LogX

Dr. John Paschkewitz
Program Manager

Proposers Day Slides

June 11, 2019

DARPA
Program Vision

LogX: Global system understanding enables adaptive, distributed operations

Supplier multi-tier supply networks
DLA acquisition and warehousing nodes
USTRANSCOM transportation networks
Operator locations and demand signals

Program Goal
Develop and demonstrate software for real-time logistics and supply chain system situational awareness, future state prediction, and assessment of resilience at unprecedented scale and speed
How do I support these assets in an ongoing mission?

**Plan and prepare**
- T-60 days+
- T-30 days
- Now

- What is the readiness of these assets?
- Do I have transport to move assets?
- Do I have enough POL in theater?
- Does my unit have enough supplies for operation?

**Support**

- T+3 days

- Do I have enough gas, ammo, batteries for my mosaic?
- When will more get here and how?

**Project**
- T+30 days

- What happens if a part breaks on this vehicle?
- What happens when the LCE’s provisions run out?
How is it done today?

**DoD**

No global awareness of enterprise: fractured and heavily siloed

- Manual fusion to Office document to support decisions

- XLS

- 1000's of databases and systems, some dating to 1960's

**Commercial**

Query: What is operational availability?

- GCSS-MC

Query: How should I build my network to handle disruption?

- Automated fusion through standardization

- Reasoning enabled by vertical integration

- Forecasting horizon * certainty in global state

- Vertically integrate data to address queries

- 10's - 100's of databases

- 1000/hour

Issues: scale, business process, heterogeneity

LogX: enable system awareness at unprecedented scale


Scale: 

\[
\frac{\text{(# of info systems)(# of indicators)}}{\text{analysis time (h)}}
\]
## LogX Approach

<table>
<thead>
<tr>
<th>Key Limitations</th>
<th>Conventional approach</th>
<th>LogX</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Awareness and Resilience</td>
<td>Monolithic enterprise stack</td>
<td>Mission-centered applications service</td>
</tr>
<tr>
<td>Scale and Speed</td>
<td>Manual data fusion and operations analysis pipelines</td>
<td>Cloud-based microservices for probabilistic understanding</td>
</tr>
</tbody>
</table>
A composable “stack” to rapidly reason over diverse logistics information
Program Structure

Focused Queries

DoD
- Queries/hypothesis, SME curation, testing, additional data

System Awareness and Resilience

TA1: Mission-Centered Applications Service
- Provides mission-centered situational awareness
- Human-machine system design
- Software architecture and API

Scale and Speed

TA2: Cloud-Based Microservices
- Constructs probabilistic understanding
- Accelerated Knowledge Exploitation
- Dynamic and Distributed State Estimation

Testing, validation, and data

Government T&E Team
- Define and provide ground truth scenarios
- Initial foresight service curation
- Evaluate systems against metrics
- Assess feasibility of forecasts and resilience recommendations

GFE elastic compute environment
The technical areas will be complemented by a Government-side test and evaluation (T&E) team that will:

- Define test scenarios for each sprint
- Provide a range of data as Government Furnished Information (GFI) for both causal model and state estimate construction (accessible at program kickoff)
- Provide ground truth adjudication
- Provide an elastic compute environment for software development

Representative data may include, but is not limited to:

- DoD logistics doctrine and process publications
- Defense Logistics Agency (DLA), Combatant Command (COCOM), or Military Service business process documentation
- System interaction diagrams (SV-6)
- Case studies on logistics process execution
- Historical data from logistics information or enterprise resource planning (ERP) systems from DLA, United States Transportation Command (USTC), Military service, and commercial sources (ranging from information in SAP and/or Oracle data formats to legacy structured data)
- Electronic Data Interchange forms
- Commercial shipping manifests
- DLA Automatic Addressing System (DAAS)
TA1 performers will develop the user-facing solution that composes TA2 microservices to provide answers to queries or hypotheses by drawing on Government T&E team-provided system and process data.

TA1 proposers should describe how their approach will:

- Develop and demonstrate:
  - *Cloud-based mission-centric applications* to provide logistics and supply chain situational awareness
  - *A versatile and scalable human-machine interface* for a range of potential user personas to make superior decisions enabling distributed, resilient operations
  - *An approach to provide distributed, secure construction and update* of the service composition logic and associated state estimates

- Develop and apply:
  - A *human-machine team approach* to build and dynamically update logistics and supply chain system understanding by calling on the appropriate TA2 microservices

- Define:
  - *The Application Programming Interface (API) and architectural structure* to compose the cloud-based data microservices

Conventional enterprise data fusion and operations research/supply chain analysis approaches are explicitly not of interest. Purely human-driven or fully automated approaches are unlikely to achieve the program metrics and are thus excluded.

TA1 proposers should address the following topics in their technical narrative:

- *System architecture & development approach*
- *User Experience/User Interface*
- *Composition Service Approach*
- *Application Programming Interface (API)*
TA2 performers will develop and demonstrate sophisticated automated reasoning tools for logistics and supply chain systems. Track 1 will provide capabilities for model initialization, query response, and model management.

TA2, Track 1, Automated Knowledge Engineering will:

• Develop methods to automatically extract information "with the model in mind" and assign uncertainty to information from a range of data sources
• Develop the means to combine this information into explanatory mechanistic models that allow reasoning over processes or system state
• Develop learning algorithms to dynamically improve, update and automatically curate/mediate models and/or sub-models (or knowledge fragments)
• Develop and demonstrate software services to instantiate these capabilities in a scalable manner

TA2, Track 1, proposers should address the following topics in their technical narrative:

• Architecture/Design Patterns
• Knowledge Representation
• Knowledge Extraction
• Model Construction, Updating and Management
• API

Given the centrality of the state estimation approach to the program concept, conventional approaches based on agent-based modeling, standard operations research modeling approaches, and enterprise data fusion are explicitly excluded.

Please read the BAA for detailed metrics
TA2 performers will develop and demonstrate sophisticated automated reasoning tools for logistics and supply chain systems. Track 2 performers will provide a means to orchestrate information collection and automatically estimate and predict system state.

TA2, Track 2, Dynamic/Distributed State Estimation will:

- Develop methods to combine distributed heterogeneous, incomplete and potentially incorrect information to obtain diagnosis or estimate of current state
- Develop methods to combine distributed heterogeneous, incomplete and potentially incorrect information to obtain prognosis or estimate of future state
- Develop and demonstrate software services to instantiate these capabilities in a scalable manner

TA2, Track 2, proposers should address the following topics in their technical narrative:

- Architecture/Design Patterns
- State Estimation
- Model Exercise
- API

TA2 Track 2 proposers should have a broad strategy to employ the “right” state estimation approaches for a range of potential model formulations and single-formulation approaches (e.g. model predictive control, particle filter approaches, hidden Markov models) are explicitly not of interest.

Please read the BAA for detailed metrics
Program Schedule

Phase I: 18 Months
- 2020
  - TA1: Mission-Centered Applications Service
    - 3 months Stack APIs defined
  - TA2: Cloud-based Microservices
    - 12 months TA1-TA2 integration
- 2021
  - Bi-monthly mini-demo sprints
- 2022
  - Integrated TA1-TA2 effort
- 2023
  - Quarterly mini-demo sprints

Phase II: 12 Months
- 2022
  - Phase 2 Proposals
  - 12 months TA1-TA2 integration
- 2023
  - Quarterly mini-demo sprints

Phase III: 12 Months
- 2023
  - Phase 3 Proposals

Phase I Deliverables
- End-end awareness and forecasting capability
- Ability to detect and mitigate supply fluctuations (bullwhip, ripple effect) validated against historical data

Phase II Deliverables
- Deployment ready capability benchmarked to best in class capabilities in DoD
- Demonstrated resilience/security

Phase III Deliverables
- Field demonstration of capability in controlled cloud enclave across Joint Logistics Enterprise
- Software deployed in DoD cloud setting

Distribution Statement A – Approved for Public Release, Distribution Unlimited
## Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Awareness</td>
<td>(Forecast horizon, days) x (% certainty in global state)</td>
</tr>
<tr>
<td>Scale &amp; Speed</td>
<td>(Number of system indicators) * (Number of information systems) / (Total analysis time, hours)</td>
</tr>
<tr>
<td>System Resilience</td>
<td>Max (Time to Recover, days) / (Time to Survive, days) (TTR/TTS)</td>
</tr>
</tbody>
</table>

### BAA Solicits Phase I only, but proposers should discuss plan to achieve option phase metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Today</th>
<th>MVP 6 months</th>
<th>Phase I 18 months</th>
<th>Phase II 30 months</th>
<th>Phase III 42 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Awareness (d)</td>
<td>&lt; 1</td>
<td>1</td>
<td>10</td>
<td>60</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>Scale &amp; Speed (#/h)</td>
<td>2</td>
<td>10</td>
<td>100</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>System Resilience</td>
<td>20</td>
<td>N/A</td>
<td>Characterized</td>
<td>1</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>
For Option phases:

- Prior to the end of the Phase 1, DARPA may issue proposal instructions to facilitate integration of TA1 and TA2 teams as needed for the potential follow on Phases 2 and 3 of the program, which may entail activity at higher classification level.

- The additional proposal instructions will require both a cost and technical proposal to address the goals and objectives of Phases 2 and 3.
  - It is anticipated that Phase 2 will have a 12 month period of performance, and Phase 3 will have a 12 month period of performance.
  - It is anticipated that Phase 3 will be a separately priced option, to be exercised at the Government's discretion.

In your proposal:

- TA1-only teams should prepare detailed cost volumes for the Phase 1 base period with an 18-month Period of Performance and provide approximate cost estimates for potential follow on Phases 2 and 3, assuming both a TA2 track 1 and 2 subcontractor, with explicit separation of and identification of costs associated with TA1 integration activity and TA2 technical development.

- Integrated TA1-TA2 teams should prepare a detailed cost volume for the Phase 1 base period with an 18-month Period of Performance and approximate cost estimates for potential follow on Phases 2 and 3, with the understanding that there may be opportunities to pursue integration with additional or different TA2 teams in future phases. As with TA1-only teams, the approximate cost estimates for the Phases 2 and 3 should clearly separate and identify costs associated with TA1 integration activity and TA2 technical development.

- TA2-only teams should prepare detailed cost volumes for the Phase 1 base period and approximate cost estimates for potential follow on Phases 2 and 3. These cost estimates would be for budgetary purposes only and would not be evaluated for cost realism.