

CS 580 Specification of Software Systems

Homework 02: Shift Register.

Consider a shift register denoted by the array $A[1:n]$ and an accumulator called $A[0]$. Initially, the accumulator holds a zero value and the shift register strictly positive integers. When the system finishes execution, the accumulator holds the sum of all the initial values stored in the shift register and the shift register is zeroed out. Here is a program that carries out these operations:

Program Shift and Sum

```
declare   A : array[0..n] of integer
initially A[0] = 0  $\wedge$   $\langle \forall i : 1 \leq i \leq n :: A[i] > 0 \rangle$ 
assign     $\langle \begin{array}{l} \parallel i : 1 \leq i < n :: A[i] := A[i+1] \\ \parallel A[n] := 0 \\ \parallel A[0] := A[0] + A[1] \end{array} \rangle$ 
end
```

For each of the property listed below, indicate whether it holds or not for this program and explain briefly how you reached this conclusion.

Let S be the sum of the values stored in the array A at the start of the program, i.e.,

$S = \langle + i : 1 \leq i \leq n :: A[i] \rangle$

1. $A[i] = k$ **unless** $A[i] > k$
2. $A[i] > 0 \wedge i > 0$ **unless** $A[i] = 0$
3. **stable** $A[0] \geq k$
4. **const** $\langle + i : 0 \leq i \leq n :: A[i] \rangle = k$
5. **inv** $\langle + i : 0 \leq i \leq n :: A[i] \rangle = S$
6. **inv** $A[n] = 0 \Rightarrow \langle \exists k : 0 \leq k < n :: \langle \forall i : k \leq i \leq n :: A[i] = 0 \rangle \rangle$
7. **inv** $\langle \exists k : 0 \leq k \leq n :: \langle + i : 0 \leq i \leq k :: A[i] \rangle = S \rangle$
8. $A[i] > 0 \wedge A[i+1] = 0 \wedge i < n$ **ensures** $A[i] = 0$
9. $A[n] = 0 \wedge n > 2$ **ensures** $A[n-2] = 0$
10. $A[0] = 0$ **leads-to** $A[0] = S$