MSE Presentation 1

MultiAgent Control of Traffic Signals (MACTS)

Bryan Nehl
MSE Candidate
Agenda

• Project Vision
• System Context
• Project Requirements and Plan
• Cost Estimation
• Project Software Quality Assurance Plan
• Candidate Architecture Overview
• Demonstration Agent Communication
• Demonstration Interaction with Simulator (SUMO)
• Phase II Deliverables
• Project Log, Risks, Spikes and Concerns
• Questions/Comments
• References
Project Vision

• Goal
The goal of this project is to create a multiagent system that is capable of traffic light signal control which results in an improved travel experience.

• Motivation
Most traffic light systems today are strictly timing based. Traffic flow studies are required to create timing plans and atypical conditions cause problems. It is also very frustrating to have to stop for a red light when there is no opposing traffic.
System Context

- SUMO Simulation Engine
- SUMO TraCI
- Road Network Configuration
- Traffic Configuration
- Communications Agent
- RabbitMQ
- SUMO GUI
- MongoDB
- Agent Network (MAS)
- Metrics Agent
Project Requirements

- SUMO
- TraCI
- Neighboring Collaboration Agent
- System Liaison
- Collaboration Agent
- Planning Agent
- Safety Agent
- Metrics Agent

MACTS
  - Displays Simulation
  - Provides current simulation state data
  - Consumes
  - Executes TLS plan
  - Transmits
  - Produces Individual Intersection state data
  - Information about current intersection status is shared
  - Incorporates data that was shared
  - Produces data to share
  - Creates Traffic Light Signal plan
  - Verifies plan is safe
  - Submits plan to be run
  - Gather Simulation Metrics
Project Plan

Phase 1: Inception
- Setup Development Environment
- Software Quality Assurance Plan
- Project Plan
- Vision Document
- PyMetrics install and learning
- PEP8 tool install and learning
- Coverage, py install and learning
- unittest learning
- pika install and learning (RabbitMQ)
- pyMongo install and learning
- modulo install and learning
- Initial Prototype
- Presentation

Project: Spike Explorations

Project: Risk Management
- SUMO
- Python
- RabbitMQ
- MongoDB
- git

Phase 2: Elaboration
- Action Items
- Vision Document Updates
- Project Plan Updates
- Formal Requirement Specification - Metrics Agent
- Architecture
- Test Plan
- Formal Technical Inspection
- Executable Architecture Prototype

Phase 3: Construction
- Action Items
This model is explained in Section 4 of the COCOMO II Design Model Definition document [8].

(Equation 1)

\[
TDEV = [C \times (PM_{NS})^F] \times \frac{SCED\%}{100}
\]

\[
F = (D + 0.2 \times [E - B])
\]

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>The scaling base-exponent for the effort equation, currently set to 0.91</td>
</tr>
<tr>
<td>C</td>
<td>Coefficient that can be calibrated currently set to 3.67</td>
</tr>
<tr>
<td>D</td>
<td>Scaling base-exponent that can be calibrated currently set to 0.28</td>
</tr>
<tr>
<td>E</td>
<td>The scaling exponent for the effort equation</td>
</tr>
<tr>
<td>PM_{NS}</td>
<td>Person-Months estimated without the SCED cost driver (Nominal Schedule)</td>
</tr>
<tr>
<td>SCED</td>
<td>Required Schedule Compression</td>
</tr>
<tr>
<td>TDEV</td>
<td>Time to Develop in calendar months</td>
</tr>
<tr>
<td>Cost Driver</td>
<td>Value (Text)</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>LANG</td>
<td>Hybrid 3\textsuperscript{rd}/4\textsuperscript{th}Python</td>
</tr>
<tr>
<td>PREC</td>
<td>Nominal</td>
</tr>
<tr>
<td>FLEX</td>
<td>High</td>
</tr>
<tr>
<td>RELY</td>
<td>Very High</td>
</tr>
<tr>
<td>DATA</td>
<td>Low</td>
</tr>
<tr>
<td>CPLX</td>
<td>Nominal</td>
</tr>
<tr>
<td>RUSE</td>
<td>Low</td>
</tr>
<tr>
<td>DOCU</td>
<td>Nominal</td>
</tr>
<tr>
<td>RESL</td>
<td>High</td>
</tr>
<tr>
<td>TEAM</td>
<td>High</td>
</tr>
<tr>
<td>ACAP</td>
<td>High</td>
</tr>
<tr>
<td>PCAP</td>
<td>High</td>
</tr>
<tr>
<td>PCON</td>
<td>Very High</td>
</tr>
<tr>
<td>APEX</td>
<td>Nominal</td>
</tr>
<tr>
<td>PLEX</td>
<td>Nominal</td>
</tr>
<tr>
<td>LTEX</td>
<td>Low</td>
</tr>
<tr>
<td>PMAT</td>
<td>High</td>
</tr>
<tr>
<td>TIME</td>
<td>Very High</td>
</tr>
<tr>
<td>STOR</td>
<td>Nominal</td>
</tr>
<tr>
<td>PVOL</td>
<td>Low</td>
</tr>
<tr>
<td>TOOL</td>
<td>Nominal</td>
</tr>
<tr>
<td>SITE</td>
<td>Extra High</td>
</tr>
<tr>
<td>SCED</td>
<td>Nominal</td>
</tr>
</tbody>
</table>
# Cost Estimation: Size Estimates

<table>
<thead>
<tr>
<th>Use Case</th>
<th>ILF</th>
<th>EIF</th>
<th>EI</th>
<th>EO</th>
<th>EQ</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Total</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All weights</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>15</td>
<td>128</td>
</tr>
<tr>
<td>Low weighted</td>
<td>63</td>
<td>15</td>
<td>6</td>
<td>44</td>
<td>15</td>
<td>128</td>
</tr>
</tbody>
</table>
Early Design Calculations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCPX</td>
<td>1.33</td>
<td>RELY + DATA + CPLX + DOCU Product Reliability and Complexity</td>
</tr>
<tr>
<td>RUSE</td>
<td>0.95</td>
<td>RUSE Developed for Reusability</td>
</tr>
<tr>
<td>PDIF</td>
<td>1.29</td>
<td>TIME + STOR + PVOL Platform Difficulty</td>
</tr>
<tr>
<td>PREX</td>
<td>1.12</td>
<td>APEX + PLEX + LTEX Personnel Experience</td>
</tr>
<tr>
<td>PERS</td>
<td>0.63</td>
<td>ACAP + PCAP + PCON Personnel Capability</td>
</tr>
<tr>
<td>FCIL</td>
<td>0.73</td>
<td>TOOL + SITE Facilities</td>
</tr>
<tr>
<td>SCED</td>
<td>1.00</td>
<td>SCED Required Development Schedule</td>
</tr>
<tr>
<td>E_Area</td>
<td>0.8395</td>
<td>Product of the above defined composite cost drivers.</td>
</tr>
</tbody>
</table>

**Size (KSLOC)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (UFP)</td>
<td>128</td>
</tr>
<tr>
<td>UFP-&gt;Lines of Code</td>
<td>50</td>
</tr>
<tr>
<td>PREC</td>
<td>0.01</td>
</tr>
<tr>
<td>FLEX</td>
<td>0.03</td>
</tr>
<tr>
<td>RESL</td>
<td>0.03</td>
</tr>
<tr>
<td>TEAM</td>
<td>0.04</td>
</tr>
<tr>
<td>PMAT</td>
<td>0.03</td>
</tr>
<tr>
<td>Process Exponent</td>
<td>1.15</td>
</tr>
</tbody>
</table>

(A sum of the PREC, FLEX, RESL, TEAM and PMAT parameters)

**Effort**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort</td>
<td>17.39</td>
</tr>
<tr>
<td>TDEV</td>
<td>2.82</td>
</tr>
<tr>
<td>TDEV Early Design</td>
<td>3.47</td>
</tr>
<tr>
<td>TDEV 1997 Calibration</td>
<td>2.50</td>
</tr>
</tbody>
</table>
Project Software Quality Assurance Plan (SQAP)

- Management Organization
- Documentation
- Standards, Practices, Conventions and Metrics
- Test plan
- Problem reporting and corrective action
- Tools, techniques and methodology
- Record collection, maintenance and retention
Candidate Architecture Overview

Phase II component to add mesh network cooperation/coordination incorporating the receiving and sharing of traffic data with neighbors as well as the adjustment of TLS plans given the
Demonstration: Agent Communication

- System Tick Agent
- Viewer Agent
- Fan Out Exchange
- Direct Exchange
- Even Agent
- Linear Agent
- Odd Agent
- Even and Odd Aggregator
- Even and Linear Aggregator
Demonstration Agent Communication
Demonstration Interaction with SUMO
Phase II Deliverables

- Action Items from Phase 1
- Vision Document 2.0
- Project Plan 2.0
- Formal Requirements Specification
- Architecture Design 1.0
- Test Plan
- Formal Technical Inspection Checklist
- Executable Architecture Prototype
- Risk Log Update
- Presentation 2
Project Log

• Maintained as a Google Document
• Exported as PDF for website
Project Risks and Spikes

Risks
- Python
- RabbitMQ
- MongoDB
- SUMO
- git
- Scope
- Time

Spikes
- Python
- RabbitMQ
  - Q Fanout
  - Aggregation
- MongoDB
  - training
- git
  - reading
  - seminars
  - hands on use

Spikes
- SUMO
  - Network Load
  - Network Double T
  - Read from TRACI
  - Send to TRACI
  - Network Metrics
  - Read Sensors
  - Add Sensors
Questions and Comments

?
References

References 2