

MODULE *TransactionV3*

EXTENDS *Integers, Sequences*

CONSTANT *accounts, initialBalances*

VARIABLE *balances, msgs*

*Init*  $\triangleq$  *balances* = *initialBalances*  
 $\wedge$  *msgs* = {}

*TransferMoney*(*from, to, amount*)  $\triangleq$  *balances*[*from*]  $\geq$  *amount*  
Account needs to have enough balance, from property testing  
 $\wedge$  *msgs'* = *msgs*  $\cup$  {[*from*  $\mapsto$  *from*  
 $\phantom{\wedge \text{msgs}' = \text{msgs} \cup \{[}$  *to*  $\mapsto$  *to*  
 $\phantom{\wedge \text{msgs}' = \text{msgs} \cup \{[}$  *amount\_from*  $\mapsto$  *balances*[*from*] - *amount*  
 $\phantom{\wedge \text{msgs}' = \text{msgs} \cup \{[}$  *amount\_to*  $\mapsto$  *balances*[*to*] + *amount*  
 $\phantom{\wedge \text{msgs}' = \text{msgs} \cup \{[}$  ]}  
 $\wedge$  UNCHANGED (*balances*)

*DbUpdate*  $\triangleq$  *msgs*  $\neq$  {}  
 $\wedge$  LET *msg*  $\triangleq$  CHOOSE *msg*  $\in$  *msgs* : TRUE  
IN *msgs'* = *msgs*  $\setminus$  {*msg*}  
 $\wedge$  *balances'* = [[*balances* EXCEPT ![*msg.from*] = *msg.amount\_from*]  
EXCEPT ![*msg.to*] = *msg.amount\_to*]

*Next*  $\triangleq$  *DbUpdate*  
 $\vee$   $\wedge \exists$  *from, to*  $\in$  *accounts* :  
 $\phantom{\vee}$  *from*  $\neq$  *to*  $\wedge \exists$  *amount*  $\in$  1 .. *balances*[*from*] : Send only positive integers, from property testing  
 $\phantom{\vee}$  *TransferMoney*(*from, to, amount*)

HELPERS

RECURSIVE *SumBalance*(-, -, -)

*SumBalance*(*accs, bal, total*)  $\triangleq$  IF *accs* = {}  
THEN *total*  
ELSE LET *acc*  $\triangleq$  CHOOSE *acc*  $\in$  *accs* : TRUE  
IN *SumBalance*(*accs*  $\setminus$  {*acc*}, *bal*, *total* + *bal*[*acc*])

INVARIANTS

*TypeOK*  $\triangleq$  *msgs*  $\subseteq$  [*from* : *accounts*, *to* : *accounts*, *amount\_from* : *Int*, *amount\_to* : *Int*]

*BalancesAlwaysPositive*  $\triangleq$   $\forall$  *acc*  $\in$  *accounts* : *balances*[*acc*]  $\geq$  0

*TotalMoneyStable*  $\triangleq$  *SumBalance*(*accounts, initialBalances, 0*) = *SumBalance*(*accounts, balances, 0*)

\\* Modification History  
\\* Last modified *Fri Aug 13 13:19:29 CEST 2021* by *rchaves*  
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