Relaxing the Consistency Condition

Local Linearizability (CONCUR16)

Local Linearizability main idea

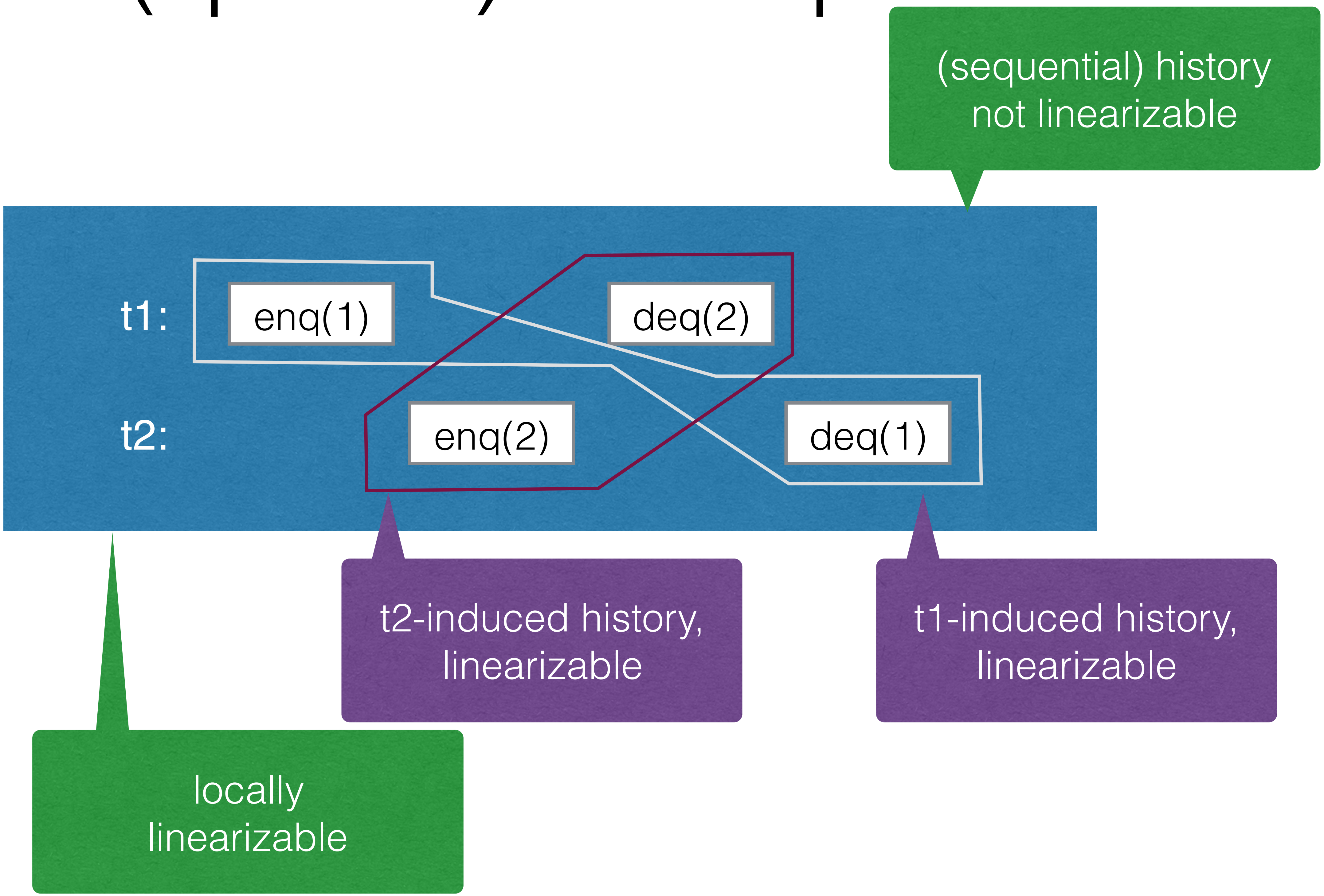
Already present in some shared-memory consistency conditions
(not in our form of choice)

- Partition a history into a set of local histories
- Require linearizability per local history

no global witness

Local sequential consistency… is also possible

Local Linearizability (queue) example



Local Linearizability (queue) definition

Queue signature $\Sigma = \{enq(x) \mid x \in V\} \cup \{deq(x) \mid x \in V\} \cup \{deq(empty)\}$

For a history **h** with a thread T, we put

$I_T = \{enq(x)^T \in \mathbf{h} \mid x \in V\}$

in-methods of thread T are enqueues performed by thread T

$O_T = \{deq(x)^{T'} \in \mathbf{h} \mid enq(x)^T \in I_T\} \cup \{deq(empty)\}$

out-methods of thread T are dequeues (performed by any thread) corresponding to enqueues that are in-methods

h is locally linearizable iff every thread-induced history

$\mathbf{h}_T = \mathbf{h} \mid (I_T \cup O_T)$

is linearizable.

Local Linearizability for Container-Type DS

Signature $\Sigma = Ins \cup Rem \cup SOb \cup DOb$

For a history **h** with a thread T, we put

$$I_T = \{m^T \in \mathbf{h} \mid m \in Ins\}$$

in-methods of thread T are inserts performed by thread T

$$O_T = \{m(a) \in \mathbf{h} \cap Rem \mid i(a)^T \in I_T\} \cup \{m(e) \mid e \in Emp\} \cup \{m(a) \in \mathbf{h} \cap DOb \mid i(a)^T \in I_T\}$$

out-methods of thread T are removes and data-observations (performed by any thread) ...n-methods

h is locally linearizable iff every thread-induced history

$$\mathbf{h}_T = \mathbf{h} \mid (I_T \cup O_T)$$

is linearizable.

Generalizations of Local Linearizability

Signature Σ

For a history **h** with n threads, choose

$In_{\mathbf{h}}(i)$

$Out_{\mathbf{h}}(i)$

in-methods of thread i, methods that go in $\mathbf{h}_i$

by increasing the in-methods, LL gradually moves to linearizability

out-methods of thread i, dependent methods on the methods in $In_{\mathbf{h}}(i)$ (performed by any thread)

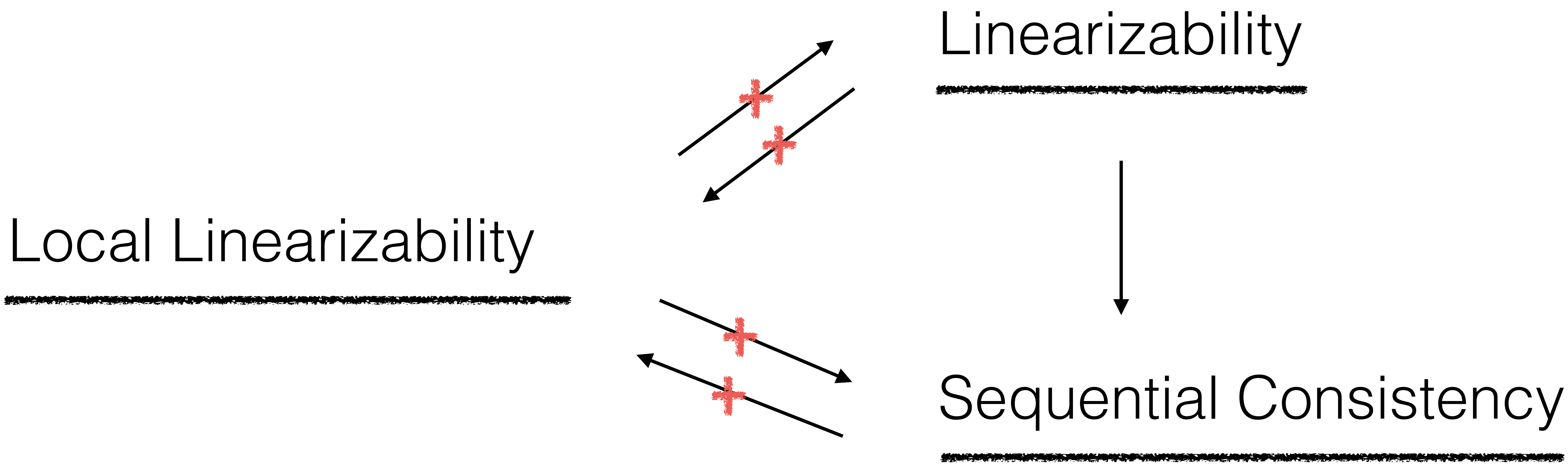
h is locally linearizable iff every thread-induced history

$$\mathbf{h}_i = \mathbf{h} \mid (In_{\mathbf{h}}(i) \cup Out_{\mathbf{h}}(i))$$

is linearizable.

Where do we stand?

In general



Where do we stand?

For queues (and most container-type data structures)

Linearizability

Local Linearizability

Sequential Consistency

Properties

Local linearizability is compositional

like linearizability
unlike sequential consistency

h (over multiple objects) is locally linearizable
iff
each per-object subhistory of **h** is locally linearizable

Local linearizability is modular / "decompositional"

uses decomposition into smaller histories, by definition

may allow for modular verification