Recall the original (non-TLA$^+$) definition:

$$R ** S \triangleq \{\langle x, y\rangle : \exists z : (\langle x, z\rangle \in R) \land (\langle z, y\rangle \in S)\}$$

Since x is replacing $\langle x, y\rangle$, we can replace x and y by $x[1]$ and $x[2]$. Hence, the definition becomes

$$R ** S \triangleq \{x \in T : \exists z : (\langle x[1], z\rangle \in R) \land (\langle z, x[2]\rangle \in S)\}$$

We now have to decide what the set T should be. A little thought reveals that the elements of $R ** S$ have to be pairs $\langle r, s\rangle$ with r a node of R and s a node of S. Therefore, we can take T to be the Cartesian product $\mathit{NodesOf}(R) \times \mathit{NodesOf}(S)$, to obtain:

$$\begin{aligned} R ** S \triangleq \{x \in \mathit{NodesOf}(R) \times \mathit{NodesOf}(S) :& \\ &\exists z : (\langle x[1], z\rangle \in R) \land (\langle z, x[2]\rangle \in S)\} \end{aligned}$$

This is a legal TLA$^+$ definition, but TLC can't evaluate it because it contains the unbounded quantifier $\exists z : \ldots$. We need to restrict the range of the bound identifier z. The body of the quantified expression is satisfied only if z is an element of both $\mathit{NodesOf}(R)$ and $\mathit{NodesOf}(S)$. So we could write this quantified expression in any of these ways:

$$\exists z \in \mathit{NodesOf}(R) : \ldots$$
$$\exists z \in \mathit{NodesOf}(S) : \ldots$$
$$\exists z \in \mathit{NodesOf}(R) \cap \mathit{NodesOf}(S) : \ldots$$

Although longer, I find the third to be a little clearer:

$$\begin{aligned} R ** S \triangleq \{x \in \mathit{NodesOf}(R) \times \mathit{NodesOf}(S) :& \\ &\exists z \in \mathit{NodesOf}(R) \cap \mathit{NodesOf}(S) : \\ &\quad (\langle x[1], z\rangle \in R) \land (\langle z, x[2]\rangle \in S)\} \end{aligned}$$

CLOSE