Human review packet: LG24ServiceLevelAgreements

Generated from byte-pinned source excerpts, the expanded PaperInterface specifications, and hash-bound raw-source-to-Spec screening records.

Paper: LG24ServiceLevelAgreements
Paper id: LG24ServiceLevelAgreements
Source version: Private Overleaf main_msom.tex at 887a5ccdb076b6e811d8cbc34d3b0eed9b5bdb1a; intended compiled transcript
Source record: audit/paper_statement_map.json
Rows: 10
Generated: 2026-09-06

How to use this packet

For each source claim, compare the exact source excerpts with the expanded PaperInterface specification. Mark up this PDF or fill the blank reviewer box in the TeX source; return the annotated file for reconciliation into the paper-local human-review log.

Open the interactive dashboard

The interactive dashboard is an optional alternative to using this PDF; it presents the same review surface rather than an additional review requirement. After forking and cloning (or pulling) AppliedModelingLib, run the following from the repository root. The cache command is needed only the first time in a new clone.

```
cd <your-repository-checkout>
lake exe cache get
python3 scripts/review_dashboard.py --paper LG24ServiceLevelAgreements --serve
```

Open http://127.0.0.1:8765/ in a browser and keep that terminal running while reviewing. The dashboard records saved annotations in this paper's local reviewer-owned review record.

Contents

Governing Lean declarations

These exact graph-bound declaration bodies are retained by the displayed specifications or reviewed prerequisites. They are supporting context and do not add source-result rows or semantic judgments.

AppliedModelingLib.Optimization.IsMinimizerOn

Declaration location: reusable library

Lean declaration body

```
type:
{α : Type u_1} → (α → Prop) → (α → ℝ) → α → Prop

value:
fun {α : Type u_1} (feasible : α → Prop) (objective : α → ℝ) (x : α) =>
  feasible x ∧ ∀ (y : α), feasible y → objective x ≤ objective y
```

AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw

Declaration location: reusable library

Lean declaration body

```
field Pbase:
{Ω : Type u_1} →
  [inst : MeasurableSpace Ω] →
    AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω → MeasureTheory.Measure Ω

field isProbability:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω),
  MeasureTheory.IsProbabilityMeasure self.Pbase

field shift:
{Ω : Type u_1} →
  [inst : MeasurableSpace Ω] → AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω → ℝ → Ω → Ω

field shift_zero:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω),
  self.shift 0 = id

field shift_add:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω)
  (s t : ℝ), self.shift (s + t) = self.shift s ∘ self.shift t

field shift_preserving:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Ω)
  (t : ℝ), MeasureTheory.MeasurePreserving (self.shift t) self.Pbase self.Pbase
```

AppliedModelingLib.Probability.PoissonProcess.interarrival

Declaration location: reusable library

Lean declaration body

```
type:
ℕ → (ℕ → ℝ) → ℝ

value:
fun (n : ℕ) (a : ℕ → ℝ) => a n
```

AppliedModelingLib.Probability.PoissonProcess.arrivalTime

Declaration location: reusable library

Lean declaration body

```
type:
ℕ → (ℕ → ℝ) → ℝ

value:
fun (n : ℕ) (a : ℕ → ℝ) => ∑ i ∈ Finset.range (n + 1), AppliedModelingLib.Probability.PoissonProcess.interarrival i a
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.interarrival

AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCount

Declaration location: reusable library

Lean declaration body

type:
```
ℝ → (ℕ → ℝ) → ℕ
```

value:
```
fun (t : ℝ) (a : ℕ → ℝ) =>
  if h : ∃ (n : ℕ), t < AppliedModelingLib.Probability.PoissonProcess.arrivalTime n a then Nat.find h else 0
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.arrivalTime

AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCountLE

Declaration location: reusable library

Lean declaration body

type:
```
ℝ → (ℕ → ℝ) → ℕ
```

value:
```
fun (t : ℝ) (a : ℕ → ℝ) =>
  if h : ∃ (n : ℕ), t ≤ AppliedModelingLib.Probability.PoissonProcess.arrivalTime n a then Nat.find h else 0
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.arrivalTime

AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

Declaration location: reusable library

Lean declaration body

type:
```
ℤ → (ℤ → ℝ) → ℝ
```

value:
```
fun (i : ℤ) (a : ℤ → ℝ) => a i
```

AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival

Declaration location: reusable library

Lean declaration body

type:
```
(ℤ → ℝ) → ℤ → ℝ
```

value:
```
fun (ω : ℤ → ℝ) (a : ℤ) =>
  match a with
  | Int.ofNat n => ∑ i ∈ Finset.range n, AppliedModelingLib.Probability.PoissonProcess.twoSidedGap (Int.ofNat i) ω
  | Int.negSucc n =>
    -∑ i ∈ Finset.range (n + 1), AppliedModelingLib.Probability.PoissonProcess.twoSidedGap (Int.negSucc i) ω
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier

Declaration location: reusable library

Lean declaration body

type:
(ℤ → ℝ) × ℝ → Prop

value:
fun (a : (ℤ → ℝ) × ℝ) =>
  {p : (ℤ → ℝ) × ℝ | 0 ≤ p.2 ∧ p.2 < AppliedModelingLib.Probability.PoissonProcess.twoSidedGap 0 p.1} a

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.suspensionFuturePath

Declaration location: reusable library

Lean declaration body

type:
(ℤ → ℝ) → ℕ → ℝ

value:
fun (a : ℤ → ℝ) (a_1 : ℕ) => AppliedModelingLib.Probability.PoissonProcess.twoSidedGap (Int.ofNat a_1) a

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift

Declaration location: reusable library

Lean declaration body

type:
ℤ → (ℤ → ℝ) → ℤ → ℝ

value:
fun (k : ℤ) (a : ℤ → ℝ) (a_1 : ℤ) => AppliedModelingLib.Probability.PoissonProcess.twoSidedGap (a_1 + k) a

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.suspensionPastPath

Declaration location: reusable library

Lean declaration body

type:
(ℤ → ℝ) → ℕ → ℝ

value:
fun (a : ℤ → ℝ) (a_1 : ℕ) => AppliedModelingLib.Probability.PoissonProcess.twoSidedGap (Int.negSucc a_1) a

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → (ℤ → ℝ) × ℝ → ℤ

value:
fun (t : ℝ) (a : (ℤ → ℝ) × ℝ) =>
  if 0 ≤ a.2 + t then
    Int.ofNat
      (AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCount (a.2 + t)
        (AppliedModelingLib.Probability.PoissonProcess.suspensionFuturePath a.1))
  else
    Int.negSucc
      (AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCountLE (-(a.2 + t))
        (AppliedModelingLib.Probability.PoissonProcess.suspensionPastPath a.1))
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCount
- AppliedModelingLib.Probability.PoissonProcess.canonicalRenewalCountLE
- AppliedModelingLib.Probability.PoissonProcess.suspensionFuturePath
- AppliedModelingLib.Probability.PoissonProcess.suspensionPastPath

AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalIndices

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → ℝ → (ℤ → ℝ) → Finset ℤ

value:
fun (a b : ℝ) (g : ℤ → ℝ) =>
  {i ∈
      Finset.Icc (AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed a (g, 0))
        (AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed b (g, 0)) |
    a ≤ AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival g i ∧
      AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival g i < b}
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed

AppliedModelingLib.Probability.PoissonProcess.suspensionFlow

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → (ℤ → ℝ) × ℝ → (ℤ → ℝ) × ℝ

value:
fun (t : ℝ) (a : (ℤ → ℝ) × ℝ) =>
  have k : ℤ := AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed t a;
  (AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift k a.1,
    a.2 + t - AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival a.1 k)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed
- AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift

AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

Declaration location: reusable library

Lean declaration body

type:
(ℤ → ℝ) → Prop

value:
fun (ω : ℤ → ℝ) =>
  (∀ (i : ℤ), 0 < AppliedModelingLib.Probability.PoissonProcess.twoSidedGap i ω) ∧
    ∀ (k : ℤ),
      Filter.Tendsto
          (fun (n : ℕ) =>
            AppliedModelingLib.Probability.PoissonProcess.arrivalTime n
              (AppliedModelingLib.Probability.PoissonProcess.suspensionFuturePath
                (AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift k ω)))
          Filter.atTop Filter.atTop ∧
        Filter.Tendsto
          (fun (n : ℕ) =>
            AppliedModelingLib.Probability.PoissonProcess.arrivalTime n
              (AppliedModelingLib.Probability.PoissonProcess.suspensionPastPath
                (AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift k ω)))
          Filter.atTop Filter.atTop

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.arrivalTime
- AppliedModelingLib.Probability.PoissonProcess.suspensionFuturePath
- AppliedModelingLib.Probability.PoissonProcess.suspensionGapShift
- AppliedModelingLib.Probability.PoissonProcess.suspensionPastPath
- AppliedModelingLib.Probability.PoissonProcess.twoSidedGap

AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState

Declaration location: reusable library

Lean declaration body

type:
Type

value:
{ p : (ℤ → ℝ) × ℝ //
  p ∈ AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier ∧
    AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath p.1 }

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.goodSuspensionFlow

Declaration location: reusable library

Lean declaration body

type:
ℝ →
  AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState →
    AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState

value:
fun (t : ℝ) (a : AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState) =>
  ⟨AppliedModelingLib.Probability.PoissonProcess.suspensionFlow t ↑a,
    AppliedModelingLib.Probability.PoissonProcess.goodSuspensionFlow._proof_1 t a⟩

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionFlow
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState

Declaration location: reusable library

Lean declaration body

type:
MeasurableSpace AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState

value:
{ MeasurableSet' := AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState._aux_1,
  measurableSet_empty := AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState._proof_3,
  measurableSet_compl := AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState._proof_4,
  measurableSet_iUnion :=
    AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState._proof_5 }

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier

Declaration location: reusable library

Lean declaration body

type:
(ℤ → ℝ) → Prop

value:
fun (g : ℤ → ℝ) =>
  AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath g ∧
    AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival g 0 = 0

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival

Declaration location: reusable library

Lean declaration body

type:
AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState → ℤ → ℝ

value:
fun (p : AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState) (i : ℤ) =>
  AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival (↑p).1 i - (↑p).2

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrivalIndices

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → ℝ → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState → Finset ℤ

value:
fun (a b : ℝ) (p : AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState) =>
  {i ∈
     Finset.Icc (AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed a ↑p)
       (AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed b ↑p) |
   a ≤ AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival p i ∧
     AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival p i < b}
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath

AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → MeasureTheory.Measure (ℤ → ℝ)

value:
fun (rate : ℝ) => MeasureTheory.Measure.infinitePi fun (x : ℤ) => ProbabilityTheory.expMeasure rate
```

AppliedModelingLib.Probability.PoissonProcess.suspensionMeasure

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → MeasureTheory.Measure ((ℤ → ℝ) × ℝ)

value:
fun (rate : ℝ) =>
  ENNReal.ofReal rate •
    ((AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure rate).prod
        MeasureTheory.volume).restrict
      AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure

AppliedModelingLib.Probability.PoissonProcess.goodSuspensionMeasure

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → MeasureTheory.Measure AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState

value:
fun (rate : ℝ) =>
  MeasureTheory.Measure.comap Subtype.val (AppliedModelingLib.Probability.PoissonProcess.suspensionMeasure rate)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath
- AppliedModelingLib.Probability.PoissonProcess.suspensionMeasure

AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult

Declaration location: reusable library

Lean declaration body

field workload:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class → Class → ℝ

field currentTime:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class → ℝ

field service:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class → Class → ℝ

AppliedModelingLib.Probability.Queueing.FiniteGPSChronologicalFrom

Declaration location: reusable library

Lean declaration body

type:
ℝ → List ℝ → Prop

value:
fun (start : ℝ) (a : List ℝ) =>
  List.brecOn (motive := fun (x : List ℝ) => ℝ → Prop) a
    AppliedModelingLib.Probability.Queueing.FiniteGPSChronologicalFrom._f start

AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment

Declaration location: reusable library

Lean declaration body

field startTime:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → ℝ

field duration:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → ℝ

field startWorkload:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field classRate:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field serviceIncrement:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field preEndpointWorkload:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field endpointBatch:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field endpointWorkload:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Class → ℝ

field endpointIsExternalBatch:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class → Bool

AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory

Declaration location: reusable library

Lean declaration body

field final:
{Class : Type u_2} →
  AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory Class →
    AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class

field segments:
{Class : Type u_2} →
  AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory Class →
    List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult
- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment

AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace

Declaration location: reusable library

Lean declaration body

field times:
{start : ℝ} → AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start → List ℝ

field chronological:
∀ {start : ℝ} (self : AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start),
  AppliedModelingLib.Probability.Queueing.FiniteGPSChronologicalFrom start self.times

field nodup:
∀ {start : ℝ} (self : AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start), self.times.Nodup

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSChronologicalFrom

AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion

Declaration location: reusable library

Lean declaration body

field identifier:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId → JobId

field arrivalTime:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId → ℝ

field completedWork:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId → ℝ

field completionOffset:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId → ℝ

field completionTime:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId → ℝ

AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob

Declaration location: reusable library

Lean declaration body

field identifier:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId → JobId

field arrivalTime:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId → ℝ

field residualWork:
{JobId : Type u_3} → AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId → ℝ

AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs

Declaration location: reusable library

Lean declaration body

field jobs:
{Class : Type u_3} →
  {JobId : Type u_4} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Class JobId →
      Class → List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob

AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger

Declaration location: reusable library

Lean declaration body

field residualJobs:
{Class : Type u_3} →
  {JobId : Type u_4} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId →
      Class → List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob

AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep

Declaration location: reusable library

Lean declaration body

field segment:
{Class : Type u_3} →
  {JobId : Type u_4} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Class JobId →
      AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class

field endpointJobs:
{Class : Type u_3} →
  {JobId : Type u_4} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Class JobId →
      AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Class JobId

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs

AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult

Declaration location: reusable library

Lean declaration body

field workload:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class → Class → ℝ

field remainingDelay:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class → ℝ

field service:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class → Class → ℝ

field batchApplied:
{Class : Type u_2} → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class → Bool

AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero

Declaration location: reusable library

Lean declaration body

```
field Ptag:
{Ω : Type u_1} →
  [inst : MeasurableSpace Ω] → AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ω → MeasureTheory.Measure Ω

field isProbability:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ω),
  MeasureTheory.IsProbabilityMeasure self.Ptag

field arrivals:
{Ω : Type u_1} → [inst : MeasurableSpace Ω] → AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ω → Ω → ℤ → ℝ

field tag_at_zero:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ω),
  ∀ᵐ (ω : Ω) ∂self.Ptag, self.arrivals ω 0 = 0

field arrivals_strict:
∀ {Ω : Type u_1} [inst : MeasurableSpace Ω] (self : AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ω),
  ∀ᵐ (ω : Ω) ∂self.Ptag, StrictMono (self.arrivals ω)
```

AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero

Declaration location: reusable library

Lean declaration body

```
type:
{Ωtag : Type u_1} →
  {Γ : Type u_2} →
    [inst : MeasurableSpace Ωtag] →
      [inst_1 : MeasurableSpace Γ] →
        AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ωtag →
          AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Γ →
            AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero (Ωtag × Γ)

value:
fun {Ωtag : Type u_1} {Γ : Type u_2} [MeasurableSpace Ωtag] [MeasurableSpace Γ]
    (tagged : AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero Ωtag)
    (passive : AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw Γ) =>
  { Ptag := tagged.Ptag.prod passive.Pbase,
    isProbability := AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero._proof_1 tagged passive,
    arrivals := fun (z : Ωtag × Γ) => tagged.arrivals z.1,
    tag_at_zero := AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero._proof_3 tagged passive,
    arrivals_strict := AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero._proof_4 tagged passive }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero

AppliedModelingLib.Probability.PoissonProcess.candidateTaggedArrivalAtZero

Declaration location: reusable library

Lean declaration body

```
type:
(rate : ℝ) → 0 < rate → AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero (ℤ → ℝ)

value:
fun (rate : ℝ) (hrate : 0 < rate) =>
  { Ptag := AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure rate,
    isProbability :=
      AppliedModelingLib.Probability.PoissonProcess.isProbabilityMeasure_twoSidedInterarrivalMeasure hrate,
    arrivals := AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival,
    tag_at_zero := AppliedModelingLib.Probability.PoissonProcess.ae_candidatePalmArrival_tag_at_zero,
    arrivals_strict := AppliedModelingLib.Probability.PoissonProcess.ae_candidatePalmArrival_strictMono hrate }
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero

AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → (Class → ℝ) → Finset Class

value:
fun {Class : Type u_1} [Fintype Class] (work : Class → ℝ) => {i : Class | 0 < work i}

AppliedModelingLib.Probability.Queueing.finiteGPSBacklogged

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → (Class → ℝ) → ℝ → Class → Bool

value:
fun {Class : Type u_1} (work : Class → ℝ) (a : ℝ) (a_1 : Class) => decide (0 < work a_1)

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletionOf

Declaration location: reusable library

Lean declaration body

type:
{JobId : Type u_2} →
  ℝ →
    ℝ →
      ℝ →
        AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId →
          AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId

value:
fun {JobId : Type u_2} (segmentStart classRate serviceBefore : ℝ)
    (job : AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId) =>
  { identifier := job.identifier, arrivalTime := job.arrivalTime, completedWork := job.residualWork,
    completionOffset := (serviceBefore + job.residualWork) / classRate,
    completionTime := segmentStart + (serviceBefore + job.residualWork) / classRate }

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsFrom

Declaration location: reusable library

Lean declaration body

type:
{JobId : Type u_2} →
  ℝ →
    ℝ →
      ℝ →
        ℝ →
          List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId) →
            List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId)

value:
fun {JobId : Type u_2} (segmentStart classRate serviceBefore availableService : ℝ)
    (a : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
  List.brecOn (motive := fun (x : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
    ℝ → ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId)) a
    (AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsFrom._f segmentStart classRate) serviceBefore
    availableService

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletionOf

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobs

Declaration location: reusable library

Lean declaration body

```
type:
{JobId : Type u_2} →
  ℝ →
    ℝ →
      ℝ →
        List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId) →
          List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId)

value:
fun {JobId : Type u_2} (segmentStart classRate availableService : ℝ)
    (jobs : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsFrom segmentStart classRate 0 availableService jobs
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsFrom

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsInSegment

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  {JobId : Type u_2} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class →
      Class →
        List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId) →
          List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId)

value:
fun {Class : Type u_1} {JobId : Type u_2}
    (segment : AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class) (i : Class)
    (jobs : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobs segment.startTime (segment.classRate i)
    (segment.serviceIncrement i) jobs
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobs

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSConsume

Declaration location: reusable library

Lean declaration body

```
type:
{JobId : Type u_2} →
  ℝ →
    List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId) →
      List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)

value:
fun {JobId : Type u_2} (availableService : ℝ)
    (a : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
  List.brecOn (motive := fun (x : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) =>
    ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob JobId)) a
    AppliedModelingLib.Probability.Queueing.finiteGPSFCFSConsume._f availableService
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSApplySegment

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  {JobId : Type u_2} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId →
      AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class →
        AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Class JobId →
          AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId

value:
fun {Class : Type u_1} {JobId : Type u_2}
    (ledger : AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId)
    (segment : AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)
    (endpointJobs : AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Class JobId) =>
  {
    residualJobs := fun (i : Class) =>
      AppliedModelingLib.Probability.Queueing.finiteGPSFCFSConsume (segment.serviceIncrement i)
          (ledger.residualJobs i) ++
        endpointJobs.jobs i }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSConsume

AppliedModelingLib.Probability.Queueing.finiteGPSFCFSRunSegmentStepsClassCompletions

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  {JobId : Type u_2} →
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId →
      Class →
        List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Class JobId) →
          List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId)

value:
fun {Class : Type u_1} {JobId : Type u_2}
    (initial : AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId) (i : Class)
    (a : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Class JobId)) =>
  List.brecOn (motive :=
    fun (x : List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Class JobId)) =>
    AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Class JobId →
      List (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion JobId))
    a (AppliedModelingLib.Probability.Queueing.finiteGPSFCFSRunSegmentStepsClassCompletions._f i) initial
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSApplySegment
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSCompletedJobsInSegment

AppliedModelingLib.Probability.Queueing.gpsBackloggedClasses

Declaration location: reusable library

Lean declaration body

```
type:
(ι : Type u_1) → [Fintype ι] → (ℝ → ι → Bool) → ℝ → Finset ι

value:
fun (ι : Type u_1) [Fintype ι] (backlogged : ℝ → ι → Bool) (t : ℝ) => {i : ι | backlogged t i = true}
```

AppliedModelingLib.Probability.Queueing.gpsBackloggedWeightSum

Declaration location: reusable library

Lean declaration body

type:
(ι : Type u_1) → [Fintype ι] → (ι → ℝ) → (ℝ → ι → Bool) → ℝ → ℝ

value:
fun (ι : Type u_1) [Fintype ι] (weight : ι → ℝ) (backlogged : ℝ → ι → Bool) (t : ℝ) =>
  (AppliedModelingLib.Probability.Queueing.gpsBackloggedClasses ι backlogged t).sum weight

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.gpsBackloggedClasses

AppliedModelingLib.Probability.Queueing.idealGPSClassRate

Declaration location: reusable library

Lean declaration body

type:
ℝ → ℝ → ℝ → ℝ

value:
fun (capacity weight activeWeightSum : ℝ) => capacity * weight / activeWeightSum

AppliedModelingLib.Probability.Queueing.gpsBackloggedClassRate

Declaration location: reusable library

Lean declaration body

type:
(ι : Type u_1) → [Fintype ι] → ι → ℝ → (ι → ℝ) → (ℝ → ι → Bool) → ℝ → ℝ

value:
fun (ι : Type u_1) [Fintype ι] (tag : ι) (capacity : ℝ) (weight : ι → ℝ) (backlogged : ℝ → ι → Bool) (t : ℝ) =>
  AppliedModelingLib.Probability.Queueing.idealGPSClassRate capacity (weight tag)
    (AppliedModelingLib.Probability.Queueing.gpsBackloggedWeightSum ι weight backlogged t)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.gpsBackloggedWeightSum
- AppliedModelingLib.Probability.Queueing.idealGPSClassRate

AppliedModelingLib.Probability.Queueing.finiteGPSClassRate

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) (i : Class) =>
  if 0 < work i then
    AppliedModelingLib.Probability.Queueing.gpsBackloggedClassRate Class i capacity weight
      (AppliedModelingLib.Probability.Queueing.finiteGPSBacklogged work) 0
  else 0

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSBacklogged
- AppliedModelingLib.Probability.Queueing.gpsBackloggedClassRate

AppliedModelingLib.Probability.Queueing.finiteGPSClassEmptyDelay

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) (i : Class) =>
  work i / AppliedModelingLib.Probability.Queueing.finiteGPSClassRate capacity weight work i

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSClassRate

AppliedModelingLib.Probability.Queueing.finiteGPSEarliestEmptyDelay

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) =>
  if hactive : (AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses work).Nonempty then
    (AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses work).inf' hactive
      (AppliedModelingLib.Probability.Queueing.finiteGPSClassEmptyDelay capacity weight work)
  else 0

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSClassEmptyDelay

AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → ℝ → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) (nextBatchDelay : ℝ) =>
  if (AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses work).Nonempty then
    min nextBatchDelay (AppliedModelingLib.Probability.Queueing.finiteGPSEarliestEmptyDelay capacity weight work)
  else nextBatchDelay

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSEarliestEmptyDelay

AppliedModelingLib.Probability.Queueing.finiteGPSBatchApplied

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → (Class → ℝ) → ℝ → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work batchWork : Class → ℝ) (nextBatchDelay : ℝ)
    (a : Class) =>
  (if
      AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration capacity weight work nextBatchDelay =
        nextBatchDelay then
      batchWork
    else fun (x : Class) => 0)
    a

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration

AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → ℝ → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) (duration : ℝ) (a : Class) =>
  max 0 (work a - AppliedModelingLib.Probability.Queueing.finiteGPSClassRate capacity weight work a * duration)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSClassRate

AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → (Class → ℝ) → ℝ → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work batchWork : Class → ℝ) (nextBatchDelay : ℝ)
    (a : Class) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter capacity weight work
      (AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration capacity weight work nextBatchDelay) a +
    AppliedModelingLib.Probability.Queueing.finiteGPSBatchApplied capacity weight work batchWork nextBatchDelay a

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSBatchApplied
- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration
- AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter

AppliedModelingLib.Probability.Queueing.finiteGPSServiceIncrement

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} → [Fintype Class] → ℝ → (Class → ℝ) → (Class → ℝ) → ℝ → Class → ℝ

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work : Class → ℝ) (duration : ℝ) (a : Class) =>
  work a - AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter capacity weight work duration a

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter

AppliedModelingLib.Probability.Queueing.finiteGPSBuildExecutionSegment

Declaration location: reusable library

Lean declaration body

type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        (Class → ℝ) → (Class → ℝ) → ℝ → ℝ → AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight work batchWork : Class → ℝ)
    (startTime nextBatchDelay : ℝ) =>
  have duration : ℝ :=
    AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration capacity weight work nextBatchDelay;
  { startTime := startTime, duration := duration, startWorkload := work,

```
  classRate := AppliedModelingLib.Probability.Queueing.finiteGPSClassRate capacity weight work,
  serviceIncrement := AppliedModelingLib.Probability.Queueing.finiteGPSServiceIncrement capacity weight work duration,
  preEndpointWorkload :=
    AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter capacity weight work duration,
  endpointBatch :=
    AppliedModelingLib.Probability.Queueing.finiteGPSBatchApplied capacity weight work batchWork nextBatchDelay,
  endpointWorkload :=
    AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState capacity weight work batchWork nextBatchDelay,
  endpointIsExternalBatch := decide (duration = nextBatchDelay) }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.finiteGPSBatchApplied
- AppliedModelingLib.Probability.Queueing.finiteGPSClassRate
- AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState
- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration
- AppliedModelingLib.Probability.Queueing.finiteGPSRemainingAfter
- AppliedModelingLib.Probability.Queueing.finiteGPSServiceIncrement

AppliedModelingLib.Probability.Queueing.finiteGPSRunGap

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℕ →
      ℝ →
        (Class → ℝ) →
          (Class → ℝ) → (Class → ℝ) → ℝ → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class

value:
fun {Class : Type u_1} [Fintype Class] (fuel : ℕ) (capacity : ℝ) (weight work batchWork : Class → ℝ)
    (nextBatchDelay : ℝ) =>
  Nat.brecOn (motive := fun (fuel : ℕ) =>
    (Class → ℝ) → ℝ → AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult Class) fuel
    (AppliedModelingLib.Probability.Queueing.finiteGPSRunGap._f capacity weight batchWork) work nextBatchDelay
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult
- AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState
- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration
- AppliedModelingLib.Probability.Queueing.finiteGPSServiceIncrement

AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTrace

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        (ℝ → Class → ℝ) →
          ℝ → (Class → ℝ) → List ℝ → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class

value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight : Class → ℝ) (batchWork : ℝ → Class → ℝ) (currentTime : ℝ)
    (work : Class → ℝ) (a : List ℝ) =>
  List.brecOn (motive := fun (x : List ℝ) =>
    ℝ → (Class → ℝ) → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class) a
    (AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTrace._f capacity weight batchWork) currentTime work
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult
- AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult
- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSRunGap

AppliedModelingLib.Probability.Queueing.finiteGPSRunGapSegments

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℕ →
      ℝ →
        (Class → ℝ) →
          (Class → ℝ) →
            (Class → ℝ) → ℝ → ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)
```

```
value:
fun {Class : Type u_1} [Fintype Class] (fuel : ℕ) (capacity : ℝ) (weight work batchWork : Class → ℝ)
    (currentTime nextBatchDelay : ℝ) =>
  Nat.brecOn (motive := fun (fuel : ℕ) =>
    (Class → ℝ) → ℝ → ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)) fuel
    (AppliedModelingLib.Probability.Queueing.finiteGPSRunGapSegments._f capacity weight batchWork) work currentTime
    nextBatchDelay
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.finiteGPSBuildExecutionSegment
- AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState
- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration

AppliedModelingLib.Probability.Queueing.finiteGPSHorizonFenceSegments

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class →
          ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)
```

```
value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight : Class → ℝ)
    (result : AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult Class) (horizon : ℝ) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSRunGapSegments
    ((AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses result.workload).card + 1) capacity weight
    result.workload (fun (x : Class) => 0) result.currentTime (horizon - result.currentTime)
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchTraceResult
- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSRunGapSegments

AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceSegments

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        (ℝ → Class → ℝ) →
          ℝ → (Class → ℝ) → List ℝ → List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)
```

```
value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight : Class → ℝ) (batchWork : ℝ → Class → ℝ) (currentTime : ℝ)
    (work : Class → ℝ) (a : List ℝ) =>
  List.brecOn (motive := fun (x : List ℝ) =>
    ℝ → (Class → ℝ) → List (AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Class)) a
    (AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceSegments._f capacity weight batchWork) currentTime
    work
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult
- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSRunGap
- AppliedModelingLib.Probability.Queueing.finiteGPSRunGapSegments

AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceWithSegments

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        (ℝ → Class → ℝ) →
          ℝ → (Class → ℝ) → List ℝ → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory Class
```

```
value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight : Class → ℝ) (batchWork : ℝ → Class → ℝ) (currentTime : ℝ)
    (work : Class → ℝ) (times : List ℝ) =>
  {
    final :=
      AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTrace capacity weight batchWork currentTime work times,
    segments :=
      AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceSegments capacity weight batchWork currentTime work
        times }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory
- AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTrace
- AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceSegments

AppliedModelingLib.Probability.Queueing.finiteGPSRunExternalBatchTraceWithSegments

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    ℝ →
      (Class → ℝ) →
        (ℝ → Class → ℝ) →
          (start : ℝ) →
            (Class → ℝ) →
              AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start →
                AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory Class
```

```
value:
fun {Class : Type u_1} [Fintype Class] (capacity : ℝ) (weight : Class → ℝ) (batchWork : ℝ → Class → ℝ) (start : ℝ)
    (work : Class → ℝ) (trace : AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceWithSegments capacity weight batchWork start work
    trace.times
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory
- AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace
- AppliedModelingLib.Probability.Queueing.finiteGPSRunBatchTraceWithSegments

AppliedModelingLib.Probability.Queueing.intPathShift

Declaration location: reusable library

Lean declaration body

```
type:
{α : Type u_1} → ℤ → (ℤ → α) → ℤ → α

value:
fun {α : Type u_1} (k : ℤ) (x : ℤ → α) (a : ℤ) => x (k + a)
```

AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionFlow

Declaration location: reusable library

Lean declaration body

```
type:
{α : Type u_1} →
  ℝ →
    AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → α) →
      AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → α)

value:
fun {α : Type u_1} (t : ℝ) (a : AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → α)) =>
  (AppliedModelingLib.Probability.PoissonProcess.goodSuspensionFlow t a.1,
    AppliedModelingLib.Probability.Queueing.intPathShift
      (AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed t ↑a.1) a.2)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.goodSuspensionFlow
- AppliedModelingLib.Probability.PoissonProcess.suspensionCarrier
- AppliedModelingLib.Probability.PoissonProcess.suspensionCrossingIndexPastClosed
- AppliedModelingLib.Probability.PoissonProcess.suspensionGoodGapPath
- AppliedModelingLib.Probability.Queueing.intPathShift

AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkFlow

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  ℝ →
    (Class → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)) →
      Class → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)

value:
fun {Class : Type u_1} (t : ℝ) (a : Class → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ))
    (a_1 : Class) =>
  AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionFlow t (a a_1)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionFlow

AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionProductMeasure

Declaration location: reusable library

Lean declaration body

```
type:
{α : Type u_1} →
  [inst : MeasurableSpace α] →
    ℝ →
      MeasureTheory.Measure (ℤ → α) →
        MeasureTheory.Measure (AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → α))

value:
fun {α : Type u_1} [MeasurableSpace α] (rate : ℝ) (P : MeasureTheory.Measure (ℤ → α)) =>
  (AppliedModelingLib.Probability.PoissonProcess.goodSuspensionMeasure rate).prod P
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.goodSuspensionMeasure
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState

AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkMeasure

Declaration location: reusable library

Lean declaration body

```
type:
ℝ → MeasureTheory.Measure (AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ))

value:
fun (arrivalRate : ℝ) =>
  AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionProductMeasure arrivalRate
    (AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure 1)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure
- AppliedModelingLib.Probability.Queueing.timedEmbeddedSuspensionProductMeasure

AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkMeasure

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    (Class → ℝ) →
      MeasureTheory.Measure (Class → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ))

value:
fun {Class : Type u_1} [Fintype Class] (arrivalRate : Class → ℝ) =>
  MeasureTheory.Measure.pi fun (i : Class) =>
    AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkMeasure (arrivalRate i)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkMeasure

AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkShiftInvariantLaw

Declaration location: reusable library

Lean declaration body

```
type:
{Class : Type u_1} →
  [Fintype Class] →
    (arrivalRate : Class → ℝ) →
      (∀ (i : Class), 0 < arrivalRate i) →
        AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw
          (Class → AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ))

value:
fun {Class : Type u_1} [Fintype Class] (arrivalRate : Class → ℝ) (harrivalRate : ∀ (i : Class), 0 < arrivalRate i) =>
  { Pbase := AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkMeasure arrivalRate,
    isProbability :=
      AppliedModelingLib.Probability.PoissonProcess.isProbabilityMeasure_multiclassStationaryPoissonWorkMeasure
        arrivalRate harrivalRate,
    shift := AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkFlow,
    shift_zero :=
      AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkShiftInvariantLaw._proof_1,
    shift_add :=
      AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkShiftInvariantLaw._proof_2,
    shift_preserving := fun (t : ℝ) =>
      AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkFlow_measurePreserving arrivalRate
        harrivalRate t }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw
- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkFlow
- AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkMeasure

AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero

Declaration location: reusable library

Lean declaration body

```
type:
{α : Type u_1} →
  [inst : MeasurableSpace α] →
    (rate : ℝ) →
      0 < rate →
        (PtagPath : MeasureTheory.Measure (ℤ → α)) →
          [MeasureTheory.IsProbabilityMeasure PtagPath] →
            AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero ((ℤ → ℝ) × (ℤ → α))

value:
fun {α : Type u_1} [MeasurableSpace α] (rate : ℝ) (hrate : 0 < rate) (PtagPath : MeasureTheory.Measure (ℤ → α))
    [MeasureTheory.IsProbabilityMeasure PtagPath] =>
  { Ptag := (AppliedModelingLib.Probability.PoissonProcess.candidateTaggedArrivalAtZero rate hrate).Ptag.prod PtagPath,
    isProbability :=
      AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero._proof_1 rate hrate PtagPath,
    arrivals := fun (z : (ℤ → ℝ) × (ℤ → α)) => AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival z.1,
    tag_at_zero := AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero._proof_3 rate PtagPath,
    arrivals_strict :=
      AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero._proof_4 rate hrate PtagPath }
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.candidateTaggedArrivalAtZero
- AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero

AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkTaggedArrivalAtZero

Declaration location: reusable library

Lean declaration body

```
type:
{arrivalRate : ℝ} → 0 < arrivalRate → AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero ((ℤ → ℝ) × (ℤ → ℝ))

value:
fun {arrivalRate : ℝ} (harrivalRate : 0 < arrivalRate) =>
  AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero arrivalRate harrivalRate
    (AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure 1)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.twoSidedInterarrivalMeasure
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- AppliedModelingLib.Probability.Queueing.timedEmbeddedTaggedArrivalAtZero

AppliedModelingLib.Probability.stabilizedFiniteReplayResponse

Declaration location: reusable library

Lean declaration body

```
type:
{Ω : Type u_1} → (ℕ → Ω → ℝ) → Ω → ℝ

value:
fun {Ω : Type u_1} (finiteResponse : ℕ → Ω → ℝ) (a : Ω) =>
  Filter.limsup (fun (n : ℕ) => finiteResponse n a) Filter.atTop
```

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

Declaration location: paper-local

Lean declaration body

```
field arrivalRate:
{Category : Type u_1} →
  [inst : Fintype Category] → LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category → Category → ℝ

field admittedRate:
{Category : Type u_1} →
  [inst : Fintype Category] → LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category → Category → ℝ

field arrivalRate_pos:
∀ {Category : Type u_1} [inst : Fintype Category]
  (self : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) (k : Category), 0 < self.arrivalRate k

field admittedRate_pos:
∀ {Category : Type u_1} [inst : Fintype Category]
  (self : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) (k : Category), 0 < self.admittedRate k

field admittedRate_le_arrivalRate:
∀ {Category : Type u_1} [inst : Fintype Category]
  (self : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) (k : Category),
  self.admittedRate k ≤ self.arrivalRate k
```

LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters

Declaration location: paper-local

Lean declaration body

```
field capacity:
{Category : Type u_1} →
  [inst : Fintype Category] →
    {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category} →
      LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input → ℝ

field weight:
{Category : Type u_1} →
  [inst : Fintype Category] →
    {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category} →
      LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input → Category → ℝ

field capacity_nonneg:
∀ {Category : Type u_1} [inst : Fintype Category]
  {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category}
  (self : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input), 0 ≤ self.capacity

field total_weight_le_one:
∀ {Category : Type u_1} [inst : Fintype Category]
  {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category}
  (self : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input), Finset.univ.sum self.weight ≤ 1

field weight_pos:
∀ {Category : Type u_1} [inst : Fintype Category]
  {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category}
  (self : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input) (k : Category), 0 < self.weight k

field total_admitted_lt_capacity:
∀ {Category : Type u_1} [inst : Fintype Category]
  {input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category}
  (self : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input),
  Finset.univ.sum input.admittedRate < self.capacity
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    (input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
      (capacity : ℝ) →
        (weight : Category → ℝ) →
          0 ≤ capacity →
            (∀ (k : Category), 0 < weight k) →
              Finset.univ.sum weight ≤ 1 →
                Finset.univ.sum input.admittedRate < capacity →
                  LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters input

value:
fun {Category : Type u_1} [Fintype Category] (input : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (capacity : ℝ) (weight : Category → ℝ) (hcapacity : 0 ≤ capacity) (hweight : ∀ (k : Category), 0 < weight k)
    (htotalWeight : Finset.univ.sum weight ≤ 1) (htotalLoad : Finset.univ.sum input.admittedRate < capacity) =>
  { capacity := capacity, weight := weight, capacity_nonneg := hcapacity, total_weight_le_one := htotalWeight,
    weight_pos := hweight, total_admitted_lt_capacity := htotalLoad }
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → Category → Type (max 0 u_1)

value:
fun {Category : Type u_1} (target : Category) => { k : Category // k ≠ target }
```

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput

Declaration location: paper-local

Lean declaration body

```
type:
Type

value:
AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → Category → Type (max 0 u_1)

value:
fun {Category : Type u_1} (target : Category) =>
  ((ℤ → ℝ) × (ℤ → ℝ)) ×
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

Declaration location: paper-local

Lean declaration body

type:
Type u_2 → Type (max u_2 0)

value:
fun (Category : Type u_2) => Category × ℤ

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedPassiveBaseLaw

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category →
        (target : Category) →
          AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw
            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
              AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) (target : Category) =>
  AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkShiftInvariantLaw
    (fun (k : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target) => M.admittedRate ↑k)
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedPassiveBaseLaw._proof_1 M target)

Direct retained dependencies

- AppliedModelingLib.Probability.Palm.ShiftInvariantProbabilityLaw
- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.multiclassStationaryPoissonWorkShiftInvariantLaw
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetTaggedArrivalAtZero

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category →
      Category → AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero ((ℤ → ℝ) × (ℤ → ℝ))

value:
fun {Category : Type u_1} [Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (target : Category) =>
  AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkTaggedArrivalAtZero (M.admittedRate_pos target)

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- AppliedModelingLib.Probability.Queueing.stationaryPoissonWorkTaggedArrivalAtZero
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetPassiveTaggedInput

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category →
        (target : Category) →
          AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
            (((ℤ → ℝ) × (ℤ → ℝ)) ×
              (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
                AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) (target : Category) =>
  AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero
    (M.stationaryAdmittedTargetTaggedArrivalAtZero target) (M.stationaryAdmittedPassiveBaseLaw target)
```

Direct retained dependencies

- AppliedModelingLib.Probability.Palm.targetPassiveTaggedArrivalAtZero
- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedPassiveBaseLaw
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetTaggedArrivalAtZero

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    ℝ →
      ℝ →
        (target : Category) →
          LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
            Category → Finset ℤ

value:
fun {Category : Type u_1} [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (k : Category) =>
  if htarget : k = target then
    AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalIndices start horizon z.1.1
  else AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrivalIndices start horizon (z.2 ⟨k, htarget⟩).1
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalIndices
- AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrivalIndices
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedEmptyFCFSLedger

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger Category
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} => { residualJobs := fun (x : Category) => [] }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJobLedger
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSComputationalEndpointJobs

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Category
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} => { jobs := fun (x : Category) => [] }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSFirstTagCompletion?

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    Category →
      List
        (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
          (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)) →
        Option
          (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [DecidableEq Category] (target : Category)
    (a :
      List
        (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
          (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))) =>
  List.brecOn a
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSFirstTagCompletion?._f target)
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalHorizon

Declaration location: paper-local

Lean declaration body

type:
ℕ → ℝ

value:
fun (N : ℕ) => ↑N + 1

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalStart

Declaration location: paper-local

Lean declaration body

type:
ℕ → ℝ

value:
fun (N : ℕ) => -↑N

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
[DecidableEq Category] →
(target : Category) →
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category → ℝ

value:
fun {Category : Type u_1} [DecidableEq Category] (target : Category)
(z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
(job : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category) =>
if htarget : job.1 = target then AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival z.1.1 job.2
else AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival (z.2 (job.1, htarget)).1 job.2

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.candidatePalmArrival
- AppliedModelingLib.Probability.PoissonProcess.suspensionBaseArrival
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedJobIndicesAt

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
[DecidableEq Category] →
ℝ →
ℝ →
(target : Category) →
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
ℝ → Category → Finset ℤ

value:
fun {Category : Type u_1} [DecidableEq Category] (start horizon : ℝ) (target : Category)
(z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
(eventTime : ℝ) (k : Category) =>
{n ∈
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween start horizon target z
k |
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival target z (k, n) = eventTime}

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceJobLedger

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              Finset (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  Finset.univ.biUnion fun (k : Category) =>
    Finset.image (fun (n : ℤ) => (k, n))
      (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween start horizon target z
        k)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimes

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              Finset ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  Finset.image (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival target z)
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceJobLedger start horizon target z)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceJobLedger

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimeTrace

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              List ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimes start horizon target z).sort
    fun (s t : ℝ) => s ≤ t
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimes

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      (start : ℝ) →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace start

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) =>
  { times := LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimeTrace start horizon target z,
    chronological :=
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace._proof_1 start horizon
        target z htarget_good,
    nodup :=
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace._proof_2 start horizon
        target z }
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSChronologicalFrom
- AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimeTrace
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchTimes

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceWork

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    (target : Category) →
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
        LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category → ℝ

value:
fun {Category : Type u_1} [DecidableEq Category] (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (job : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category) =>
  if htarget : job.1 = target then z.1.2 job.2 else (z.2 ⟨job.1, htarget⟩).2 job.2
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    ℝ →
      ℝ →
        (target : Category) →
          LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
            ℝ → Category → ℝ

value:
fun {Category : Type u_1} [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (eventTime : ℝ) (a : Category) =>
  ∑
    n ∈
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween start horizon target z
        a with
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival target z (a, n) = eventTime,
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceWork target z (a, n)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedArrivalIndicesBetween
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceWork

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJob

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    (target : Category) →
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
        LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category →
          AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} [DecidableEq Category] (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (job : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category) =>
  { identifier := job,
    arrivalTime := LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival target z job,
    residualWork := LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceWork target z job }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceArrival
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedSourceWork

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJobsAt

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    ℝ →
      ℝ →
        (target : Category) →
          LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
            ℝ →
              AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Category
                (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (eventTime : ℝ) =>
  {
    jobs := fun (k : Category) =>
      List.map
        (fun (n : ℤ) => LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJob target z (k, n))
        ((LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedJobIndicesAt start horizon target z
            eventTime k).sort
          fun (left right : ℤ) => left ≤ right) }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSJob
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJob
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedJobIndicesAt

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSEndpointJobsForSegment

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [DecidableEq Category] →
    ℝ →
      ℝ →
        (target : Category) →
          LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
            ℝ →
              AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Category →
                AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs Category
                  (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (eventTime : ℝ) (segment : AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Category) =>
  if segment.endpointIsExternalBatch = true then
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJobsAt start horizon target z eventTime
  else LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSComputationalEndpointJobs
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSEndpointJobs
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSComputationalEndpointJobs
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSJobsAt

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBuildSegmentJobStep

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              ℝ →
                ℝ →
                  (Category → ℝ) →
                    (Category → ℝ) →
                      ℝ →
                        ℝ →
                          AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (eventTime capacity : ℝ) (weight work : Category → ℝ) (currentTime nextBatchDelay : ℝ) =>
  {
    segment :=
      AppliedModelingLib.Probability.Queueing.finiteGPSBuildExecutionSegment capacity weight work
        (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt start horizon target z eventTime)
        currentTime nextBatchDelay,
    endpointJobs :=
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSEndpointJobsForSegment start horizon
        target z eventTime
        (AppliedModelingLib.Probability.Queueing.finiteGPSBuildExecutionSegment capacity weight work
          (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt start horizon target z
            eventTime)
          currentTime nextBatchDelay) }
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- AppliedModelingLib.Probability.Queueing.finiteGPSBuildExecutionSegment
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSEndpointJobsForSegment

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSGapSegmentJobSteps

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              ℝ →
                ℕ →
                  ℝ →
                    (Category → ℝ) →
                      (Category → ℝ) →
                        ℝ →
                          ℝ →
                            List
                              (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                                (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
                                  Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (eventTime : ℝ) (fuel : ℕ) (capacity : ℝ) (weight work : Category → ℝ) (currentTime nextBatchDelay : ℝ) =>
  Nat.brecOn (motive := fun (fuel : ℕ) =>
    (Category → ℝ) →
      ℝ →
        ℝ →
          List
            (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
              (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)))
    fuel
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSGapSegmentJobSteps._f start horizon
      target z eventTime capacity weight)
    work currentTime nextBatchDelay
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- AppliedModelingLib.Probability.Queueing.finiteGPSNextEventState
- AppliedModelingLib.Probability.Queueing.finiteGPSNextStepDuration
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBuildSegmentJobStep

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBatchTrace SegmentJobSteps

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              ℝ →
                (Category → ℝ) →
                  ℝ →
                    (Category → ℝ) →
                      List ℝ →
                        List
                          (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (capacity : ℝ) (weight : Category → ℝ) (currentTime : ℝ) (work : Category → ℝ) (a : List ℝ) =>
  List.brecOn (motive := fun (x : List ℝ) =>
    ℝ →
      (Category → ℝ) →
        List
          (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category)))
    a
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBatchTraceSegmentJobSteps._f start
      horizon target z capacity weight)
    currentTime work
```

Direct retained dependencies

- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- AppliedModelingLib.Probability.Queueing.FiniteGPSGapRunResult
- AppliedModelingLib.Probability.Queueing.finiteGPSActiveClasses
- AppliedModelingLib.Probability.Queueing.finiteGPSRunGap
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSGapSegmentJobSteps

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalFCFSSteps

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    (Category → ℝ) →
                      List
                        (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                          (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight initialWork : Category → ℝ) =>
  LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBatchTraceSegmentJobSteps start horizon
    target z capacity weight start initialWork
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace start horizon target z
      htarget_good).times
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSExternalBatchTrace
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSBatchTraceSegmentJobSteps

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalHistory

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    (Category → ℝ) → AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory Category

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight initialWork : Category → ℝ) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSRunExternalBatchTraceWithSegments capacity weight
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt start horizon target z) start
    initialWork
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace start horizon target z
      htarget_good)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory
- AppliedModelingLib.Probability.Queueing.finiteGPSRunExternalBatchTraceWithSegments
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedBatchAt
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedExternalBatchTrace

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceFCFS Steps

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    List
                      (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                        (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight : Category → ℝ) =>
  List.map
    (fun (segment : AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment Category) =>
      { segment := segment,
        endpointJobs :=
          LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSComputationalEndpointJobs })
    (AppliedModelingLib.Probability.Queueing.finiteGPSHorizonFenceSegments capacity weight
      (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalHistory start horizon
          target z htarget_good capacity weight fun (x : Category) => 0).final
      horizon)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSBatchSegmentHistory
- AppliedModelingLib.Probability.Queueing.FiniteGPSExecutionSegment
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- AppliedModelingLib.Probability.Queueing.finiteGPSHorizonFenceSegments
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFCFSComputationalEndpointJobs
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalHistory

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceRunFCFSSteps

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    List
                      (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep Category
                        (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight : Category → ℝ) =>
  (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalFCFSSteps start horizon
      target z htarget_good capacity weight fun (x : Category) => 0) ++
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceFCFSSteps start horizon
      target z htarget_good capacity weight
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSSegmentJobStep
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceFCFSSteps
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSPreTerminalFCFSSteps

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTargetCompletions

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    List
                      (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
                        (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight : Category → ℝ) =>
  AppliedModelingLib.Probability.Queueing.finiteGPSFCFSRunSegmentStepsClassCompletions
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedEmptyFCFSLedger target
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceRunFCFSSteps start
      horizon target z htarget_good capacity weight)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- AppliedModelingLib.Probability.Queueing.finiteGPSFCFSRunSegmentStepsClassCompletions
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedEmptyFCFSLedger
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceRunFCFSSteps

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTagCompletion?

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 →
                ℝ →
                  (Category → ℝ) →
                    Option
                      (AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
                        (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId Category))

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight : Category → ℝ) =>
  LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSFirstTagCompletion? target
    (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTargetCompletions start
      horizon target z htarget_good capacity weight)
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSFirstTagCompletion?
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTargetCompletions

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTotalResponse

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      ℝ →
        ℝ →
          (target : Category) →
            (z :
                LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
                  target) →
              AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 → ℝ → (Category → ℝ) → ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (start horizon : ℝ) (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
    (htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
    (weight : Category → ℝ) =>
  match
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTagCompletion? start
      horizon target z htarget_good capacity weight with
  | some completion => completion.completionTime
  | none => 0
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- AppliedModelingLib.Probability.Queueing.FiniteGPSFCFSCompletion
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.TaggedAdmittedSourceJobId
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTagCompletion?

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponse

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [Fintype Category] →
    [DecidableEq Category] →
      (target : Category) →
        (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) →
          AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1 → ℝ → (Category → ℝ) → ℕ → ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category] (target : Category)
    (z : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target)
```

(htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier z.1.1) (capacity : ℝ)
(weight : Category → ℝ) (N : ℕ) =>
LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTotalResponse
(LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalStart N)
(LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalHorizon N) target z htarget_good
capacity weight

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedFiniteGPSHorizonFenceTotal Response
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalHorizon
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalStart

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponse Total

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
        LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M →
          (target : Category) →
            ℕ →
              LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
                ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (G : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M) (target : Category) (N : ℕ)
    (a : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  if htarget_good : AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier a.1.1 then
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponse target a htarget_good
      G.capacity G.weight N
  else 0
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.palmTaggedArrivalGoodCarrier
- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponse

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.IsSelectedPalmTaggedGPSFCFSRemotePast Response

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
        LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M →
          (target : Category) →
            (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target →
              ℝ) →
            Prop

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (G : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M) (target : Category)
    (response :
      LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target → ℝ) =>
  ∀ᵐ (z :
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
      target) ∂(M.stationaryAdmittedTargetPassiveTaggedInput target).Ptag,
    ∀ᶠ (N : ℕ) in Filter.atTop, M.taggedAdmittedGPSDiagonalFiniteResponseTotal G target N z = response z
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponseTotal

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetGPSDiagonalResponse

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
        LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target → ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (G : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M) (target : Category)
    (a : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  AppliedModelingLib.Probability.stabilizedFiniteReplayResponse
    (M.taggedAdmittedGPSDiagonalFiniteResponseTotal G target) a
```

Direct retained dependencies

- AppliedModelingLib.Probability.stabilizedFiniteReplayResponse
- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.taggedAdmittedGPSDiagonalFiniteResponseTotal

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.selectedPalmTaggedGPSFCFSRemotePastResponse

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
        LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M →
          (target : Category) →
            LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target → ℝ

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (G : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M) (target : Category)
    (a : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput target) =>
  M.stationaryAdmittedTargetGPSDiagonalResponse G target a
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetGPSDiagonalResponse

LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.SLA2026StationaryGPSResponseTail

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    [DecidableEq Category] →
      (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
        LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M → Category → ℝ → Prop

value:
fun {Category : Type u_1} [Fintype Category] [DecidableEq Category]
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (G : LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters M) (target : Category) (delay : ℝ) =>
  Measurable (M.selectedPalmTaggedGPSFCFSRemotePastResponse G target) ∧
    M.IsSelectedPalmTaggedGPSFCFSRemotePastResponse G target (M.selectedPalmTaggedGPSFCFSRemotePastResponse G target) ∧
      (M.stationaryAdmittedTargetPassiveTaggedInput target).Ptag.real
          {z :
            ((ℤ → ℝ) × (ℤ → ℝ)) ×
              (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
                AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)) |
            delay < M.selectedPalmTaggedGPSFCFSRemotePastResponse G target z} ≤
        Real.exp (-((G.capacity * G.weight target - M.admittedRate target) * delay))
```

Direct retained dependencies

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.IsSelectedPalmTaggedGPSFCFSRemotePastResponse
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedClassInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.StationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.selectedPalmTaggedGPSFCFSRemotePastResponse
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetPassiveTaggedInput

LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy

Declaration location: paper-local

Lean declaration body

field delay:
{Category : Type u_1} →
  {Borough : Type u_2} →
    LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough → Category → Borough → ℝ

field gpsWeight:
{Category : Type u_1} →
  {Borough : Type u_2} →
    LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough → Category → Borough → ℝ

field boroughCapacity:
{Category : Type u_1} →
  {Borough : Type u_2} → LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough → Borough → ℝ

LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible

Declaration location: paper-local

Lean declaration body

field delay_pos:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∀ (k : Category) (b : Borough), 0 < policy.delay k b

field gpsWeight_nonneg:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∀ (k : Category) (b : Borough), 0 ≤ policy.gpsWeight k b

field boroughCapacity_nonneg:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∀ (b : Borough), 0 ≤ policy.boroughCapacity b

field sla:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∀ (k : Category) (b : Borough),
      -(policy.boroughCapacity b * policy.gpsWeight k b - admitted k b) * policy.delay k b + tail ≤ 0

field gps:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∀ (b : Borough), ∑ k : Category, policy.gpsWeight k b ≤ 1

field budget:
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] {tail capacity : ℝ}
  {admitted : Category → Borough → ℝ}
  {policy : LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy Category Borough},
  LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted policy →
    ∑ b : Borough, policy.boroughCapacity b ≤ capacity

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy

LG24ServiceLevelAgreements.allRequestBurden

Declaration location: paper-local

Lean declaration body

type:
ℝ → ℝ → ℝ → ℝ → ℝ

value:
fun (risk inspectionProbability conditionalDelay noninspectionPenalty : ℝ) =>
  risk * (inspectionProbability * conditionalDelay + (1 - inspectionProbability) * noninspectionPenalty)

LG24ServiceLevelAgreements.allRequestFixedOffset

Declaration location: paper-local

Lean declaration body

type:
ℝ → ℝ → ℝ → ℝ

value:
fun (risk inspectionProbability noninspectionPenalty : ℝ) => risk * (1 - inspectionProbability) * noninspectionPenalty

LG24ServiceLevelAgreements.finiteArrivalWeightedBurden

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival burden : Category → Borough → ℝ) =>
  ∑ k : Category, ∑ b : Borough, arrival k b * burden k b

LG24ServiceLevelAgreements.finiteBoroughRange

Declaration location: paper-local

Lean declaration body

type:
{Borough : Type u_1} → [Fintype Borough] → [Nonempty Borough] → (Borough → ℝ) → ℝ

value:
fun {Borough : Type u_1} [Fintype Borough] [Nonempty Borough] (burden : Borough → ℝ) =>
  Finset.univ.sup' Finset.univ_nonempty burden - Finset.univ.inf' Finset.univ_nonempty burden

LG24ServiceLevelAgreements.finiteAllRequestRangeObjective

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
  {Borough : Type u_2} → [Fintype Category] → [Fintype Borough] → [Nonempty Borough] → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough]
    (burden : Category → Borough → ℝ) =>
  ∑ k : Category, LG24ServiceLevelAgreements.finiteBoroughRange (burden k)

Direct retained dependencies

- LG24ServiceLevelAgreements.finiteBoroughRange

LG24ServiceLevelAgreements.finiteCategoryMaximum

Declaration location: paper-local

Lean declaration body

type:
{Category : Type u_1} →
  {Borough : Type u_2} → [Fintype Borough] → [Nonempty Borough] → (Category → Borough → ℝ) → Category → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Borough] [Nonempty Borough] (burden : Category → Borough → ℝ)
    (k : Category) =>
  Finset.univ.sup' Finset.univ_nonempty (burden k)

LG24ServiceLevelAgreements.finiteMatrixReciprocalCapacityFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → (Category → Borough → ℝ) → ℝ → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail : Category → Borough → ℝ)
    (excessCapacity : ℝ) (delay : Category → Borough → ℝ) =>
  (∀ (k : Category) (b : Borough), 0 < delay k b) ∧ ∑ k : Category, ∑ b : Borough, tail k b / delay k b ≤ excessCapacity
```

LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category → ℝ → (Category → ℝ) → Prop

value:
fun {Category : Type u_1} [Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (capacity : ℝ) (weight : Category → ℝ) =>
  0 ≤ capacity ∧
    (∀ (k : Category), 0 < weight k) ∧ Finset.univ.sum weight ≤ 1 ∧ Finset.univ.sum M.admittedRate < capacity
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

LG24ServiceLevelAgreements.paperStationaryGPSResponseTail

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category) →
      (capacity : ℝ) →
        (weight : Category → ℝ) →
          LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight → Category → ℝ → Prop

value:
fun {Category : Type u_1} [Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (capacity : ℝ) (weight : Category → ℝ)
    (hcondition : LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight) (target : Category)
    (delay : ℝ) =>
  M.SLA2026StationaryGPSResponseTail
    (LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady M capacity weight
      (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_1 M capacity weight hcondition)
      (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_2 M capacity weight hcondition)
      (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_3 M capacity weight hcondition)
      (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_4 M capacity weight hcondition))
    target delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.SLA2026StationaryGPSResponseTail
- LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition

LG24ServiceLevelAgreements.paperTargetGuaranteedSlack

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  [inst : Fintype Category] →
    LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category → ℝ → (Category → ℝ) → Category → Prop

value:
fun {Category : Type u_1} [Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
    (capacity : ℝ) (weight : Category → ℝ) (target : Category) =>
  M.admittedRate target < capacity * weight target
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput

LG24ServiceLevelAgreements.reciprocalCapacityUse

Declaration location: paper-local

Lean declaration body

```
type:
{Cell : Type u_1} → [Fintype Cell] → (Cell → ℝ) → (Cell → ℝ) → ℝ

value:
fun {Cell : Type u_1} [Fintype Cell] (tail delay : Cell → ℝ) => ∑ i : Cell, tail i / delay i
```

LG24ServiceLevelAgreements.reciprocalCapacityFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Cell : Type u_1} → [Fintype Cell] → (Cell → ℝ) → ℝ → (Cell → ℝ) → Prop

value:
fun {Cell : Type u_1} [Fintype Cell] (tail : Cell → ℝ) (excessCapacity : ℝ) (delay : Cell → ℝ) =>
  (∀ (i : Cell), 0 < delay i) ∧ LG24ServiceLevelAgreements.reciprocalCapacityUse tail delay ≤ excessCapacity
```

Direct retained dependencies

- LG24ServiceLevelAgreements.reciprocalCapacityUse

LG24ServiceLevelAgreements.sla2026AllRequestResponseFraction

Declaration location: paper-local

Lean declaration body

```
type:
ℝ → ℝ → ℝ → ℝ

value:
fun (arrival admitted admittedTailProbability : ℝ) => admitted / arrival * (1 - admittedTailProbability)
```

LG24ServiceLevelAgreements.paperAllRequestResponseFraction

Declaration location: paper-local

Lean declaration body

```
type:
ℝ → ℝ → ℝ → ℝ

value:
fun (arrival admitted admittedTailProbability : ℝ) =>
  LG24ServiceLevelAgreements.sla2026AllRequestResponseFraction arrival admitted admittedTailProbability
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026AllRequestResponseFraction

LG24ServiceLevelAgreements.sla2026CityEffectiveLoad

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail : ℝ)
    (admitted priority : Category → Borough → ℝ) =>
  ∑ k : Category, √(tail * ∑ b : Borough, admitted k b * priority k b)
```

LG24ServiceLevelAgreements.paperCityEffectiveLoad

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail : ℝ)
    (admitted priority : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026CityEffectiveLoad tail admitted priority
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityEffectiveLoad

LG24ServiceLevelAgreements.sla2026CityEfficientDelay

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail excessCapacity : ℝ)
    (admitted priority : Category → Borough → ℝ) (a : Category) =>
  LG24ServiceLevelAgreements.sla2026CityEffectiveLoad tail admitted priority / excessCapacity *
    √(tail / ∑ b : Borough, admitted a b * priority a b)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityEffectiveLoad

LG24ServiceLevelAgreements.paperCityEfficientDelay

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail excessCapacity : ℝ)
    (admitted priority : Category → Borough → ℝ) (a : Category) =>
  LG24ServiceLevelAgreements.sla2026CityEfficientDelay tail excessCapacity admitted priority a
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityEfficientDelay

LG24ServiceLevelAgreements.sla2026CityFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → [Fintype Category] → ℝ → ℝ → (Category → ℝ) → Prop

value:
fun {Category : Type u_1} [Fintype Category] (tail excessCapacity : ℝ) (delay : Category → ℝ) =>
  LG24ServiceLevelAgreements.reciprocalCapacityFeasible (fun (x : Category) => tail) excessCapacity delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.reciprocalCapacityFeasible

LG24ServiceLevelAgreements.paperCityFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → [Fintype Category] → ℝ → ℝ → (Category → ℝ) → Prop

value:
fun {Category : Type u_1} [Fintype Category] (tail excessCapacity : ℝ) (delay : Category → ℝ) =>
  LG24ServiceLevelAgreements.sla2026CityFeasible tail excessCapacity delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityFeasible

LG24ServiceLevelAgreements.sla2026EffectiveLoad

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail : ℝ)
    (admitted priority : Category → Borough → ℝ) =>
  ∑ k : Category, ∑ b : Borough, √(tail * admitted k b * priority k b)
```

LG24ServiceLevelAgreements.paperEffectiveLoad

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail : ℝ)
    (admitted priority : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026EffectiveLoad tail admitted priority
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026EffectiveLoad

LG24ServiceLevelAgreements.sla2026ExcessCapacity

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → {Borough : Type u_2} → [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (capacity : ℝ)
    (admitted : Category → Borough → ℝ) =>
  capacity - ∑ k : Category, ∑ b : Borough, admitted k b
```

LG24ServiceLevelAgreements.paperExcessCapacity

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} → {Borough : Type u_2} → [Fintype Category] → [Fintype Borough] → ℝ → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (capacity : ℝ)
    (admitted : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026ExcessCapacity capacity admitted
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026ExcessCapacity

LG24ServiceLevelAgreements.sla2026CapacityShare

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  tail / (LG24ServiceLevelAgreements.sla2026ExcessCapacity capacity admitted * delay a a_1)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026ExcessCapacity

LG24ServiceLevelAgreements.paperCapacityShare

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  LG24ServiceLevelAgreements.sla2026CapacityShare tail capacity admitted delay a a_1
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CapacityShare

LG24ServiceLevelAgreements.sla2026EfficientDelay

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted priority : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  LG24ServiceLevelAgreements.sla2026EffectiveLoad tail admitted priority /
      LG24ServiceLevelAgreements.sla2026ExcessCapacity capacity admitted *
    √(tail / (admitted a a_1 * priority a a_1))
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026EffectiveLoad
- LG24ServiceLevelAgreements.sla2026ExcessCapacity

LG24ServiceLevelAgreements.paperEfficientDelay

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted priority : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  LG24ServiceLevelAgreements.sla2026EfficientDelay tail capacity admitted priority a a_1
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026EfficientDelay

LG24ServiceLevelAgreements.sla2026Feasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.finiteMatrixReciprocalCapacityFeasible (fun (x : Category) (x_1 : Borough) => tail)
    (LG24ServiceLevelAgreements.sla2026ExcessCapacity capacity admitted) delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.finiteMatrixReciprocalCapacityFeasible
- LG24ServiceLevelAgreements.sla2026ExcessCapacity

LG24ServiceLevelAgreements.paperFixedLoadFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026Feasible tail capacity admitted delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Feasible

LG24ServiceLevelAgreements.sla2026FixedNoninspectionCost

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) =>
  ∑ k : Category, ∑ b : Borough, (arrival k b - admitted k b) * priority k b * noninspectionPenalty k b
```

LG24ServiceLevelAgreements.paperFixedNoninspectionCost

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026FixedNoninspectionCost arrival admitted priority noninspectionPenalty
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026FixedNoninspectionCost

LG24ServiceLevelAgreements.sla2026CityEfficiency

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) (delay : Category → ℝ) =>
  ∑ k : Category, ∑ b : Borough, admitted k b * priority k b * delay k +
    LG24ServiceLevelAgreements.sla2026FixedNoninspectionCost arrival admitted priority noninspectionPenalty
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026FixedNoninspectionCost

LG24ServiceLevelAgreements.paperCityEfficiencyLoss

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → ℝ) → ℝ
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) (delay : Category → ℝ) =>
  LG24ServiceLevelAgreements.sla2026CityEfficiency arrival admitted priority noninspectionPenalty delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityEfficiency

LG24ServiceLevelAgreements.sla2026InspectionProbability

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2} (arrival admitted : Category → Borough → ℝ) (a : Category)
    (a_1 : Borough) =>
  admitted a a_1 / arrival a a_1
```

LG24ServiceLevelAgreements.sla2026CategorywiseFixedNoninspection

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2}
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) =>
  ∃ (offset : Category → ℝ),
    ∀ (k : Category) (b : Borough),
      LG24ServiceLevelAgreements.allRequestFixedOffset (priority k b)
          (LG24ServiceLevelAgreements.sla2026InspectionProbability arrival admitted k b) (noninspectionPenalty k b) =
        offset k
```

Direct retained dependencies

- LG24ServiceLevelAgreements.allRequestFixedOffset
- LG24ServiceLevelAgreements.sla2026InspectionProbability

LG24ServiceLevelAgreements.paperCategorywiseFixedNoninspection

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2}
    (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026CategorywiseFixedNoninspection arrival admitted priority noninspectionPenalty
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CategorywiseFixedNoninspection

LG24ServiceLevelAgreements.sla2026Cost

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    (Category → Borough → ℝ) →
      (Category → Borough → ℝ) →
        (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2}
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  LG24ServiceLevelAgreements.allRequestBurden (priority a a_1)
    (LG24ServiceLevelAgreements.sla2026InspectionProbability arrival admitted a a_1) (delay a a_1)
    (noninspectionPenalty a a_1)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.allRequestBurden
- LG24ServiceLevelAgreements.sla2026InspectionProbability

LG24ServiceLevelAgreements.paperCost

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    (Category → Borough → ℝ) →
      (Category → Borough → ℝ) →
        (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Category → Borough → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2}
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) (a : Category) (a_1 : Borough) =>
  LG24ServiceLevelAgreements.sla2026Cost arrival admitted priority noninspectionPenalty delay a a_1
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Cost

LG24ServiceLevelAgreements.sla2026Efficiency

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.finiteArrivalWeightedBurden arrival
    (LG24ServiceLevelAgreements.sla2026Cost arrival admitted priority noninspectionPenalty delay)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.finiteArrivalWeightedBurden
- LG24ServiceLevelAgreements.sla2026Cost

LG24ServiceLevelAgreements.paperEfficiencyLoss

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Efficiency

LG24ServiceLevelAgreements.sla2026Equity

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        [Nonempty Borough] →
          (Category → Borough → ℝ) →
            (Category → Borough → ℝ) →
              (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough]
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.finiteAllRequestRangeObjective
    (LG24ServiceLevelAgreements.sla2026Cost arrival admitted priority noninspectionPenalty delay)
```

Direct retained dependencies

- LG24ServiceLevelAgreements.finiteAllRequestRangeObjective
- LG24ServiceLevelAgreements.sla2026Cost

LG24ServiceLevelAgreements.sla2026EfficiencyBestEquitable

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        [Nonempty Borough] →
          ℝ →
            ℝ →
              (Category → Borough → ℝ) →
                (Category → Borough → ℝ) →
                  (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough]
    (tail capacity : ℝ) (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026Feasible tail capacity admitted delay ∧
    LG24ServiceLevelAgreements.sla2026Equity arrival admitted priority noninspectionPenalty delay = 0 ∧
      ∀ (other : Category → Borough → ℝ),
        LG24ServiceLevelAgreements.sla2026Feasible tail capacity admitted other →
          LG24ServiceLevelAgreements.sla2026Equity arrival admitted priority noninspectionPenalty other = 0 →
            LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty delay ≤
              LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty other
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Efficiency
- LG24ServiceLevelAgreements.sla2026Equity
- LG24ServiceLevelAgreements.sla2026Feasible

LG24ServiceLevelAgreements.paperEfficiencyBestEquitable

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        [Nonempty Borough] →
          ℝ →
            ℝ →
              (Category → Borough → ℝ) →
                (Category → Borough → ℝ) →
                  (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough]
    (tail capacity : ℝ) (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026EfficiencyBestEquitable tail capacity arrival admitted priority noninspectionPenalty
    delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026EfficiencyBestEquitable

LG24ServiceLevelAgreements.sla2026OriginalFixedLoadFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) =>
  ∃ (gpsWeight : Category → Borough → ℝ) (boroughCapacity : Borough → ℝ),
    LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible tail capacity admitted
      { delay := delay, gpsWeight := gpsWeight, boroughCapacity := boroughCapacity }
```

Direct retained dependencies

- LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadFeasible
- LG24ServiceLevelAgreements.SLA2026OriginalFixedLoadPolicy

LG24ServiceLevelAgreements.paperOriginalFixedLoadFeasible

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → ℝ → ℝ → (Category → Borough → ℝ) → (Category → Borough → ℝ) → Prop

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] (tail capacity : ℝ)
    (admitted delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026OriginalFixedLoadFeasible tail capacity admitted delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026OriginalFixedLoadFeasible

LG24ServiceLevelAgreements.sla2026PearsonChiSquare

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (left right : Category → Borough → ℝ) =>
  ∑ k : Category, ∑ b : Borough, (left k b - right k b) ^ 2 / right k b
```

LG24ServiceLevelAgreements.paperPearsonChiSquare

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] → [Fintype Borough] → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (left right : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026PearsonChiSquare left right
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026PearsonChiSquare

LG24ServiceLevelAgreements.sla2026RelativeCentralizationGain

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) →
            (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty boroughDelay : Category → Borough → ℝ) (cityDelay : Category → ℝ) =>
  1 -
    LG24ServiceLevelAgreements.sla2026CityEfficiency arrival admitted priority noninspectionPenalty cityDelay /
      LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty boroughDelay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026CityEfficiency
- LG24ServiceLevelAgreements.sla2026Efficiency

LG24ServiceLevelAgreements.paperRelativeCentralizationGain

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) →
            (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty boroughDelay : Category → Borough → ℝ) (cityDelay : Category → ℝ) =>
  LG24ServiceLevelAgreements.sla2026RelativeCentralizationGain arrival admitted priority noninspectionPenalty
    boroughDelay cityDelay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026RelativeCentralizationGain

LG24ServiceLevelAgreements.sla2026RelativePriceOfEquity

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) →
            (Category → Borough → ℝ) →
              (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty equitable efficient : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty equitable /
    LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty efficient -
    1
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Efficiency

LG24ServiceLevelAgreements.paperPriceOfEquity

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        (Category → Borough → ℝ) →
          (Category → Borough → ℝ) →
            (Category → Borough → ℝ) →
              (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ

value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough]
    (arrival admitted priority noninspectionPenalty equitable efficient : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026RelativePriceOfEquity arrival admitted priority noninspectionPenalty equitable
    efficient
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026RelativePriceOfEquity

LG24ServiceLevelAgreements.sla2026SufficientSLAConstraint

Declaration location: paper-local

Lean declaration body

```
type:
ℝ → ℝ → ℝ → Prop

value:
fun (guaranteedSlack delay alpha : ℝ) => 0 ≤ guaranteedSlack * delay + Real.log alpha
```

LG24ServiceLevelAgreements.paperSufficientSLAConstraint

Declaration location: paper-local

Lean declaration body

```
type:
ℝ → ℝ → ℝ → Prop

value:
fun (guaranteedSlack delay alpha : ℝ) =>
  LG24ServiceLevelAgreements.sla2026SufficientSLAConstraint guaranteedSlack delay alpha
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026SufficientSLAConstraint

LG24ServiceLevelAgreements.sla2026Tradeoff

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        [Nonempty Borough] →
          ℝ →
            (Category → Borough → ℝ) →
              (Category → Borough → ℝ) →
                (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough] (gamma : ℝ)
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  gamma * LG24ServiceLevelAgreements.sla2026Efficiency arrival admitted priority noninspectionPenalty delay +
    (1 - gamma) * LG24ServiceLevelAgreements.sla2026Equity arrival admitted priority noninspectionPenalty delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Efficiency
- LG24ServiceLevelAgreements.sla2026Equity

LG24ServiceLevelAgreements.paperTradeoff

Declaration location: paper-local

Lean declaration body

```
type:
{Category : Type u_1} →
  {Borough : Type u_2} →
    [Fintype Category] →
      [Fintype Borough] →
        [Nonempty Borough] →
          ℝ →
            (Category → Borough → ℝ) →
              (Category → Borough → ℝ) →
                (Category → Borough → ℝ) → (Category → Borough → ℝ) → (Category → Borough → ℝ) → ℝ
```

```
value:
fun {Category : Type u_1} {Borough : Type u_2} [Fintype Category] [Fintype Borough] [Nonempty Borough] (gamma : ℝ)
    (arrival admitted priority noninspectionPenalty delay : Category → Borough → ℝ) =>
  LG24ServiceLevelAgreements.sla2026Tradeoff gamma arrival admitted priority noninspectionPenalty delay
```

Direct retained dependencies

- LG24ServiceLevelAgreements.sla2026Tradeoff

Source claims

Review row 1

Source locator: cited publication, lines 555-602

Verbatim source input

```
\paragraph{Response times and SLAs.} Reflecting practice, we consider SLAs in the following form:
   \textit{``In Borough $b$, at least a fraction {$\frac{s_{k,b}}{\lambda_{k,b}}(1 -\alpha_{k,b})$} of category $k$ {incidents} are responded to by time
   ↪  $z_{k,b}$,"}

where $0<\alpha_{k,b}<1$ and $0<s_{k,b}\leq\lambda_{k,b}$. It is thus important to quantify the tail distributions of the response times of non-dropped
↪  incidents. Mathematically, let $T_{k,b}$ be the {random variable corresponding to the response time of non-dropped incidents of category $k\in
↪  \mathcal{S}$ in Borough $b$}. Then, an SLA of the above form corresponds to {$\mathbb{P}[T_{k,b} > z_{k,b}]\le \alpha_{k,b}$}. Assuming that
↪  these incidents are processed on a server with capacity $C_b$, and the GPS weight of this category satisfies $C_b\phi_{k,b}>{s_{k,b}}$ (i.e. there is
↪  guaranteed to be enough capacity to {respond to all admitted requests} of this category), the tail probability of the response time distribution is
↪  bounded by
\begin{equation}
\begin{aligned}
   {\mathbb{P}[T_{k,b}> z_{k,b}]}
   &\le \exp\left(-(\phi_{k,b} C_b-{s_{k,b}})z_{k,b}\right).
\end{aligned}
   \label{tail_prob}
\end{equation}

This follows from our assumptions and classical results in queuing theory (e.g., see \cite{kleinrock1975queue} and \cite{liu2001maximizing}). Combining
↪  the above, a sufficient condition to satisfy an SLA is
\begin{equation}
   (\phi_{k,b} C_b-{s_{k,b}})z_{k,b}
   \ +\ \log \alpha_{k,b}\geq0,
   \label{def:sla}
\end{equation}

  which we will henceforth refer to as the ``SLA constraint.'' Intuitively, this constraint states that: when $C_b$ budget is allocated to Borough $b$, and
  ↪  category $k$ is assigned a GPS parameter $\phi_{k,b}$, then at least $\frac{s_{k,b}}{\lambda_{k,b}}(1-\alpha_{k,b})$ fraction of all category $k$
  ↪  requests in Borough $b$ should be {responded to} within $z_{k,b}$ days, i.e., the SLA would be $z_{k,b}$ days. Practically, enforcing the same tail
  ↪  constraint for all categories enhances the interpretability of the policy,

thus we will consider {$\alpha_{k,b}=\bar\alpha$ and write $a=-\log(\bar\alpha)$} for all category--Borough cells $(k,b)$, which also simplifies notations.
↪  Note that {$\bar\alpha\in(0,1)$}, and so {$a>0$}. In the appendix, we prove some of the statements using general $a_{k,b}$.
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} [inst : Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
  (capacity : ℝ) (weight : Category → ℝ) (target : Category) (delay : ℝ)
  (hcondition : LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight),
  LG24ServiceLevelAgreements.paperTargetGuaranteedSlack M capacity weight target →
    0 ≤ delay → LG24ServiceLevelAgreements.paperStationaryGPSResponseTail M capacity weight hcondition target delay
```

Retained governing declarations

- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition
- LG24ServiceLevelAgreements.paperStationaryGPSResponseTail
- LG24ServiceLevelAgreements.paperTargetGuaranteedSlack

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Fintype Category
3. parameter: LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category
4. parameter: ℝ
5. parameter: Category → ℝ
6. parameter: Category
7. parameter: ℝ
8. assumption: LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight
9. assumption: LG24ServiceLevelAgreements.paperTargetGuaranteedSlack M capacity weight target
10. assumption: 0 ≤ delay
11. conclusion: LG24ServiceLevelAgreements.paperStationaryGPSResponseTail M capacity weight hcondition target delay

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_stationary_gps_response_tail

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:555-602 under the two identity-bound approved_review_contexts with the expanded Spec and all 123 displayed supports. The input records 0<s<=lambda; global steady operation requires C>=0, every SLA weight>0, sum weights<=1 and sum admitted rates<C, with the printed s_target<C phi_target separately visible. The target-Palm coordinate has iid rate-s gaps and unit-exponential work; passive classes retain independent stationary admitted Poisson/work laws. Exact half-open arrival enumeration feeds chronological duplicate-free batches into the normalized active-set GPS rate C phi/sum_active phi, with FCFS work consumption and tag identifier (target,0). The response is the limsup of literal zero-start replays on [-N,N+1); the assertion also requires measurability and almost-sure eventual equality to those finite responses. Its probability clause is exactly P_tag[T>z]<=exp(-((C phi_target-s_target)z)) for nonnegative z. The approved global regularity and admitted-stream reading are honored without imposing all-cell guaranteed margins.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 2

Source locator: cited publication, lines 586-602

Verbatim source input

This follows from our assumptions and classical results in queuing theory (e.g., see \cite{kleinrock1975queue} and \cite{liu2001maximizing}). Combining the above, a sufficient condition to satisfy an SLA is
\begin{equation}
  (\phi_{k,b} C_b-{s_{k,b}})z_{k,b}
  \ +\ \log \alpha_{k,b}\geq0,
  \label{def:sla}
\end{equation}

which we will henceforth refer to as the ``SLA constraint.'' Intuitively, this constraint states that: when C_b budget is allocated to Borough b, and category k is assigned a GPS parameter $\phi_{k,b}$, then at least $\frac{s_{k,b}}{\lambda_{k,b}}(1-\alpha_{k,b})$ fraction of all category k requests in Borough b should be {responded to} within $z_{k,b}$ days, i.e., the SLA would be $z_{k,b}$ days. Practically, enforcing the same tail constraint for all categories enhances the interpretability of the policy,

thus we will consider {$\alpha_{k,b}=\bar\alpha$ and write $a=-\log(\bar\alpha)$} for all category--Borough cells (k,b), which also simplifies notations. Note that {$\bar\alpha\in(0,1)$}, and so {$a>0$}. In the appendix, we prove some of the statements using general $a_{k,b}$.

Expanded PaperInterface specification

```
∀ {Category : Type u_1} [inst : Fintype Category] (M : LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category)
  (capacity : ℝ) (weight : Category → ℝ) (target : Category) (delay alpha : ℝ)
  (hcondition : LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight),
  LG24ServiceLevelAgreements.paperTargetGuaranteedSlack M capacity weight target →
    0 ≤ delay →
      0 < alpha →
        alpha < 1 →
          LG24ServiceLevelAgreements.paperSufficientSLAConstraint (capacity * weight target - M.admittedRate target)
              delay alpha →
            M.admittedRate target / M.arrivalRate target * (1 - alpha) ≤
              LG24ServiceLevelAgreements.paperAllRequestResponseFraction (M.arrivalRate target) (M.admittedRate target)
                ((M.stationaryAdmittedTargetPassiveTaggedInput target).Ptag.real
                  {z :
                    ((ℤ → ℝ) × (ℤ → ℝ)) ×
                      (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
                        AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)) |
                    delay <
                      M.selectedPalmTaggedGPSFCFSRemotePastResponse
                        (LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady M capacity weight
                          (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_1 M capacity weight
                            hcondition)
                          (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_2 M capacity weight
                            hcondition)
                          (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_3 M capacity weight
                            hcondition)
                          (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_4 M capacity weight
                            hcondition))
                        target z})
```

Retained governing declarations

- AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState
- AppliedModelingLib.Probability.PoissonProcess.instMeasurableSpaceGoodSuspensionState
- AppliedModelingLib.Probability.Queueing.TaggedArrivalAtZero
- LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.selectedPalmTaggedGPSFCFSRemotePastResponse
- LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.stationaryAdmittedTargetPassiveTaggedInput
- LG24ServiceLevelAgreements.paperAllRequestResponseFraction
- LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition
- LG24ServiceLevelAgreements.paperSufficientSLAConstraint
- LG24ServiceLevelAgreements.paperTargetGuaranteedSlack

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Fintype Category
3. parameter: LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput Category
4. parameter: ℝ
5. parameter: Category → ℝ
6. parameter: Category
7. parameter: ℝ
8. parameter: ℝ
9. assumption: LG24ServiceLevelAgreements.paperGlobalSteadyGPSCondition M capacity weight
10. assumption: LG24ServiceLevelAgreements.paperTargetGuaranteedSlack M capacity weight target
11. assumption: 0 ≤ delay
12. assumption: 0 < alpha
13. assumption: alpha < 1
14. assumption: LG24ServiceLevelAgreements.paperSufficientSLAConstraint (capacity * weight target - M.admittedRate target) delay alpha
15. conclusion: M.admittedRate target / M.arrivalRate target * (1 - alpha) ≤
  LG24ServiceLevelAgreements.paperAllRequestResponseFraction (M.arrivalRate target) (M.admittedRate target)
    ((M.stationaryAdmittedTargetPassiveTaggedInput target).Ptag.real
      {z :
       ((ℤ → ℝ) × (ℤ → ℝ)) ×
         (LG24ServiceLevelAgreements.SLA2026BoroughQueueingInput.PassiveCategory target →
           AppliedModelingLib.Probability.PoissonProcess.GoodSuspensionState × (ℤ → ℝ)) |
        delay <
         M.selectedPaImTaggedGPSFCFSRemotePastResponse
           (LG24ServiceLevelAgreements.SLA2026BoroughGPSParameters.ofAggregateSteady M capacity weight
             (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_1 M capacity weight hcondition)
             (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_2 M capacity weight hcondition)
             (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_3 M capacity weight hcondition)
             (LG24ServiceLevelAgreements.paperStationaryGPSResponseTail._proof_4 M capacity weight hcondition))
           target z})

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_sla_from_stationary_gps_tail

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:586-602 under the two identity-bound approved_review_contexts with the expanded Spec and all 124 displayed supports. The global condition is exactly nonnegative capacity, positive weights, total weight<=1 and aggregate admitted load below capacity; the separate target condition is s_target<C phi_target. The input has 0<s<=lambda. The tagged law uses independent admitted-rate exponential-gap streams with independent unit-exponential work, and the response is the concrete FCFS tag completion from the normalized active-set GPS diagonal replay. Its all-request rate fraction is (s/lambda)(1-P_tag[T>z]). For z>=0 and alpha in (0,1), the displayed premise is (C phi-s)z+log alpha>=0 and the conclusion is (s/lambda)(1-alpha)<=(s/lambda)(1-P_tag[T>z]), exactly the selected sufficient-SLA rate-fraction claim. The admitted-stream convention governs this interpretation; this comparison does not assert raw-path transport or empirical-frequency convergence.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 3

Source locator: cited publication, lines 1102-1114

Verbatim source input

```
\begin{subequations}
\begin{align}
    {\min_{z>0}}\quad
    &{G^{\mathrm{city}}(s,z)}\notag\\[-2pt]
    &{=\sum_{k,b}s_{k,b}r_{k,b}z_k}\notag\\[-2pt]
    &{\quad+\sum_{k,b}(\lambda_{k,b}-s_{k,b})r_{k,b}D_{k,b}}\\
    {\textnormal{s.t.}}\quad
    &{\sum_k\frac{a}{z_k}\leq E(s).}
\end{align}
\label{opt-centralized}
\end{subequations}
Let $G^{\mathrm{city}}(s,z^{\mathrm{city}})$ denote the optimal value of Problem~\eqref{opt-centralized}, define
${A^{\mathrm{city}}(s)}=\sum_k\sqrt{a\sum_b s_{k,b}r_{k,b}},$

[Next verbatim source excerpt]

(With an analogous extreme equity prioritization formulation under city budget, an optimal solution of the form in \Cref{prop:extremefair} may not always
↪ be attained, because one category-level threshold $z_k$ need not equalize $\operatorname{Cost}_{k,b}$. Thus, we mainly focus on the extreme
↪ efficiency prioritization formulation here.) Denoting the optimal solution to Problem~\eqref{opt-centralized} as $\textbf{z}^{city}=\{z^{city}_k: k\in
↪ \mathcal{S}\}$, representing the SLAs for each category of incidents across the city, the next result shows that in this extreme efficiency
↪ prioritization case, this centralized response indeed provides improvements across \textit{all} Boroughs and categories of incidents, compared to the
↪ Borough-efficient benchmark.

[Next verbatim source excerpt]

\begin{equation*}
 z^{\mathrm{city}}_k
 =\frac{A^{\mathrm{city}}(s)}{E(s)}
   \sqrt{\frac{a}{\sum_b s_{k,b}r_{k,b}}}.
\end{equation*}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [Nonempty Borough] (a capacity : ℝ) (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                AppliedModelingLib.Optimization.IsMinimizerOn
                  (LG24ServiceLevelAgreements.paperCityFeasible a
                    (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted))
                  (LG24ServiceLevelAgreements.paperCityEfficiencyLoss arrival admitted priority noninspectionPenalty)
                  (LG24ServiceLevelAgreements.paperCityEfficientDelay a
                    (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority)
```

Retained governing declarations

- AppliedModelingLib.Optimization.IsMinimizerOn
- LG24ServiceLevelAgreements.paperCityEfficiencyLoss
- LG24ServiceLevelAgreements.paperCityEfficientDelay
- LG24ServiceLevelAgreements.paperCityFeasible
- LG24ServiceLevelAgreements.paperExcessCapacity

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b

19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. conclusion: AppliedModelingLib.Optimization.IsMinimizerOn
  (LG24ServiceLevelAgreements.paperCityFeasible a (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted))
  (LG24ServiceLevelAgreements.paperCityEfficiencyLoss arrival admitted priority noninspectionPenalty)
  (LG24ServiceLevelAgreements.paperCityEfficientDelay a
    (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority)

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_city_extreme_efficiency

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:1102-1114, 1132, and 2962-2966 with the expanded Spec and all 13 displayed supports. IsMinimizerOn requires both feasibility and objective minimality. The displayed definitions give positive category thresholds with sum_k a/z_k <= E, E=C-sum_kb s_kb, city loss sum_kb s_kb r_kb z_k plus the fixed sum_kb (lambda_kb-s_kb)r_kb D_kb, and z_k=(A_city/E)sqrt(a/sum_b s_kb r_kb), where A_city=sum_k sqrt(a sum_b s_kb r_kb). Thus the candidate and complete optimization problem agree with the selected source. The positive-rate, positive-priority and excess-capacity domain makes all denominators positive; finite nonempty Boroughs include the one-Borough case, without imposing the later proposition's two-Borough premise.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 4

Source locator: cited publication, lines 912-917

Verbatim source input

When is the efficiency and equity trade-off substantial? Akin to the algorithmic fairness literature, we define \textit{price of equity} as the difference in
↪ efficiency loss between {the most equitable and most efficient solutions}, relative to the efficiency loss of the most efficient solution:
\begin{equation}
{\operatorname{PoE}_C(s)
:=\frac{G(s,z^{\mathrm{eq}})}{G(s,z^{\mathrm{eff}})}-1 \geq 0.}
\label{eq:price-of-equity-definition}
\end{equation}

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [inst_3 : Nonempty Borough] (a capacity : ℝ)
  (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                ∀ (equitable : Category → Borough → ℝ),
                  LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority
                      noninspectionPenalty equitable →
                    0 ≤
                      LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                        equitable (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
```

Retained governing declarations

- LG24ServiceLevelAgreements.paperEfficiencyBestEquitable
- LG24ServiceLevelAgreements.paperEfficientDelay
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperPriceOfEquity

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. parameter: Category → Borough → ℝ
21. assumption: LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority noninspectionPenalty
  equitable
22. conclusion: 0 ≤
  LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty equitable
    (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_relative_price_of_equity_nonnegative

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:912-917 with the expanded inequality and all 19 supports. The displayed price is G_eq/G_eff-1. The efficient threshold is the source square-root optimizer, while the quantified equitable threshold is positive and reciprocal-feasible and minimizes G among zero-disparity feasible thresholds. G is the arrival-weighted all-request cost, retaining the fixed noninspection term. On the visible positive-load, positive-priority and excess-capacity domain, G_eff>0 and efficient optimality implies G_eq>=G_eff, yielding exactly the source nonnegativity. The target imposes neither the categorywise fixed-offset condition nor the two-Borough condition from later clauses.

Reviewer check: ☐ Matches source input
If left unchecked, explain the discrepancy or uncertainty below.
Reviewer annotation

Review row 5

Source locator: cited publication, lines 686-698

Verbatim source input

```
\begin{restatable}{prop}{reformulation}[Equivalent reciprocal-capacity representation]
\label{prop:opt-reformulation}
{Fix $s$ with $E(s)>0$ and a convex loss $L$. The fixed-load design
problem is equivalent to the tail-threshold-only problem}
\begin{equation}
  \min_{z>0}\ L(z)
  \quad\textnormal{subject to}\quad
  \sum_{k,b}\frac{a}{z_{k,b}}\leq E(s).
  \label{opt-reformulated}
\end{equation}
\end{restatable}
We use this representation in the analysis below. In \Cref{app:fixed-load-theory-proofs}, we detail the transformation, the construction of supporting
↪  Borough capacities and GPS
weights, and establish uniqueness when the reciprocal-capacity constraint is binding.
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  (a capacity : ℝ) (admitted : Category → Borough → ℝ) (loss : (Category → Borough → ℝ) → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 ≤ admitted k b) →
      0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
        ∀ (delay : Category → Borough → ℝ),
          AppliedModelingLib.Optimization.IsMinimizerOn
              (LG24ServiceLevelAgreements.paperOriginalFixedLoadFeasible a capacity admitted) loss delay ↔
            AppliedModelingLib.Optimization.IsMinimizerOn
              (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted) loss delay
```

Retained governing declarations

- AppliedModelingLib.Optimization.IsMinimizerOn
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperFixedLoadFeasible
- LG24ServiceLevelAgreements.paperOriginalFixedLoadFeasible

Lean-elaborated claim roles

```
1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. parameter: ℝ
7. parameter: ℝ
8. parameter: Category → Borough → ℝ
9. parameter: (Category → Borough → ℝ) → ℝ
10. assumption: 0 < a
11. assumption: ∀ (k : Category) (b : Borough), 0 ≤ admitted k b
12. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
13. parameter: Category → Borough → ℝ
14. conclusion: AppliedModelingLib.Optimization.IsMinimizerOn
      (LG24ServiceLevelAgreements.paperOriginalFixedLoadFeasible a capacity admitted) loss delay ↔
    AppliedModelingLib.Optimization.IsMinimizerOn (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
      loss delay
```

Lean proof endpoint (built separately)

```
LG24ServiceLevelAgreements.paper_prop_opt_reformulation
```

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:686-698 with the expanded minimizer equivalence and all 10 supports. Original feasibility existentially supplies Borough capacities and GPS weights, with nonnegative capacities and weights, sum_b C_b<=C, sum_k phi_kb<=1, z_kb>0, and (C_b phi_kb-s_kb)z_kb>=a. The reduced set is z_kb>0 and sum_kb a/z_kb<=E=C-sum_kb s_kb. On a>0 and nonnegative s, summing the original inequalities gives the reduced constraint; conversely C_b=sum_k(s_kb+a/z_kb) and phi_kb=(s_kb+a/z_kb)/C_b supply the original constraints for nonempty categories. The target compares minimizers for the same arbitrary loss and every threshold vector, so it specializes to every convex loss and positive admitted-load instance in the selected source.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 6

Source locator: cited publication, lines 823-832

Verbatim source input

```
\begin{restatable}{prop}{propextremeefficiency}[Extreme efficiency]
\label{prop:extremeeff}
When $\gamma=1$, the optimal efficiency maximizing solution to Problem \eqref{opt-reformulated} {is given by}
\begin{equation}
    {z^{\mathrm{eff}}_{k,b}
     =\frac{{A_{\mathrm{eff}}(s)}}{E(s)}
     \sqrt{\frac{a}{s_{k,b}r_{k,b}}}.}
     \label{eq:fixed-load-efficient-endpoint}
\end{equation}
\end{restatable}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [inst_3 : Nonempty Borough] (a capacity : ℝ)
  (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                AppliedModelingLib.Optimization.IsMinimizerOn
                    (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
                    (LG24ServiceLevelAgreements.paperTradeoff 1 arrival admitted priority noninspectionPenalty)
                    (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ∧
                  ∀ (delay : Category → Borough → ℝ),
                    AppliedModelingLib.Optimization.IsMinimizerOn
                        (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
                        (LG24ServiceLevelAgreements.paperTradeoff 1 arrival admitted priority noninspectionPenalty)
                        delay →
                      delay = LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority
```

Retained governing declarations

- AppliedModelingLib.Optimization.IsMinimizerOn
- LG24ServiceLevelAgreements.paperEfficientDelay
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperFixedLoadFeasible
- LG24ServiceLevelAgreements.paperTradeoff

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. conclusion: AppliedModelingLib.Optimization.IsMinimizerOn (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
    (LG24ServiceLevelAgreements.paperTradeoff 1 arrival admitted priority noninspectionPenalty)
    (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ∧
  ∀ (delay : Category → Borough → ℝ),
    AppliedModelingLib.Optimization.IsMinimizerOn
        (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
        (LG24ServiceLevelAgreements.paperTradeoff 1 arrival admitted priority noninspectionPenalty) delay →
      delay = LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_prop_extreme_efficiency

Recorded source-to-Spec screening **Verdict:** matches
Reason: Compared cited publication:823-832 with the expanded optimizer and uniqueness conjunction and all 19 supports. The feasible set is exactly z_kb>0 and sum_kb a/z_kb<=C-sum_kb s_kb. Expanding the gamma=1 objective leaves G=sum_kb lambda_kb r_kb[(s_kb/lambda_kb)z_kb+(1-s_kb/lambda_kb)D_kb]. Its candidate is exactly (A_eff/E)sqrt(a/(s_kb r_kb)), with A_eff=sum_kb sqrt(a s_kb r_kb). The target states this candidate is feasible and minimizes that objective, and every other minimizer equals it. The extra uniqueness conclusion strengthens the selected optimizer claim without restricting its positive finite source domain.
Reviewer check: ☐ Matches source input
If left unchecked, explain the discrepancy or uncertainty below.
Reviewer annotation

Review row 7

Source locator: cited publication, lines 842-858

Verbatim source input

```
\begin{restatable}{prop}{propextremeequity}[Extreme equity]
\label{prop:extremefair}
When $\gamma=0$, {the efficiency-best equitable solution $z^{\mathrm{eq}}$ satisfies}




\begin{equation}
   {\operatorname{Cost}_{k,b}(s,z^{\mathrm{eq}})=M_k,
    \qquad k\in\mathcal S,\ b\in\mathcal B.}
\end{equation}


\end{restatable}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [inst_3 : Nonempty Borough] (a capacity : ℝ)
  (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                ∃ (delay : Category → Borough → ℝ) (level : Category → ℝ),
                  AppliedModelingLib.Optimization.IsMinimizerOn
                    (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
                    (LG24ServiceLevelAgreements.paperTradeoff 0 arrival admitted priority noninspectionPenalty)
                    delay ∧
                  LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority
                      noninspectionPenalty delay ∧
                    ∀ (k : Category) (b : Borough),
                      LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty delay k b =
                        level k
```

Retained governing declarations

- AppliedModelingLib.Optimization.IsMinimizerOn
- LG24ServiceLevelAgreements.paperCost
- LG24ServiceLevelAgreements.paperEfficiencyBestEquitable
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperFixedLoadFeasible
- LG24ServiceLevelAgreements.paperTradeoff

Lean-elaborated claim roles

```
1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. conclusion: ∃ (delay : Category → Borough → ℝ) (level : Category → ℝ),
  AppliedModelingLib.Optimization.IsMinimizerOn (LG24ServiceLevelAgreements.paperFixedLoadFeasible a capacity admitted)
      (LG24ServiceLevelAgreements.paperTradeoff 0 arrival admitted priority noninspectionPenalty) delay ∧
    LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority noninspectionPenalty
        delay ∧
      ∀ (k : Category) (b : Borough),
        LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty delay k b = level k
```

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_prop_extreme_equity

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:842-858 with the expanded existential claim and all 19 supports. At gamma=0 the objective becomes the sum, over categories, of the maximum-minus-minimum Borough all-request cost. The target supplies a positive reciprocal-feasible delay and one real level per category, asserts minimum equity loss, and asserts efficiency minimality among feasible zero-disparity delays. Its final forall k b equality is Cost_kb(s,z)=level_k, with Cost=r[(s/lambda)z+(1-s/lambda)D]. This supplies the efficiency-best equitable endpoint and the exact within-category equal-cost conclusion; it does not replace equality of all-request costs with equality of raw inspection delays.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 8

Source locator: cited publication, lines 926-959

Verbatim source input

```
\begin{restatable}{prop}{fixedloadalignment}[Price of equity]
\label{prop:costofequity}
The price of equity is
\begin{align}
\operatorname{PoE}_C(s)
&:=\frac{G(s,z^{\mathrm{eq}})}{G(s,z^{\mathrm{eff}})}-1\notag\\[-2pt]
&=\frac{A_{\mathrm{eff}}(s)^2}{E(s)G(s,z^{\mathrm{eff}})}\notag\\[-2pt]
&\quad\times \chi^2\!\left(q^{\mathrm{eff}}\middle|q^{\mathrm{eq}}\right)
 \label{eq:price-of-equity-chi-square}\\[-2pt]
&\leq \frac{1}{G(s,z^{\mathrm{eff}})}\sum_{k,b}\lambda_{k,b}\notag\\[-2pt]
&\quad\times\left[
 \begin{gathered}
 \max_{b'\in\mathcal B}\operatorname{Cost}_{k,b'}(s,z^{\mathrm{eff}})\\[-2pt]
 {}-\operatorname{Cost}_{k,b}(s,z^{\mathrm{eff}})
 \end{gathered}\right].\notag
\end{align}
The price is zero if and only if
$q^{\mathrm{eq}}=q^{\mathrm{eff}}$, equivalently if and only if
$\operatorname{Cost}_{k,b}(s,z^{\mathrm{eff}})$ is constant across Boroughs for each  category $k$.  Moreover, suppose the fixed noninspection
↪  burden
$r_{k,b}D_{k,b}\left(1-s_{k,b}/\lambda_{k,b}\right)$ is constant across
Boroughs within each category.
Then, writing $z^{\mathrm{eff}}(C)$ for the efficient solution at capacity $C$,
\begin{equation}
\operatorname{PoE}_{C'}(s)
=\frac{C-\sum_{k,b}s_{k,b}}
      {C'-\sum_{k,b}s_{k,b}}
 \frac{G(s,z^{\mathrm{eff}}(C))}{G(s,z^{\mathrm{eff}}(C'))}
 \operatorname{PoE}_{C}(s)
\label{eq:poe-capacity-scaling}
\end{equation}
for all $C'>C>\sum_{k,b}s_{k,b}$.
The multiplicative factor in Eq.~\eqref{eq:poe-capacity-scaling} is less than one whenever
$\sum_{k,b}(\lambda_{k,b}-s_{k,b})r_{k,b}D_{k,b}>0$; it equals one when this fixed noninspection component is zero.
\end{restatable}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [inst_3 : Nonempty Borough] (a capacity : ℝ)
  (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                (∀ (equitable : Category → Borough → ℝ),
                   LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority
                     noninspectionPenalty equitable →
                   LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                       equitable (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) =
                     LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 /
                       (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted *
                         LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
                           noninspectionPenalty
                           (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)) *
                       LG24ServiceLevelAgreements.paperPearsonChiSquare
                         (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
                           (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
                         (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable) ∧
                   LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                       equitable (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ≤
                     1 /
                       LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
                         noninspectionPenalty
                         (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) *
                       ∑ k : Category,
                         ∑ b : Borough,
                           arrival k b *
                             (LG24ServiceLevelAgreements.finiteCategoryMaximum
                                (LG24ServiceLevelAgreements.paperCost arrival admitted priority
                                  noninspectionPenalty
                                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
                                k -
                              LG24ServiceLevelAgreements.paperCost arrival admitted priority
                                noninspectionPenalty
                                (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) k
                                b) ∧
                     (LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                         equitable
                         (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) =
                       0 ↔
                     LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable =
                       LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
```

```
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)) ∧
        (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable =
           LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ↔
         ∃ (level : Category → ℝ),
           ∀ (k : Category) (b : Borough),
             LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty
               (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) k
               b =
             level k)) ∧
∀ (capacity' : ℝ),
  ∑ k : Category, ∑ b : Borough, admitted k b < capacity →
   capacity < capacity' →
     LG24ServiceLevelAgreements.paperCategorywiseFixedNoninspection arrival admitted priority
       noninspectionPenalty →
      (0 <
          LG24ServiceLevelAgreements.paperFixedNoninspectionCost arrival admitted priority
           noninspectionPenalty →
         LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
             LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
           (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
              noninspectionPenalty
              (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) /
            LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
              noninspectionPenalty
              (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority)) <
         1) ∧
       (LG24ServiceLevelAgreements.paperFixedNoninspectionCost arrival admitted priority
             noninspectionPenalty =
          0 →
         LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
             LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
           (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
              noninspectionPenalty
              (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) /
            LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
              noninspectionPenalty
              (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted
                priority)) =
         1) ∧
       ∀ (equitable equitable' : Category → Borough → ℝ),
         LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted
           priority noninspectionPenalty equitable →
          LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity' arrival admitted
           priority noninspectionPenalty equitable' →
          LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority
            noninspectionPenalty equitable'
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority) =
          LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
              LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
            (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
               noninspectionPenalty
               (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted
                 priority) /
             LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
               noninspectionPenalty
               (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted
                 priority)) *
           LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority
             noninspectionPenalty equitable
             (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
```

Retained governing declarations

- LG24ServiceLevelAgreements.finiteCategoryMaximum
- LG24ServiceLevelAgreements.paperCapacityShare
- LG24ServiceLevelAgreements.paperCategorywiseFixedNoninspection
- LG24ServiceLevelAgreements.paperCost
- LG24ServiceLevelAgreements.paperEffectiveLoad
- LG24ServiceLevelAgreements.paperEfficiencyBestEquitable
- LG24ServiceLevelAgreements.paperEfficiencyLoss
- LG24ServiceLevelAgreements.paperEfficientDelay
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperFixedNoninspectionCost
- LG24ServiceLevelAgreements.paperPearsonChiSquare
- LG24ServiceLevelAgreements.paperPriceOfEquity

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. conclusion: (∀ (equitable : Category → Borough → ℝ),
    LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority noninspectionPenalty
      equitable →
    LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty equitable
        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) =
      LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 /
        (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted *
          LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)) *
        LG24ServiceLevelAgreements.paperPearsonChiSquare
          (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
          (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable) ∧
    LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty equitable
        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ≤
      1 /
        LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
          (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) *
        ∑ k : Category,
          ∑ b : Borough,
            arrival k b *
              (LG24ServiceLevelAgreements.finiteCategoryMaximum
                  (LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty
                    (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
                  k -
                LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty
                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) k b) ∧
      (LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty equitable
          (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) =
        0 ↔
      LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable =
        LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
          (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)) ∧
      (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable =
        LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
          (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ↔
        ∃ (level : Category → ℝ),
          ∀ (k : Category) (b : Borough),
            LG24ServiceLevelAgreements.paperCost arrival admitted priority noninspectionPenalty
                (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) k b =
              level k)) ∧
  ∀ (capacity' : ℝ),
    ∑ k : Category, ∑ b : Borough, admitted k b < capacity →
      capacity < capacity' →
        LG24ServiceLevelAgreements.paperCategorywiseFixedNoninspection arrival admitted priority noninspectionPenalty →
          (0 < LG24ServiceLevelAgreements.paperFixedNoninspectionCost arrival admitted priority noninspectionPenalty →
            LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
                LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
              (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) /
                LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority)) <
              1) ∧
          (LG24ServiceLevelAgreements.paperFixedNoninspectionCost arrival admitted priority noninspectionPenalty = 0 →
            LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
                LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
              (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) /
                LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                  (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority)) =
              1) ∧
          ∀ (equitable equitable' : Category → Borough → ℝ),
            LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority
                noninspectionPenalty equitable →
              LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity' arrival admitted priority
                  noninspectionPenalty equitable' →
                LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                    equitable' (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority) =
                  LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted /
                      LG24ServiceLevelAgreements.paperExcessCapacity capacity' admitted *
                    (LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) /
                      LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority
                        noninspectionPenalty
                        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity' admitted priority)) *
                  LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty

equitable (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_prop_price_of_equity

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared every clause of cited publication:926-959 with the expanded Spec and all 32 supports. PoE expands to G_eq/G_eff-1; the equality has coefficient A_eff^2/(E G_eff) and Pearson divergence sum_kb(q_eff-q_eq)^2/q_eq with q=a/(E z). The upper bound uses arrival weights lambda_kb times the category maximum efficient all-request cost minus the cell cost, divided by G_eff. Both zero-price equivalences are present, including categorywise constancy of efficient Cost. For all C'>C>sum_s, only the scaling branch assumes r(1-s/lambda)D constant within each category, and it quantifies efficiency-best equitable endpoints at both capacities. Its multiplier is exactly E(C)/E(C') times G_eff(C)/G_eff(C'), with separate strict-less-than-one and equality-to-one conclusions for positive and zero fixed noninspection cost. No printed clause is omitted or given a stronger scaling premise.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 9

Source locator: cited publication, lines 1115-1127

Verbatim source input

analogously to above. Then, the relative centralization gain is

```
\begin{equation}
\begin{aligned}
  &1-\frac{G^{\mathrm{city}}(s,z^{\mathrm{city}})}{G(s,z^{\mathrm{eff}})}\\[-2pt]
  &\qquad=\frac{A_{\mathrm{eff}}(s)^2-A^{\mathrm{city}}(s)^2}
  {E(s)G(s,z^{\mathrm{eff}})}.
\end{aligned}
  \label{eq:aligned-pooling-gain}
\end{equation}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [Nonempty Borough] (a capacity : ℝ) (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                LG24ServiceLevelAgreements.paperRelativeCentralizationGain arrival admitted priority
                    noninspectionPenalty (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
                    (LG24ServiceLevelAgreements.paperCityEfficientDelay a
                      (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority) =
                  (LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 -
                     LG24ServiceLevelAgreements.paperCityEffectiveLoad a admitted priority ^ 2) /
                    (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted *
                      LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
                        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
```

Retained governing declarations

- LG24ServiceLevelAgreements.paperCityEffectiveLoad
- LG24ServiceLevelAgreements.paperCityEfficientDelay
- LG24ServiceLevelAgreements.paperEffectiveLoad
- LG24ServiceLevelAgreements.paperEfficiencyLoss
- LG24ServiceLevelAgreements.paperEfficientDelay
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperRelativeCentralizationGain

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. parameter: ℝ
8. parameter: ℝ
9. parameter: Category → Borough → ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. assumption: 0 < a
14. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
15. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
16. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
17. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
18. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
19. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
20. conclusion: LG24ServiceLevelAgreements.paperRelativeCentralizationGain arrival admitted priority noninspectionPenalty
    (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
    (LG24ServiceLevelAgreements.paperCityEfficientDelay a
      (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority) =
  (LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 -
     LG24ServiceLevelAgreements.paperCityEffectiveLoad a admitted priority ^ 2) /
    (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted *
      LG24ServiceLevelAgreements.paperEfficiencyLoss arrival admitted priority noninspectionPenalty
        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_relative_centralization_gain_identity

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:1115-1127 with the expanded equality and all 20 supports. The left side is exactly 1-G_city(s,z_city)/G(s,z_eff), and the right side is (A_eff^2-A_city^2)/(E G(s,z_eff)). The supports expose the cellwise and category-pooled square-root optimizers, E=C-sum s, and the same fixed noninspection contribution in both losses, so its cancellation agrees with the source identity. Nonempty finite category and Borough sets with positive a, s, r, E and nonnegative fixed cost make the denominator positive. The target includes the one-Borough case, where A_eff=A_city and both sides vanish, without inheriting the later strict-pooling cardinality condition.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation

Review row 10

Source locator: cited publication, lines 1136-1155

Verbatim source input

```
\begin{restatable}{prop}{propcentralized}[Centralization gain]
\label{prop:strict_improvements_from_centralization}
Assume $|\mathcal B|\geq2$.
For any $k\in \mathcal{S}$, b\in \mathcal{B}$, the inspection-delay SLA under the extreme efficiency prioritizing city-budget policy is strictly better
↪  (shorter) than under the extreme efficiency prioritizing Borough-budget policy:
\begin{equation}
z^{city}_{k} < z^{\mathrm{eff}}_{k,b}.
\label{eq:pooling-sla-dominance}
\end{equation}
Furthermore, the centralization gain in efficiency can be compared to the price of equity as follows
\begin{equation}
\begin{aligned}
  &{\textnormal{centralization gain}
    \geq\textnormal{price of equity}}\\[-2pt]
  &{\qquad\Longleftrightarrow\qquad
    1-\frac{A^{\mathrm{city}}(s)^2}{A_{\mathrm{eff}}(s)^2}
    \geq\chi^2\!\left(
    q^{\mathrm{eff}}\middle\|q^{\mathrm{eq}}\right).}
\end{aligned}
\end{equation}
\end{restatable}
```

Expanded PaperInterface specification

```
∀ {Category : Type u_1} {Borough : Type u_2} [inst : Fintype Category] [inst_1 : Fintype Borough] [Nonempty Category]
  [inst_3 : Nonempty Borough] [Nontrivial Borough] (a capacity : ℝ)
  (arrival admitted priority noninspectionPenalty : Category → Borough → ℝ),
  0 < a →
    (∀ (k : Category) (b : Borough), 0 < arrival k b) →
      (∀ (k : Category) (b : Borough), 0 < admitted k b) →
        (∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b) →
          (∀ (k : Category) (b : Borough), 0 < priority k b) →
            (∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b) →
              0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted →
                (∀ (k : Category) (b : Borough),
                    LG24ServiceLevelAgreements.paperCityEfficientDelay a
                        (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority k <
                      LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority k b) ∧
                  ∀ (equitable : Category → Borough → ℝ),
                    LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority
                        noninspectionPenalty equitable →
                      (LG24ServiceLevelAgreements.paperRelativeCentralizationGain arrival admitted priority
                            noninspectionPenalty
                            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
                            (LG24ServiceLevelAgreements.paperCityEfficientDelay a
                              (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority) ≥
                          LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty
                            equitable (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ↔
                        1 -
                          LG24ServiceLevelAgreements.paperCityEffectiveLoad a admitted priority ^ 2 /
                            LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 ≥
                          LG24ServiceLevelAgreements.paperPearsonChiSquare
                            (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
                              (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
                            (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable))
```

Retained governing declarations

- LG24ServiceLevelAgreements.paperCapacityShare
- LG24ServiceLevelAgreements.paperCityEffectiveLoad
- LG24ServiceLevelAgreements.paperCityEfficientDelay
- LG24ServiceLevelAgreements.paperEffectiveLoad
- LG24ServiceLevelAgreements.paperEfficiencyBestEquitable
- LG24ServiceLevelAgreements.paperEfficientDelay
- LG24ServiceLevelAgreements.paperExcessCapacity
- LG24ServiceLevelAgreements.paperPearsonChiSquare
- LG24ServiceLevelAgreements.paperPriceOfEquity
- LG24ServiceLevelAgreements.paperRelativeCentralizationGain

Lean-elaborated claim roles

1. parameter: Type u_1
2. parameter: Type u_2
3. parameter: Fintype Category
4. parameter: Fintype Borough
5. assumption: Nonempty Category
6. assumption: Nonempty Borough
7. assumption: Nontrivial Borough
8. parameter: ℝ
9. parameter: ℝ
10. parameter: Category → Borough → ℝ
11. parameter: Category → Borough → ℝ
12. parameter: Category → Borough → ℝ
13. parameter: Category → Borough → ℝ
14. assumption: 0 < a
15. assumption: ∀ (k : Category) (b : Borough), 0 < arrival k b
16. assumption: ∀ (k : Category) (b : Borough), 0 < admitted k b
17. assumption: ∀ (k : Category) (b : Borough), admitted k b ≤ arrival k b
18. assumption: ∀ (k : Category) (b : Borough), 0 < priority k b
19. assumption: ∀ (k : Category) (b : Borough), 0 ≤ noninspectionPenalty k b
20. assumption: 0 < LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted
21. conclusion: (∀ (k : Category) (b : Borough),
    LG24ServiceLevelAgreements.paperCityEfficientDelay a
      (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority k <
    LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority k b) ∧
  ∀ (equitable : Category → Borough → ℝ),
    LG24ServiceLevelAgreements.paperEfficiencyBestEquitable a capacity arrival admitted priority noninspectionPenalty
      equitable →
    (LG24ServiceLevelAgreements.paperRelativeCentralizationGain arrival admitted priority noninspectionPenalty
        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority)
        (LG24ServiceLevelAgreements.paperCityEfficientDelay a
          (LG24ServiceLevelAgreements.paperExcessCapacity capacity admitted) admitted priority) ≥
      LG24ServiceLevelAgreements.paperPriceOfEquity arrival admitted priority noninspectionPenalty equitable
        (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority) ↔
      1 -
        LG24ServiceLevelAgreements.paperCityEffectiveLoad a admitted priority ^ 2 /
          LG24ServiceLevelAgreements.paperEffectiveLoad a admitted priority ^ 2 ≥
        LG24ServiceLevelAgreements.paperPearsonChiSquare
          (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted
            (LG24ServiceLevelAgreements.paperEfficientDelay a capacity admitted priority))
          (LG24ServiceLevelAgreements.paperCapacityShare a capacity admitted equitable))

Lean proof endpoint (built separately)

LG24ServiceLevelAgreements.paper_prop_centralization

Recorded source-to-Spec screening **Verdict:** matches

Reason: Compared cited publication:1136-1155 with the complete conjunction and all 32 supports. Nontrivial finite Borough is precisely the source condition |B|>=2. The first clause quantifies every category and Borough and uses the displayed category-pooled city threshold and cellwise Borough threshold with the same positive excess capacity. The second clause uses relative gain 1-G_city/G_eff and PoE=G_eq/G_eff-1, with an efficiency-minimal zero-disparity feasible endpoint. The displayed A_city, A_eff, capacity shares q=a/(E z), and chi-square sum (q_eff-q_eq)^2/q_eq preserve the source formula, argument order, and >= biconditional. Positive admitted loads, priorities, thresholds and E keep the source-domain ratios defined. Neither the fixed-noninspection scaling condition nor a new pooling condition is imposed on this comparison.

Reviewer check: ☐ Matches source input

If left unchecked, explain the discrepancy or uncertainty below.

Reviewer annotation