Zone Coverage Algorithm — Stepwise Formulation

Project Cleo – Field Ops

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Sets & Inputs (over date range D)

- $\mathcal{Z}$: zones, $\mathcal{T}$: teams, $\mathcal{U}$: users.
- J_z: jobs due in zone z.
- $s_z > 0$: Service-per-hour (SPH) for zone z.
- $P_z \subset \mathcal{U}$: Primary Service Pros for z.
- $A_z \subset \mathcal{T}$: Teams assigned to z.
- $A(t) := \{z \in \mathcal{Z} \mid t \text{ assigned to } z\}$.
- $M_t \subset \mathcal{U}$: members of team t.
- $h_u \geq 0$: scheduled+forecasted *routeable* hours seen on u's calendar (includes appointment blocks).
- $b_u \geq 0$: sum of break time and non-appointment events for u (lunch, meetings, trainings) during D.
- $\rho_u^{\text{rs}} \in [0, 1]$: reservice rate for u (fraction of appointment time historically or forecasted spent on *reservice* jobs that do not count toward production targets).
- $\rho_u \in [0, 1]$: residual routeable ratio for calendar noise / misc. filtering.
- Define: $\bar{h}_u := \max(0,\, h_u - b_u)$ (appointment-capable hours after subtracting breaks and non-appointment events).
- Define: $\hat{h}_u := \rho_u(1 - \rho_u^{\text{rs}})\, \bar{h}_u$ (effective *production-counting* hours for u).
- $\eta_1, \eta_2, \eta_3 \in [0, 1]$: efficiency multipliers (Primary / Assigned Teams / Overflow).
- $r_z \in \{0, 1\}$: remote flag (1 = remote, no overflow allowed).
- $w_z := \dfrac{J_z}{\sum_{z' \in \mathcal{Z}} J_{z'}}$: density share of due jobs.

Explanation. We extend the inputs to (i) **subtract** breaks and non-appointment calendar time (b_u) from each user's hours and (ii) **discount** the remaining appointment-capable time by the user's reservice rate ρ_u^{rs}, since reservice work consumes time but does not contribute to production targets. The resulting $\hat{h}_u$ is the per-user hour supply that truly counts toward production.

Stepwise Algorithm

1) Demand (hours)

$$H_z^{\mathrm{need}} := \frac{J_z}{s_z}.$$

Convert due jobs in zone z into the number of production hours required, using zone SPH.

2) Tier 1 (Primary)

$$H_z^{(1)} := \eta_1 \sum_{u \in P_z} \hat{h}_u.$$

Use per-user effective *hours $\hat{h}_u$ (after breaks and reservice) for Primaries and apply Primary efficiency.*

3) Team → Zone Weights (renormalized over assignments)

$$\omega_{t,z} := \begin{cases} \dfrac{w_z}{\sum_{y \in A(t)} w_y}, & z \in A(t), \\ 0, & \text{otherwise.} \end{cases} \qquad \Rightarrow \qquad \sum_{z \in A(t)} \omega_{t,z} = 1.$$

Distribute a team's effort only across the zones it actually serves, in proportion to density w_z.

4) Tier 2 (Assigned Teams, no double-counting)

$$\tilde{H}_t^{\mathrm{asg}} := \sum_{u \in M_t \setminus P_z} \hat{h}_u, \qquad H_z^{(2)} := \eta_2 \sum_{t \in A_z} \omega_{t,z} \, \tilde{H}_t^{\mathrm{asg}}.$$

Aggregate effective *hours for each assigned team excluding primaries, weight to zone z via $\omega_{t,z}$, then apply team efficiency.*

5) Shortfall after Tiers 1+2

$$H_z^{12} := H_z^{(1)} + H_z^{(2)}, \qquad \Delta_z := \max\big(0,\, H_z^{\mathrm{need}} - H_z^{12}\big).$$

Compute hours still missing after Primary and Assigned Team capacity; clip negative gaps at zero.

6) Service-Center Pool (remaining *effective* hours)

$$\tilde{H}^{\mathrm{SC}}_{\mathrm{all}} := \sum_{t\in\mathcal{T}} \sum_{u\in M_t} \hat{h}_u,$$

$$\tilde{H}^{\mathrm{raw1}} := \sum_{z\in\mathcal{Z}} \frac{H_z^{(1)}}{\eta_1}, \qquad \tilde{H}^{\mathrm{raw2}} := \sum_{t\in\mathcal{T}} \left(\sum_{z\in\mathcal{Z}} \omega_{t,z}\right) \tilde{H}^{\mathrm{asg}}_t,$$

$$\tilde{H}^{\mathrm{SC}}_{\mathrm{pool}} := \max\Big(0, \tilde{H}^{\mathrm{SC}}_{\mathrm{all}} - \tilde{H}^{\mathrm{raw1}} - \tilde{H}^{\mathrm{raw2}}\Big).$$

Build the service-center overflow pool from the sum of effective *hours* $\hat{h}_u$ *minus the hours already claimed by Tiers 1 and 2.*

7) Smooth Help Probability & Fair Allocation

$$\sigma(x) := \frac{1}{1+e^{-x}}, \qquad q_z := (1-r_z)\,\sigma\!\left(\beta\left(\frac{\Delta_z}{H_z^{\mathrm{need}}} - \tau\right)\right),$$

$$S := \sum_{z\in\mathcal{Z}} \Delta_z, \qquad \alpha_z := \begin{cases} \Delta_z/S, & S>0, \\ 0, & S=0. \end{cases}$$

Gate overflow with a smooth logistic of unmet need and block for remote zones ($r_z = 1$)*. Allocate the available pool in proportion to each zone's shortfall.*

8) Tier 3 (Overflow)

$$H_z^{(3)} := \eta_3\, q_z\, \alpha_z\, \tilde{H}^{\mathrm{SC}}_{\mathrm{pool}}.$$

Add overflow hours from the remaining pool, scaled by efficiency, help probability, and fair-share weight.

9) Totals & KPIs

$$H_z^{\mathrm{eff}} := H_z^{12} + H_z^{(3)}, \qquad \widehat{J}_z := s_z H_z^{\mathrm{eff}}, \qquad C_z := \frac{\widehat{J}_z}{J_z}.$$

$$\mathrm{ShortfallHours}_z := \max(0, H_z^{\mathrm{need}} - H_z^{\mathrm{eff}}), \qquad \mathrm{ShortfallJobs}_z := \max(0, J_z - \widehat{J}_z).$$

Compute total effective hours and translate back to jobs covered. Report coverage and any residual shortfall in hours and jobs.