Poseidon House
Castle Park
Cambridge CB3 0RD
United Kingdom

TELEPHONE: **Cambridge (01223) 515010**
INTERNATIONAL: **+44 1223 515010**
FAX: **+44 1223 359779**
E-MAIL: **apm@ansa.co.uk**

Training

ANSAwise - Exercise Briefings: Airport Shuttle System

Mark Madsen

Abstract

These are the briefing notes for the airport shuttle system exercise.

APM.1737.02 **Approved** 5th February 1997
Briefing Note

Distribution:
Supersedes:
Superseded by:

ANSAwise - Exercise Briefings: Airport Shuttle System

ANSAwise - Exercise Briefings: Airport Shuttle System

Mark Madsen

APM.1737.02

5th February 1997

The material in this Report has been developed as part of the ANSA Architecture for Open Distributed Systems. ANSA is a collaborative initiative, managed by APM Limited on behalf of the companies sponsoring the ANSA Workprogramme.

The ANSA initiative is open to all companies and organisations. Further information on the ANSA Workprogramme, the material in this report, and on other reports can be obtained from the address below.

The authors acknowledge the help and assistance of their colleagues, in sponsoring companies and the ANSA team in Cambridge in the preparation of this report.

APM Limited

Poseidon House
Castle Park
CAMBRIDGE
CB3 0RD
United Kingdom

TELEPHONE UK	(01223) 515010
INTERNATIONAL	+44 1223 515010
FAX	+44 1223 359779
E-MAIL	apm@ansa.co.uk

Contents

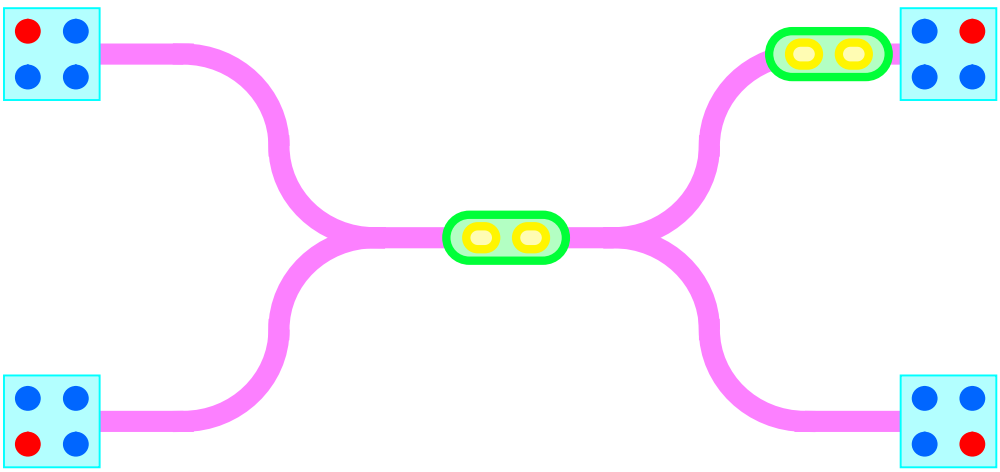
1 Airport Shuttle System Exercise Participant Briefing

1.1 Introduction to the Problem

1.1.1 What is an airport shuttle system?

An airport shuttle system is a mini-railroad that connects passenger terminals via a track on which dedicated trains run.

For the purposes of this exercise, the airport shuttle system is represented by the following diagram



It consists of 4 passenger terminals connected by a railway network. These are arranged on the corners of a rectangle and named (clockwise from top right) North East, South East, South West, North West. Automatic trains, controlled by the distributed computer control system transport passengers between the terminals.

There may be up to 3 electrically powered trains in operation.

Apassenger arriving at a terminal may request transport to one of the others by going to the platform and pressing a button associated with their desired destination terminal.

In response, the system must select an available train, tell it to service the request, and control its journey through the rail network. The selected train will often need to go first to where the passenger is, and then to their destination.

At the same time, there may be other trains travelling between stations. Clearly, they must not be allowed to collide, so there is a rule that only one train at a time is allowed on the branch line leading to a station.

Requests for service may be issued faster than the trains can service them, and the system therefore places requests on a queue for servicing.

1.2 Requirements of the exercise

The purpose of this exercise is to analyse the specified requirements carefully, and to design a control system based on the flow of data between the objects in the system.

1.2.1 Proximity of trains

Consider how to monitor the proximity of trains to each other.

1. What abstract kind of hardware would be necessary? (That is, what function would the hardware need to have?)
2. How many proximity detectors would need to be used to ensure that no collisions ever occur?
3. What actions would the proximity detectors need to take to prevent collisions?
   (i) Could this be accomplished by having other hardware components controlled by the proximity detectors?
   (ii) What functionality would those hardware components require?
   (iii) Where should they be placed?

1.2.2 Overall control

Assume there is a single overall control function, possibly provided by a distributed network of computers.

1. Define each of the objects in the system in terms of
   (i) The other objects with which they communicate
   (ii) The kind of messages they send and receive
2. Summarise this information in a diagram

1.2.3 Conflict avoidance

Design a scenario with 2 trains on the track which

- Involves simultaneous requests from different stations
- Has the possibility of conflict

Now step through the scenario in which

1. The conflict is detected and
2. Resolved
3. Does the data flow match that in your model?

2 Airport Shuttle Exercise Participant Summary

From this exercise one is expected to get a feeling for the ideas of distributed control.

2.1 Concepts Illustrated

Specific concepts this exercise is designed to illustrate are

2.1.1 Identification of components

This exercise does not specify the problem rigidly, so that you have the opportunity to exercise your own creativity in developing the form of the solution. The exact components chosen to solve a problem will generally affect the cost and effectiveness of the solution.

2.1.2 Identification of communications

It is crucial that the components communicate with enough of the other components to achieve a solution.

2.1.3 Flow of messages and queuing

The messages that flow must be of the right type, such as the freeing up of a piece of track for use by the next train after it has been cleared by the last.

2.1.4 Distributed control

The control of the train network is distributed in the sense that it involves communication between a variety of component objects which are located at different and distinct positions within the system.

2.1.5 Conflict detection and resolution

The system must always detect conflicts in advance of their consequences, and must always be capable of resolving those conflicts without serious consequences for either

- the well-being of the passengers
- the continuing function of the system
- the performance of the system

2.2 Ideal solution components

An ideal solution to the exercise as set should include work on all of the following components

2.2.1 Data flow

A summary of the kinds of state detected in different parts of the system.

2.2.2 Message architecture

A categorisation of the kinds of messages passed between different components of the system.

2.2.3 Design choices

Coherent reasons why your proximity detectors and power shut-off switches are placed where they are, and how many are needed.

2.2.4 Conflict resolution

An effective method of conflict resolution when one is detected, and a convincing argument that your system achieves this in all scenarios.

3 Airport Shuttle Exercise Instructor Briefing

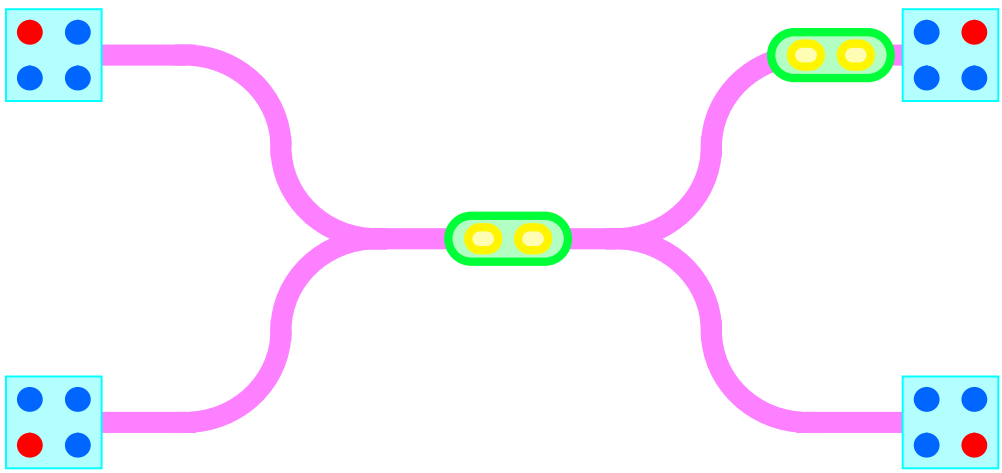
Here is the exercise as presented to the participants:

3.1 Introduction to the Problem

3.1.1 What is an airport shuttle system?

An airport shuttle system is a mini-railroad that connects passenger terminals via a track on which dedicated trains run.

For the purposes of this exercise, the airport shuttle system is represented by the following diagram



It consists of 4 passenger terminals connected by a railway network. These are arranged on the corners of a rectangle and named (clockwise from top right) North East, South East, South West, North West. Automatic trains, controlled by the distributed computer control system transport passengers between the terminals.

There may be up to 3 electrically powered trains in operation.

A passenger arriving at a terminal may request transport to one of the others by going to the platform and pressing a button associated with their desired destination terminal.

In response, the system must select an available train, tell it to service the request, and control its journey through the rail network. The selected train will often need to go first to where the passenger is, and then to their destination.

At the same time, there may be other trains travelling between stations. Clearly, they must not be allowed to collide, so there is a rule that only one train at a time is allowed on the branch line leading to a station.

Requests for service may be issued faster than the trains can service them, and the system therefore places requests on a queue for servicing.

3.2 Requirements of the exercise

The purpose of this exercise is to analyse the specified requirements carefully, and to design a control system based on the flow of data between the objects in the system.

3.2.1 Proximity of trains

Consider how to monitor the proximity of trains to each other.

1. What abstract kind of hardware would be necessary? (That is, what function would the hardware need to have?)
2. How many proximity detectors would need to be used to ensure that no collisions ever occur?
3. What actions would the proximity detectors need to take to prevent collisions?
   (i) Could this be accomplished by having other hardware components controlled by the proximity detectors?
   (ii) What functionality would those hardware components require?
   (iii) Where should they be placed?

3.2.2 Overall control

Assume there is a single overall control function, possibly provided by a distributed network of computers.

1. Define each of the objects in the system in terms of
   (i) The other objects with which they communicate
   (ii) The kind of messages they send and receive
2. Summarise this information in a diagram

3.2.3 Conflict avoidance

Design a scenario with 2 trains on the track which

- Involves simultaneous requests from different stations
- Has the possibility of conflict

Now step through the scenario in which

1. The conflict is detected and
2. Resolved

Does the data flow match that in your model?

Here is the summary as presented to the participants

From this exercise one is expected to get a feeling for the ideas of distributed control.

3.3 Concepts Illustrated

Specific concepts this exercise is designed to illustrate are

3.3.1 Identification of components

This exercise does not specify the problem rigidly, so that you have the opportunity to exercise your own creativity in developing the form of the solution. The exact components chosen to solve a problem will generally affect the cost and effectiveness of the solution.

3.3.2 Identification of communications

It is crucial that the components communicate with enough of the other components to achieve a solution.

3.3.3 Flow of messages and queuing

The messages that flow must be of the right type, such as the freeing up of a piece of track for use by the next train after it has been cleared by the last.

3.3.4 Distributed control

The control of the train network is distributed in the sense that it involves communication between a variety of component objects which are located at different and distinct positions within the system.

3.3.5 Conflict detection and resolution

The system must always detect conflicts in advance of their consequences, and must always be capable of resolving those conflicts without serious consequences for either

- the well-being of the passengers
- the continuing function of the system
- the performance of the system

3.4 Ideal solution components

An ideal solution to the exercise as set should include work on all of the following components

3.4.1 Data flow

A summary of the kinds of state detected in different parts of the system.

3.4.2 Message architecture

A categorisation of the kinds of messages passed between different components of the system.

3.4.3 Design choices

Coherent reasons why your proximity detectors and power shut-off switches are placed where they are, and how many are needed.

3.4.4 Conflict resolution

An effective method of conflict resolution when one is detected, and a convincing argument that your system achieves this in all scenarios.