

**THEORY** Theo4Liveness

**IMPORT** EvtBPO

**TYPE PARAMETERS** EVENT, STATE

**OPERATORS**

**TLLeads\_From\_P1\_To\_P2\_OneEvt** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p1 : \mathbb{P}(\text{STATE}), p2 : \mathbb{P}(\text{STATE}), e : \text{EVENT}$ )

**well-definedness**  $e \in \text{Progress}(m)$

**direct definition**

$\text{BAP}(m)[\{e\}][p1 \cap \text{Grd}(m)[\{e\}] \cap \text{Inv}(m)] \subseteq p2$

**TLLeads\_From\_P1\_To\_P2** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p1 : \mathbb{P}(\text{STATE}), p2 : \mathbb{P}(\text{STATE})$ )

**direct definition**

$\forall e \cdot e \in \text{Progress}(m) \Rightarrow \text{TLLeadsP1ToP2\_OneEvt}(m, p1, p2, e)$

**TLConvergent\_In\_P\_OneEvt** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z}), e : \text{EVENT}$ )

**well-definedness**  $e \in \text{Progress}(m), \text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{variant}[\text{Inv}(m) \cap p \cap \text{Grd}(m)[\{e\}]] \subseteq \mathbb{N} \wedge$

$(\forall s, sp \cdot s \in \text{Inv}(m) \wedge s \in p \cap \text{Grd}(m)[\{e\}] \wedge sp \in \text{BAP}(m)[\{e\}][\{s\}]$

$\Rightarrow \text{variant}(s) > \text{variant}(sp))$

**TLConvergent\_In\_P** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\forall e \cdot e \in \text{Progress}(m) \Rightarrow \text{TLConvergent\_In\_P\_OneEvt}(m, p, \text{variant}, e)$

**TLDivergent\_In\_P\_OneEvt** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z}), e : \text{EVENT}$ )

**well-definedness**  $e \in \text{Progress}(m), \text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{TLConvergent\_In\_P\_OneEvt}(m, \text{STATE} \setminus p, \text{variant}, e) \wedge$

$(\forall s, sp \cdot s \in \text{Inv}(m) \wedge s \in p \cap \text{Grd}(m)[\{e\}] \wedge sp \in \text{BAP}(m)[\{e\}][\{s\}] \wedge \text{variant}(sp) \in \mathbb{N}$

$\Rightarrow \text{variant}(s) \geq \text{variant}(sp))$

**TLDivergent\_In\_P** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\forall e \cdot e \in \text{Progress}(m) \Rightarrow \text{TLDivergent\_In\_P\_OneEvt}(m, p, \text{variant}, e)$

**TLDeadlock\_Free\_In\_P** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE})$ )

**direct definition**

$p \cap \text{Inv}(m) \subseteq \text{Grd}(m)[\text{Progress}(m)]$

**TLGlobally** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), I : \mathbb{P}(\text{STATE})$ )

**direct definition**

$\text{Inv}(m) \subseteq I$

**TLExistence** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{TLConvergent\_In\_P}(m, \text{STATE} \setminus p, \text{variant}) \wedge$

$\text{TLDeadlock\_Free\_In\_P}(m, \text{STATE} \setminus p)$

**TLUntil** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z}), p1 : \mathbb{P}(\text{STATE}), p2 : \mathbb{P}(\text{STATE})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{TLLeadsP1ToP2}(m, p1 \cap (\text{STATE} \setminus p2), p1 \cup p2) \wedge$

$\text{TLExistence}(m, (\text{STATE} \setminus p1) \cup p2, \text{variant})$

**TLProgress** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z}), p1 : \mathbb{P}(\text{STATE}), p2 : \mathbb{P}(\text{STATE}), p3 : \mathbb{P}(\text{STATE})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{TLGlobally}(m, p3 \cup p2 \cup (\text{STATE} \setminus p1)) \wedge$

$\text{TLUntil}(m, \text{variant}, p3, p2)$

**TLPersistence** *predicate* ( $m : \text{Machine}(\text{STATE}, \text{EVENT}), p : \mathbb{P}(\text{STATE}), \text{variant} : \mathbb{P}(\text{STATE} \times \mathbb{Z})$ )

**well-definedness**  $\text{variant} \in \text{STATE} \rightarrow \mathbb{Z}$

**direct definition**

$\text{TLDivergent\_In\_P}(m, p, \text{variant}) \wedge$

$\text{TLDeadlock\_Free\_In\_P}(m, \text{STATE} \setminus p)$

**END**