Grand Theater

Showings	
Star Wars	**7pm**
Star Wars	**9pm**
Spectre	**6:30pm**

List[Event]

latency(page load) ≤ 20ms

STAR WARS

7pm Remaining: **5**

Purchase

Counter

invariant: *error tolerance:*
tickets ≥ 0   tickets ± 5%

⊤ := Consistent[T]

Datastore-specific
consistency levels

Interval[T]   Rushed[T]   LocalQuorum[T]...

⊥ := Inconsistent[T]

T

×

×
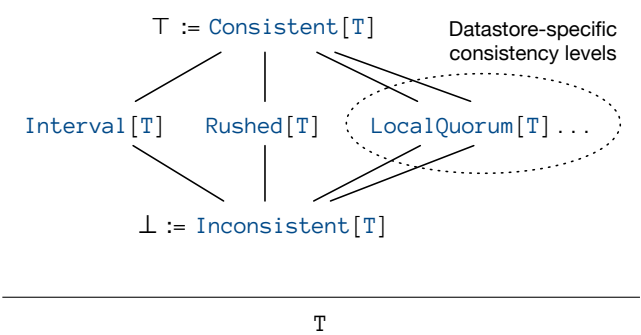
Counter

SetTSet[T] with Consistency(Strong)SetSet[T] with LatencyB

LatencyBound(x)
ErrorTolerance(x%)sizeSet

Setsizecontains
ErrorTolerance(5%)List

TInconsistent[T]Consistent[T]T≺

$$\frac{\tau\tau'}{\tau'[T] \prec \tau[T]}$$

BoundedCounter

Consistent[T]T
Inconsistent[T]Inconsistent[T]Consistent(x)Consistent[T]

$$\frac{\Gamma \vdash e_1 : \tau[T] \quad T \prec \tau[T]}{\Gamma \vdash \text{Consistent}(e_1) : T}$$
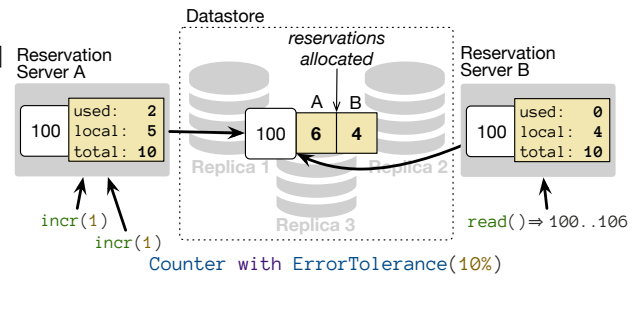
Set[T]

Inconsistent[T]

Rushed[T]LatencyBound(x)Rushed[T]LatencyBoundRushed[T]
Rushed[T]
   Rushed[T]Consistent[T]LocalQuorum[T]Inconsistent[T]

```
set.contains() match {
  case Consistent(x) => print(x)
  case LocalQuorum(x) => print(x + ", locally")
  case Inconsistent(_) => print("unknown")
}
```

Inconsistent(_)

Interval[T]ErrorTolerance(x%)Interval[T]
   Interval[T]Setsizeaddsizesize[95,105][100,107]add

   Interval[Int]

Counter with ErrorTolerance(10%)

Setaddremovesize

```
Interval(min = v - removePool.delta()
         max = v + addPool.delta())
```

vdelta

```
delta(): pool.total - (pool.local - pool.used)
```

$$W + R > N(N+1)/2 \text{QUORUM} N \text{ALLONELOCAL\_QUORUM}$$

LatencyBound

   Counter
   Setaddremovecontainssizesize
   BoundedCounter
   UUIDPoolBoundedCounter
   List

QUORUMQUORUM

tc netemnetem

   Counter
   ALL
   [100,106]

incr(1)read

```scala
trait LatencyBound {
  // execute readOp with strongest consistency possible
  // within the latency bound
  def rush[T](bound: Duration,
              readOp: ConsistencyLevel => T): Rushed[T]
}

/* Generic reservaton pool, conceptually one per
 * ADT instance. `max` recomputed as needed
 * (e.g. for percent error) */
abstract class ReservationPool(max: () => Int) {
  def take(n: Int): Boolean // try to take tokens
  def sync(): Unit          // sync to regain used tokens
  def delta(): Int          // # possible ops outstanding
}

/* Counter with ErrorBound (simplified) */
class Counter(key: UUID) with ErrorBound {
  def error: Float // error bound
  def computeMax(): Int = (cass.read(key) * error).toInt

  val incrPool = ReservationPool(computeMax)
  val decrPool = ReservationPool(computeMax)

  def value(): Interval[Int] = {
    val v = cass.read(key)
    Interval(v - decrPool.delta,
             v + incrPool.delta)
  }

  def incr(n: Int): Unit = {
    waitFor(incrPool.take(n)) {
      cass.incr(key, n)
    }
  }
}
```
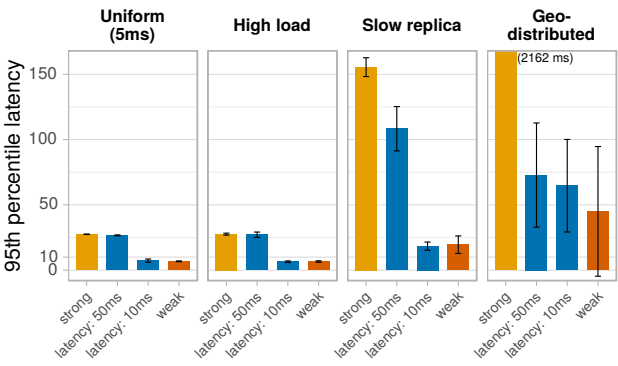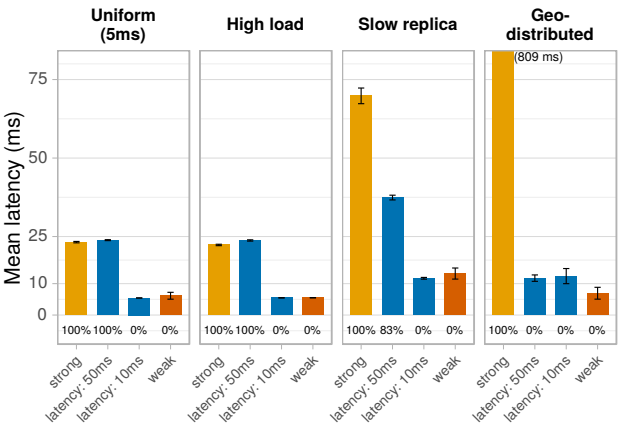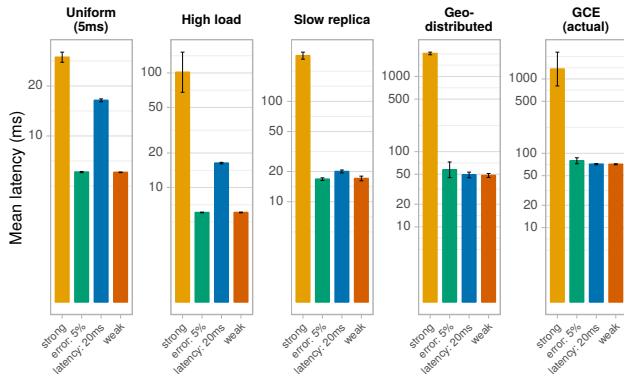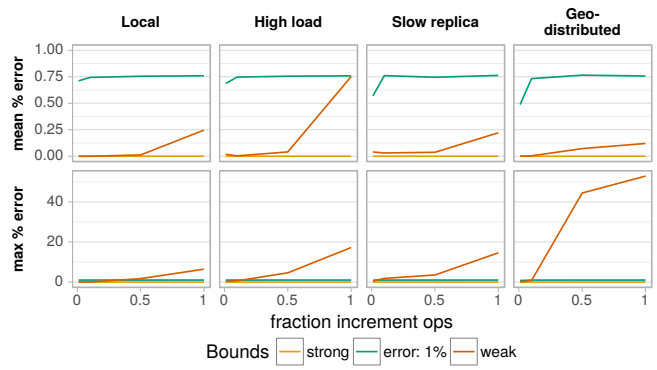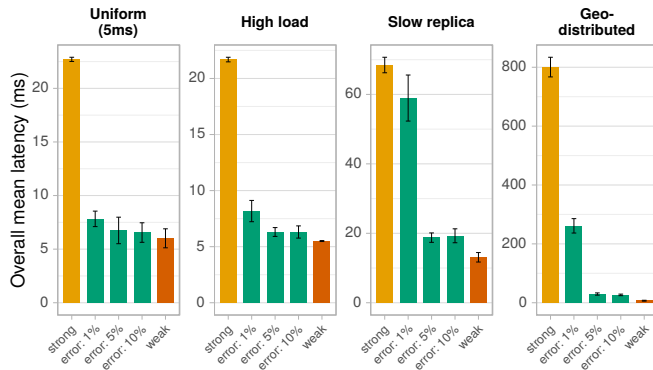

QUORUM

weakALLQUORUM

ALL

us–eastus–centraleurope–westasia–east

browse
viewEvent
purchase
addEvent

ListUUIDPoolBoundedCounter
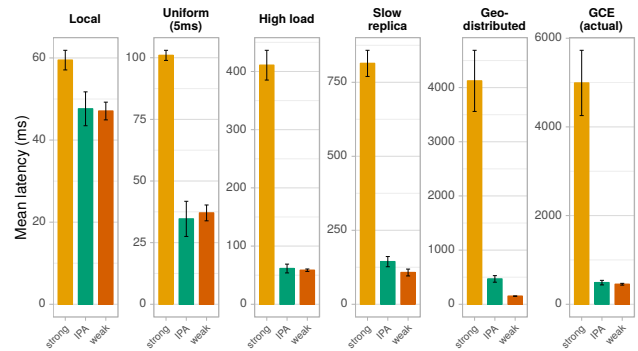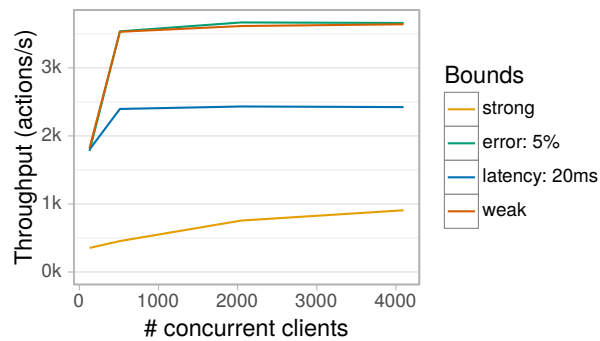BoundedCounter

×Pool

```
User(id: UserID,
     name: String,
     followers: Set[UserID] with LatencyBound(20 ms),
     timeline: List[TweetID] with LatencyBound(20 ms)
)

Tweet(id: TweetID,
      user: UserID,
      text: String,
      posted: DateTime,
      retweets: Set[UserID] with Size(ErrorTolerance(5%))
)
```

size

tweet

×

Interval

timelinetweetretweetfollownewUser

viewEventbrowsepurchaseaddEvent ×purchaseBoundedCounter
× ×
viewEventbrowse

PoolCounter

SetSetListListSet

Rushed[T]

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<>

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