OPERATING SYSTEMS

PROJECT

Section: K23SA

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TOPIC: **Real-Time Process Monitoring Dashboard**

Repository name: **Resource_Monitoring_System**

Repository link: **https://github.com/Ayushh-k/Resource_Monitoring_System.git t**

Real-Time Process Monitoring Dashboard

REAL-TIME PROCESS MONITORING DASHBOARD

The **Real-Time Process Monitoring Dashboard** is an advanced graphical interface designed to provide administrators with real-time insights into the performance and status of system processes. By continuously monitoring key metrics such as **process states, CPU usage, and memory consumption**, this dashboard enables proactive system management, helping to swiftly detect and resolve potential performance issues.

Key Features

1. **Real-Time System Insights**
    - Displays active processes and their states, ensuring administrators have an up-to-date view of system activity.
    - Continuously tracks CPU and memory utilization, allowing for efficient resource management.
2. **Intuitive Graphical Interface**
    - Provides interactive charts and visual indicators that simplify performance analysis.
    - Offers a customizable layout for administrators to focus on specific metrics based on their needs.
3. **Performance Analysis & Alerts**
    - Detects unusual spikes or anomalies in resource consumption, helping to identify potential system slowdowns or failures.
    - Sends real-time alerts when predefined thresholds are breached, ensuring timely intervention.
4. **Historical Data & Trend Analysis**
    - Maintains logs of past performance metrics to support detailed trend analysis.

  - Helps in forecasting potential system bottlenecks based on historical patterns.

5. **Process Control & Management**
   - Allows administrators to pause, resume, or terminate processes directly from the dashboard.
   - Provides insights into resource-hungry applications, helping optimize system efficiency.

Benefits

- **Enhanced System Performance**: Helps administrators maintain an optimized and well-managed system by tracking resource usage.
- **Proactive Issue Detection**: Enables rapid troubleshooting and problem resolution through real-time monitoring and alerts.
- **Improved Decision-Making**: Provides actionable insights based on historical data and trends, assisting in resource planning and system improvements.
- **Efficient Resource Allocation**: Ensures balanced CPU and memory usage to prevent system overload or inefficiency.

Conclusion

The **Real-Time Process Monitoring Dashboard** is an essential tool for administrators aiming to maintain a high-performance computing environment. By offering real-time insights, alerting mechanisms, and historical trend analysis, it significantly enhances system management and optimizes overall efficiency.

Would you like me to refine specific sections or add additional details?

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Real-Time Process Monitoring Dashboard: Detailed Explanation

1. Introduction

Efficient system monitoring plays a vital role in ensuring the **optimal performance and stability** of computing environments. The **Real-Time Process Monitoring Dashboard** is a **web-based application** designed to provide administrators with **real-time insights** into system resource usage, including **CPU, memory, disk, and network activity**.

This dashboard offers **a visual representation** of system performance, enabling administrators to analyze trends, detect anomalies, and ensure smooth operation. Additionally, it provides the ability to **manage running processes dynamically**, allowing administrators to **start, pause, and terminate processes** in real time.

2. Objectives

The primary goals of the Real-Time Process Monitoring Dashboard are:

- **Real-Time System Monitoring:** Continuously tracks and displays **system resource usage** to provide a clear overview of system health.
- **Graphical Representation:** Uses interactive **charts and visual indicators** to present **CPU, memory, disk, and network usage** in an easily interpretable format.
- **Process Management:** Allows administrators to **view and control active processes**, including the ability to terminate unresponsive or resource-heavy processes.
- **User-Friendly Interface:** Designed with a **web-based UI** to ensure ease of access and seamless navigation for system administrators.
- **Live Alerts for System Issues:** Implements a **real-time alert mechanism** to notify administrators about **critical issues**, such as excessive CPU or memory consumption, allowing for quick resolution.

3. Technologies Used

The Real-Time Process Monitoring Dashboard is built using **a combination of backend and frontend technologies** to ensure efficient data processing and visualization.

Backend Technologies:

- **Python (Flask, psutil, Flask-SocketIO):**
  - **Flask:** A lightweight web framework that powers the dashboard’s backend.

- **psutil:** A Python library that provides system monitoring capabilities, such as fetching CPU and memory usage statistics.
- **Flask-SocketIO:** Enables real-time communication between the server and the client using WebSockets, ensuring seamless live updates.

Frontend Technologies:

- **HTML, CSS, JavaScript:** Used to design the dashboard's interface for displaying monitoring data effectively.
- **Chart.js:** A JavaScript library that provides dynamic and interactive charts for representing resource usage visually.
- **Socket.io:** Facilitates real-time updates between the client and server to keep monitoring data fresh without delays.

Essential Libraries & Dependencies:

The following Python libraries are used for backend development:

- Flask==2.2.2: Handles web application functionality and request routing.
- psutil==5.9.0: Enables real-time system monitoring by retrieving CPU, memory, and disk usage statistics.
- python-socketio==5.7.2: Supports WebSocket-based communication for instant data updates.
- eventlet==0.33.0: Provides asynchronous networking support, ensuring smooth real-time interactions.

4. System Design

The Real-Time Process Monitoring Dashboard is built using a modular approach, consisting of two main components:

1. **Backend Server (Python - Flask & SocketIO)**
    - The backend is responsible for gathering system resource data using psutil, a Python library that provides real-time metrics related to CPU, memory, disk, and network usage.
    - This data is **streamed to the frontend** using WebSockets (Flask-SocketIO), ensuring administrators receive updates in real time without needing manual page refreshes.
2. **Frontend (HTML, CSS, JavaScript)**

- The frontend serves as a **visual interface**, presenting real-time system metrics using interactive graphs and dynamic tables.
- Administrators can **monitor active processes** and **initiate management actions**, such as starting and terminating processes.

Data Flow:

- The **backend continuously collects** real-time system metrics and active process details.
- This data is **transmitted via WebSockets** to the frontend.
- The **frontend dynamically updates** its graphs and tables to reflect real-time changes without requiring a page reload.
- Users can **control system processes**, such as terminating or starting new processes, using API requests handled by Flask.

5. Implementation

Backend (server.py)

- Initializes a **Flask server** to handle requests and process system monitoring.
- Uses psutil to collect real-time **CPU, memory, disk, and network usage** data.
- Implements Flask-SocketIO to **stream live system metrics** to the frontend in real time.
- Provides **API endpoints** for process management, allowing users to **start or terminate** system processes.

Frontend (index.html, JavaScript)

- **Visualizes system metrics** using Chart.js, a JavaScript library for creating interactive graphs.
- Implements a **dynamic table** to display active running processes.
- Provides **search and sorting functionalities**, enabling administrators to filter and locate specific processes efficiently.
- Sends **requests to the backend** via API calls to manage system processes.

6. Features

- **Real-Time Performance Monitoring:**
    - Displays live graphs for **CPU, memory, disk, and network usage** to help administrators track system health dynamically.

- **Process Management:**
    - Allows users to **start or terminate processes** directly from the dashboard.
    - Provides visibility into **process states and resource consumption**.
- **Alerts & Notifications:**
    - Detects **high CPU or memory usage** and sends notifications, helping administrators react quickly to potential issues.
- **Interactive UI:**
    - Supports **search, sorting, and filtering** for active processes, improving system navigation and usability.
- **Web-Based Dashboard:**
    - Designed to be **accessible from any device** with a web browser, ensuring flexibility in system monitoring.

7. Conclusion

The **Real-Time Process Monitoring Dashboard** is a robust and efficient tool designed to **enhance system monitoring and management**. By providing **real-time visual insights** into **CPU, memory, disk, and network usage**, it empowers administrators to **maintain system performance** and **quickly detect potential bottlenecks or issues**.

With **interactive graphs, dynamic process management, live alerts, and a web-based interface**, the dashboard simplifies **system resource tracking** and **optimizes workflow efficiency**. Its **backend, built with Flask and SocketIO**, ensures **seamless data transmission**, while the **frontend, powered by JavaScript and Chart.js**, delivers an intuitive user experience.

Looking ahead, potential **future enhancements**, such as **user authentication, historical data storage, process prioritization, and multi-system monitoring**, can further improve its capabilities and scalability.

Ultimately, this dashboard serves as a **powerful asset** for system administrators, providing the necessary tools to ensure **real-time monitoring, proactive issue detection, and efficient system management**, all within an easily accessible web-based interface.

References

- Flask Documentation: https://flask.palletsprojects.com/
- psutil Documentation: https://psutil.readthedocs.io/
- Chart.js Documentation: https://www.chartjs.org/
- Flask-SocketIO Documentation: https://flask-socketio.readthedocs.io/

HERE ARE SOME SNAPSHOT'S OF SOURCE CODE

```python
from flask import Flask, render_template, request, jsonify
from flask_socketio import SocketIO
import psutil
import time
import os
import threading

app = Flask(__name__)
socketio = SocketIO(app)

# Store historical data (simple in-memory for now)
history = {'cpu': [], 'memory': [], 'disk': [], 'network': []}

# Gather detailed system and process data
def get_system_data():
    processes = []
    for proc in psutil.process_iter(['pid', 'name', 'cpu_percent', 'memory_percent', 'num_threads', 'io_counters']):
        try:
            io = proc.io_counters() if hasattr(proc, 'io_counters') else None
            processes.append({
                'pid': proc.info['pid'],
                'name': proc.info['name'],
                'cpu': proc.info['cpu_percent'],
                'memory': proc.info['memory_percent'],
                'threads': proc.info['num_threads'],
                'disk_read': io.read_bytes / 1024 / 1024 if io else 0,  # MB
                'disk_write': io.write_bytes / 1024 / 1024 if io else 0  # MB
            })
        except (psutil.NoSuchProcess, psutil.AccessDenied):
            continue

    net = psutil.net_io_counters()
    disk = psutil.disk_io_counters()

```

```python
    data = {
        'cpu_usage': psutil.cpu_percent(interval=1),
        'memory_usage': psutil.virtual_memory().percent,
        'disk_usage': psutil.disk_usage('/').percent,
        'net_sent': net.bytes_sent / 1024 / 1024,  # MB
        'net_recv': net.bytes_recv / 1024 / 1024,  # MB
        'disk_read': disk.read_bytes / 1024 / 1024 if disk else 0,  # MB
        'disk_write': disk.write_bytes / 1024 / 1024 if disk else 0,  # MB
        'uptime': time.time() - psutil.boot_time(),
        'processes': sorted(processes, key=lambda x: x['cpu'], reverse=True)[:15]  # Top 15 by CPU
    }

    # Store historical data (limit to 60 entries ~ 1 minute)
    for key in ['cpu', 'memory', 'disk', 'network']:
        history[key].append(data[f'{key}_usage'] if key != 'network' else data['net_sent'] + data['net_recv'])
        if len(history[key]) > 60:
            history[key].pop(0)

    return data

# Route for the dashboard
@app.route('/')
def index():
    return render_template('index.html')
```

```python
# API to kill a process
@app.route('/kill/<int:pid>', methods=['POST'])
def kill_process(pid):
    try:
        proc = psutil.Process(pid)
        proc.terminate()
        return jsonify({'status': 'success', 'message': f'Process {pid} terminated'})
    except Exception as e:
        return jsonify({'status': 'error', 'message': str(e)})

# API to start a process (example: notepad on Windows)
@app.route('/start', methods=['POST'])
def start_process():
    try:
        process_name = request.json.get('name', 'notepad.exe')  # Default to notepad
        os.startfile(process_name) if os.name == 'nt' else os.system(f'{process_name} &')
        return jsonify({'status': 'success', 'message': f'Started {process_name}'})
    except Exception as e:
        return jsonify({'status': 'error', 'message': str(e)})

# Background task for real-time updates
def background_task():
    while True:
        data = get_system_data()
        socketio.emit('update', data)
        # Check for alerts
        if data['cpu_usage'] > 80 or data['memory_usage'] > 80:
            socketio.emit('alert', {'message': f"High usage detected! CPU: {data['cpu_usage']}%, Memory: {data['memory_usage']}%"})
        time.sleep(1)

@socketio.on('connect')
def handle_connect():
    socketio.start_background_task(background_task)

if __name__ == '__main__':
    socketio.run(app, debug=True, host='0.0.0.0', port=5000)
```

```
        // Table filtering
        function filterTable() {
            const input = document.getElementById('search').value.toLowerCase();
            const table = document.getElementById('processTable');
            const tr = table.getElementsByTagName('tr');
            for (let i = 1; i < tr.length; i++) {
                const td = tr[i].getElementsByTagName('td');
                let match = false;
                for (let j = 0; j < td.length; j++) {
                    if (td[j] && td[j].textContent.toLowerCase().indexOf(input) > -1) {
                        match = true;
                        break;
                    }
                }
                tr[i].style.display = match ? '' : 'none';
            }
        }
    </script>
</body>
</html>
```

```

    <div id="performance" class="tab-content active">
        <div class="container">
            <div><h2>CPU Usage</h2><canvas id="cpuChart"></canvas></div>
            <div><h2>Memory Usage</h2><canvas id="memoryChart"></canvas></div>
            <div><h2>Disk Usage</h2><canvas id="diskChart"></canvas></div>
            <div><h2>Network Usage</h2><canvas id="networkChart"></canvas></div>
        </div>
        <p><strong>Uptime:</strong> <span id="uptime">0</span> seconds</p>
    </div>

    <div id="processes" class="tab-content">
        <input type="text" id="search" placeholder="Search processes..." onkeyup="filterTable()">
        <button onclick="startProcess()">Start New Process</button>
        <table id="processTable">
            <thead>
                <tr>
                    <th onclick="sortTable(0)">PID</th>
                    <th onclick="sortTable(1)">Name</th>
                    <th onclick="sortTable(2)">CPU (%)</th>
                    <th onclick="sortTable(3)">Memory (%)</th>
                    <th onclick="sortTable(4)">Threads</th>
                    <th onclick="sortTable(5)">Disk Read (MB)</th>
                    <th onclick="sortTable(6)">Disk Write (MB)</th>
                    <th>Actions</th>
                </tr>
            </thead>
            <tbody></tbody>
        </table>
    </div>
```

```
        socket.on('update', (data) => {
            const tbody = document.querySelector('#processTable tbody');
            tbody.innerHTML = '';
            data.processes.forEach(proc => {
                tbody.innerHTML += `<tr>
                    <td>${proc.pid}</td>
                    <td>${proc.name}</td>
                    <td>${proc.cpu.toFixed(2)}</td>
                    <td>${proc.memory.toFixed(2)}</td>
                    <td>${proc.threads}</td>
                    <td>${proc.disk_read.toFixed(2)}</td>
                    <td>${proc.disk_write.toFixed(2)}</td>
                    <td><button onclick="killProcess(${proc.pid})">Kill</button></td>
                </tr>`;
            });
        });

        socket.on('alert', (data) => {
            document.getElementById('alerts').textContent = data.message;
            setTimeout(() => document.getElementById('alerts').textContent = '', 5000);
        });

        // Process control functions
        function killProcess(pid) {
            fetch(`/kill/${pid}`, { method: 'POST' })
                .then(res => res.json())
                .then(data => alert(data.message));
        }
```

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Advanced Process Monitoring Dashboard</title>
    <script src="https://cdn.socket.io/4.5.0/socket.io.min.js"></script>
    <script src="https://cdn.jsdelivr.net/npm/chart.js"></script>
    <style>
        body { font-family: Arial, sans-serif; margin: 20px; background: #f5f5f5; }
        .tabs { overflow: hidden; border-bottom: 1px solid #ccc; }
        .tab-button { float: left; padding: 10px 20px; cursor: pointer; background: #ddd; }
        .tab-button.active { background: #fff; font-weight: bold; }
        .tab-content { display: none; padding: 20px; background: #fff; border: 1px solid #ccc; }
        .tab-content.active { display: block; }
        .container { display: flex; flex-wrap: wrap; gap: 20px; }
        canvas { max-width: 400px; }
        table { border-collapse: collapse; width: 100%; max-width: 800px; }
        th, td { border: 1px solid #ddd; padding: 8px; text-align: left; }
        th { background-color: #f2f2f2; cursor: pointer; }
        button { padding: 5px 10px; cursor: pointer; }
        #alerts { color: red; font-weight: bold; }
    </style>
</head>
<body>
    <h1>Advanced Process Monitoring Dashboard</h1>
    <div class="tabs">
        <div class="tab-button active" onclick="openTab('performance')">Performance</div>
        <div class="tab-button" onclick="openTab('processes')">Processes</div>
    </div>
```

```
    <div id="alerts"></div>

    <script>
        const socket = io();
        const charts = {};
        const chartConfigs = {
            'cpu': { id: 'cpuChart', label: 'CPU Usage (%)', color: 'blue' },
            'memory': { id: 'memoryChart', label: 'Memory Usage (%)', color: 'green' },
            'disk': { id: 'diskChart', label: 'Disk Usage (%)', color: 'purple' },
            'network': { id: 'networkChart', label: 'Network Usage (MB)', color: 'orange' }
        };

        // Initialize charts
        Object.keys(chartConfigs).forEach(key => {
            const cfg = chartConfigs[key];
            charts[key] = new Chart(document.getElementById(cfg.id).getContext('2d'), {
                type: 'line',
                data: { labels: [], datasets: [{ label: cfg.label, data: [], borderColor: cfg.color, fill: false }] },
                options: { scales: { y: { min: 0, max: key === 'network' ? null : 100 } } }
            });
        });
```

```
        function startProcess() {
            const name = prompt('Enter process name (e.g., notepad.exe):');
            if (name) {
                fetch('/start', {
                    method: 'POST',
                    headers: { 'Content-Type': 'application/json' },
                    body: JSON.stringify({ name })
                })
                .then(res => res.json())
                .then(data => alert(data.message));
            }
        }

        // Tab functionality
        function openTab(tabName) {
            document.querySelectorAll('.tab-content').forEach(tab => tab.classList.remove('active'));
            document.querySelectorAll('.tab-button').forEach(btn => btn.classList.remove('active'));
            document.getElementById(tabName).classList.add('active');
            document.querySelector(`[onclick="openTab('${tabName}')"]`).classList.add('active');
        }
```

```
function sortTable(n) {
    const table = document.getElementById('processTable');
    let rows, switching = true, i, shouldSwitch, dir = 'asc', switchCount = 0;
    while (switching) {
        switching = false;
        rows = table.rows;
        for (i = 1; i < rows.length - 1; i++) {
            shouldSwitch = false;
            const x = rows[i].getElementsByTagName('TD')[n];
            const y = rows[i + 1].getElementsByTagName('TD')[n];
            const xVal = isNaN(x.innerHTML) ? x.innerHTML.toLowerCase() : parseFloat(x.innerHTML);
            const yVal = isNaN(y.innerHTML) ? y.innerHTML.toLowerCase() : parseFloat(y.innerHTML);
            if (dir === 'asc' ? xVal > yVal : xVal < yVal) {
                shouldSwitch = true;
                break;
            }
        }
        if (shouldSwitch) {
            rows[i].parentNode.insertBefore(rows[i + 1], rows[i]);
            switching = true;
            switchCount++;
        } else if (switchCount === 0 && dir === 'asc') {
            dir = 'desc';
            switching = true;
        }
    }
}
```

```
// Real-time updates
socket.on('update', (data) => {
    const time = new Date().toLocaleTimeString();
    ['cpu', 'memory', 'disk'].forEach(key => {
        const chart = charts[key];
        chart.data.labels.push(time);
        chart.data.datasets[0].data.push(data[`${key}_usage`]);
        if (chart.data.labels.length > 60) {
            chart.data.labels.shift();
            chart.data.datasets[0].data.shift();
        }
        chart.update();
    });

    charts['network'].data.labels.push(time);
    charts['network'].data.datasets[0].data.push(data.net_sent + data.net_recv);
    if (charts['network'].data.labels.length > 60) {
        charts['network'].data.labels.shift();
        charts['network'].data.datasets[0].data.shift();
    }
    charts['network'].update();

    document.getElementById('uptime').textContent = Math.floor(data.uptime);
```