Parameterized and Runtime-tunable Snapshot Isolation in Distributed Transactional Key-value Stores

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RVSI: Relaxed Version Snapshot Isolation

1. Definition of RVSI

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Principle of RVSI

- Parameters (k_1, k_2, k_3) to control the severity of the anomalies w.r.t SI

[1] RC: Read Committed

Principle of RVSI

- Parameters (k_1, k_2, k_3) to control the severity of the anomalies w.r.t SI
- RC [1] $\supset$ RVSI$(k_1, k_2, k_3) \supset$ SI
- RVSI$(\infty, \infty, \infty) =$ RC RVSI$(1, 0, *) =$ SI

[1] RC: Read Committed

Principle of RVSI

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– *"Snapshot Read" property of SI*

1. "stale" data versions

Principle of RVSI

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– *"Snapshot Read" property of SI*

1. "stale" data versions
2. "concurrent" data versions

Principle of RVSI

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– *"Snapshot Read" property of SI*

1. "stale" data versions
2. "concurrent" data versions
3. "non-snapshot" data versions

Principle of RVSI

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– *"Snapshot Read" property of SI*

1. "stale" data versions bounded staleness
2. "concurrent" data versions
3. "non-snapshot" data versions

Principle of RVSI

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– *"Snapshot Read" property of SI*

1. "stale" data versions — bounded staleness
2. "concurrent" data versions — bounded concurrency level
3. "non-snapshot" data versions

Principle of RVSI

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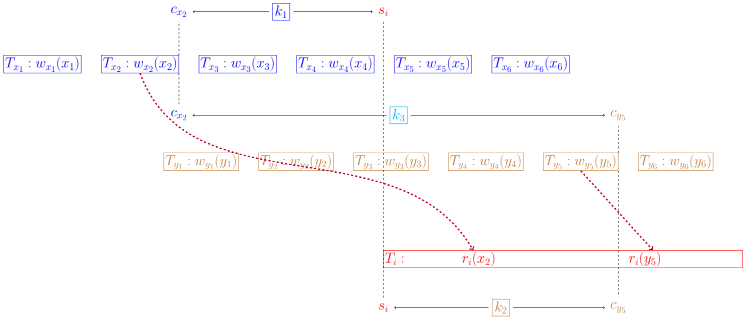
– *"Snapshot Read" property of SI*

1. "stale" data versions — bounded staleness
2. "concurrent" data versions — bounded concurrency level
3. "non-snapshot" data versions — bounded distance

Illustration of RVSI



Definition of RVSI

(k_1-BV)

$$\forall r_i(x_j), w_k(x_k), c_k \in h : \left(c_j \in h \land \bigwedge_{k=1}^{m} (c_j \prec_h c_k \prec_h s_i) \right) \Rightarrow m < k_1,$$

(k_2-FV)

$$\forall r_i(x_j), w_k(x_k), c_k \in h : \left(c_j \in h \land \bigwedge_{k=1}^{m} (s_i \prec_h c_k \prec_h c_j) \right) \Rightarrow m \leq k_2,$$

(k_3-SV)

$$\forall r_i(x_j), r_i(y_l), w_k(x_k), c_k \in h : \left(\bigwedge_{k=1}^{m} (c_j \prec_h c_k \prec_h c_l) \right) \Rightarrow m \leq k_3.$$

Definition of RVSI

$$h \in \mathsf{RVSI} \iff h \in k_1\text{-}\mathsf{BV} \cap k_2\text{-}\mathsf{FV} \cap k_3\text{-}\mathsf{SV} \cap \mathsf{WCF}.$$

Theorem

$$\mathsf{RVSI}(1, 0, *) = \mathsf{SI}.$$