$[NAME]$

$[SURNAME]$

$[TELEPHONE]$

__ *TelephoneDirectory* _____
$persons : NAME \rightarrow SURNAME$
$phoneNumbers : NAME \nrightarrow TELEPHONE$

$\mathrm{dom}\, phoneNumbers = \mathrm{dom}\, persons$
_____

__ *InitTelephoneDirectory* _____
$TelephoneDirectory'$

$phoneNumbers' = \{\}$
$persons' = \{\}$
_____

__ *AddPerson* _____
$\Delta TelephoneDirectory$
$name? : NAME$
$surname? : SURNAME$
$phone? : TELEPHONE$

$name? \mapsto surname? \notin persons$
$persons' = persons \cup \{name? \mapsto surname?\}$
_____

__ *AddNumber* _____
$\Delta TelephoneDirectory$
$n? : NAME$
$s? : SURNAME$
$p? : TELEPHONE$

$n? \mapsto s? \in persons$
$p? \notin \mathrm{ran}\, phoneNumbers$
$phoneNumbers' = phoneNumbers \cup \{name? \mapsto phone?\}$
_____

__ *RemovePerson* _____
$\Delta TelephoneDirectory$
$n? : NAME$
$s? : SURNAME$
$p? : TELEPHONE$

$n? \mapsto s? \in persons$
$n? \mapsto p? \notin phoneNumbers$
$persons' = persons \setminus \{n? \mapsto s?\}$
_____

```
┌─ RemoveNumber ─────────────────────────────────
│ Δ TelephoneDirectory
│ p? : TELEPHONE
├────────────────────────────────────────────────
│ p? ∈ ran phoneNumbers
│ ∃ m : dom persons •
│ m ↦ p? ∈ phoneNumbers ∧
│ phoneNumbers' = phoneNumbers \ {m ↦ p?}
└────────────────────────────────────────────────
```

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

```
┌─ Success ──────────────────────────────────────
│ message! : OUTPUT
├────────────────────────────────────────────────
│ message! = success
└────────────────────────────────────────────────
```

```
┌─ AlreadyInDirectory ───────────────────────────
│ Ξ TelephoneDirectory
│ message! : OUTPUT
│ n? : NAME
│ s? : SURNAME
├────────────────────────────────────────────────
│ n? ↦ s? ∈ persons
│ message! = alreadyInDirectory
└────────────────────────────────────────────────
```

```
┌─ NameNotInDirectory ───────────────────────────
│ Ξ TelephoneDirectory
│ message! : OUTPUT
│ n? : NAME
│ s? : SURNAME
├────────────────────────────────────────────────
│ n? ↦ s? ∉ persons
│ message! = nameNotInDirectory
└────────────────────────────────────────────────
```

```
┌─ NumberInUse ──────────────────────────────────
│ message! : OUTPUT
│ p? : TELEPHONE
├────────────────────────────────────────────────
│ p? ∈ ran phoneNumbers
│ message! = numberInUse
└────────────────────────────────────────────────
```

```
┌─ NumberDoesntExist ─────────────────────────────────────────
│  message! : OUTPUT
│  p? : TELEPHONE
│ ─────────────────────
│  p? ∉ ran phoneNumbers
│  message! = numberDoesntExist
└─────────────────────────────────────────────────────────────
```

$TotalAddPerson \mathrel{\widehat{=}} (AddPerson \land Success) \lor AlreadyInDirectory$

$TotalRemovePerson \mathrel{\widehat{=}} (RemovePerson \land Success) \lor NameNotInDirectory$

$TotalAddNumber \mathrel{\widehat{=}} (AddNumber \land Success) \lor NameNotInDirectory \lor NumberInUse$

$TotalRemoveNumber \mathrel{\widehat{=}} (RemoveNumber \land Success) \lor NumberDoesntExist \lor NameNotInDirectory$

$TotalPhone \mathrel{\widehat{=}} TotalAddPerson \lor TotalRemovePerson \lor TotalAddNumber \lor TotalRemoveNumber$

$TotalPhoneAndTotalAddPerson \mathrel{\widehat{=}} TotalPhone \lor TotalAddPerson$