

1. $\langle \text{dat}_{\text{id}} = X_{\text{id}} \wedge \text{root}_{\text{id}} = r \wedge \text{val}_{\text{id}} = v_{\text{id}} \wedge X_{\text{id}}[\text{id}] = v_{\text{id}} \wedge 0 \leq r < n, \emptyset \rangle$ (seq 1.1, 1.2)
 $\langle \text{gather; bcast}$
 $\langle \forall t \in [n]. Z_{\text{id}}[t] = X_t[t] \wedge \text{dat}_{\text{id}} = Z_{\text{id}},$
 $\{\text{\texttt{\textbackslash no \textbackslash exit(id) \textbackslash after \textbackslash enter(id) \textbackslash until \textbackslash enter(r) \}}$
 $\rangle$
- 1.1. $\langle \text{dat}_{\text{id}} = X_{\text{id}} \wedge \text{root}_{\text{id}} = r \wedge \text{val}_{\text{id}} = v_{\text{id}} \wedge X_{\text{id}}[\text{id}] = v_{\text{id}} \wedge 0 \leq r < n,$
 $\{\text{\texttt{\textbackslash no \textbackslash send(id, r) \textbackslash after \textbackslash exit(id) \textbackslash until \textbackslash exit(r) \}}$
 $\rangle$
 gather
 $\langle (\forall t \in [n]. Y_r[t] = X_t[t]) \wedge \text{dat}_{\text{id}} = Y_{\text{id}} \wedge \text{root}_{\text{id}} = r \wedge 0 \leq r < n, \emptyset \rangle$
- 1.2. $\langle (\forall t \in [n]. Y_r[t] = X_t[t]) \wedge \text{dat}_{\text{id}} = Y_{\text{id}} \wedge \text{root}_{\text{id}} = r \wedge 0 \leq r < n, \emptyset \rangle$
 bcast
 $\langle (\forall t \in [n]. Y_r[t] = X_t[t]) \wedge \text{dat}_{\text{id}} = Z_{\text{id}} \wedge Z_{\text{id}} = Z_r \wedge Z_r = Y_r,$
 $\{\text{\texttt{\textbackslash no \textbackslash send(id, r) \textbackslash after \textbackslash enter(id) \textbackslash until \textbackslash enter(r),$
 $\text{\texttt{\textbackslash no \textbackslash exit(id) \textbackslash after \textbackslash enter(id) \textbackslash until \textbackslash enter(r) \}}$
 $\rangle$