```
================================================================================
FILE: package.json (.json file)
================================================================================

{
  "name": "pcb-client",
  "version": "0.1.0",
  "private": true,
  "dependencies": {
    "@testing-library/dom": "^10.4.1",
    "@testing-library/jest-dom": "^6.7.0",
    "@testing-library/react": "^16.3.0",
    "@testing-library/user-event": "^13.5.0",
    "@types/jest": "^27.5.2",
    "@types/node": "^16.18.126",
    "@types/react": "^19.1.10",
    "@types/react-dom": "^19.1.7",
    "react": "^19.1.1",
    "react-dom": "^19.1.1",
    "react-scripts": "5.0.1",
    "typescript": "^4.9.5",
    "web-vitals": "^2.1.4"
  },
  "scripts": {
    "start": "react-scripts start",
    "build": "react-scripts build",
    "test": "react-scripts test",
    "eject": "react-scripts eject",
    "dev": "react-scripts start"
  },
  "eslintConfig": {
    "extends": [
      "react-app",
      "react-app/jest"
    ]
  },
  "browserslist": {
    "production": [
      ">0.2%",
      "not dead",
      "not op_mini all"
    ],
    "development": [
      "last 1 chrome version",
      "last 1 firefox version",
      "last 1 safari version"
    ]
  }
}



================================================================================
FILE: public\index.html (.html file)
================================================================================

<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8" />
    <link rel="icon" href="%PUBLIC_URL%/favicon.ico" />
    <meta name="viewport" content="width=device-width, initial-scale=1" />
    <meta name="theme-color" content="#000000" />
    <meta
      name="description"
      content="Web site created using create-react-app"
    />
    <link rel="apple-touch-icon" href="%PUBLIC_URL%/logo192.png" />
    <!--
      manifest.json provides metadata used when your web app is installed on a
      user's mobile device or desktop. See https://developers.google.com/web/fundamentals/web-app-manifest/
    -->
    <link rel="manifest" href="%PUBLIC_URL%/manifest.json" />
    <!--
      Notice the use of %PUBLIC_URL% in the tags above.
      It will be replaced with the URL of the `public` folder during the build.
      Only files inside the `public` folder can be referenced from the HTML.

      Unlike "/favicon.ico" or "favicon.ico", "%PUBLIC_URL%/favicon.ico" will
      work correctly both with client-side routing and a non-root public URL.
      Learn how to configure a non-root public URL by running `npm run build`.
    -->
    <title>React App</title>
  </head>
  <body>
    <noscript>You need to enable JavaScript to run this app.</noscript>
    <div id="root"></div>
    <!--
```

```
      This HTML file is a template.
      If you open it directly in the browser, you will see an empty page.

      You can add webfonts, meta tags, or analytics to this file.
      The build step will place the bundled scripts into the <body> tag.

      To begin the development, run `npm start` or `yarn start`.
      To create a production bundle, use `npm run build` or `yarn build`.
    -->
  </body>
</html>
```

```
================================================================================
FILE: public\manifest.json (.json file)
================================================================================

{
  "short_name": "React App",
  "name": "Create React App Sample",
  "icons": [
    {
      "src": "favicon.ico",
      "sizes": "64x64 32x32 24x24 16x16",
      "type": "image/x-icon"
    },
    {
      "src": "logo192.png",
      "type": "image/png",
      "sizes": "192x192"
    },
    {
      "src": "logo512.png",
      "type": "image/png",
      "sizes": "512x512"
    }
  ],
  "start_url": ".",
  "display": "standalone",
  "theme_color": "#000000",
  "background_color": "#ffffff"
}
```

```
================================================================================
FILE: src\App.css (.css file)
================================================================================

.App {
  text-align: center;
  max-width: 1200px;
  margin: 0 auto;
  padding: 20px;
}

.App-header {
  background-color: #282c34;
  padding: 20px;
  color: white;
  margin-bottom: 30px;
  border-radius: 8px;
}

.App-header h1 {
  margin: 0;
  font-size: 2rem;
}

main {
  display: flex;
  flex-direction: column;
  gap: 30px;
}

/* Simulation Controls */
.simulation-controls {
  background-color: #f5f5f5;
  padding: 20px;
  border-radius: 8px;
  text-align: left;
}

.simulation-controls h2 {
  margin-top: 0;
  color: #333;
}
```

```
.control-group {
  margin-bottom: 15px;
}

.control-group label {
  display: block;
  margin-bottom: 5px;
  font-weight: bold;
}

.control-group select,
.control-group input {
  padding: 8px;
  border: 1px solid #ddd;
  border-radius: 4px;
  font-size: 16px;
  margin-left: 10px;
}

.button-group {
  display: flex;
  gap: 10px;
  margin-bottom: 15px;
  flex-wrap: wrap;
}

.btn-primary,
.btn-secondary,
.btn-danger {
  padding: 10px 20px;
  border: none;
  border-radius: 4px;
  cursor: pointer;
  font-size: 16px;
  transition: background-color 0.3s;
}

.btn-primary {
  background-color: #007bff;
  color: white;
}

.btn-primary:hover:not(:disabled) {
  background-color: #0056b3;
}

.btn-secondary {
  background-color: #6c757d;
  color: white;
}

.btn-secondary:hover:not(:disabled) {
  background-color: #545b62;
}

.btn-danger {
  background-color: #dc3545;
  color: white;
}

.btn-danger:hover:not(:disabled) {
  background-color: #c82333;
}

button:disabled {
  opacity: 0.6;
  cursor: not-allowed;
}

/* Messages */
.message {
  padding: 15px;
  border-radius: 4px;
  margin: 10px 0;
  font-weight: bold;
}

.message.success {
  background-color: #d4edda;
  color: #155724;
  border: 1px solid #c3e6cb;
}

.message.error {
  background-color: #f8d7da;
  color: #721c24;
  border: 1px solid #f5c6cb;
}
```

```
.loading {
  padding: 15px;
  background-color: #fff3cd;
  color: #856404;
  border: 1px solid #ffeaa7;
  border-radius: 4px;
  margin: 10px 0;
  font-weight: bold;
}

/* Results */
.results-container {
  text-align: left;
}

.results {
  background-color: #fff;
  border: 1px solid #ddd;
  border-radius: 8px;
  padding: 20px;
}

.simulation-result {
  margin-bottom: 30px;
  padding: 20px;
  border: 1px solid #eee;
  border-radius: 8px;
  background-color: #fafafa;
}

.simulation-result h3 {
  margin-top: 0;
  color: #333;
  border-bottom: 2px solid #007bff;
  padding-bottom: 10px;
}

.simulation-result h4 {
  color: #555;
  margin-top: 20px;
}

.summary {
  display: grid;
  grid-template-columns: repeat(auto-fit, minmax(200px, 1fr));
  gap: 10px;
  margin: 15px 0;
  padding: 15px;
  background-color: #e9f7ff;
  border-radius: 4px;
}

.summary p {
  margin: 0;
}

.failures,
.defects {
  margin: 20px 0;
}

table {
  width: 100%;
  border-collapse: collapse;
  margin: 10px 0;
}

table th,
table td {
  border: 1px solid #ddd;
  padding: 12px;
  text-align: left;
}

table th {
  background-color: #f8f9fa;
  font-weight: bold;
}

table tr:nth-child(even) {
  background-color: #f9f9f9;
}

.formatted-report {
  margin-top: 20px;
}

.formatted-report pre {
  background-color: #f8f9fa;
```

```
  padding: 15px;
  border-radius: 4px;
  overflow-x: auto;
  white-space: pre-wrap;
  font-family: 'Courier New', monospace;
  font-size: 14px;
  line-height: 1.4;
}

/* Responsive design */
@media (max-width: 768px) {
  .App {
    padding: 10px;
  }

  .button-group {
    flex-direction: column;
  }

  .btn-primary,
  .btn-secondary,
  .btn-danger {
    width: 100%;
  }

  .summary {
    grid-template-columns: 1fr;
  }
}
```

```
================================================================================
FILE: src\App.test.tsx (.tsx file)
================================================================================

import React from 'react';
import { render, screen } from '@testing-library/react';
import App from './App';

test('renders learn react link', () => {
  render(<App />);
  const linkElement = screen.getByText(/learn react/i);
  expect(linkElement).toBeInTheDocument();
});
```

```
================================================================================
FILE: src\App.tsx (.tsx file)
================================================================================

import React, { useState } from 'react';
import './App.css';
import SimulationControls from './components/SimulationControls';
import SimulationResult from './components/SimulationResult';
import { apiService } from './services/api';
import { SimulationReport, PCBType } from './types';

function App() {
  const [results, setResults] = useState<SimulationReport[]>([]);
  const [isLoading, setIsLoading] = useState(false);
  const [message, setMessage] = useState<string>('');
  const [error, setError] = useState<string>('');

  const showMessage = (msg: string) => {
    setMessage(msg);
    setError('');
    setTimeout(() => setMessage(''), 3000);
  };

  const showError = (err: string) => {
    setError(err);
    setMessage('');
    setTimeout(() => setError(''), 5000);
  };

  const handleRunSimulation = async (pcbType: PCBType, quantity: number) => {
    setIsLoading(true);
    try {
      const response = await apiService.runSimulation(pcbType, quantity);
      showMessage(response);
    } catch (error) {
      showError(`Failed to start simulation: ${error}`);
    } finally {
      setIsLoading(false);
    }
  };
```

```
  const handleRunAllSimulations = async (quantity: number) => {
    setIsLoading(true);
    try {
      const response = await apiService.runAllSimulations(quantity);
      showMessage(response);
    } catch (error) {
      showError(`Failed to start simulations: ${error}`);
    } finally {
      setIsLoading(false);
    }
  };

  const handleGetResults = async (pcbType?: PCBType) => {
    setIsLoading(true);
    try {
      if (pcbType) {
        const result = await apiService.getSimulationResults(pcbType);
        setResults([result]);
        showMessage(`Results retrieved for ${pcbType}`);
      } else {
        const allResults = await apiService.getAllSimulationResults();
        setResults(allResults);
        showMessage(`Retrieved ${allResults.length} simulation results`);
      }
    } catch (error) {
      showError(`Failed to get results: ${error}`);
    } finally {
      setIsLoading(false);
    }
  };

  const handleClearResults = async () => {
    setIsLoading(true);
    try {
      const response = await apiService.clearAllResults();
      setResults([]);
      showMessage(response);
    } catch (error) {
      showError(`Failed to clear results: ${error}`);
    } finally {
      setIsLoading(false);
    }
  };

  return (
    <div className="App">
      <header className="App-header">
        <h1>PCB Assembly Line Simulation Client</h1>
      </header>

      <main>
        <SimulationControls
          onRunSimulation={handleRunSimulation}
          onRunAllSimulations={handleRunAllSimulations}
          onGetResults={handleGetResults}
          onClearResults={handleClearResults}
          isLoading={isLoading}
        />

        {message && <div className="message success">{message}</div>}
        {error && <div className="message error">{error}</div>}
        {isLoading && <div className="loading">Processing...</div>}

        <div className="results-container">
          {results.length > 0 && (
            <div className="results">
              <h2>Simulation Results</h2>
              {results.map((result, index) => (
                <SimulationResult key={index} report={result} />
              ))}
            </div>
          )}
        </div>
      </main>
    </div>
  );
}

export default App;



================================================================================
FILE: src\components\SimulationControls.tsx (.tsx file)
================================================================================

import React, { useState } from 'react';
import { PCBType } from '../types';
```

```
interface SimulationControlsProps {
  onRunSimulation: (pcbType: PCBType, quantity: number) => void;
  onRunAllSimulations: (quantity: number) => void;
  onGetResults: (pcbType?: PCBType) => void;
  onClearResults: () => void;
  isLoading: boolean;
}

const SimulationControls: React.FC<SimulationControlsProps> = ({
  onRunSimulation,
  onRunAllSimulations,
  onGetResults,
  onClearResults,
  isLoading,
}) => {
  const [selectedPcbType, setSelectedPcbType] = useState<PCBType>('test');
  const [quantity, setQuantity] = useState<number>(1000);

  const pcbTypes: { value: PCBType; label: string }[] = [
    { value: 'test', label: 'Test Board' },
    { value: 'sensor', label: 'Sensor Board' },
    { value: 'gateway', label: 'Gateway Board' },
  ];

  return (
    <div className="simulation-controls">
      <h2>PCB Simulation Controls</h2>

      <div className="control-group">
        <label>
          PCB Type:
          <select
            value={selectedPcbType}
            onChange={(e) => setSelectedPcbType(e.target.value as PCBType)}
            disabled={isLoading}
          >
            {pcbTypes.map((type) => (
              <option key={type.value} value={type.value}>
                {type.label}
              </option>
            ))}
          </select>
        </label>
      </div>

      <div className="control-group">
        <label>
          Quantity:
          <input
            type="number"
            value={quantity}
            onChange={(e) => setQuantity(parseInt(e.target.value))}
            min="1"
            max="10000"
            disabled={isLoading}
          />
        </label>
      </div>

      <div className="button-group">
        <button
          onClick={() => onRunSimulation(selectedPcbType, quantity)}
          disabled={isLoading}
          className="btn-primary"
        >
          Run Single Simulation
        </button>

        <button
          onClick={() => onRunAllSimulations(quantity)}
          disabled={isLoading}
          className="btn-primary"
        >
          Run All Simulations
        </button>
      </div>

      <div className="button-group">
        <button
          onClick={() => onGetResults(selectedPcbType)}
          disabled={isLoading}
          className="btn-secondary"
        >
          Get Single Results
        </button>

        <button
          onClick={() => onGetResults()}
          disabled={isLoading}
```

```
          className="btn-secondary"
        >
          Get All Results
        </button>
      </div>

      <div className="button-group">
        <button
          onClick={onClearResults}
          disabled={isLoading}
          className="btn-danger"
        >
          Clear All Results
        </button>
      </div>
    </div>
  );
};

export default SimulationControls;


================================================================================
FILE: src\components\SimulationResult.tsx (.tsx file)
================================================================================

import React from 'react';
import { SimulationReport } from '../types';

interface SimulationResultProps {
  report: SimulationReport;
}

const SimulationResult: React.FC<SimulationResultProps> = ({ report }) => {
  return (
    <div className="simulation-result">
      <h3>{report.pcbType} Results</h3>

      <div className="summary">
        <p><strong>PCBs Run:</strong> {report.pcbsRun}</p>
        <p><strong>Total Produced:</strong> {report.totalPcbsProduced}</p>
        <p><strong>Total Failed:</strong> {report.totalFailedPcbs}</p>
        <p><strong>Success Rate:</strong> {((report.totalPcbsProduced / report.pcbsRun) * 100).toFixed(2)}%</p>
      </div>

      <div className="failures">
        <h4>Station Failures</h4>
        <table>
          <thead>
            <tr>
              <th>Station</th>
              <th>Failures</th>
            </tr>
          </thead>
          <tbody>
            {Object.entries(report.stationFailures).map(([station, failures]) => (
              <tr key={station}>
                <td>{station}</td>
                <td>{failures}</td>
              </tr>
            ))}
          </tbody>
        </table>
      </div>

      <div className="defects">
        <h4>Defect Failures</h4>
        <table>
          <thead>
            <tr>
              <th>Defect Type</th>
              <th>Failures</th>
            </tr>
          </thead>
          <tbody>
            {Object.entries(report.defectFailures).map(([defect, failures]) => (
              <tr key={defect}>
                <td>{defect}</td>
                <td>{failures}</td>
              </tr>
            ))}
          </tbody>
        </table>
      </div>

      <div className="formatted-report">
        <h4>Detailed Report</h4>
        <pre>{report.formattedReport}</pre>
      </div>
```

```
    </div>
  );
};

export default SimulationResult;


================================================================================
FILE: src\index.css (.css file)
================================================================================

body {
  margin: 0;
  font-family: -apple-system, BlinkMacSystemFont, 'Segoe UI', 'Roboto', 'Oxygen',
    'Ubuntu', 'Cantarell', 'Fira Sans', 'Droid Sans', 'Helvetica Neue',
    sans-serif;
  -webkit-font-smoothing: antialiased;
  -moz-osx-font-smoothing: grayscale;
}

code {
  font-family: source-code-pro, Menlo, Monaco, Consolas, 'Courier New',
    monospace;
}



================================================================================
FILE: src\index.tsx (.tsx file)
================================================================================

import React from 'react';
import ReactDOM from 'react-dom/client';
import './index.css';
import App from './App';
import reportWebVitals from './reportWebVitals';

const root = ReactDOM.createRoot(
  document.getElementById('root') as HTMLElement
);
root.render(
  <React.StrictMode>
    <App />
  </React.StrictMode>
);

// If you want to start measuring performance in your app, pass a function
// to log results (for example: reportWebVitals(console.log))
// or send to an analytics endpoint. Learn more: https://bit.ly/CRA-vitals
reportWebVitals();



================================================================================
FILE: src\react-app-env.d.ts (.ts file)
================================================================================

/// <reference types="react-scripts" />



================================================================================
FILE: src\reportWebVitals.ts (.ts file)
================================================================================

import { ReportHandler } from 'web-vitals';

const reportWebVitals = (onPerfEntry?: ReportHandler) => {
  if (onPerfEntry && onPerfEntry instanceof Function) {
    import('web-vitals').then(({ getCLS, getFID, getFCP, getLCP, getTTFB }) => {
      getCLS(onPerfEntry);
      getFID(onPerfEntry);
      getFCP(onPerfEntry);
      getLCP(onPerfEntry);
      getTTFB(onPerfEntry);
    });
  }
};

export default reportWebVitals;



================================================================================
FILE: src\services\api.ts (.ts file)
================================================================================

import { SimulationReport, PCBType } from '../types';
```

```
const BASE_URL = 'http://localhost:8080/api/simulation';

class ApiService {
  private async fetchWithErrorHandling<T>(url: string, options?: RequestInit): Promise<T> {
    try {
      const response = await fetch(url, options);

      if (!response.ok) {
        throw new Error(`HTTP error! status: ${response.status}`);
      }

      return await response.json();
    } catch (error) {
      console.error('API call failed:', error);
      throw error;
    }
  }

  async runSimulation(pcbType: PCBType, quantity: number = 1000): Promise<string> {
    const response = await fetch(`${BASE_URL}/run/${pcbType}?quantity=${quantity}`, {
      method: 'POST',
      headers: {
        'Content-Type': 'application/json',
      },
    });

    if (!response.ok) {
      throw new Error(`Failed to start simulation: ${response.status}`);
    }

    return await response.text();
  }

  async runAllSimulations(quantity: number = 1000): Promise<string> {
    const response = await fetch(`${BASE_URL}/run/all?quantity=${quantity}`, {
      method: 'POST',
      headers: {
        'Content-Type': 'application/json',
      },
    });

    if (!response.ok) {
      throw new Error(`Failed to start simulations: ${response.status}`);
    }

    return await response.text();
  }

  async getSimulationResults(pcbType: PCBType): Promise<SimulationReport> {
    return this.fetchWithErrorHandling<SimulationReport>(`${BASE_URL}/results/${pcbType}`);
  }

  async getAllSimulationResults(): Promise<SimulationReport[]> {
    return this.fetchWithErrorHandling<SimulationReport[]>(`${BASE_URL}/results/all`);
  }

  async getPcbTypes(): Promise<string[]> {
    return this.fetchWithErrorHandling<string[]>(`${BASE_URL}/types`);
  }

  async clearAllResults(): Promise<string> {
    const response = await fetch(`${BASE_URL}/results`, {
      method: 'DELETE',
    });

    if (!response.ok) {
      throw new Error(`Failed to clear results: ${response.status}`);
    }

    return await response.text();
  }
}

export const apiService = new ApiService();


================================================================================
FILE: src\setupTests.ts (.ts file)
================================================================================

// jest-dom adds custom jest matchers for asserting on DOM nodes.
// allows you to do things like:
// expect(element).toHaveTextContent(/react/i)
// learn more: https://github.com/testing-library/jest-dom
import '@testing-library/jest-dom';



================================================================================
```

```
FILE: src\types.ts (.ts file)
================================================================================

export interface SimulationReport {
  pcbType: string;
  pcbsRun: number;
  stationFailures: Record<string, number>;
  defectFailures: Record<string, number>;
  totalFailedPcbs: number;
  totalPcbsProduced: number;
  formattedReport: string;
}

export type PCBType = 'test' | 'sensor' | 'gateway';


================================================================================
FILE: tsconfig.json (.json file)
================================================================================

{
  "compilerOptions": {
    "target": "es5",
    "lib": [
      "dom",
      "dom.iterable",
      "esnext"
    ],
    "allowJs": true,
    "skipLibCheck": true,
    "esModuleInterop": true,
    "allowSyntheticDefaultImports": true,
    "strict": true,
    "forceConsistentCasingInFileNames": true,
    "noFallthroughCasesInSwitch": true,
    "module": "esnext",
    "moduleResolution": "node",
    "resolveJsonModule": true,
    "isolatedModules": true,
    "noEmit": true,
    "jsx": "react-jsx"
  },
  "include": [
    "src"
  ]
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\PcbApplication.java
================================================================================

package com.cu5448.pcb;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.boot.context.properties.EnableConfigurationProperties;
import org.springframework.scheduling.annotation.EnableAsync;

/**
 * Main Spring Boot Application with Configuration Properties Support
 *
 * <p>Demonstrates Dependency Injection design pattern implementation:
 * - @EnableConfigurationProperties enables property-driven configuration - REST API endpoints
 * available for running simulations on demand - All dependencies managed by Spring IoC container
 * - @EnableAsync enables asynchronous method execution for simulation processing
 *
 * <p>Server starts and waits for client API calls to run simulations and retrieve results.
 */
@SpringBootApplication
@EnableConfigurationProperties
@EnableAsync
public class PcbApplication {

    public static void main(String[] args) {
        SpringApplication.run(PcbApplication.class, args);
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\api\SimulationApiController.java
================================================================================

package com.cu5448.pcb.api;

import java.util.ArrayList;
import java.util.List;
import java.util.Map;

import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.*;

import com.cu5448.pcb.controller.SimulationController;
import com.cu5448.pcb.dto.SimulationReportDto;
import com.cu5448.pcb.dto.SimulationReportMapper;
import com.cu5448.pcb.service.StatisticsCollector;

import lombok.RequiredArgsConstructor;

/**
 * REST API Controller for PCB simulation operations. Implements the server-side requirement: run
 * simulations to gather failure results in memory, then wait for client API calls to retrieve the
 * stored simulation results as JSON.
 *
 * <p>Provides separate endpoints for running simulations and retrieving stored results, ensuring
 * results are maintained in memory between API calls.
 */
@RestController
@RequestMapping("/api/simulation")
@CrossOrigin(origins = "http://localhost:3000")
@RequiredArgsConstructor
public class SimulationApiController {

    private final SimulationController simulationController;
    private final SimulationReportMapper reportMapper;

    /**
     * Start simulation for a specific PCB type asynchronously and store results in memory.
     *
     * @param pcbType the type of PCB to simulate (test, sensor, gateway)
     * @param quantity number of PCBs to process (default: 1000)
     * @return 201 Created status to indicate simulation started
     */
    @PostMapping("/run/{pcbType}")
    public ResponseEntity<String> runSimulation(
            @PathVariable String pcbType, @RequestParam(defaultValue = "1000") int quantity) {

        // Start simulation asynchronously using @Async method
        simulationController.runSimulationAsync(pcbType, quantity);

        return ResponseEntity.status(201)
                .body(
                        String.format(
                                "Simulation started asynchronously for PCB type: %s with quantity: %d",
```

```
                                pcbType, quantity));
    }

    /**
     * Start simulations for all three PCB types asynchronously and store results in memory.
     *
     * @param quantity number of PCBs to process for each type (default: 1000)
     * @return 201 Created status to indicate simulations started
     */
    @PostMapping("/run/all")
    public ResponseEntity<String> runAllSimulations(
            @RequestParam(defaultValue = "1000") int quantity) {

        // Start all simulations asynchronously using @Async method
        simulationController.runAllSimulationsAsync();

        return ResponseEntity.status(201)
                .body(
                        String.format(
                                "Simulations started asynchronously for all PCB types with quantity: %d",
                                quantity));
    }

    /**
     * Retrieve stored simulation results for a specific PCB type.
     *
     * @param pcbType the type of PCB to get results for
     * @return simulation report as JSON, or 404 if not found
     */
    @GetMapping("/results/{pcbType}")
    public ResponseEntity<SimulationReportDto> getSimulationResults(@PathVariable String pcbType) {
        StatisticsCollector stats = simulationController.getSimulationResults(pcbType);

        if (stats == null) {
            return ResponseEntity.notFound().build();
        }

        SimulationReportDto report = reportMapper.toDto(stats, pcbType);
        return ResponseEntity.ok(report);
    }

    /**
     * Retrieve all stored simulation results.
     *
     * @return list of simulation reports for all stored results
     */
    @GetMapping("/results/all")
    public ResponseEntity<List<SimulationReportDto>> getAllSimulationResults() {
        Map<String, StatisticsCollector> allResults =
                simulationController.getAllSimulationResults();

        if (allResults.isEmpty()) {
            return ResponseEntity.notFound().build();
        }

        List<SimulationReportDto> reports = new ArrayList<>();
        for (Map.Entry<String, StatisticsCollector> entry : allResults.entrySet()) {
            SimulationReportDto report = reportMapper.toDto(entry.getValue(), entry.getKey());
            reports.add(report);
        }

        return ResponseEntity.ok(reports);
    }

    /**
     * Get available PCB types.
     *
     * @return list of supported PCB types
     */
    @GetMapping("/types")
    public ResponseEntity<List<String>> getPcbTypes() {
        List<String> types = List.of("Test Board", "Sensor Board", "Gateway Board");
        return ResponseEntity.ok(types);
    }

    /**
     * Clear all stored simulation results.
     *
     * @return success response
     */
    @DeleteMapping("/results")
    public ResponseEntity<String> clearAllResults() {
        simulationController.clearAllResults();
        return ResponseEntity.ok("All simulation results cleared");
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\config\CorsConfig.java
================================================================================

package com.cu5448.pcb.config;

import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.web.cors.CorsConfiguration;
import org.springframework.web.cors.CorsConfigurationSource;
import org.springframework.web.cors.UrlBasedCorsConfigurationSource;
import org.springframework.web.servlet.config.annotation.CorsRegistry;
import org.springframework.web.servlet.config.annotation.WebMvcConfigurer;

/**
 * CORS configuration to allow React client (localhost:3000) to communicate with the Spring Boot
 * server (localhost:8080).
 */
@Configuration
public class CorsConfig implements WebMvcConfigurer {

    @Override
    public void addCorsMappings(CorsRegistry registry) {
        registry.addMapping("/api/**")
                .allowedOrigins("http://localhost:3000")
                .allowedMethods("GET", "POST", "PUT", "DELETE", "OPTIONS")
                .allowedHeaders("*")
                .allowCredentials(true);
    }

    @Bean
    public CorsConfigurationSource corsConfigurationSource() {
        CorsConfiguration configuration = new CorsConfiguration();
        configuration.addAllowedOrigin("http://localhost:3000");
        configuration.addAllowedMethod("*");
        configuration.addAllowedHeader("*");
        configuration.setAllowCredentials(true);

        UrlBasedCorsConfigurationSource source = new UrlBasedCorsConfigurationSource();
        source.registerCorsConfiguration("/api/**", configuration);
        return source;
    }
}


================================================================================
FILE: src\main\java\com\cu5448\pcb\config\PCBProperties.java
================================================================================

package com.cu5448.pcb.config;

import org.springframework.boot.context.properties.ConfigurationProperties;
import org.springframework.stereotype.Component;

import com.cu5448.pcb.model.DefectRates;

import lombok.Data;

/**
 * PCB Configuration Properties that directly create DefectRates instances. This approach eliminates
 * nested property classes and provides direct access to DefectRates objects for each PCB type.
 */
@Data
@Component
@ConfigurationProperties(prefix = "pcb")
public class PCBProperties {

    private DefectRates testboard = new DefectRates();

    private DefectRates sensorboard = new DefectRates();

    private DefectRates gatewayboard = new DefectRates();
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\config\PCBSimulationConfig.java
================================================================================

package com.cu5448.pcb.config;

import java.util.List;

import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;

import com.cu5448.pcb.factory.StationFactory;
import com.cu5448.pcb.station.*;
```

```
import lombok.RequiredArgsConstructor;

/**
 * Spring Configuration Class using Abstract Factory Pattern for PCB Assembly Line Stations. The
 * configuration delegates station creation to a StationFactory, maintaining the factory pattern
 * while leveraging Spring's dependency injection.
 */
@Configuration
@RequiredArgsConstructor
public class PCBSimulationConfig {

    private final StationFactory stationFactory;

    /**
     * Creates ordered list of stations for the assembly line using the abstract factory pattern.
     * This ensures consistent station creation and proper manufacturing process flow.
     */
    @Bean
    public List<Station> createAssemblyLineStations() {
        return List.of(
                stationFactory.createStation("ApplySolderPaste"),
                stationFactory.createStation("PlaceComponents"),
                stationFactory.createStation("ReflowSolder"),
                stationFactory.createStation("OpticalInspection"),
                stationFactory.createStation("HandSoldering"),
                stationFactory.createStation("Cleaning"),
                stationFactory.createStation("Depanelization"),
                stationFactory.createStation("Test"));
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\config\StationProperties.java
================================================================================

package com.cu5448.pcb.config;

import org.springframework.boot.context.properties.ConfigurationProperties;
import org.springframework.stereotype.Component;

import lombok.Data;

/** Station Configuration Properties using Lombok @Data generates all necessary boilerplate code */
@Data
@Component
@ConfigurationProperties(prefix = "station")
public class StationProperties {

    private double failureRate = 0.002;
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\controller\SimulationController.java
================================================================================

package com.cu5448.pcb.controller;

import java.util.HashMap;
import java.util.Map;
import java.util.concurrent.CompletableFuture;

import org.springframework.scheduling.annotation.Async;
import org.springframework.stereotype.Component;

import com.cu5448.pcb.service.AssemblyLine;
import com.cu5448.pcb.service.StatisticsCollector;

import lombok.RequiredArgsConstructor;

/**
 * Main Simulation Controller using Spring Dependency Injection and Lombok @RequiredArgsConstructor
 * generates constructor for final fields. This controller orchestrates PCB simulations and manages
 * results storage for REST API access.
 *
 * <p>Supports the server-side requirement: run simulations to gather failure results in memory,
 * then wait for client API calls to retrieve the stored simulation results.
 */
@Component
@RequiredArgsConstructor
public class SimulationController {

    private final AssemblyLine assemblyLine;

    private final Map<String, StatisticsCollector> results = new HashMap<>();
```

```
    /**
     * Run simulation for a specific PCB type asynchronously and store results in memory.
     *
     * @param pcbType the type of PCB to simulate
     * @param quantity number of PCBs to process
     * @return CompletableFuture with the statistics collector results
     */
    @Async
    public CompletableFuture<StatisticsCollector> runSimulationAsync(String pcbType, int quantity) {
        StatisticsCollector stats = assemblyLine.runSimulation(pcbType, quantity);
        results.put(pcbType, stats);
        return CompletableFuture.completedFuture(stats);
    }

    /**
     * Run simulation for a specific PCB type synchronously (for internal use).
     *
     * @param pcbType the type of PCB to simulate
     * @param quantity number of PCBs to process
     * @return the statistics collector with simulation results
     */
    public StatisticsCollector runSimulation(String pcbType, int quantity) {
        StatisticsCollector stats = assemblyLine.runSimulation(pcbType, quantity);
        results.put(pcbType, stats);
        return stats;
    }

    /**
     * Run simulation for a specific PCB type with default quantity (1000).
     *
     * @param pcbType the type of PCB to simulate
     * @return the statistics collector with simulation results
     */
    public StatisticsCollector runSimulation(String pcbType) {
        return runSimulation(pcbType, 1000);
    }

    /**
     * Run simulations for all three PCB types asynchronously and store results in memory.
     *
     * @return CompletableFuture that completes when all simulations are done
     */
    @Async
    public CompletableFuture<Map<String, StatisticsCollector>> runAllSimulationsAsync() {
        runSimulation("Test Board");
        runSimulation("Sensor Board");
        runSimulation("Gateway Board");
        return CompletableFuture.completedFuture(new HashMap<>(results));
    }

    /**
     * Run simulations for all three PCB types synchronously (for internal use).
     *
     * @return map of all simulation results by PCB type
     */
    public Map<String, StatisticsCollector> runAllSimulations() {
        runSimulation("Test Board");
        runSimulation("Sensor Board");
        runSimulation("Gateway Board");
        return new HashMap<>(results);
    }

    /**
     * Retrieve stored simulation results for a specific PCB type.
     *
     * @param pcbType the type of PCB to get results for
     * @return the statistics collector with results, or null if not found
     */
    public StatisticsCollector getSimulationResults(String pcbType) {
        return results.get(pcbType);
    }

    /**
     * Retrieve all stored simulation results.
     *
     * @return map of all simulation results by PCB type
     */
    public Map<String, StatisticsCollector> getAllSimulationResults() {
        return new HashMap<>(results);
    }

    /**
     * Check if simulation results exist for a specific PCB type.
     *
     * @param pcbType the type of PCB to check
     * @return true if results exist, false otherwise
     */
    public boolean hasSimulationResults(String pcbType) {
```

```
        return results.containsKey(pcbType);
    }

    /** Clear all stored simulation results. */
    public void clearAllResults() {
        results.clear();
    }

    /**
     * Print results to console (for debugging/testing purposes).
     *
     * @param pcbType the type of PCB to print results for
     */
    public void printResults(String pcbType) {
        StatisticsCollector stats = results.get(pcbType);
        if (stats != null) {
            System.out.println(stats.generateReport(pcbType));
        } else {
            System.out.printf("No results found for PCB type: %s\n", pcbType);
        }
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\dto\SimulationReportDto.java
================================================================================

package com.cu5448.pcb.dto;

import java.util.Map;

import com.fasterxml.jackson.annotation.JsonProperty;

import lombok.AllArgsConstructor;
import lombok.Data;
import lombok.NoArgsConstructor;

/**
 * Data Transfer Object for simulation report data used in REST API communication between server and
 * client applications.
 */
@Data
@NoArgsConstructor
@AllArgsConstructor
public class SimulationReportDto {

    @JsonProperty("pcbType")
    private String pcbType;

    @JsonProperty("pcbsRun")
    private int pcbsRun;

    @JsonProperty("stationFailures")
    private Map<String, Integer> stationFailures;

    @JsonProperty("defectFailures")
    private Map<String, Integer> defectFailures;

    @JsonProperty("totalFailedPcbs")
    private int totalFailedPcbs;

    @JsonProperty("totalPcbsProduced")
    private int totalPcbsProduced;

    @JsonProperty("formattedReport")
    private String formattedReport;
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\dto\SimulationReportMapper.java
================================================================================

package com.cu5448.pcb.dto;

import org.springframework.stereotype.Component;

import com.cu5448.pcb.service.StatisticsCollector;

/**
 * Mapper class to convert StatisticsCollector data to SimulationReportDto for API communication.
 */
@Component
public class SimulationReportMapper {

    public SimulationReportDto toDto(StatisticsCollector stats, String pcbType) {
```

```
        SimulationReportDto dto = new SimulationReportDto();

        dto.setPcbType(pcbType);
        dto.setPcbsRun(stats.getPcbsSubmitted());
        dto.setStationFailures(stats.getStationFailures());
        dto.setDefectFailures(stats.getDefectFailures());
        dto.setTotalFailedPcbs(stats.getPcbsSubmitted() - stats.getCompletedPCBs());
        dto.setTotalPcbsProduced(stats.getCompletedPCBs());
        dto.setFormattedReport(stats.generateReport(pcbType));

        return dto;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\factory\PCBFactory.java
================================================================================

package com.cu5448.pcb.factory;

import org.springframework.stereotype.Component;

import com.cu5448.pcb.config.PCBProperties;
import com.cu5448.pcb.model.GatewayBoard;
import com.cu5448.pcb.model.PCB;
import com.cu5448.pcb.model.SensorBoard;
import com.cu5448.pcb.model.TestBoard;

import lombok.RequiredArgsConstructor;

/**
 * Factory Pattern Implementation using Spring Dependency Injection and
 * Lombok @RequiredArgsConstructor generates constructor for final fields This factory creates PCB
 * instances with configuration-driven defect rates.
 */
@Component
@RequiredArgsConstructor
public class PCBFactory {

    private final PCBProperties pcbProperties;

    public PCB createPCB(String type) {
        return switch (type.toLowerCase()) {
            case "testboard", "test", "test board" -> new TestBoard(pcbProperties.getTestboard());
            case "sensorboard", "sensor", "sensor board" ->
                    new SensorBoard(pcbProperties.getSensorboard());
            case "gatewayboard", "gateway", "gateway board" ->
                    new GatewayBoard(pcbProperties.getGatewayboard());
            default -> throw new IllegalArgumentException("Unknown PCB type: " + type);
        };
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\factory\StationFactory.java
================================================================================

package com.cu5448.pcb.factory;

import java.util.Map;
import java.util.function.Function;

import org.springframework.stereotype.Component;

import com.cu5448.pcb.config.StationProperties;
import com.cu5448.pcb.station.*;

import lombok.RequiredArgsConstructor;

/**
 * Abstract Factory for creating PCB manufacturing stations using Spring Dependency Injection. This
 * factory uses a registry pattern to eliminate the need for individual creation methods for each
 * station type, making it more extensible and following the Abstract Factory pattern.
 */
@Component
@RequiredArgsConstructor
public class StationFactory {

    private final StationProperties stationProperties;

    // Registry of station constructors using method references
    private final Map<String, Function<Double, Station>> stationRegistry =
            Map.of(
                    "ApplySolderPaste", ApplySolderPasteStation::new,
                    "PlaceComponents", PlaceComponentsStation::new,
```

```
                    "ReflowSolder", ReflowSolderStation::new,
                    "OpticalInspection", OpticalInspectionStation::new,
                    "HandSoldering", HandSolderingStation::new,
                    "Cleaning", CleaningStation::new,
                    "Depanelization", DepanelizationStation::new,
                    "Test", TestStation::new);

    /**
     * Creates a station by type name using the Abstract Factory pattern. This method uses a
     * registry of constructor method references to eliminate the need for individual creation
     * methods.
     *
     * @param stationType the type of station to create (e.g., "ApplySolderPaste", "Test")
     * @return Station instance of the specified type
     * @throws IllegalArgumentException if station type is unknown
     */
    public Station createStation(String stationType) {
        Function<Double, Station> constructor = stationRegistry.get(stationType);
        if (constructor == null) {
            throw new IllegalArgumentException("Unknown station type: " + stationType);
        }
        return constructor.apply(stationProperties.getFailureRate());
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\model\DefectRates.java
================================================================================

package com.cu5448.pcb.model;

import lombok.AllArgsConstructor;
import lombok.Builder;
import lombok.Data;
import lombok.NoArgsConstructor;

/**
 * DefectRates encapsulates defect rates for different manufacturing stations. This class replaces
 * the Map<String, Double> approach with a type-safe, immutable object.
 *
 * <p>Only four stations can detect defects: PlaceComponents, OpticalInspection, HandSoldering, and
 * Test.
 */
@Data
@Builder
@AllArgsConstructor
@NoArgsConstructor
public class DefectRates {

    private double placeComponentsDefectRate;
    private double opticalInspectionDefectRate;
    private double handSolderingDefectRate;
    private double testDefectRate;

    /**
     * Gets the defect rate for a specific station type.
     *
     * @param stationType the station type name
     * @return the defect rate for the station, or 0.0 if the station doesn't detect defects
     */
    public double getDefectRate(String stationType) {
        return switch (stationType) {
            case "PlaceComponents" -> placeComponentsDefectRate;
            case "OpticalInspection" -> opticalInspectionDefectRate;
            case "HandSoldering" -> handSolderingDefectRate;
            case "Test" -> testDefectRate;
            default -> 0.0; // Stations that don't detect defects
        };
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\model\GatewayBoard.java
================================================================================

package com.cu5448.pcb.model;

import lombok.EqualsAndHashCode;

/** Gateway Board PCB Implementation using Lombok */
@EqualsAndHashCode(callSuper = true)
public class GatewayBoard extends PCB {

    private final DefectRates defectRates;
```

```
    public GatewayBoard(DefectRates defectRates) {
        super("GatewayBoard");
        this.defectRates = defectRates;
    }

    @Override
    public double getDefectRate(String stationType) {
        return defectRates.getDefectRate(stationType);
    }

    @Override
    public DefectRates getDefectRates() {
        return defectRates;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\model\PCB.java
================================================================================

package com.cu5448.pcb.model;

import java.util.UUID;

import lombok.Getter;
import lombok.ToString;

/**
 * Abstract PCB Model using Lombok @Getter generates getters for all fields @ToString generates
 * toString method
 */
@Getter
@ToString
public abstract class PCB {

    private final String id;

    private final String type;

    private boolean failed = false;

    private String failureReason = null;

    public PCB(String type) {
        this.id = UUID.randomUUID().toString();
        this.type = type;
    }

    public void setFailed(String reason) {
        this.failed = true;
        this.failureReason = reason;
    }

    public abstract double getDefectRate(String stationType);

    public abstract DefectRates getDefectRates();
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\model\SensorBoard.java
================================================================================

package com.cu5448.pcb.model;

import lombok.EqualsAndHashCode;

/** Sensor Board PCB Implementation using Lombok */
@EqualsAndHashCode(callSuper = true)
public class SensorBoard extends PCB {

    private final DefectRates defectRates;

    public SensorBoard(DefectRates defectRates) {
        super("SensorBoard");
        this.defectRates = defectRates;
    }

    @Override
    public double getDefectRate(String stationType) {
        return defectRates.getDefectRate(stationType);
    }

    @Override
    public DefectRates getDefectRates() {
        return defectRates;
```

```
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\model\TestBoard.java
================================================================================

package com.cu5448.pcb.model;

import lombok.EqualsAndHashCode;

/** Test Board PCB Implementation using Lombok */
@EqualsAndHashCode(callSuper = true)
public class TestBoard extends PCB {

    private final DefectRates defectRates;

    public TestBoard(DefectRates defectRates) {
        super("TestBoard");
        this.defectRates = defectRates;
    }

    @Override
    public double getDefectRate(String stationType) {
        return defectRates.getDefectRate(stationType);
    }

    @Override
    public DefectRates getDefectRates() {
        return defectRates;
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\service\AssemblyLine.java
================================================================================

package com.cu5448.pcb.service;

import java.util.List;

import org.springframework.context.ApplicationContext;
import org.springframework.stereotype.Service;

import com.cu5448.pcb.factory.PCBFactory;
import com.cu5448.pcb.model.PCB;
import com.cu5448.pcb.station.Station;

import lombok.RequiredArgsConstructor;

/**
 * Assembly Line Service using Spring Dependency Injection. Station beans are injected as an ordered
 * list, eliminating the need for manual station creation and initialization.
 */
@Service
@RequiredArgsConstructor
public class AssemblyLine {

    private final List<Station> stations;

    private final PCBFactory factory;

    private final ApplicationContext applicationContext;

    public void processPCB(PCB pcb, StatisticsCollector stats) {
        for (Station station : stations) {
            station.process(pcb, stats);
            if (pcb.isFailed()) {
                break;
            }
        }
    }

    public StatisticsCollector runSimulation(String pcbType, int quantity) {
        // Get a new prototype instance of StatisticsCollector for this simulation
        StatisticsCollector stats = applicationContext.getBean(StatisticsCollector.class);

        for (int i = 0; i < quantity; i++) {
            PCB pcb = factory.createPCB(pcbType);
            stats.recordSubmission();

            processPCB(pcb, stats);

            if (!pcb.isFailed()) {
                stats.recordCompletion();
```

```
            }
        }

        return stats;
    }

    public List<Station> getStations() {
        return List.copyOf(stations);
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\service\StatisticsCollector.java
================================================================================

package com.cu5448.pcb.service;

import java.util.HashMap;
import java.util.Map;

import org.springframework.context.annotation.Scope;
import org.springframework.stereotype.Service;

import lombok.Getter;

/**
 * Observer Pattern Implementation as Spring Service using Lombok @Getter generates getter methods
 * for all fields This service observes events from stations during PCB processing. Uses prototype
 * scope to create new instances for each simulation run.
 */
@Service
@Scope("prototype")
@Getter
public class StatisticsCollector {

    private int pcbsSubmitted;

    private final Map<String, Integer> defectFailures;

    private final Map<String, Integer> stationFailures;

    private int completedPCBs;

    public StatisticsCollector() {
        this.pcbsSubmitted = 0;
        this.defectFailures = new HashMap<>();
        this.stationFailures = new HashMap<>();
        this.completedPCBs = 0;
    }

    public void recordSubmission() {
        pcbsSubmitted++;
    }

    public void recordDefectFailure(String station) {
        defectFailures.merge(station, 1, Integer::sum);
    }

    public void recordStationFailure(String station) {
        stationFailures.merge(station, 1, Integer::sum);
    }

    public void recordCompletion() {
        completedPCBs++;
    }

    public String generateReport(String pcbType) {
        StringBuilder report = new StringBuilder();

        // Format according to project specification
        report.append(String.format("PCB type: %s\n", pcbType));
        report.append(String.format("PCBs run: %d\n", pcbsSubmitted));

        report.append("\nStation Failures\n");
        // Show all stations in assembly order
        String[] stationNames = {
            "Apply Solder Paste",
            "Place Components",
            "Reflow Solder",
            "Optical Inspection",
            "Hand Soldering/Assembly",
            "Cleaning",
            "Depanelization",
            "Test (ICT or Flying Probe)"
        };

        String[] stationKeys = {
```

```
            "ApplySolderPaste",
            "PlaceComponents",
            "ReflowSolder",
            "OpticalInspection",
            "HandSoldering",
            "Cleaning",
            "Depanelization",
            "Test"
        };

        for (int i = 0; i < stationNames.length; i++) {
            int failures = stationFailures.getOrDefault(stationKeys[i], 0);
            report.append(String.format("%s: %d\n", stationNames[i], failures));
        }

        report.append("\nPCB Defect Failures\n");
        // Only show defect-detecting stations
        String[] defectStationNames = {
            "Place Components",
            "Optical Inspection",
            "Hand Soldering/Assembly",
            "Test (ICT or Flying Probe)"
        };
        String[] defectStationKeys = {
            "PlaceComponents", "OpticalInspection", "HandSoldering", "Test"
        };

        for (int i = 0; i < defectStationNames.length; i++) {
            int failures = defectFailures.getOrDefault(defectStationKeys[i], 0);
            report.append(String.format("%s %d\n", defectStationNames[i], failures));
        }

        // Calculate total failures and successful PCBs
        int totalFailed = pcbsSubmitted - completedPCBs;

        report.append("\nFinal Results\n");
        report.append(String.format("Total failed PCBs: %d\n", totalFailed));
        report.append(String.format("Total PCBs produced: %d\n", completedPCBs));

        return report.toString();
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\ApplySolderPasteStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

public class ApplySolderPasteStation extends Station {

    public ApplySolderPasteStation(double failureRate) {
        super("ApplySolderPaste", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        return true;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\CleaningStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

public class CleaningStation extends Station {

    public CleaningStation(double failureRate) {
        super("Cleaning", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        return true;
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\station\DepanelizationStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

public class DepanelizationStation extends Station {

    public DepanelizationStation(double failureRate) {
        super("Depanelization", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        return true;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\HandSolderingStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

import lombok.EqualsAndHashCode;

/** Hand Soldering Station using Lombok */
@EqualsAndHashCode(callSuper = true)
public class HandSolderingStation extends Station {

    public HandSolderingStation(double failureRate) {
        super("HandSoldering", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        double defectRate = pcb.getDefectRate("HandSoldering");
        return random.nextDouble() >= defectRate;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\OpticalInspectionStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

import lombok.EqualsAndHashCode;

/** Optical Inspection Station using Lombok */
@EqualsAndHashCode(callSuper = true)
public class OpticalInspectionStation extends Station {

    public OpticalInspectionStation(double failureRate) {
        super("OpticalInspection", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        double defectRate = pcb.getDefectRate("OpticalInspection");
        return random.nextDouble() >= defectRate;
    }
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\PlaceComponentsStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

import lombok.EqualsAndHashCode;

/**
 * Place Components Station using Lombok @EqualsAndHashCode(callSuper = true) includes parent class
 * fields in equals/hashCode
```

```
 */
@EqualsAndHashCode(callSuper = true)
public class PlaceComponentsStation extends Station {

    public PlaceComponentsStation(double failureRate) {
        super("PlaceComponents", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        double defectRate = pcb.getDefectRate("PlaceComponents");
        return random.nextDouble() >= defectRate;
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\station\ReflowSolderStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

public class ReflowSolderStation extends Station {

    public ReflowSolderStation(double failureRate) {
        super("ReflowSolder", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        return true;
    }
}
```

```
================================================================================
FILE: src\main\java\com\cu5448\pcb\station\Station.java
================================================================================

package com.cu5448.pcb.station;

import java.util.Random;

import com.cu5448.pcb.model.PCB;
import com.cu5448.pcb.service.StatisticsCollector;

import lombok.Getter;

/**
 * Abstract Station class that can be used as a Spring bean. StatisticsCollector is injected per
 * simulation run rather than at construction time.
 */
@Getter
public abstract class Station {

    protected final String name;

    protected final double stationFailureRate;

    protected final Random random = new Random();

    public Station(String name, double failureRate) {
        this.name = name;
        this.stationFailureRate = failureRate;
    }

    public void process(PCB pcb, StatisticsCollector stats) {
        if (pcb.isFailed()) {
            return;
        }

        if (checkStationFailure()) {
            stats.recordStationFailure(name);
            pcb.setFailed("Station failure at " + name);
            return;
        }

        boolean operationSuccessful = performOperation(pcb);
        if (!operationSuccessful) {
            stats.recordDefectFailure(name);
            pcb.setFailed("Defect detected at " + name);
        }
    }

    protected boolean checkStationFailure() {
```

```
        return random.nextDouble() < stationFailureRate;
    }

    protected abstract boolean performOperation(PCB pcb);
}



================================================================================
FILE: src\main\java\com\cu5448\pcb\station\TestStation.java
================================================================================

package com.cu5448.pcb.station;

import com.cu5448.pcb.model.PCB;

import lombok.EqualsAndHashCode;

/** Test Station using Lombok */
@EqualsAndHashCode(callSuper = true)
public class TestStation extends Station {

    public TestStation(double failureRate) {
        super("Test", failureRate);
    }

    @Override
    protected boolean performOperation(PCB pcb) {
        double defectRate = pcb.getDefectRate("Test");
        return random.nextDouble() >= defectRate;
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\PcbApplicationTests.java
================================================================================

package com.cu5448.pcb;

import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;

@SpringBootTest
class PcbApplicationTests {

    @Test
    void contextLoads() {}
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\config\SpringBeanConfigurationTest.java
================================================================================

package com.cu5448.pcb.config;

import static org.junit.jupiter.api.Assertions.*;

import java.util.List;

import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.test.context.TestConstructor;

import com.cu5448.pcb.service.AssemblyLine;
import com.cu5448.pcb.station.*;

import lombok.RequiredArgsConstructor;

/** Test class to verify Spring bean configuration using Abstract Factory Pattern */
@SpringBootTest
@TestConstructor(autowireMode = TestConstructor.AutowireMode.ALL)
@RequiredArgsConstructor
class SpringBeanConfigurationTest {

    private final AssemblyLine assemblyLine;

    private final List<Station> stations;

    @Test
    void testAssemblyLineInjection() {
        assertNotNull(assemblyLine, "AssemblyLine should be injected");

        List<Station> assemblyStations = assemblyLine.getStations();
        assertEquals(8, assemblyStations.size(), "Assembly line should have 8 stations");
    }
```

```
    @Test
    void testStationListOrder() {
        assertNotNull(stations, "Station list should be injected");
        assertEquals(8, stations.size(), "Should have 8 stations");

        // Verify the correct order of stations
        assertEquals("ApplySolderPaste", stations.get(0).getName());
        assertEquals("PlaceComponents", stations.get(1).getName());
        assertEquals("ReflowSolder", stations.get(2).getName());
        assertEquals("OpticalInspection", stations.get(3).getName());
        assertEquals("HandSoldering", stations.get(4).getName());
        assertEquals("Cleaning", stations.get(5).getName());
        assertEquals("Depanelization", stations.get(6).getName());
        assertEquals("Test", stations.get(7).getName());
    }

    @Test
    void testStationFailureRatesAreConfigured() {
        // All stations should have the same configured failure rate
        double expectedFailureRate = 0.002; // From application.properties

        for (Station station : stations) {
            assertEquals(
                    expectedFailureRate,
                    station.getStationFailureRate(),
                    "Station " + station.getName() + " should have configured failure rate");
        }
    }

    @Test
    void testAssemblyLineStationsAreSameAsInjectedList() {
        List<Station> assemblyStations = assemblyLine.getStations();

        // Verify same stations are used (but different list instance due to List.copyOf)
        assertEquals(stations.size(), assemblyStations.size());

        for (int i = 0; i < stations.size(); i++) {
            assertSame(
                    stations.get(i),
                    assemblyStations.get(i),
                    "Station " + i + " should be the same bean instance");
        }
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\config\SpringConfigurationTest.java
================================================================================

package com.cu5448.pcb.config;

import static org.junit.jupiter.api.Assertions.*;

import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.test.context.TestConstructor;

import com.cu5448.pcb.controller.SimulationController;
import com.cu5448.pcb.factory.PCBFactory;
import com.cu5448.pcb.service.AssemblyLine;

import lombok.RequiredArgsConstructor;

@SpringBootTest
@TestConstructor(autowireMode = TestConstructor.AutowireMode.ALL)
@RequiredArgsConstructor
class SpringConfigurationTest {

    private final SimulationController simulationController;

    private final AssemblyLine assemblyLine;

    private final PCBFactory pcbFactory;

    private final StationProperties stationProperties;

    private final PCBProperties pcbProperties;

    @Test
    void testSpringDependencyInjection() {
        // Verify that all Spring beans are properly injected
        assertNotNull(simulationController);
        assertNotNull(assemblyLine);
        assertNotNull(pcbFactory);
    }
```

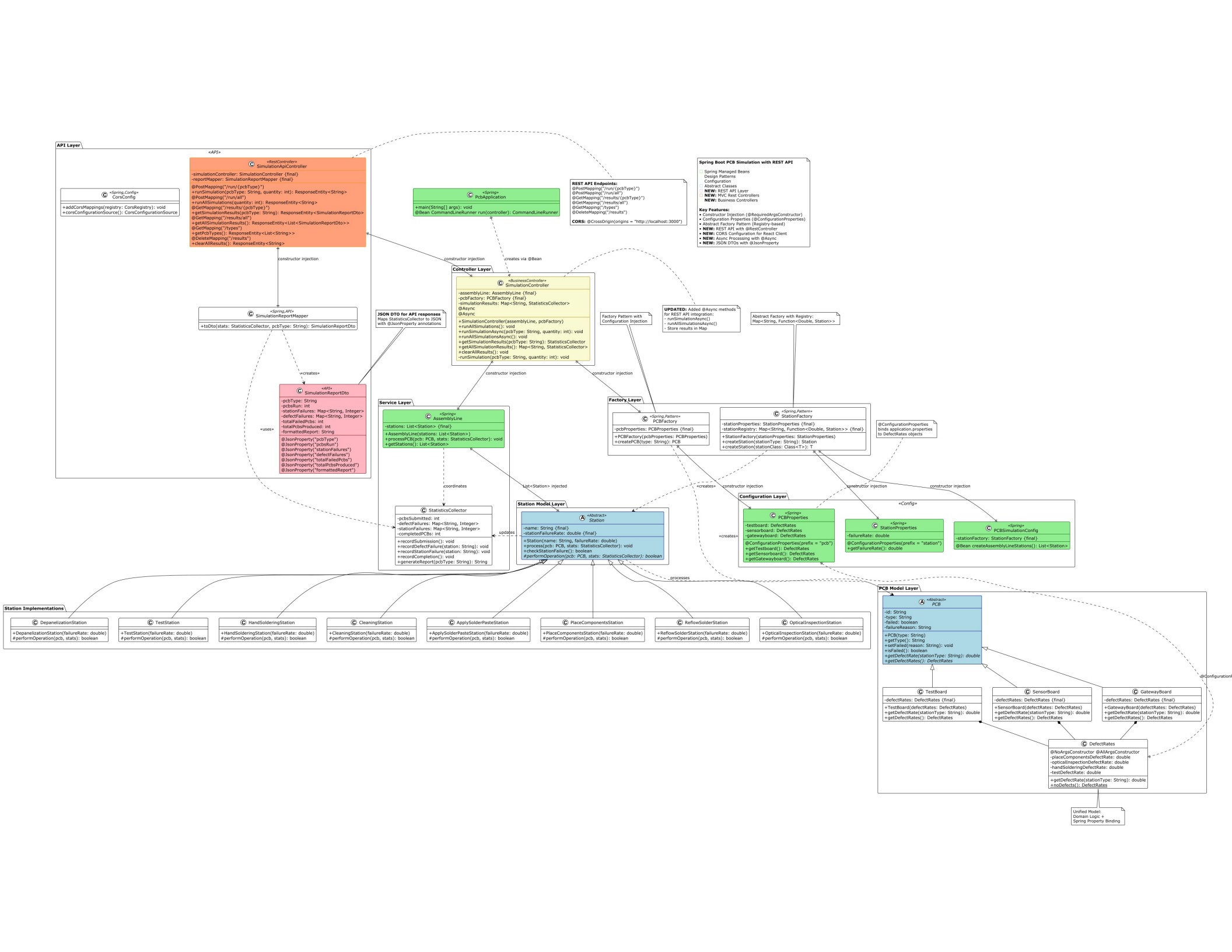
```
    @Test
    void testConfigurationProperties() {
        // Verify that configuration properties are loaded correctly
        assertEquals(0.002, stationProperties.getFailureRate(), 0.0001);

        // Test PCB defect rates from properties (using Lombok-generated getters)
        assertEquals(0.05, pcbProperties.getTestboard().getPlaceComponentsDefectRate(), 0.0001);
        assertEquals(0.002, pcbProperties.getSensorboard().getPlaceComponentsDefectRate(), 0.0001);
        assertEquals(0.004, pcbProperties.getGatewayboard().getPlaceComponentsDefectRate(), 0.0001);
    }

    @Test
    void testPCBFactoryWithConfiguration() {
        // Test that PCB factory creates boards with configuration-driven defect rates
        var testBoard = pcbFactory.createPCB("Test Board");
        assertEquals("TestBoard", testBoard.getType());
        assertEquals(0.05, testBoard.getDefectRate("PlaceComponents"), 0.0001);

        var sensorBoard = pcbFactory.createPCB("Sensor Board");
        assertEquals("SensorBoard", sensorBoard.getType());
        assertEquals(0.002, sensorBoard.getDefectRate("PlaceComponents"), 0.0001);
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\factory\PCBFactoryTest.java
================================================================================

package com.cu5448.pcb.factory;

import static org.junit.jupiter.api.Assertions.*;

import org.junit.jupiter.api.BeforeEach;
import org.junit.jupiter.api.Test;

import com.cu5448.pcb.config.PCBProperties;
import com.cu5448.pcb.model.*;

class PCBFactoryTest {

    private PCBFactory factory;

    @BeforeEach
    void setUp() {
        factory = new PCBFactory(new PCBProperties());
    }

    @Test
    void testCreateTestBoard() {
        PCB pcb = factory.createPCB("testboard");
        assertInstanceOf(TestBoard.class, pcb);
        assertEquals("TestBoard", pcb.getType());
    }

    @Test
    void testCreateSensorBoard() {
        PCB pcb = factory.createPCB("sensorboard");
        assertInstanceOf(SensorBoard.class, pcb);
        assertEquals("SensorBoard", pcb.getType());
    }

    @Test
    void testCreateGatewayBoard() {
        PCB pcb = factory.createPCB("gatewayboard");
        assertInstanceOf(GatewayBoard.class, pcb);
        assertEquals("GatewayBoard", pcb.getType());
    }

    @Test
    void testCreateWithAlternativeNames() {
        assertInstanceOf(TestBoard.class, factory.createPCB("test"));
        assertInstanceOf(SensorBoard.class, factory.createPCB("sensor"));
        assertInstanceOf(GatewayBoard.class, factory.createPCB("gateway"));
    }

    @Test
    void testCreateWithInvalidType() {
        assertThrows(IllegalArgumentException.class, () -> factory.createPCB("invalid"));
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\factory\StationFactoryTest.java
================================================================================
```

```
package com.cu5448.pcb.factory;

import static org.junit.jupiter.api.Assertions.*;

import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.test.context.TestConstructor;

import com.cu5448.pcb.station.*;

import lombok.RequiredArgsConstructor;

/** Test class for StationFactory implementation */
@SpringBootTest
@TestConstructor(autowireMode = TestConstructor.AutowireMode.ALL)
@RequiredArgsConstructor
class StationFactoryTest {

    private final StationFactory stationFactory;

    @Test
    void testFactoryInjection() {
        assertNotNull(stationFactory, "StationFactory should be injected");
    }

    @Test
    void testCreateIndividualStations() {
        // Test station creation using abstract factory method
        Station applySolderPaste = stationFactory.createStation("ApplySolderPaste");
        assertNotNull(applySolderPaste);
        assertEquals("ApplySolderPaste", applySolderPaste.getName());

        Station placeComponents = stationFactory.createStation("PlaceComponents");
        assertNotNull(placeComponents);
        assertEquals("PlaceComponents", placeComponents.getName());

        Station reflowSolder = stationFactory.createStation("ReflowSolder");
        assertNotNull(reflowSolder);
        assertEquals("ReflowSolder", reflowSolder.getName());

        Station opticalInspection = stationFactory.createStation("OpticalInspection");
        assertNotNull(opticalInspection);
        assertEquals("OpticalInspection", opticalInspection.getName());

        Station handSoldering = stationFactory.createStation("HandSoldering");
        assertNotNull(handSoldering);
        assertEquals("HandSoldering", handSoldering.getName());

        Station cleaning = stationFactory.createStation("Cleaning");
        assertNotNull(cleaning);
        assertEquals("Cleaning", cleaning.getName());

        Station depanelization = stationFactory.createStation("Depanelization");
        assertNotNull(depanelization);
        assertEquals("Depanelization", depanelization.getName());

        Station test = stationFactory.createStation("Test");
        assertNotNull(test);
        assertEquals("Test", test.getName());
    }

    @Test
    void testCreateStationByType() {
        // Test station creation by type name using abstract factory
        Station applySolder = stationFactory.createStation("ApplySolderPaste");
        assertInstanceOf(ApplySolderPasteStation.class, applySolder);
        assertEquals("ApplySolderPaste", applySolder.getName());

        Station placeComponents = stationFactory.createStation("PlaceComponents");
        assertInstanceOf(PlaceComponentsStation.class, placeComponents);
        assertEquals("PlaceComponents", placeComponents.getName());

        Station test = stationFactory.createStation("Test");
        assertInstanceOf(TestStation.class, test);
        assertEquals("Test", test.getName());
    }

    @Test
    void testCreateStationByTypeInvalid() {
        // Test invalid station type using abstract factory
        assertThrows(
                IllegalArgumentException.class,
                () -> stationFactory.createStation("InvalidStation"),
                "Should throw exception for invalid station type");

        assertThrows(
                IllegalArgumentException.class,
                () -> stationFactory.createStation(""),
                "Should throw exception for empty station type");
```

```
        assertThrows(
                IllegalArgumentException.class,
                () -> stationFactory.createStation("SomeRandomName"),
                "Should throw exception for random station type");
    }

    @Test
    void testAllStationTypesSupported() {
        // Test all expected station types are supported by abstract factory
        String[] stationTypes = {
            "ApplySolderPaste",
            "PlaceComponents",
            "ReflowSolder",
            "OpticalInspection",
            "HandSoldering",
            "Cleaning",
            "Depanelization",
            "Test"
        };

        for (String stationType : stationTypes) {
            assertDoesNotThrow(
                    () -> {
                        Station station = stationFactory.createStation(stationType);
                        assertNotNull(
                                station, "Station should be created for type: " + stationType);
                    },
                    "Should be able to create station for type: " + stationType);
        }
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\model\DefectRatesTest.java
================================================================================

package com.cu5448.pcb.model;

import static org.junit.jupiter.api.Assertions.*;

import org.junit.jupiter.api.Test;

/** Test class for DefectRates model */
class DefectRatesTest {

    @Test
    void testBuilderPattern() {
        DefectRates rates =
                DefectRates.builder()
                        .placeComponentsDefectRate(0.01)
                        .opticalInspectionDefectRate(0.02)
                        .handSolderingDefectRate(0.03)
                        .testDefectRate(0.04)
                        .build();

        assertEquals(0.01, rates.getPlaceComponentsDefectRate());
        assertEquals(0.02, rates.getOpticalInspectionDefectRate());
        assertEquals(0.03, rates.getHandSolderingDefectRate());
        assertEquals(0.04, rates.getTestDefectRate());
    }

    @Test
    void testGetDefectRateWithValidStations() {
        DefectRates rates =
                DefectRates.builder()
                        .placeComponentsDefectRate(0.05)
                        .opticalInspectionDefectRate(0.10)
                        .handSolderingDefectRate(0.05)
                        .testDefectRate(0.10)
                        .build();

        assertEquals(0.05, rates.getDefectRate("PlaceComponents"));
        assertEquals(0.10, rates.getDefectRate("OpticalInspection"));
        assertEquals(0.05, rates.getDefectRate("HandSoldering"));
        assertEquals(0.10, rates.getDefectRate("Test"));
    }

    @Test
    void testGetDefectRateWithInvalidStation() {
        DefectRates rates =
                DefectRates.builder()
                        .placeComponentsDefectRate(0.05)
                        .opticalInspectionDefectRate(0.10)
                        .handSolderingDefectRate(0.05)
                        .testDefectRate(0.10)
                        .build();
```

```
        assertEquals(0.0, rates.getDefectRate("ApplySolderPaste"));
        assertEquals(0.0, rates.getDefectRate("ReflowSolder"));
        assertEquals(0.0, rates.getDefectRate("Cleaning"));
        assertEquals(0.0, rates.getDefectRate("Depanelization"));
        assertEquals(0.0, rates.getDefectRate("NonExistentStation"));
    }

    @Test
    void testPCBIntegration() {
        // Test that PCB implementations can use DefectRates
        DefectRates testRates =
                DefectRates.builder()
                        .placeComponentsDefectRate(0.05)
                        .opticalInspectionDefectRate(0.10)
                        .handSolderingDefectRate(0.05)
                        .testDefectRate(0.10)
                        .build();
        TestBoard testBoard = new TestBoard(testRates);
        DefectRates defectRates = testBoard.getDefectRates();

        assertNotNull(defectRates);
        assertEquals(0.05, testBoard.getDefectRate("PlaceComponents"));
        assertEquals(0.05, defectRates.getDefectRate("PlaceComponents"));

        DefectRates sensorRates =
                DefectRates.builder()
                        .placeComponentsDefectRate(0.002)
                        .opticalInspectionDefectRate(0.002)
                        .handSolderingDefectRate(0.004)
                        .testDefectRate(0.004)
                        .build();
        SensorBoard sensorBoard = new SensorBoard(sensorRates);
        DefectRates actualSensorRates = sensorBoard.getDefectRates();

        assertNotNull(actualSensorRates);
        assertEquals(0.002, sensorBoard.getDefectRate("PlaceComponents"));
        assertEquals(0.002, actualSensorRates.getDefectRate("PlaceComponents"));
    }
}



================================================================================
FILE: src\test\java\com\cu5448\pcb\service\StatisticsCollectorTest.java
================================================================================

package com.cu5448.pcb.service;

import static org.junit.jupiter.api.Assertions.*;

import org.junit.jupiter.api.BeforeEach;
import org.junit.jupiter.api.Test;

class StatisticsCollectorTest {

    private StatisticsCollector stats;

    @BeforeEach
    void setUp() {
        stats = new StatisticsCollector();
    }

    @Test
    void testInitialState() {
        assertEquals(0, stats.getPcbsSubmitted());
        assertEquals(0, stats.getCompletedPCBs());
        assertTrue(stats.getDefectFailures().isEmpty());
        assertTrue(stats.getStationFailures().isEmpty());
    }

    @Test
    void testRecordSubmission() {
        stats.recordSubmission();
        stats.recordSubmission();
        assertEquals(2, stats.getPcbsSubmitted());
    }

    @Test
    void testRecordCompletion() {
        stats.recordCompletion();
        stats.recordCompletion();
        assertEquals(2, stats.getCompletedPCBs());
    }

    @Test
    void testRecordDefectFailure() {
        stats.recordDefectFailure("PlaceComponents");
        stats.recordDefectFailure("PlaceComponents");
```

```
        stats.recordDefectFailure("Test");

        assertEquals(2, stats.getDefectFailures().get("PlaceComponents"));
        assertEquals(1, stats.getDefectFailures().get("Test"));
    }

    @Test
    void testRecordStationFailure() {
        stats.recordStationFailure("ApplySolderPaste");
        stats.recordStationFailure("Cleaning");

        assertEquals(1, stats.getStationFailures().get("ApplySolderPaste"));
        assertEquals(1, stats.getStationFailures().get("Cleaning"));
    }

    @Test
    void testGenerateReport() {
        stats.recordSubmission();
        stats.recordSubmission();
        stats.recordCompletion();
        stats.recordDefectFailure("Test");
        stats.recordStationFailure("Cleaning");

        String report = stats.generateReport("Test Board");

        assertTrue(report.contains("PCB type: Test Board"));
        assertTrue(report.contains("PCBs run: 2"));
        assertTrue(report.contains("Total failed PCBs: 1"));
        assertTrue(report.contains("Total PCBs produced: 1"));
        assertTrue(report.contains("Test (ICT or Flying Probe) 1"));
        assertTrue(report.contains("Cleaning: 1"));
    }
}
```


API Layer
«API»
«RestController»
SimulationApiController
-simulationController: SimulationController {final}
-reportMapper: SimulationReportMapper {final}
@PostMapping("/run/{pcbType}")
+runSimulation(pcbType: String, quantity: int): ResponseEntity<String>
@PostMapping("/run/all")
+runAllSimulations(quantity: int): ResponseEntity<String>
@GetMapping("/results/{pcbType}")
+getSimulationResults(pcbType: String): ResponseEntity<SimulationReportDto>
@GetMapping("/results/all")
+getAllSimulationResults(): ResponseEntity<List<SimulationReportDto>>
@GetMapping("/types")
+getPcbTypes(): ResponseEntity<List<String>>
@DeleteMapping("/results")
+clearAllResults(): ResponseEntity<String>
«Spring,Config»
CorsConfig
+addCorsMappings(registry: CorsRegistry): void
+corsConfigurationSource(): CorsConfigurationSource
«Spring»
PcbApplication
+main(String[] args): void
@Bean CommandLineRunner run(controller): CommandLineRunner
REST API Endpoints:
@PostMapping("/run/{pcbType}")
@PostMapping("/run/all")
@GetMapping("/results/{pcbType}")
@GetMapping("/results/all")
@GetMapping("/types")
@DeleteMapping("/results")
CORS: @CrossOrigin(origins = "http://localhost:3000")
Spring Boot PCB Simulation with REST API
Spring Managed Beans
Design Patterns
Configuration
Abstract Classes
NEW: REST API Layer
NEW: MVC Rest Controllers
NEW: Business Controllers
Key Features:
• Constructor Injection (@RequiredArgsConstructor)
• Configuration Properties (@ConfigurationProperties)
• Abstract Factory Pattern (Registry-based)
• NEW: REST API with @RestController
• NEW: CORS Configuration for React Client
• NEW: Async Processing with @Async
• NEW: JSON DTOs with @JsonProperty
constructor injection
creates via @Bean
Controller Layer
«BusinessController»
SimulationController
-assemblyLine: AssemblyLine {final}
-pcbFactory: PCBFactory {final}
-simulationResults: Map<String, StatisticsCollector>
@Async
@Async
+SimulationController(assemblyLine, pcbFactory)
+runAllSimulations(): void
+runSimulationAsync(pcbType: String, quantity: int): void
+runAllSimulationsAsync(): void
+getSimulationResults(pcbType: String): StatisticsCollector
+getAllSimulationResults(): Map<String, StatisticsCollector>
+clearAllResults(): void
-runSimulation(pcbType: String, quantity: int): void
«Spring,API»
SimulationReportMapper
+toDto(stats: StatisticsCollector, pcbType: String): SimulationReportDto
JSON DTO for API responses
Maps StatisticsCollector to JSON
with @JsonProperty annotations
UPDATED: Added @Async methods
for REST API integration:
- runSimulationAsync()
- runAllSimulationsAsync()
- Store results in Map
Factory Pattern with
Configuration Injection
Abstract Factory with Registry:
Map<String, Function<Double, Station>>
«creates»
«uses»
«API»
SimulationReportDto
-pcbType: String
-pcbsRun: int
-stationFailures: Map<String, Integer>
-defectFailures: Map<String, Integer>
-totalFailedPcbs: int
-totalPcbsProduced: int
-formattedReport: String
@JsonProperty("pcbType")
@JsonProperty("pcbsRun")
@JsonProperty("stationFailures")
@JsonProperty("defectFailures")
@JsonProperty("totalFailedPcbs")
@JsonProperty("totalPcbsProduced")
@JsonProperty("formattedReport")
Service Layer
«Spring»
AssemblyLine
-stations: List<Station> {final}
+AssemblyLine(stations: List<Station>)
+processPCB(pcb: PCB, stats: StatisticsCollector): void
+getStations(): List<Station>
coordinates
List<Station> injected
StatisticsCollector
-pcbsSubmitted: int
-defectFailures: Map<String, Integer>
-stationFailures: Map<String, Integer>
-completedPCBs: int
+recordSubmission(): void
+recordDefectFailure(station: String): void
+recordStationFailure(station: String): void
+recordCompletion(): void
+generateReport(pcbType: String): String
updates
Station Model Layer
«Abstract»
Station
-name: String {final}
-stationFailureRate: double {final}
+Station(name: String, failureRate: double)
+process(pcb: PCB, stats: StatisticsCollector): void
+checkStationFailure(): boolean
#performOperation(pcb: PCB, stats: StatisticsCollector): boolean
Factory Layer
«Spring,Pattern»
PCBFactory
-pcbProperties: PCBProperties {final}
+PCBFactory(pcbProperties: PCBProperties)
+createPCB(type: String): PCB
«Spring,Pattern»
StationFactory
-stationProperties: StationProperties {final}
-stationRegistry: Map<String, Function<Double, Station>> {final}
+StationFactory(stationProperties: StationProperties)
+createStation(stationType: String): Station
+createStation(stationClass: Class<T>): T
@ConfigurationProperties
binds application.properties
to DefectRates objects
«creates»
constructor injection
constructor injection
constructor injection
Configuration Layer
«Config»
«Spring»
PCBProperties
-testboard: DefectRates
-sensorboard: DefectRates
-gatewayboard: DefectRates
@ConfigurationProperties(prefix = "pcb")
+getTestboard(): DefectRates
+getSensorboard(): DefectRates
+getGatewayboard(): DefectRates
«Spring»
StationProperties
-failureRate: double
@ConfigurationProperties(prefix = "station")
+getFailureRate(): double
«Spring»
PCBSimulationConfig
-stationFactory: StationFactory {final}
@Bean createAssemblyLineStations(): List<Station>
«creates»
processes
Station Implementations
DepanelizationStation
+DepanelizationStation(failureRate: double)
#performOperation(pcb, stats): boolean
TestStation
+TestStation(failureRate: double)
#performOperation(pcb, stats): boolean
HandSolderingStation
+HandSolderingStation(failureRate: double)
#performOperation(pcb, stats): boolean
CleaningStation
+CleaningStation(failureRate: double)
#performOperation(pcb, stats): boolean
ApplySolderPasteStation
+ApplySolderPasteStation(failureRate: double)
#performOperation(pcb, stats): boolean
PlaceComponentsStation
+PlaceComponentsStation(failureRate: double)
#performOperation(pcb, stats): boolean
ReflowSolderStation
+ReflowSolderStation(failureRate: double)
#performOperation(pcb, stats): boolean
OpticalInspectionStation
+OpticalInspectionStation(failureRate: double)
#performOperation(pcb, stats): boolean
PCB Model Layer
«Abstract»
PCB
-id: String
-type: String
-failed: boolean
-failureReason: String
+PCB(type: String)
+getType(): String
+setFailed(reason: String): void
+isFailed(): boolean
+getDefectRate(stationType: String): double
+getDefectRates(): DefectRates
TestBoard
-defectRates: DefectRates {final}
+TestBoard(defectRates: DefectRates)
+getDefectRate(stationType: String): double
+getDefectRates(): DefectRates
SensorBoard
-defectRates: DefectRates {final}
+SensorBoard(defectRates: DefectRates)
+getDefectRate(stationType: String): double
+getDefectRates(): DefectRates
GatewayBoard
-defectRates: DefectRates {final}
+GatewayBoard(defectRates: DefectRates)
+getDefectRate(stationType: String): double
+getDefectRates(): DefectRates
@ConfigurationP
DefectRates
@NoArgsConstructor @AllArgsConstructor
-placeComponentsDefectRate: double
-opticalInspectionDefectRate: double
-handSolderingDefectRate: double
-testDefectRate: double
+getDefectRate(stationType: String): double
+noDefects(): DefectRates
Unified Model:
Domain Logic +
Spring Property Binding