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

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

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

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

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 $NodesOf(R) \times NodesOf(S)$, to obtain:

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

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 $NodesOf(R)$ and $NodesOf(S)$. So we could write this quantified expression in any of these ways:

$$\begin{aligned} & \exists z \in NodesOf(R) : \ldots \\ & \exists z \in NodesOf(S) : \ldots \\ & \exists z \in NodesOf(R) \cap NodesOf(S) : \ldots \end{aligned}$$

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

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

CLOSE