$[NAME]$

$[SURNAME]$

$\begin{array}{|l}
\hline \text{\textit{TelephoneDirectory}} \\
\hline
persons : NAME \rightarrow SURNAME \\
phoneNumbers : NAME \nrightarrow TELEPHONE \\
\hline
\mathrm{dom}\, phoneNumbers = \mathrm{dom}\, persons \\
\hline
\end{array}$

$\begin{array}{|l}
\hline \text{\textit{InitTelephoneDirectory}} \\
\hline
TelephoneDirectory' \\
\hline
phoneNumbers' = \{\} \\
persons' = \{\} \\
\hline
\end{array}$

$\begin{array}{|l}
\hline \text{\textit{AddPerson}} \\
\hline
TheTelephoneDirectory \\
name? : NAME \\
surname? : SURNAME \\
\hline
name? \mapsto surname? \notin persons \\
persons' = persons \cup \{name? \mapsto surname?\} \\
\hline
\end{array}$

$\begin{array}{|l}
\hline \text{\textit{AddNumber}} \\
\hline
\Delta TelephoneDirectory \\
n? : NAME \\
s? : SURNAME \\
p? : TELEPHONE \\
\hline
n \mapsto s \in persons \\
p? \notin \mathrm{ran}\, phoneNumbers \\
phoneNumbers' = phoneNumbers \cup \{n \mapsto phone?\} \\
\hline
\end{array}$

$\begin{array}{|l}
\hline \text{\textit{RemovePerson}} \\
\hline
\Delta TelephoneDirectory \\
n? : NAME \\
s? : SURNAME \\
p? : TELEPHONE \\
\hline
n? \mapsto s? \in persons \\
n? \mapsto p? \notin phoneNumbers \\
persons' = persons \setminus \{n? \mapsto s?\} \\
\hline
\end{array}$

$OUTPUT ::= success \mid alreadyInDirectory \mid nameNotInDirectory \mid numberInUse$

__ *Success* _____
$message! : OUTPUT$

$message! = success$

__ *AlreadyInDirectory* _____
$message! : OUTPUT$
$n? : NAME$
$s? : SURNAME$

$n? \mapsto s \in person$
$message! = alreadyInDirectory$

__ *NameNotInDirectory* _____
$message! : OUTPUT$
$n? : NAME$
$s? : SURNAME$

$n? \mapsto s? \notin persons$
$message! = NotInDirectory$

__ *NumberInUse* _____
$message! : OUTPUT$
$p? : TELEPHONE$

$p? \in \operatorname{ran} phoneNumbers$
$message! = numberInUse$

$TotalAddPerson \mathrel{\widehat{=}} (AddPerson \land Success) \lor AlreadyInDirectory$
$TotalRemovePerson \mathrel{\widehat{=}} (RemovePerson \land Success) \lor NameNotInDirectory$
$TotalAddNumber \mathrel{\widehat{=}} (AddNumber \land Success) \lor NameNotInDirectory \lor NumberInUse$