout. | MVP |  | Same engine, limited scope. |
| Vacation intake (ranked choices) | Users submit 3 ranked vacation weeks per month; engine resolves fairly. | MVP |  | Fairness ledger tie-breaks. |
| PT day allocation (auto-assign) | Auto-balance part-time days per FTE across weekdays. | MVP |  | Weekday balance limits. |
| PT day selection (user-pick mode) | Users pick PT days; UI enforces weekday balance. |  | v1 | Toggle between auto vs user-pick per group. |
| Subspecialty eligibility mapping | Shift types restricted to eligible subspecialties or named users. | MVP |  | From ‘Shifts’ sheet & admin overrides. |
| Named eligibility exceptions | Certain shifts (e.g., MA1 subset, Coiling) restricted to specific rads. | MVP |  | Requires named lists from admin. |
| Swap (same shift type, same day) | Initiate swap with an eligible counterpart for the same shift/day. | MVP |  | Sequential notifications to candidates. |
| Swap (equivalent shift types, multi-target) | Swap across defined equivalence sets; offer to multiple targets sequentially. |  | v1 | Needs Equivalence Set config. |
| Giveaway (weekend call, etc.) | Give away allowed shift types to eligible pool (sequential offers). | MVP |  | List of giveaway-eligible shifts required. |
| Away windows | Block receiving swap/giveaway requests on specified dates. |  | v1 | Per-user setting. |
| Admin overrides + local re-balance | Manual edits with local re-balancing to keep fairness. | MVP |  | Audit trail for changes. |
| One-way Google Calendar sync | Push published assignments to each user’s Google Calendar. |  | v1 | OAuth per user; ICS fallback. |
| Reporting: monthly CSV + YTD | Per-user shift counts & $ totals; group roll-ups; YTD totals. | MVP |  | Dollar value table needed for $ totals. |
| Reporting: PDF outputs | Nicely formatted PDFs for bookkeeper and leadership. |  | v1 | Branding and summary pages. |
| Audit logging | Who changed what, when (engine runs, overrides, approvals). | MVP |  | Immutable log entries. |
| Resident-call plan (free) | Lightweight plan targeting residency call scheduling. |  | v1 | Go-to-market channel. |
| Billing (per-group or per-user) | Stripe-based subscriptions and plan management. |  | v1 | Pricing model decision. |
| Optimizer (OR-Tools) | Constraint programming solver for tighter optimality. |  | v1.5+ | Toggle vs heuristic engine. |
| AI linting (suggested fixes) | Post-gen checks suggesting swaps to reduce risk/fatigue. |  | v1.5+ | Optional and explainable. |

# 5. Configuration (No Hardcoding)

Org-configurable: timezone, week-start, subspecialties, shift types (code/name/time/recurrence), eligibility (subspecialty or named-only or anyone), and vacation policy (weeks per month, ranked options).

Admin onboarding wizard collects these settings and materializes shift instances for the two-month generation window.

# 6. Data Model (Postgres)

### Schema Summary

|  |  |
| --- | --- |
| Table | Columns (summary) |
| orgs | id, name, timezone, week\_start, created\_at |
| users | id, email, name, created\_at |
| memberships | id, org\_id, user\_id, role[SUPER\_ADMIN|ADMIN|CHIEF|RAD], subspecialty\_id NULL, is\_active |
| subspecialties | id, org\_id, code, name, is\_active |
| shift\_types | id, org\_id, code, name, start\_time, end\_time, recur\_mon..recur\_sun BOOL, required\_subspecialty\_id NULL, allow\_any BOOL, is\_active |
| shift\_named\_eligibility | id, org\_id, shift\_type\_id, member\_id |
| vacation\_policy | org\_id PK, weeks\_per\_month INT DEFAULT 1, ranked\_options INT DEFAULT 3, max\_consecutive\_weeks INT DEFAULT 2 |
| vacation\_prefs | id, org\_id, member\_id, year INT, month INT, week\_index INT, rank INT |
| vacation\_lock | org\_id, year, month, locked BOOL |
| shift\_instances | id, org\_id, date DATE, shift\_type\_id, UNIQUE(org\_id, date, shift\_type\_id) |
| assignments | id, org\_id, shift\_instance\_id, member\_id, status[draft|published], created\_at |
| fairness\_ledger | id, org\_id, member\_id, year INT, month INT, delta INT, reason TEXT |
| audit\_log | id, org\_id, actor\_id, action, entity, entity\_id, before JSONB, after JSONB, created\_at |
| email\_log | id, org\_id, member\_id, template, status, meta JSONB, sent\_at |

# 7. End-to-End Flows

7.1 Org Creation → Super Admin creates org (name, timezone, week-start).

7.2 Admin Setup → subspecialties → shift types → named eligibility → vacation policy → generate shift instances for next two months.

7.3 Roster Import → upload CSV (name, email, subspecialty) → create users & memberships; promote chiefs as needed.

7.4 Vacation Intake → invite radiologists; each submits up to 3 ranked weeks per month; admin can lock per month.

7.5 Generation → run engine → draft assignments → admin can edit → publish (emails out).

7.6 Calendars & Export → master view, personal view, CSV export; audit logs recorded.

# 8. Vacation Model & Fairness

Policy: 1 vacation week per month; users submit 3 ranked options/month (configurable).

Resolution: give 1st choices where possible; collisions break by fairness ledger (higher score favored), then seeded random; fallback to 2nd/3rd choices.

Fairness Ledger: +0 (1st), +1 (2nd), +2 (3rd), +3 (none). When a ledger boost helps you win, your score decays by 1 next month.

# 9. Scheduling Engine (MVP Heuristic)

Inputs: shift instances, members & subspecialties, shift eligibility, vacation prefs, vacation policy.

Algorithm (per month): (1) resolve vacations & record fairness; (2) mark unavailability; (3) fill each shift by eligible pool, preferring lowest count for that shift type and lowest total assignments; (4) repair pass flags unsatisfiable instances; (5) deterministic via seeded RNG.

Hard rules: eligibility and coverage; soft tie-breakers: fairness and counts.

# 10. API Contracts (REST)

### MVP Endpoints

|  |  |
| --- | --- |
| Endpoint | Contract |
| /api/admin/orgs [POST] | {name, timezone, weekStart} → {orgId} |
| /api/subspecialties [POST] | [{code, name}] |
| /api/shift-types [POST] | [{code, name, start, end, recur:{mon..sun}, requiredSubspecialtyId|null, allowAny}] |
| /api/shift-types/{id}/named-eligibility [POST] | [{memberId}] |
| /api/vacation-policy [PUT] | {weeksPerMonth, rankedOptions, maxConsecutiveWeeks} |
| /api/members/import [POST] | [{name, email, subspecialtyCode, role}] |
| /api/members [GET] | List members |
| /api/vacation/invite [POST] | {monthRange:[{year,month}]} |
| /api/vacation/prefs [POST] | {year, month, weeks:[{weekIndex, rank}]} // user |
| /api/vacation/lock [POST] | {year, month, locked:true} |
| /api/instances/generate [POST] | {from:{y,m}, to:{y,m}} |
| /api/schedule/generate [POST] | {year, month} |
| /api/schedule/publish [POST] | {year, month} |
| /api/export/schedule.csv [GET] | Querystring year,month |

# 11. UI Routes & Components

/login → NextAuth

/ → dashboard (role-aware)

/org/setup → wizard (subspecialties → shift types → eligibility → vacation policy → generate instances)

/org/roster → roster table & CSV import

/vacation → radiologist picker (next 2 months)

/vacation/manage → admin progress, reminders, lock

/schedule/generate → run generator, review draft, publish

/calendar/master, /calendar/me → views

/export → CSV

/audit → basic audit log

# 12. Emails & Notifications

Templates: Invite to set preferences; Reminder before lock; Publish notice. Log to email\_log; throttling to prevent spam.

# 13. Configuration & Environment

.env: DATABASE\_URL, NEXTAUTH\_SECRET, NEXTAUTH\_URL, email provider creds.

Feature flags (MVP): FEATURE\_SWAP=false, FEATURE\_GOOGLE\_CAL=false.

# 14. Validation & Constraints

Vacation: 1 week/month; 3 ranked options; prevent duplicates per month.

Eligibility precedence: required subspecialty → named eligibility → allow\_any.

Instances uniqueness: (org\_id, date, shift\_type\_id).

# 15. Testing & Acceptance

Unit: vacation resolver, eligibility filter, assignment selection (deterministic seed).

Integration: org→setup→roster→invite→prefs→lock→generate→publish→export.

Acceptance: Admin can produce a fully filled schedule for 2 months, publish emails, and export CSV; audit captures generation & publish.

# 16. Milestones

M0 Setup/Auth (0.5–1w); M1 Org & Catalog (1w); M2 Roster & Intake (1w); M3 Engine & Publish (1–1.5w); M4 Polish/QA (0.5w).

# 17. Defaults vs Unknowns (Cross-Reference)

See appendices for full tables extracted from the gap-list workbook.

# Appendix A — Features/Deliverables (Full)

|  |  |  |  |  |
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# Appendix B — Knowns & Assumptions (Full)

Legend: Status 'Confirmed' (source-backed), 'Assumed' or 'Unclear/Needs validation' require client confirmation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Current detail | Status | How we know / assumption | Notes |
| Roster | 27 radiologists with subspecialties. | Confirmed | File: Shift hours (1).xlsx ▸ Radiologists | Mixed subspecialty tags exist (e.g., Chest/Body, MSK/Body). |
| Shift catalog | 23 shift types with hours and subspecialty gating. | Confirmed | File: Shift hours (1).xlsx ▸ Shifts | Includes late blocks (Body/Neuro 16–18, 18–21). |
| Schedule layout pattern | Weekly sheets like June 2-8, June 9-15 … | Confirmed | File: June 2025 sked v April 1.xlsx | Columns: Week of, Mon–Fri, Sat/Sun; initials & notes. |
| Neuro-only shifts | Neuro 1–4 restricted to neurorads. | Confirmed | Transcript + Shifts sheet | From transcript: 'Neural 1234 are only done by neuro'. |
| IR vascular | Vascular on-site restricted to IR. | Confirmed | Transcript + Shifts sheet |  |
| Body-only modalities | CT/US, MSK, Body MRI, Body volume support by Body. | Confirmed | Transcript + Shifts sheet |  |
| Chest-only cardiac | Cardiac CT/MRI by Chest rads. | Confirmed | Transcript + Shifts sheet |  |
| General X-ray | Anyone (commonly covered by Body). | Confirmed | Transcript + Shifts sheet | Eligible = Any; cultural norm = Body covers often. |
| Coiling (INR) | INR-only; currently one named person. | Needs validation | Transcript | We need the named person & coverage plan during their vacation. |
| MA1 named eligibility | MA1 may be restricted to a named subset. | Unclear | Transcript | If not truly 'Any', provide the eligible list. |
| Vacation policy | 1 week/month; 3 ranked choices; fairness across year. | Confirmed | Client’s feature list + transcript | Engine uses fairness to resolve ties. |
| Vacation fairness scoring | Exact tie-break scoring/decay. | Assumed | Design default | VFS: 0/1/2/3 with decay after tie-win. |
| PT days per FTE | Mapping for 60/70/80/90/100%. | Unclear | Transcript (20% ≈ 1 day/wk) → needs table | Temporary config table proposed. |
| PT weekday balance | Limit Mon/Fri bias. | Assumed | Design default | Mon/Fri ≤ others +1 within month. |
| Equivalence sets | Which shift types are swappable equivalents. | Unclear | Not in files/transcript | Needed to enable cross-type swaps. |
| Giveaway-eligible shifts | Which shifts (e.g., weekend call) can be given away. | Unclear | Not in files/transcript | Needed for giveaway rules. |
| Dollar values | Per shift (and weekend/holiday premiums?). | Unclear | Not in files/transcript | Required for payout reports. |
| Holidays | Ontario stat list & coverage/value rules. | Unclear | Not in files/transcript | Default: normal coverage, no premium. |
| Rest/sequence caps | Max consecutive nights; night→day rest; weekend call caps. | Unclear | Not in files/transcript | Default: no special caps (MVP avoids stacking heuristically). |
| Coverage exceptions | Any shifts allowed to go uncovered. | Unclear | Not in files/transcript | Default: all defined instances must be filled. |
| Fellows | Names, eligibility, and vacation/PT rules. | Unclear | Not in files/transcript | Default: none for first run. |
| Calendar naming | Event title/desc conventions. | Assumed | Design default | Title: '<Shift Code> — <Site/Notes>'; ICS fallback. |
| Billing mode | Per-group vs per-user for this client. | Unclear | Not in files/transcript | Default: per-group for simplicity. |
| Timezone & week start | America/Toronto; week starts Monday. | Assumed | Design default |  |
| Initials mapping & flags | Initials↔full name; meanings of '\*', '+late', 'rds'. | Unclear | From June sheet notation | We’ll ingest notes as free-text until defined. |
| Swap approval thresholds | When chief approval is required. | Assumed | Design default | Any soft-rule violation → chief approval; hard rules never broken. |

# Appendix C — Unknowns, Defaults, and Why (Full)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Topic / Decision Needed | What we need from client | Default applied now | Why this default | Impact / Priority |
| Dollar values per shift | Provide $ per shift and any weekend/holiday premiums. | Default $0 for all except a single Weekend Call rate. | We need a table to compute payouts; a single call rate allows reports to function until finalized. | Medium |
| Giveaway-eligible list | Confirm which shift types can be given away vs swap-only. | Weekend call giveaway; others swap-only. | Matches your note; minimizes risk until rules clarified. | Medium |
| MA1 named eligibility | List who can take MA1 (if not truly 'Any'). | Treat as 'Any' until named list provided. | Avoids blocking assignments; easy to tighten later. | Medium |
| Coiling coverage | Name the INR person(s) and backup plan. | Assume 1 named radiologist; no backup. | We must warn on uncovered days; needs policy. | High |
| PT mapping per FTE | Days/month for 60/70/80/90/100%. | Table: 100%=0; 90%=2; 80%=4; 70%=6; 60%=8. | Implements transcript heuristic (~1 day/week per 20%). | High |
| PT weekday balance | Define exact cap on Mon/Fri vs others. | Mon/Fri ≤ others+1 per month. | Prevents 'every Friday off' clustering. | Medium |
| Equivalence sets | Which shift types can swap across types. | None (same-type only) in MVP. | Safe until you specify equivalences. | Medium |
| Rest/sequence caps | Max consecutive nights; rest before day; weekend call caps. | No hard caps; heuristic avoids stacks. | We’ll add constraints once numbers are known. | Low |
| Holidays | Holiday dates + coverage/value rules. | Ontario stats; no premium; normal coverage. | Safe baseline; easy to update. | Low |
| Coverage exceptions | Any shifts allowed to be unfilled on specific dates. | None allowed. | Ensures full coverage; admin can override if needed. | Medium |
| Fellows | Names, eligibility, vacation/PT rules. | No fellows in first run. | Add when provided. | Medium |
| Calendar naming | Exact event title/desc/location style. | Title '<Shift Code> — <Site/Notes>' | Readable defaults; consistent. | Low |
| Billing mode | Per-group vs per-user. | Per-group. | Fastest to deploy and invoice. | Low |
| Initials & flags | Initials map; flags meanings ('\*', '+late', 'rds'). | Import flags as notes only. | Avoids logic errors until defined. | Medium |
| Swap approval thresholds | Define when chief must approve. | Any soft-rule violation. | Keeps governance strong until tuned. | Medium |