

# CS 4632 Modeling and Simulation

## Milestone 3: Complete Implementation & Testing

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## 1 Overview

This milestone represents the completion of your simulation implementation. Building on the foundation established in M2, you should now have a fully functional simulation that can execute complete runs, collect comprehensive data, and demonstrate all proposed features.

### Milestone Objectives

- Complete all remaining implementation features
- Execute multiple simulation runs with varying parameters
- Implement comprehensive data collection mechanisms
- Perform basic verification testing
- Document simulation execution and results

## 2 Implementation Requirements

### 2.1 Core Functionality Completion

Your simulation must now demonstrate:

**Required Implementation Elements**

- **Complete Simulation Logic**
  - All current models/algorithms fully implemented
  - Complete entity lifecycle management
  - Full event handling or time-stepping mechanisms
  - Core features operational
- **Scope Updates**
  - Document any changes from original proposal
  - Explain rationale for modifications
  - Show how changes improve the simulation
- **Parameterization**
  - Configuration file or command-line parameters
  - Ability to modify key simulation parameters
  - Parameter validation and error handling
  - Default parameter sets for different scenarios
- **Data Collection System**
  - Automated data capture during runs
  - Multiple metrics tracked simultaneously
  - Data export capabilities (CSV, JSON, etc.)
  - Timestamped results for analysis

## 2.2 Simulation Execution

Document your simulation runs in a structured manner:

**Execution Requirements**

- Minimum of 10 distinct simulation runs
- Vary at least 3 different parameters across runs
- Each run should complete successfully
- Record execution time and performance metrics

### 2.2.1 Example Run Documentation

Here's how you might structure your run documentation:

Run ID	Purpose	Parameters Changed	Duration	Data File
001	Baseline	All defaults	2m 15s	run_001.csv
002	High Entity Count	entities=500 (default=100)	8m 42s	run_002.csv
003	Fast Service Rate	service_rate=0.8 (default=0.5)	1m 54s	run_003.csv
004	Combined Stress	entities=500, service_rate=0.3	12m 03s	run_004.csv

### 2.2.2 Data Collection Structure

Consider organizing your data collection around these principles:

#### Data Organization Guidelines

- **Consistent Naming:** Use clear, systematic file naming
- **Metadata Inclusion:** Record parameters with each dataset
- **Time Stamps:** Include both simulation time and real time
- **Structured Format:** Use standard formats (CSV, JSON) for portability
- **Documentation:** Include headers and units in data files

Example data structure (conceptual):

Data Element	Purpose
Run identifier	Links data to specific configuration
Timestamp	When data point was collected
Simulation time	Current time in simulation
System state	Key state variables
Performance metrics	Throughput, utilization, etc.
Event counts	Number of events processed

### 2.2.3 Configuration Management

Document how parameters are set for each run. Consider using configuration files that specify:

- Run identification
- Parameter values
- Random seeds (for reproducibility)
- Data collection settings
- Any special conditions

## 3 Data Collection Requirements

### 3.1 Metrics to Collect

Your simulation should track relevant metrics throughout execution:

**Essential Data Points**

- **Time-Series Data**
  - System state at regular intervals
  - Queue lengths or waiting times
  - Resource utilization percentages
  - Entity counts and statuses
- **Event Data**
  - Event types and timestamps
  - State transitions
  - Service completions
- **Summary Statistics**
  - Average values across the run
  - Maximum/minimum observations
  - Total counts and throughput

### 3.2 Data Organization Example

Structure your output data for easy analysis:

File Type	Naming	Format	Contents
Time Series	run_XXX_timeseries.csv	CSV	Periodic state snapshots
Events	run_XXX_events.csv	CSV	Individual event records
Summary	run_XXX_summary.json	JSON	Aggregate statistics
Config	run_XXX_config.json	JSON	Parameters used

### 3.3 Implementation Tips

**Best Practices for Data Collection**

- Buffer writes to avoid impacting simulation performance
- Include timestamps for all data points
- Use consistent units across all metrics
- Validate data integrity after each run
- Create a master index file listing all runs

## 4 Deliverables

### 4.1 Simulation Report

Submit a comprehensive PDF document containing:

#### 4.1.1 1. Implementation Summary

- Overview of current implementation
- Status of features and functionality
- Any scope changes from original proposal with rationale
- Architecture or design updates

#### 4.1.2 2. Execution Documentation

- Run summary table (as shown in examples)
- Parameter configurations for each run
- Execution environment details
- Any issues encountered during runs

#### 4.1.3 3. Data Collection Overview

- Description of metrics collected
- Data samples and excerpts
- Screenshots or visualizations of data
- Initial observations from the data

#### 4.1.4 4. Preliminary Results

- Basic statistics from simulation runs
- Simple charts or tables showing trends
- Performance observations
- Interesting patterns noticed

## 5 Simulation Run Documentation

### 5.1 Run Summary Table

Include a table summarizing your simulation runs:

Run ID	Purpose	Key Parameters	Duration	Status
1	Baseline	Default values	2.3 min	Complete
2	High load	Entities = 1000	5.1 min	Complete
...	...	...	...	...

## 5.2 Data Collection Metrics

Document what data you're collecting:

- Performance metrics (throughput, utilization, etc.)
- System state variables
- Event counts and timings
- Resource consumption
- Quality/accuracy measures

## 6 Evaluation Criteria

### Assessment Focus

- **Completeness:** All proposed features implemented
- **Functionality:** Simulation runs successfully with various parameters
- **Data Collection:** Comprehensive metrics captured
- **Testing:** Evidence of systematic verification
- **Documentation:** Clear instructions and results presentation

## 7 Common Issues to Avoid

- **Inflexible Implementation:** Be prepared to adapt from original proposal
- **Hard-coded Values:** Use configuration files or parameters
- **Missing Data:** Verify all metrics are being collected
- **Poor Documentation:** Clearly explain what your simulation does
- **Inadequate Runs:** Ensure variety in your parameter settings

## 8 Submission Requirements

### 8.1 What to Submit

Submit a single PDF document: CS4632\_FirstName\_LastName\_M3.pdf

The PDF should include:

- All sections outlined above
- Data excerpts and samples embedded in the document
- Screenshots or visualizations as appropriate
- Clear labeling of all figures and tables

## 8.2 Submission Checklist

### Before Submitting

- ☐ Completed at least 10 simulation runs
- ☐ Documented all parameter variations
- ☐ Included data samples in report
- ☐ Created run summary table
- ☐ Documented any scope changes
- ☐ Included preliminary observations
- ☐ Report is well-organized and clear

## 9 Looking Ahead

This milestone prepares you for:

- **M4:** Deep analysis of your results including sensitivity analysis and validation
- **M5:** Final presentation and comprehensive report

Use the data collected here as the foundation for your analytical work in M4.