**Operating Systems Lab 1**

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COSC 4327.01

Grade Option A

**C Option Code**

**Coption.adb**

with Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

use Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

procedure Coption is

-- definitions

package Duration\_IO is new Ada.Text\_IO.Fixed\_IO(duration); use Duration\_IO;

package integerIO is new Ada.Text\_IO.Integer\_IO(integer); use integerIO;

randNum: Generator; -- used to generate 0.0 <= random numbers <1.0.

--"Random(randNum)" generates a random number, 0.0 < random number < 1.0.

-- Duration(Random(randNum) ) coerces the random number to the data type

-- required by the "delay" statement when requesting a process be put to sleep.

type RequestType is (Permission\_To\_Land, Call\_The\_Ball, Touch\_Down);

type ShuttleNameType is (Atlantis, Challenger, Ranger, MeanMachine);

package ShuttleNameIO is new Ada.Text\_IO.Enumeration\_IO(ShuttleNameType);

use ShuttleNameIO;

-- This entire procedure represents a critical resource where access must be controlled.

procedure LandingControlOfficer( Request: in RequestType; Shuttle: in ShuttleNameType) is

begin

case Request is

when Permission\_To\_Land =>

delay Duration(Random(randNum) \* 5.0); -- 0 <= Delay < 5.0 uniformly distributed.

-- Make decision.

put(Shuttle); put(" is granted permission to land."); new\_line;

when Call\_The\_Ball =>

delay Duration(Random(randNum) \* 5.0);

-- Prepare gudiance system..

put(Shuttle); put(" call the ball!"); new\_line;

when Touch\_Down =>

put(Shuttle); put(", permission is granted for final approach."); new\_line;

delay Duration(Random(randNum) \* 10.0);

-- Wait for shuttle to land.

end case;

end LandingControlOfficer;

--Global Variables for Decker's Algorithm

AtlantisControl : Integer := 0;

RangerControl : Integer := 0;

Turn : Integer := 1;

task ShuttleAtlantis;

task body ShuttleAtlantis is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Decker's Algorithm

AtlantisControl := 1;

while RangerControl = 1 loop

if Turn = 2 then

AtlantisControl := 0;

while Turn = 2 loop

null;

end loop;

AtlantisControl := 1;

end if;

end loop;

put("Atlantis entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Atlantis );

LandingControlOfficer( Call\_The\_Ball, Atlantis );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Atlantis );

landingComplete := seconds(clock);

put("Shuttle Atlantis docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Atlantis leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Decker's Algorithm

AtlantisControl := 0;

Turn := 2;

end loop;

end ShuttleAtlantis;

task ShuttleRanger;

task body ShuttleRanger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Decker's Algorithm

RangerControl := 1;

while AtlantisControl = 1 loop

if Turn = 1 then

RangerControl := 0;

while Turn = 1 loop

null;

end loop;

RangerControl := 1;

end if;

end loop;

put("Ranger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Ranger );

LandingControlOfficer( Call\_The\_Ball, Ranger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Ranger );

landingComplete := seconds(clock);

put("Shuttle Ranger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Ranger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Decker's Algorithm

RangerControl := 0;

Turn := 1;

end loop;

end ShuttleRanger;

begin

put("Shuttle operations are authorized."); new\_line;

-- Used as a container by the mother ship to launch and recover shuttles.

end Coption;

**C Option Results**

Shuttle operations are authorized.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 8.550105983 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 7.028545260 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 10.769338992 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 14.794489263 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 17.334668143 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 18.107227498 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 14.055475536 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 10.119423262 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 14.382440998 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 5.335641091 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 8.516888648 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 10.031345652 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 13.796490749 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 10.367348798 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 10.526374825 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 10.296539790 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 14.797522779 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 6.948231448 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 15.375461845 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 5.380145270 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

**B Option Code**

**Boption.adb**

with Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

use Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

procedure Boption is

-- definitions

package Duration\_IO is new Ada.Text\_IO.Fixed\_IO(duration); use Duration\_IO;

package integerIO is new Ada.Text\_IO.Integer\_IO(integer); use integerIO;

randNum: Generator; -- used to generate 0.0 <= random numbers <1.0.

--"Random(randNum)" generates a random number, 0.0 < random number < 1.0.

-- Duration(Random(randNum) ) coerces the random number to the data type

-- required by the "delay" statement when requesting a process be put to sleep.

type RequestType is (Permission\_To\_Land, Call\_The\_Ball, Touch\_Down);

type ShuttleNameType is (Atlantis, Challenger, Ranger, MeanMachine);

package ShuttleNameIO is new Ada.Text\_IO.Enumeration\_IO(ShuttleNameType);

use ShuttleNameIO;

-- This entire procedure represents a critical resource where access must be controlled.

procedure LandingControlOfficer( Request: in RequestType; Shuttle: in ShuttleNameType) is

begin

case Request is

when Permission\_To\_Land =>

delay Duration(Random(randNum) \* 5.0); -- 0 <= Delay < 5.0 uniformly distributed.

-- Make decision.

put(Shuttle); put(" is granted permission to land."); new\_line;

when Call\_The\_Ball =>

delay Duration(Random(randNum) \* 5.0);

-- Prepare gudiance system..

put(Shuttle); put(" call the ball!"); new\_line;

when Touch\_Down =>

put(Shuttle); put(", permission is granted for final approach."); new\_line;

delay Duration(Random(randNum) \* 10.0);

-- Wait for shuttle to land.

end case;

end LandingControlOfficer;

--Global variables for Peterson's Algorithm

AtlantisFlag : Boolean := False;

RangerFlag : Boolean := False;

Turn : Integer := 1;

task ShuttleAtlantis;

task body ShuttleAtlantis is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

AtlantisFlag := True;

Turn := 1;

while RangerFlag and Turn = 1 loop

null;

end loop;

put("Atlantis entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Atlantis );

LandingControlOfficer( Call\_The\_Ball, Atlantis );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Atlantis );

landingComplete := seconds(clock);

put("Shuttle Atlantis docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Atlantis leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Peterson's Algorithm

AtlantisFlag := False;

end loop;

end ShuttleAtlantis;

task ShuttleRanger;

task body ShuttleRanger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

RangerFlag := True;

Turn := 0;

while AtlantisFlag and Turn = 0 loop

null;

end loop;

put("Ranger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Ranger );

LandingControlOfficer( Call\_The\_Ball, Ranger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Ranger );

landingComplete := seconds(clock);

put("Shuttle Ranger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Ranger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Peterson's Algorithm

RangerFlag := False;

end loop;

end ShuttleRanger;

begin

Reset(randNum, seconds(clock));

put("Shuttle operations are authorized."); new\_line;

-- Used as a container by the mother ship to launch and recover shuttles.

end Boption;

**B Option Results**

Shuttle operations are authorized.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 15.120589813 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 12.262465523 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 6.098204944 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 11.923433986 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 9.086315611 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 11.355436086 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 12.204836119 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 11.524092264 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 13.125456899 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 12.292588601 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 11.082346970 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.923859489 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 10.983117851 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 5.436206775 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 13.360627392 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.739348830 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 13.425511003 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.540502634 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 9.833360740 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 9.395304978 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

**B Option Discussion**

The main reason this approach would not work is because distributed systems do not have shared memory, which is required for memory interlock approaches to work. One of the main techniques used in memory interlock is causing a process to waste it’s time slice by sitting in a spin-lock state. These spin-lock sections of code usually take the form of:

While(SharedVariable == True) {  
 //do nothing

}

Notice that in order to do this, the while-statement must continuously check on the state of a shared variable. In a distributed system, a process could not directly access shared memory like you could in a parallel system, so this becomes problematic. Since each component of a distributed system has its own section of memory, only one of the components would be able to access the variable directly, and the others would have to request the state of the variable asynchronously over a network. This introduces lag in memory access to every component that can’t access the shared variable directly, and because the access requests would be asynchronous, there would need to be a timestamp system in place to determine who accessed the variable in what order, otherwise race conditions could occur. Because of the nature of distributed systems, it would also be possible for a process to sit in spin-lock for longer than it should be due to the way a timestamp system would affect requests to the shared variable, i.e. in some cases a request might have to be rejected, and Peterson’s algorithm would have to be modified to accommodate these occurences.

**A Option Code**

This version of the A option uses one Landing Officer.

**Aoption1.adb**

with Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

use Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

procedure Aoption1 is

-- definitions

package Duration\_IO is new Ada.Text\_IO.Fixed\_IO(duration); use Duration\_IO;

package integerIO is new Ada.Text\_IO.Integer\_IO(integer); use integerIO;

randNum: Generator; -- used to generate 0.0 <= random numbers <1.0.

--"Random(randNum)" generates a random number, 0.0 < random number < 1.0.

-- Duration(Random(randNum) ) coerces the random number to the data type

-- required by the "delay" statement when requesting a process be put to sleep.

type RequestType is (Permission\_To\_Land, Call\_The\_Ball, Touch\_Down);

type ShuttleNameType is (Atlantis, Challenger, Ranger, MeanMachine);

package ShuttleNameIO is new Ada.Text\_IO.Enumeration\_IO(ShuttleNameType);

use ShuttleNameIO;

-- This entire procedure represents a critical resource where access must be controlled.

procedure LandingControlOfficer( Request: in RequestType; Shuttle: in ShuttleNameType) is

begin

case Request is

when Permission\_To\_Land =>

delay Duration(Random(randNum) \* 5.0); -- 0 <= Delay < 5.0 uniformly distributed.

-- Make decision.

put(Shuttle); put(" is granted permission to land."); new\_line;

when Call\_The\_Ball =>

delay Duration(Random(randNum) \* 5.0);

-- Prepare gudiance system..

put(Shuttle); put(" call the ball!"); new\_line;

when Touch\_Down =>

put(Shuttle); put(", permission is granted for final approach."); new\_line;

delay Duration(Random(randNum) \* 10.0);

-- Wait for shuttle to land.

end case;

end LandingControlOfficer;

--Peterson's Algorithm Globals

Flag : array (ShuttleNameType) of Integer := (others => -1);

Turn: array (0..2) of ShuttleNameType := (others => MeanMachine);

task ShuttleAtlantis;

task body ShuttleAtlantis is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..2 loop

Flag(Atlantis) := Level;

Turn(Level) := Atlantis;

while Turn(Level) = Atlantis and then (Flag(Challenger) >= Level or Flag(Ranger) >= Level) loop

null;

end loop;

end loop;

put("Atlantis entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Atlantis );

LandingControlOfficer( Call\_The\_Ball, Atlantis );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Atlantis );

landingComplete := seconds(clock);

put("Shuttle Atlantis docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Atlantis leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Peterson's Algorithm

Flag(Atlantis) := -1;

end loop;

end ShuttleAtlantis;

task ShuttleRanger;

task body ShuttleRanger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..2 loop

Flag(Ranger) := Level;

Turn(Level) := Ranger;

while Turn(Level) = Ranger and then (Flag(Atlantis) >= Level or Flag(Challenger) >= Level) loop

null;

end loop;

end loop;

put("Ranger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Ranger );

LandingControlOfficer( Call\_The\_Ball, Ranger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Ranger );

landingComplete := seconds(clock);

put("Shuttle Ranger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Ranger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Peterson's Algorithm

Flag(Ranger) := -1;

end loop;

end ShuttleRanger;

task ShuttleChallenger;

task body ShuttleChallenger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..2 loop

Flag(Challenger) := Level;

Turn(Level) := Challenger;

while Turn(Level) = Challenger and then (Flag(Atlantis) >= Level or Flag(Ranger) >= Level) loop

null;

end loop;

end loop;

put("Challenger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Challenger );

LandingControlOfficer( Call\_The\_Ball, Challenger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Challenger );

landingComplete := seconds(clock);

put("Shuttle Challenger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Challenger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

--Peterson's Algorithm

Flag(Challenger) := -1;

end loop;

end ShuttleChallenger;

begin

put("Shuttle operations are authorized."); new\_line;

-- Used as a container by the mother ship to launch and recover shuttles.

end Aoption1;

This version of the A option uses two Landing Officers.

**Aoption2.adb**

with Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

use Ada.Text\_IO, Ada.Calendar, Ada.Numerics.Float\_Random;

procedure Aoption2 is

-- definitions

package Duration\_IO is new Ada.Text\_IO.Fixed\_IO(duration); use Duration\_IO;

package integerIO is new Ada.Text\_IO.Integer\_IO(integer); use integerIO;

randNum: Generator; -- used to generate 0.0 <= random numbers <1.0.

--"Random(randNum)" generates a random number, 0.0 < random number < 1.0.

-- Duration(Random(randNum) ) coerces the random number to the data type

-- required by the "delay" statement when requesting a process be put to sleep.

type RequestType is (Permission\_To\_Land, Call\_The\_Ball, Touch\_Down);

type ShuttleNameType is (Atlantis, Challenger, Ranger, MeanMachine);

package ShuttleNameIO is new Ada.Text\_IO.Enumeration\_IO(ShuttleNameType);

use ShuttleNameIO;

-- This entire procedure represents a critical resource where access must be controlled.

procedure LandingControlOfficer( Request: in RequestType; Shuttle: in ShuttleNameType) is

begin

case Request is

when Permission\_To\_Land =>

delay Duration(Random(randNum) \* 5.0); -- 0 <= Delay < 5.0 uniformly distributed.

-- Make decision.

put(Shuttle); put(" is granted permission to land. (Officer 1)"); new\_line;

when Call\_The\_Ball =>

delay Duration(Random(randNum) \* 5.0);

-- Prepare gudiance system..

put(Shuttle); put(" call the ball! (Officer 1)"); new\_line;

when Touch\_Down =>

put(Shuttle); put(", permission is granted for final approach. (Officer 1)"); new\_line;

delay Duration(Random(randNum) \* 10.0);

-- Wait for shuttle to land.

end case;

end LandingControlOfficer;

-- This entire procedure represents a critical resource where access must be controlled.

procedure LandingControlOfficer2( Request: in RequestType; Shuttle: in ShuttleNameType) is

begin

case Request is

when Permission\_To\_Land =>

delay Duration(Random(randNum) \* 5.0); -- 0 <= Delay < 5.0 uniformly distributed.

-- Make decision.

put(Shuttle); put(" is granted permission to land. (Officer 2)"); new\_line;

when Call\_The\_Ball =>

delay Duration(Random(randNum) \* 5.0);

-- Prepare gudiance system..

put(Shuttle); put(" call the ball! (Officer 2)"); new\_line;

when Touch\_Down =>

put(Shuttle); put(", permission is granted for final approach. (Officer 2)"); new\_line;

delay Duration(Random(randNum) \* 10.0);

-- Wait for shuttle to land.

end case;

end LandingControlOfficer2;

--Peterson's Algorithm Globals

Flag : array (ShuttleNameType) of Integer := (others => -1);

Turn: array (0..2) of ShuttleNameType := (others => MeanMachine);

Officer1 : Boolean := False;

Officer2 : Boolean := False;

task ShuttleAtlantis;

task body ShuttleAtlantis is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..1 loop

Flag(Atlantis) := Level;

Turn(Level) := Atlantis;

while Turn(Level) = Atlantis and then ((Flag(Challenger) >= Level or Flag(Ranger) >= Level) or (Officer1 and Officer2)) loop

null;

end loop;

end loop;

if Officer1 = False then

Officer1 := True;

--Peterson's Algorithm

Flag(Atlantis) := -1;

put("Atlantis entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Atlantis );

LandingControlOfficer( Call\_The\_Ball, Atlantis );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Atlantis );

landingComplete := seconds(clock);

put("Shuttle Atlantis docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Atlantis leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer1 := False;

elsif Officer2 = False then

Officer2 := True;

--Peterson's Algorithm

Flag(Atlantis) := -1;

put("Atlantis entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer2( Permission\_To\_Land, Atlantis );

LandingControlOfficer2( Call\_The\_Ball, Atlantis );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer2( Touch\_Down, Atlantis );

landingComplete := seconds(clock);

put("Shuttle Atlantis docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Atlantis leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer2 := False;

end if;

end loop;

end ShuttleAtlantis;

task ShuttleRanger;

task body ShuttleRanger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..1 loop

Flag(Ranger) := Level;

Turn(Level) := Ranger;

while Turn(Level) = Ranger and then ((Flag(Atlantis) >= Level or Flag(Challenger) >= Level) or (Officer1 and Officer2)) loop

null;

end loop;

end loop;

if Officer1 = False then

Officer1 := True;

--Peterson's Algorithm

Flag(Ranger) := -1;

put("Ranger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Ranger );

LandingControlOfficer( Call\_The\_Ball, Ranger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Ranger );

landingComplete := seconds(clock);

put("Shuttle Ranger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Ranger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer1 := False;

elsif Officer2 = False then

Officer2 := True;

--Peterson's Algorithm

Flag(Ranger) := -1;

put("Ranger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer2( Permission\_To\_Land, Ranger );

LandingControlOfficer2( Call\_The\_Ball, Ranger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer2( Touch\_Down, Ranger );

landingComplete := seconds(clock);

put("Shuttle Ranger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Ranger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer2 := False;

end if;

end loop;

end ShuttleRanger;

task ShuttleChallenger;

task body ShuttleChallenger is

initiateLandingSequence: duration;

landingComplete: duration;

begin

for I in 1..10 loop

delay Duration(Random(RandNum) \* 15.0); --Crew boarding and perform mission.

--Peterson's Algorithm

for Level in 0..1 loop

Flag(Challenger) := Level;

Turn(Level) := Challenger;

while Turn(Level) = Challenger and then ((Flag(Atlantis) >= Level or Flag(Ranger) >= Level) or (Officer1 and Officer2)) loop

null;

end loop;

end loop;

if Officer1 = False then

Officer1 := True;

--Peterson's Algorithm

Flag(Challenger) := -1;

put("Challenger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer( Permission\_To\_Land, Challenger );

LandingControlOfficer( Call\_The\_Ball, Challenger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer( Touch\_Down, Challenger );

landingComplete := seconds(clock);

put("Shuttle Challenger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Challenger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer1 := False;

elsif Officer2 = False then

Officer2 := True;

--Peterson's Algorithm

Flag(Challenger) := -1;

put("Challenger entering its critical landing section."); new\_line(2);

initiateLandingSequence:= seconds(clock);

LandingControlOfficer2( Permission\_To\_Land, Challenger );

LandingControlOfficer2( Call\_The\_Ball, Challenger );

delay Duration(Random(randNum) \* 3.0); -- line up shuttle with mother ship

LandingControlOfficer2( Touch\_Down, Challenger );

landingComplete := seconds(clock);

put("Shuttle Challenger docked in "); put( landingComplete - initiateLandingSequence );

put(" seconds." ); new\_line;

put("Challenger leavings its critical section. Obtain new crew and start next mission.");

New\_Line(2);

Officer2 := False;

end if;

end loop;

end ShuttleChallenger;

begin

put("Shuttle operations are authorized."); new\_line;

-- Used as a container by the mother ship to launch and recover shuttles.

end Aoption2;

**A Option Results**

Below are the results for Aoption1.adb

Shuttle operations are authorized.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 9.778477083 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 7.675902742 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 9.906293374 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 14.375461845 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.297465881 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 12.798446542 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 9.545325350 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.559465265 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 14.231507355 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 6.084177666 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 7.453534644 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 8.756393507 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 7.001827153 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 8.705272811 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 16.626731146 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 11.370637556 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 12.310999558 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 4.725177949 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 9.542474026 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 6.862372441 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 8.704960816 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 14.996534289 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 13.712696966 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 19.741535885 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 10.279354425 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 12.441392140 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land.

CHALLENGER call the ball!

CHALLENGER, permission is granted for final approach.

Shuttle Challenger docked in 10.221283682 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 12.723429377 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land.

RANGER call the ball!

RANGER, permission is granted for final approach.

Shuttle Ranger docked in 10.251359524 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land.

ATLANTIS call the ball!

ATLANTIS, permission is granted for final approach.

Shuttle Atlantis docked in 13.943596918 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Below are the results for Aoption2.adb

Shuttle operations are authorized.

Challenger entering its critical landing section.

Ranger entering its critical landing section.

RANGER is granted permission to land. (Officer 2)

CHALLENGER is granted permission to land. (Officer 1)

CHALLENGER call the ball! (Officer 1)

RANGER call the ball! (Officer 2)

CHALLENGER, permission is granted for final approach. (Officer 1)

Shuttle Challenger docked in 5.680333254 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

RANGER, permission is granted for final approach. (Officer 2)

Challenger entering its critical landing section.

Shuttle Ranger docked in 9.236288860 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

CHALLENGER is granted permission to land. (Officer 1)

CHALLENGER call the ball! (Officer 1)

CHALLENGER, permission is granted for final approach. (Officer 1)

ATLANTIS is granted permission to land. (Officer 2)

Shuttle Challenger docked in 7.248226181 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

ATLANTIS call the ball! (Officer 2)

Ranger entering its critical landing section.

ATLANTIS, permission is granted for final approach. (Officer 2)

RANGER is granted permission to land. (Officer 1)

Shuttle Atlantis docked in 15.233525430 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

RANGER call the ball! (Officer 1)

RANGER, permission is granted for final approach. (Officer 1)

CHALLENGER is granted permission to land. (Officer 2)

CHALLENGER call the ball! (Officer 2)

Shuttle Ranger docked in 16.450538672 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

CHALLENGER, permission is granted for final approach. (Officer 2)

ATLANTIS is granted permission to land. (Officer 1)

ATLANTIS call the ball! (Officer 1)

ATLANTIS, permission is granted for final approach. (Officer 1)

Shuttle Challenger docked in 15.626024499 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land. (Officer 2)

Shuttle Atlantis docked in 12.694394588 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

RANGER call the ball! (Officer 2)

CHALLENGER is granted permission to land. (Officer 1)

RANGER, permission is granted for final approach. (Officer 2)

CHALLENGER call the ball! (Officer 1)

CHALLENGER, permission is granted for final approach. (Officer 1)

Shuttle Challenger docked in 12.127930961 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land. (Officer 1)

Shuttle Ranger docked in 16.633593300 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

ATLANTIS call the ball! (Officer 1)

ATLANTIS, permission is granted for final approach. (Officer 1)

Shuttle Atlantis docked in 3.273592404 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

Atlantis entering its critical landing section.

CHALLENGER is granted permission to land. (Officer 1)

CHALLENGER call the ball! (Officer 1)

CHALLENGER, permission is granted for final approach. (Officer 1)

ATLANTIS is granted permission to land. (Officer 2)

Shuttle Challenger docked in 6.088831987 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

ATLANTIS call the ball! (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 2)

RANGER is granted permission to land. (Officer 1)

RANGER call the ball! (Officer 1)

RANGER, permission is granted for final approach. (Officer 1)

Shuttle Atlantis docked in 12.205508408 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land. (Officer 2)

ATLANTIS call the ball! (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 2)

Shuttle Ranger docked in 12.730437926 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land. (Officer 1)

Shuttle Atlantis docked in 10.367293792 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

CHALLENGER call the ball! (Officer 1)

Ranger entering its critical landing section.

CHALLENGER, permission is granted for final approach. (Officer 1)

RANGER is granted permission to land. (Officer 2)

RANGER call the ball! (Officer 2)

RANGER, permission is granted for final approach. (Officer 2)

Shuttle Challenger docked in 12.644750923 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

Shuttle Ranger docked in 11.174324866 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

ATLANTIS is granted permission to land. (Officer 1)

Ranger entering its critical landing section.

ATLANTIS call the ball! (Officer 1)

RANGER is granted permission to land. (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 1)

RANGER call the ball! (Officer 2)

RANGER, permission is granted for final approach. (Officer 2)

Shuttle Atlantis docked in 13.676499376 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

Shuttle Ranger docked in 8.778352518 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

CHALLENGER is granted permission to land. (Officer 1)

Atlantis entering its critical landing section.

CHALLENGER call the ball! (Officer 1)

CHALLENGER, permission is granted for final approach. (Officer 1)

ATLANTIS is granted permission to land. (Officer 2)

ATLANTIS call the ball! (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 2)

Shuttle Challenger docked in 14.067512683 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land. (Officer 1)

Shuttle Atlantis docked in 13.473388269 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

RANGER call the ball! (Officer 1)

RANGER, permission is granted for final approach. (Officer 1)

Challenger entering its critical landing section.

Shuttle Ranger docked in 6.370198376 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

CHALLENGER is granted permission to land. (Officer 2)

CHALLENGER call the ball! (Officer 2)

CHALLENGER, permission is granted for final approach. (Officer 2)

Atlantis entering its critical landing section.

Shuttle Challenger docked in 12.976772633 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

ATLANTIS is granted permission to land. (Officer 1)

RANGER is granted permission to land. (Officer 2)

ATLANTIS call the ball! (Officer 1)

RANGER call the ball! (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 1)

RANGER, permission is granted for final approach. (Officer 2)

Shuttle Ranger docked in 9.148046230 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Challenger entering its critical landing section.

CHALLENGER is granted permission to land. (Officer 2)

Shuttle Atlantis docked in 18.588933415 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

CHALLENGER call the ball! (Officer 2)

CHALLENGER, permission is granted for final approach. (Officer 2)

Shuttle Challenger docked in 5.915524308 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

RANGER is granted permission to land. (Officer 1)

RANGER call the ball! (Officer 1)

Challenger entering its critical landing section.

RANGER, permission is granted for final approach. (Officer 1)

CHALLENGER is granted permission to land. (Officer 2)

Shuttle Ranger docked in 9.297416113 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land. (Officer 1)

CHALLENGER call the ball! (Officer 2)

ATLANTIS call the ball! (Officer 1)

ATLANTIS, permission is granted for final approach. (Officer 1)

CHALLENGER, permission is granted for final approach. (Officer 2)

Shuttle Challenger docked in 15.630517292 seconds.

Challenger leavings its critical section. Obtain new crew and start next mission.

Ranger entering its critical landing section.

Shuttle Atlantis docked in 11.858284776 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

RANGER is granted permission to land. (Officer 2)

Atlantis entering its critical landing section.

ATLANTIS is granted permission to land. (Officer 1)

RANGER call the ball! (Officer 2)

ATLANTIS call the ball! (Officer 1)

RANGER, permission is granted for final approach. (Officer 2)

ATLANTIS, permission is granted for final approach. (Officer 1)

Shuttle Atlantis docked in 9.985186034 seconds.

Atlantis leavings its critical section. Obtain new crew and start next mission.

Shuttle Ranger docked in 19.913811243 seconds.

Ranger leavings its critical section. Obtain new crew and start next mission.

**A Option Discussion**

These number were calculated by adding the dock completion times for each Landing Officer in each option.

A option statistics using one Landing Officer:

|  |  |
| --- | --- |
|  | **Landing Officer 1** |
| **Time to Finish** | 331.62 seconds |

A option statistics using two Landing Officers:

|  |  |  |
| --- | --- | --- |
|  | **Landing Officer 1** | **Landing Officer 1** |
| **Time to Finish** | 172.8 seconds | 176.3 seconds |

It is clear that the introduction of another Landing Officer drastically reduced the total time needed to complete all docking operations. Because the two Landing Officers are executing in parallel in the second version, the actual time to finish is simply the longest time of the two (in this case 176.3 seconds). Theoretically, the second version should be able to complete the same amount of work in half the amount of time. In this example. The second version was only 10.49 seconds away from this predicted performance, which is a ~6% difference. Overall the inclusion of a second officer increased the performance of the program very close to its predicted effect.