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WEB BASED EVALUATION OF MATERIAL HANDLING ALTERNATIVES FOR AUTOMATED MANUFACTURING: A PARALLEL REPLICATIONS APPROACH

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ABSTRACT

This paper describes the application of a master/slave configuration of processors to study a comparison of alternative material handling configurations for automated manufacturing. Such a study usually requires a large number of simulation replications, and carrying out those replications on a multi-processor platform yields significant savings in elapsed time. In the present application, a master processor carries out the statistical computations for a 2^k factorial design on up to eight slave processors. This paper will compare the results from using two, four and eight processors.

1 INTRODUCTION

The need for fast and reliable simulation results is an ever-increasing topic within industry today. In the past, conducting simulation studies required vast resources and processing time to complete. Advancing technology is now helping us to do more in less time. Although we can complete simulation studies in a fraction of the time in which it required in the past, complex simulations take greater amounts of time and processing power to complete. The goal of this study is to define a network based simulation configuration, which will allow simulation replications to be completed in a fraction of the original simulation time requirements. Large simulation models can sometimes take up to a week in order to run to completion. Building, verifying, and validating a simulation model is sometimes a daunting task, however if we could run these models faster, we could optimize the systems faster as well.

Similar research studies have been conducted using packages such as JavaSim (Luo, Chen, Yucesan, and Lee, 2000), and other Java-based simulations (Marr, Storey, Biles, and Kleijnen, 2000). The objective of this study is to implement a variation of these attempts using Microsoft Visual Basic, VBA, and Rockwell Automation's Arena.

2 PHYSICAL CONFIGURATION

Although there are several different methods in which to set up a network in order to facilitate network simulation, this system functions through a 'master-slave' type relationship, (Biles 1985). The 'slave' computers are dedicated to running simulation replications, while the 'master' is utilized as a 'simulation server'. The 'master' is set up for remote access in order to build and execute simulation models, should the need arise.

The hardware/software configuration of the system is as follows:Hardware/Software:

Slave computers

- Dell Optiplex GX1
  - 128Mb RAM
  - 400MHz processor
- Microsoft Windows XP Professional
- Arena 7.0.1 Student Edition

Master computer

- Dell Optiplex GX1
  - 256Mb RAM
  - 400Mhz processor
- Microsoft Windows XP Professional
- Microsoft Office XP Professional
- Arena 7.0.1 Student Edition
- Microsoft Visual Studio 6.0

Web Server

- Cobalt Qube 2

Switching Device

- Belkin OmniView 8-Port KVM Switch

Ethernet Hub

- 3Com OfficeConnect Dual Speed Switch 16 Plus

The physical simulation system configuration consists of eight 'slaves', one 'master', a web server, an 8-port switching device, and an Ethernet hub (Figure 1 demonstrates this relationship).

3 SOFTWARE CONFIGURATION

The current state of this project allows the analyst to build, run, and compile results of parallel replications executed on dedicated 'slaves'. The remote replications are called and executed through a visual basic application. This application, Parallel Replication Master (PRM), utilizes two main components: Microsoft Common Dialogue Control, and Microsoft Winsock Control.

The common dialogue control is used to select simulation models to transfer to remote 'slaves'. The Winsock control is used in establishing and maintaining network connections with the 'slave' computers (figure 2 represents the functionality of this simulation configuration). The fol-

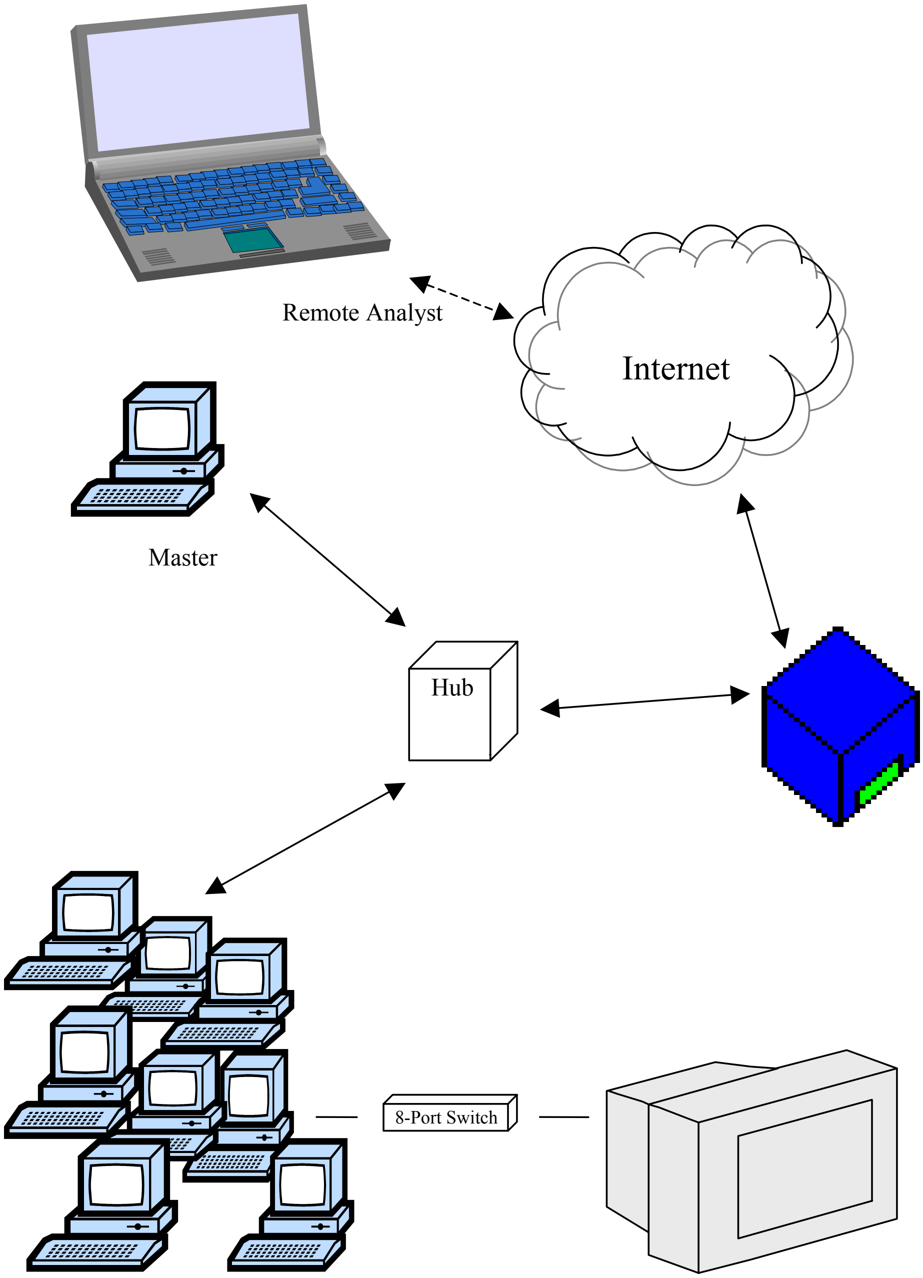

Figure 1: Physical Representation of Simulation System

lowing pseudo code demonstrates how the connection is established:

```
Initialize Connection Parameters
   winsock.RemoteHost = "…"
   winsock.RemotePort = "…"

Establish a connection
   If tcpServer1.State <> sckClosed
Then
      tcpServer1.Close
   End if
Winsock.Connect

Display the Connection State
   Select Case winsock.State
      Case sckClosed
      …
Case sckError
      End Select
```

After the connection has been established, the analyst can begin running simulations on 'slave' computers. This is again done through the use of Winsock controls. Text boxes display results of remote replications as they are communicated to the 'master' computer, and then to the PRM application (Figure 3). The client or slave application can be seen in Figure 4. As previously mentioned, upon completing this project the application will provide the analyst with the appropriate experimental factor levels, which will optimize the system.

4 DESCRIPTION OF THE EXPERIMENTAL SIMULATION MODEL

A cellular manufacturing model was selected for use within this study (Model 8-2 and 8-4, Kelton, Sawowski, and Sturrock, 2004), Figure 5 and 6. Both models consist of four manufacturing cells, each of which are preceded and followed by assignment modules. These modules increment and decrement a variable tracking that cell's respective WIP. Cells 1, 2, and 4 have only a single machine, while cell 3 has two machines (old and new respectively). Model 8-2 simulates free path transporters, while model 8-4 simulates a non-accumulating conveyor system.

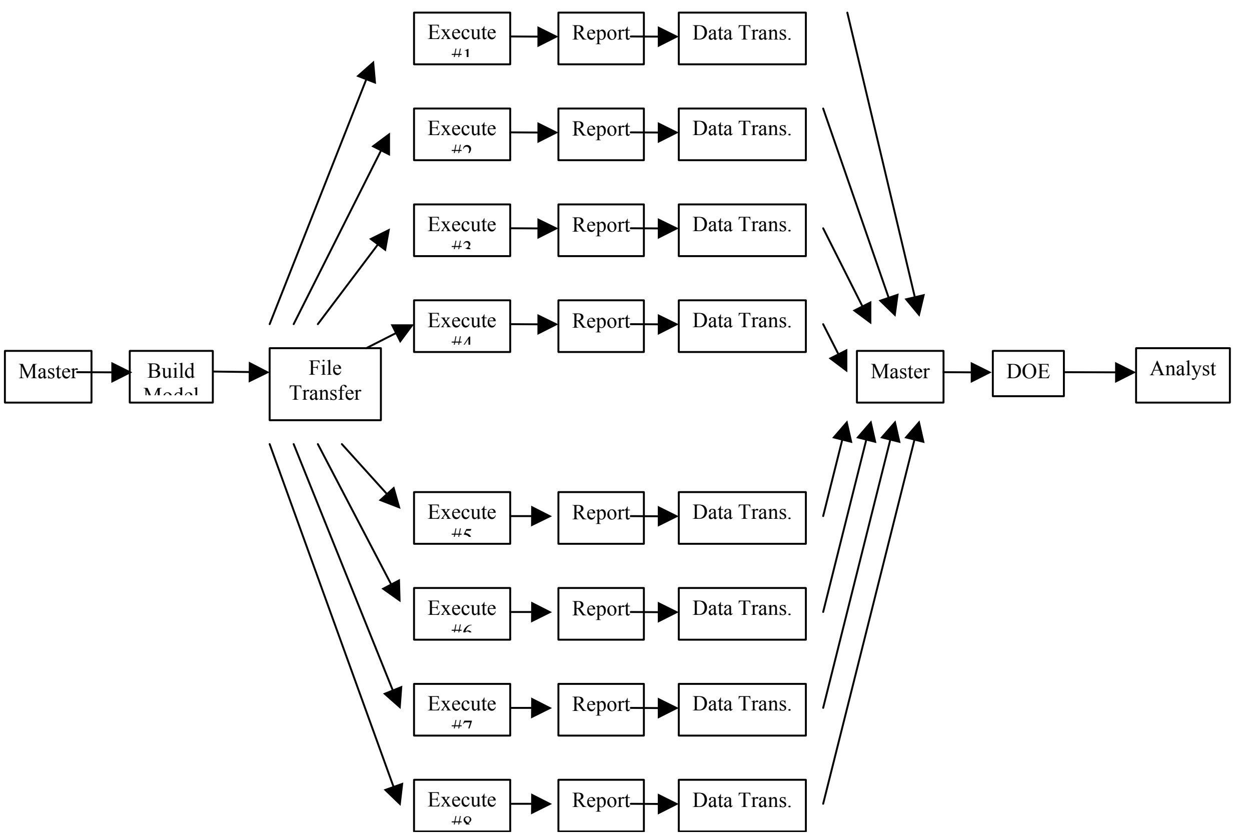

Figure 2: Functional Diagram Logical for System Operation

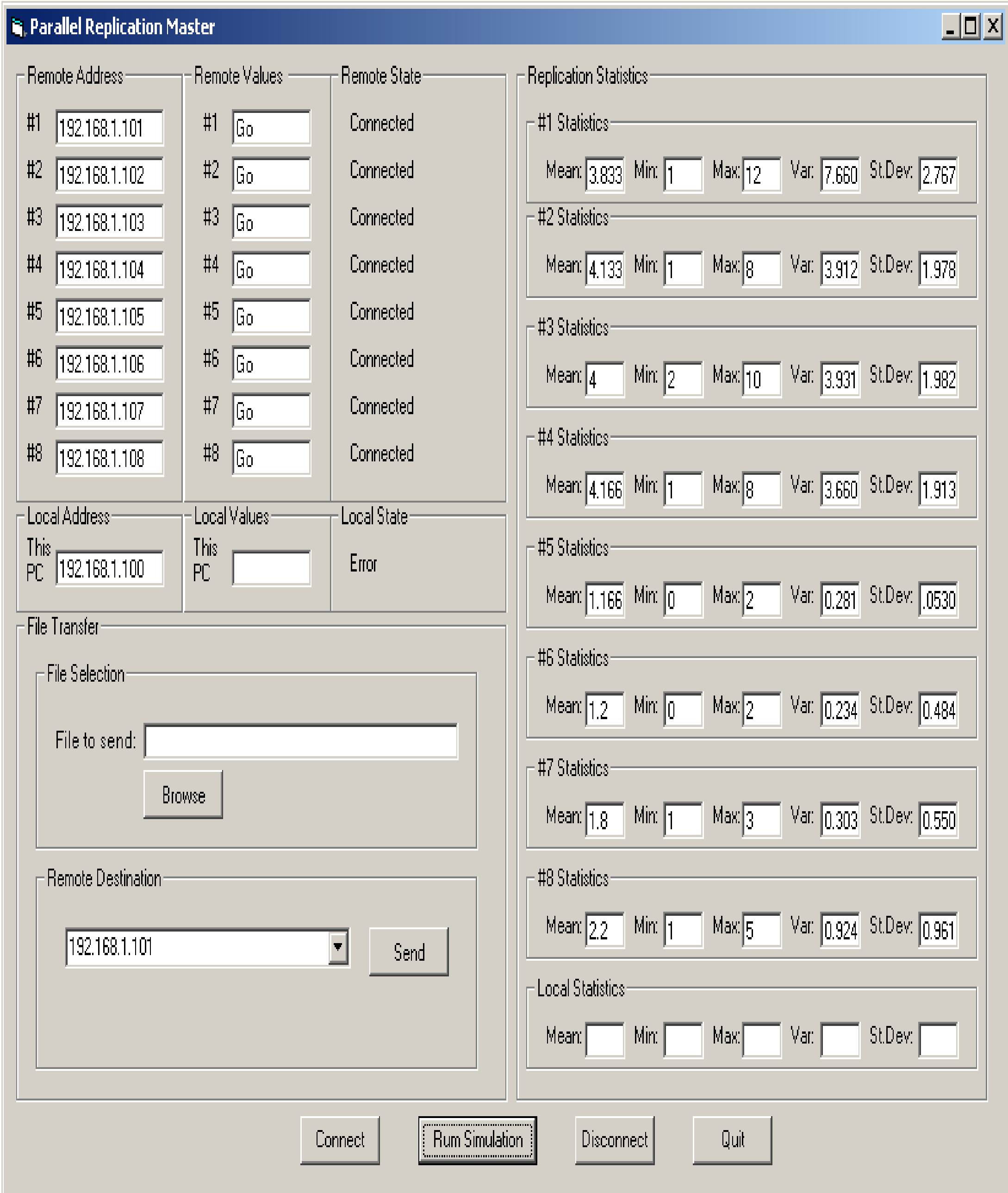

Figure 3: The PRM Application

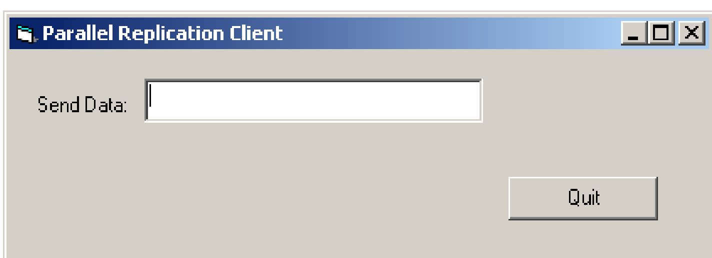

Figure 4: The PRC Application

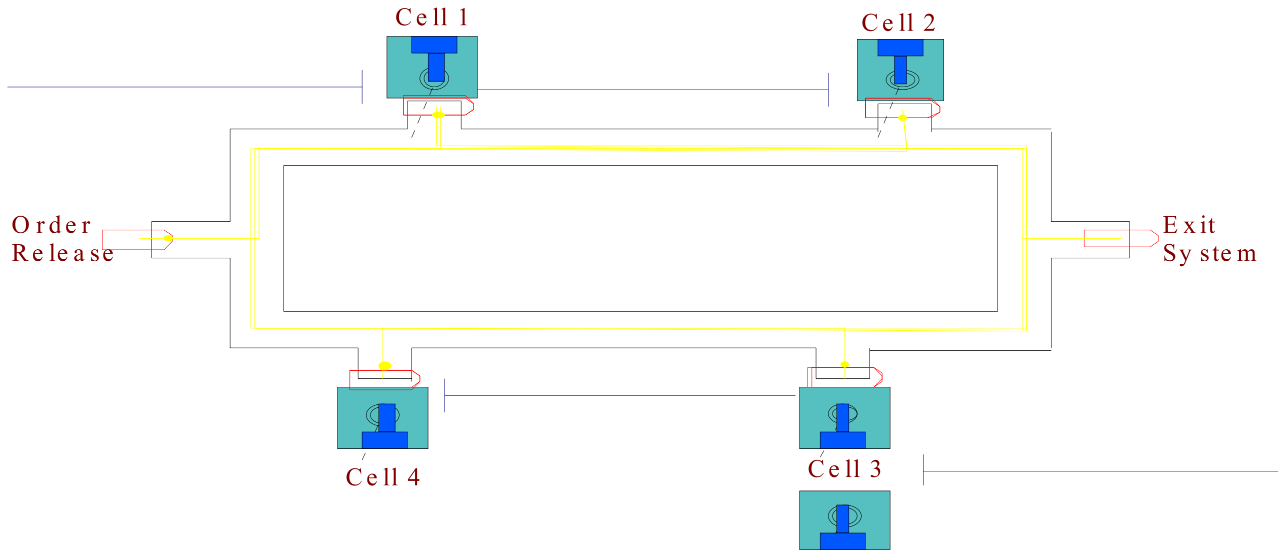

Figure 5: Physical Layout of Experimental Simulation Model (Delton, Sawowski, and Sturrock 2004)

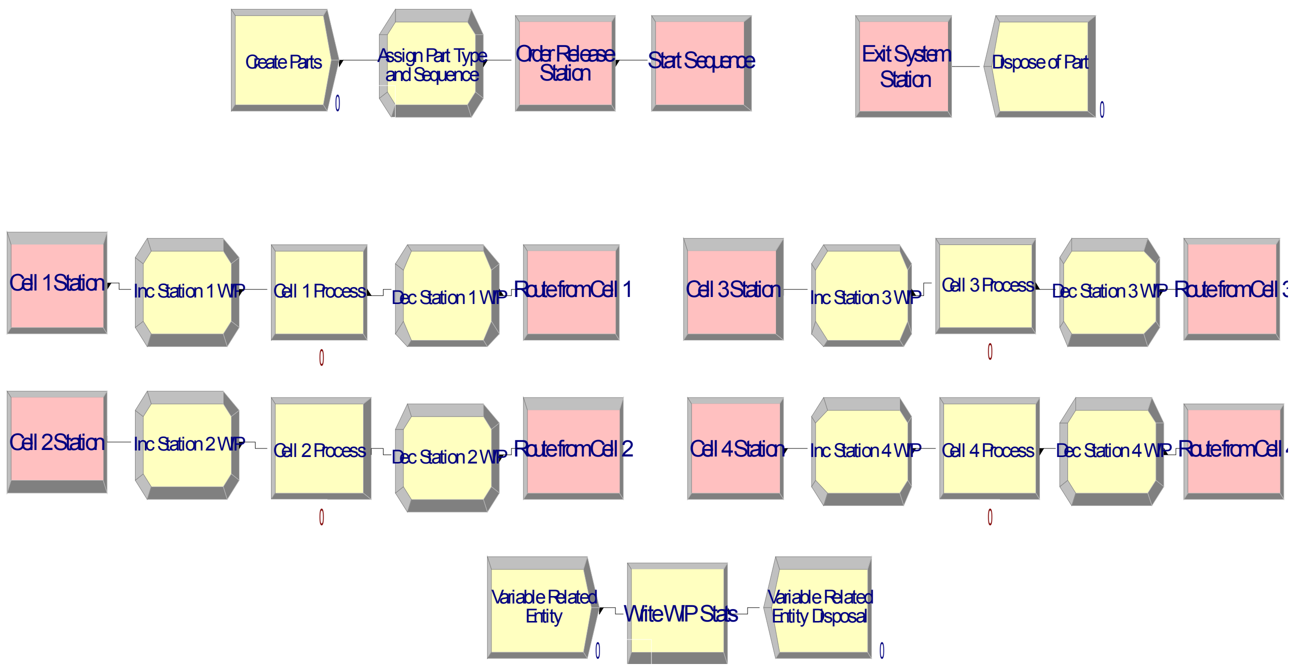

Figure 6: Arena Model Logic for Experimental Simulation Model (Kelton, Sawowski, and Sturrock 2004)

Table 1: Variables Associated with the Experimental Model

Response	Max. WIP
Factors (High)	Conveyor
	10
	Cell 3 efficiency – 60%
Factors (Low)	Transporters
	20
	Cell 3 efficiency – 80%

Table 2: Typical Results from a 2^3 Factorial Design When Run in the Parallel Replications Format

	Factor Level Coding							
	---	--+	-+-	-++	+--	+-+	++-	+++
	C106	C108	C206	C208	T106	T108	T206	T208
Mean	3.83	4.13	4	4.17	1.17	1.2	1.8	2.2
Min	1	1	2	1	0	0	1	1
Max	12	8	10	8	2	2	3	5
Var.	7.66	3.91	3.93	3.66	0.28	0.23	0.3	0.92
St.Dev.	2.77	1.98	1.98	1.91	0.53	0.48	0.55	0.96

5 SUMMARY AND CONCLUSIONS

Following the completion of coding, the outcome of this study will address the primary issue of completing simulation trials on a faster basis. The results will become available to the analyst in a timelier fashion. As this system is streamlined, the objective will be to provide fast and reliable results for simulations with increasing complexity. The ultimate goal will be to reduce the simulation time for complex models by a factor relating to the number of computers serving as 'slaves' in the array.

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