524 In the program

chan c: $int\cdot$ c?

(a) add the time spent waiting for input according to the transit time measure.

(b) including the time (from part (a)), rewrite the program without using **chan** or ? , and simplify as much as possible.

After trying the question, scroll down to the solution.

(a) add the time spent waiting for input according to the transit time measure.

§ **chan** c: $int\cdot$ $t := t\uparrow(\mathcal{T}_r + 1).$ $c?$

(b) including the time (from part (a)), rewrite the program without using **chan** or ? , and simplify as much as possible.

§ **chan** c: $int\cdot$ $t := t\uparrow(\mathcal{T}_r + 1).$ $c?$

$$= \quad \exists \mathcal{M}, \mathcal{T}, r, r', w, w'\cdot \quad (\forall i, j: nat\cdot\ i \le j \ \Rightarrow\ t \le \mathcal{T}_i \le \mathcal{T}_j \le t') \wedge r = w = 0$$
$$\wedge\ (t := t\uparrow(\mathcal{T}_r + 1).\ r := r+1)$$

replace final assignment

$$= \quad \exists \mathcal{M}, \mathcal{T}, r, r', w, w'\cdot \quad (\forall i, j: nat\cdot\ i \le j \ \Rightarrow\ t \le \mathcal{T}_i \le \mathcal{T}_j \le t') \wedge r = w = 0$$
$$\wedge\ (t := t\uparrow(\mathcal{T}_r + 1).\ r' = r+1 \wedge w' = w \wedge t' = t)$$

substitution law

$$= \quad \exists \mathcal{M}, \mathcal{T}, r, r', w, w'\cdot \quad (\forall i, j: nat\cdot\ i \le j \ \Rightarrow\ t \le \mathcal{T}_i \le \mathcal{T}_j \le t') \wedge r = w = 0$$
$$\wedge\ r' = r+1 \wedge w' = w \wedge t' = t\uparrow(\mathcal{T}_r + 1)$$

one-point law twice

$$= \quad \exists \mathcal{M}, \mathcal{T}, r', w'\cdot \quad (\forall i, j: nat\cdot\ i \le j \ \Rightarrow\ t \le \mathcal{T}_i \le \mathcal{T}_j \le t')$$
$$\wedge\ r' = 0+1 \wedge w' = 0 \wedge t' = t\uparrow(\mathcal{T}_0 + 1)$$

one-point and unused quantifiers

$$= \quad \exists \mathcal{T}\cdot\ (\forall i, j: nat\cdot\ i \le j \ \Rightarrow\ t \le \mathcal{T}_i \le \mathcal{T}_j \le t') \wedge t' = t\uparrow(\mathcal{T}_0 + 1)$$

$$= \quad t' \ge t$$