MITRE

UAS Loss of Link (UL2) Progress Report

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Background

- MITRE Corporation
  - This project is being sponsored by The MITRE Corporation, which is a not-for-profit organization that manages Federally Funded Research and Development Centers (FFRDCs).
- Unmanned Aircraft System (UAS)
  - A UAS is remotely piloted from ground stations via a real-time command and control (C2) data link.
  - If the link between the ground station and UAS is lost, the aircraft becomes autonomous until the link is re-established.

Problem Definition

- When an Unmanned Aircraft (UA) becomes autonomous, it becomes unpredictable to Air Traffic Control (ATC)
  - ATC cannot adequately control airspace
  - Risk of a loss of separation or collision
  - Unnecessary rerouting of air traffic
  - Excess workload for ATC
  - Creates a potential risk and/or safety hazard
- Standardized procedures for loss of link situations are necessary
  - Events become more predictable/easier to manage for ATC
  - Standardized procedures assist in bringing UAS to commercial airspace in greater numbers
- Develop methodology for evaluating loss of link procedures

Approach

- Qualitative
  - Interviews to determine metrics from different stakeholders
    - Global Hawk Pilot
    - ATC
    - UAS Experts
    - Data Specialists
- Absolute/Binary
  - Determine thresholds that must be met
- Technical
  - Develop simulations that analyze individual procedures
    - Based on specific metrics (predictability, ATC workload)

Scope

- In Scope
  - Within non-segregated civil airspace- National Airspace System (NAS)
  - Primary focus on UAS that are capable of extended flight operations in Class A airspace
  - To test/evaluate our approach with proposed procedure

- Out of Scope
  - Identification of optimal procedure for loss of link situations

Expected Results

- Set of metrics that are important to UAS stakeholders

- A methodology that can be used to evaluate procedures
  - Repeatable and adaptable to different procedures
  - Capable of being used for further research and analysis by the sponsor

Next Steps from Proposal

- Continue meeting with Sponsor
  - ✓ Met with sponsor to discuss technical approach
  - ✓ Got approval for project proposal
- Develop Functional Requirements for evaluation methodology
  - ✓ Developed and finalized both functional and project requirements
- Set up meetings with Subject Matter Experts (SMEs)
  - ✓ Created questionnaires for each SME
  - ✓ Interviewed all five SMEs recommended by our sponsor
  - ✓ Had several follow-on interviews with people recommended by SMEs
- Finalize draft of project proposal
  - ✓ Finalized project proposal

SME Interviews

- Met with all the SMEs recommended to us by our sponsor:
  - Global Hawk UAS pilot
  - ATC human-in-the-loop experiment analyst
  - UAS loss of link data analyst
  - Lead developer of automated ATC tool
  - Traffic flow management lead architect

Modeling

- Technical modeling approaches were based on:
  - Feedback from sponsor
  - Interviews with SMEs
- UL2 team decided to focus on two main metrics:
 - Predictability
  - Air Traffic Control workload

Predictability Model - Timeline
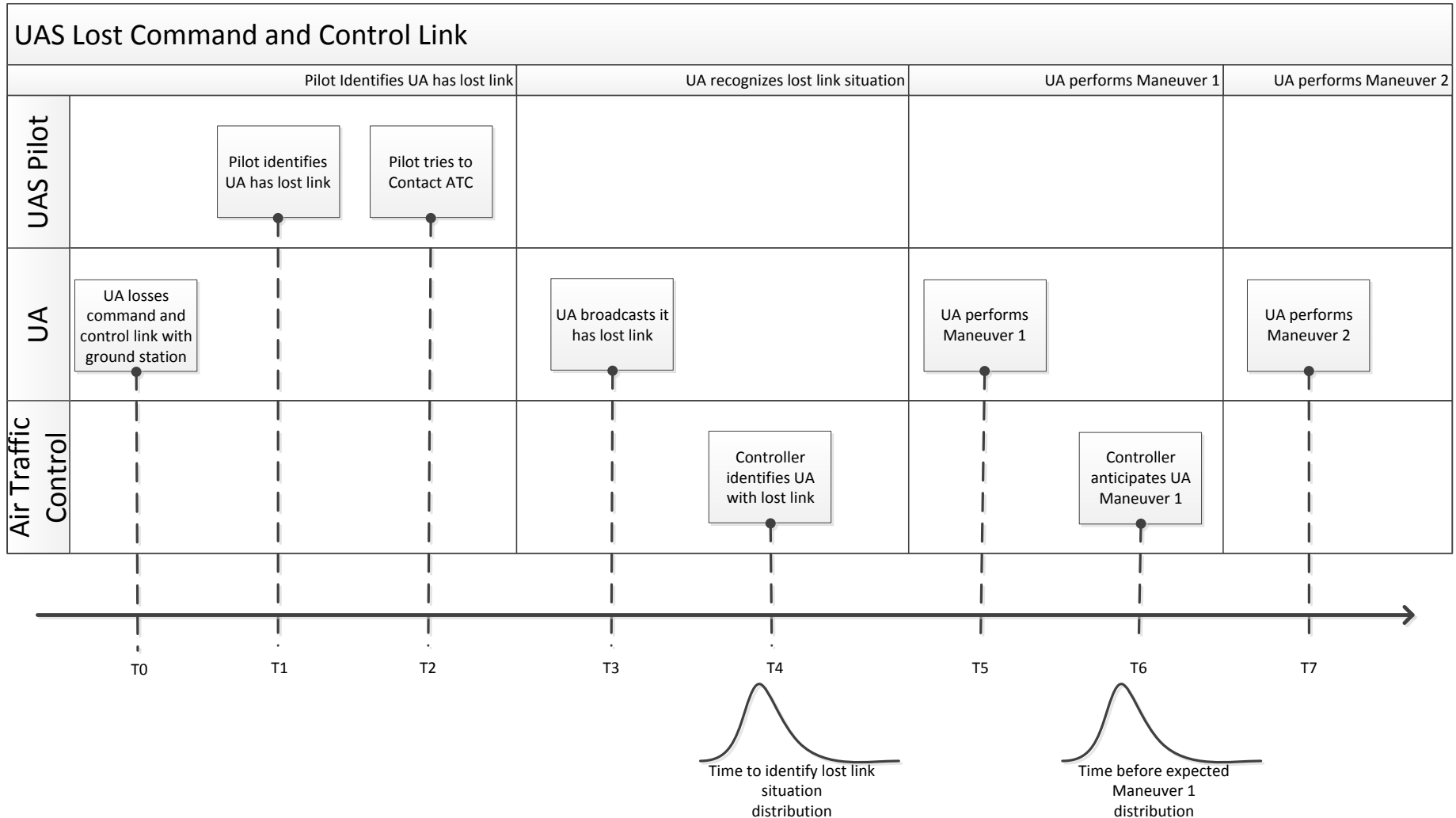
Predictability Model - Details

- Pseudo-measure for predictability will be time
  - Time it take for the controller to realize the UA is in a loss of link situation
    - T4-T3
  - The difference between the expected time the UA will make its next maneuver and actual
    - T6-T5

- Input
  - Controller reaction times to UA signaling loss-of-link
- Outputs
  - Times of interest:
    - T3, T4, T5, T6

- To enhance the model, the model will also include the possibility of conflict
  - Tc is the time to conflict
  - Analyze the probability the UA will be in conflict before the controller realizes there is a loss of link situation

Predictability Model - Sample Output

Histogram of T3 and Tc
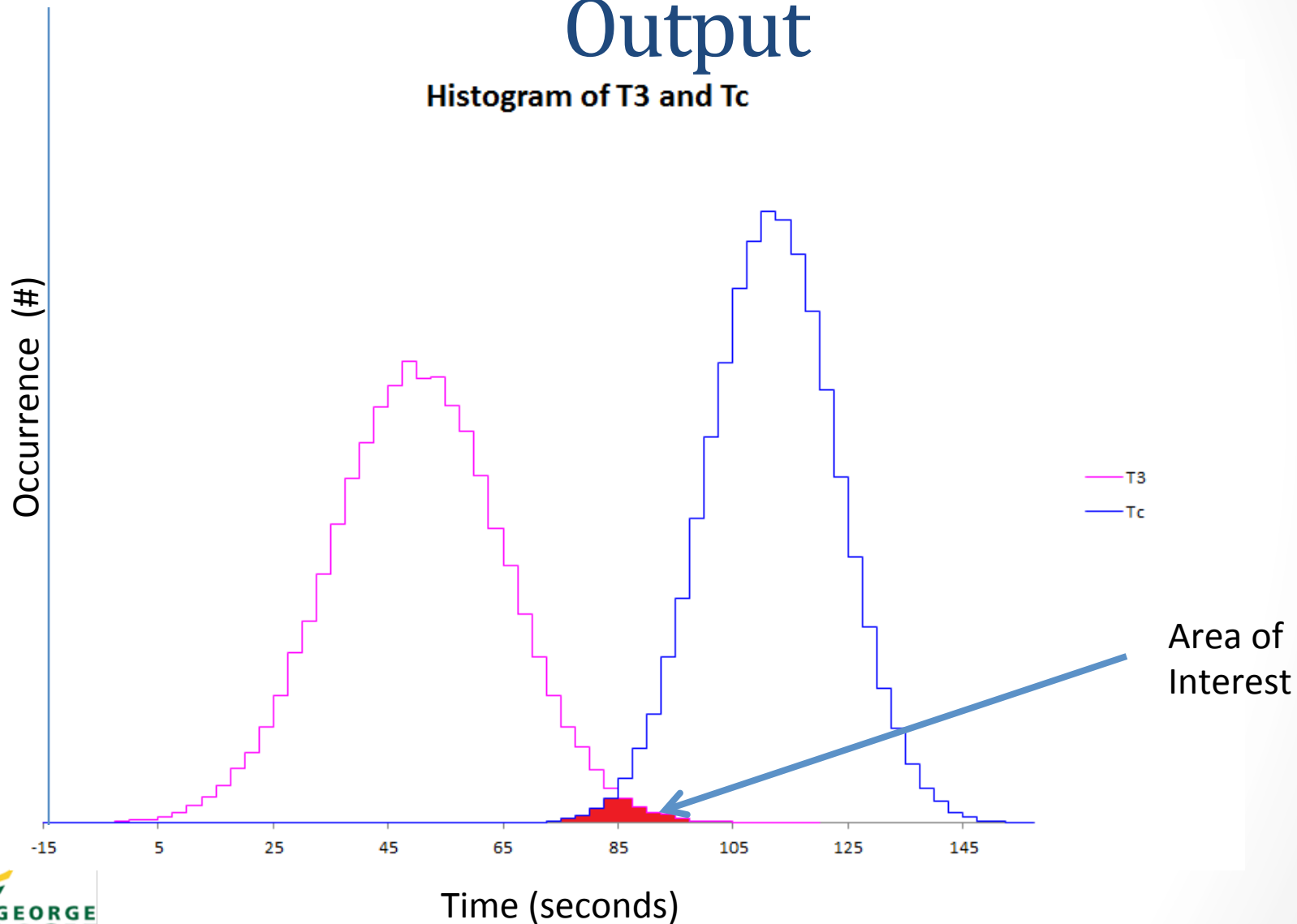
airspaceAnalyzer – Controller Workload

- Simulation tool developed by MITRE to automatically separate, sequence, and space aircraft

- Measures sector complexity based on the amount of effort required to separate traffic

- Evaluates the impact of changes to sector on controller workload. Examples of potential changes include:
  - New Traffic Flows
  - New Sector Boundaries
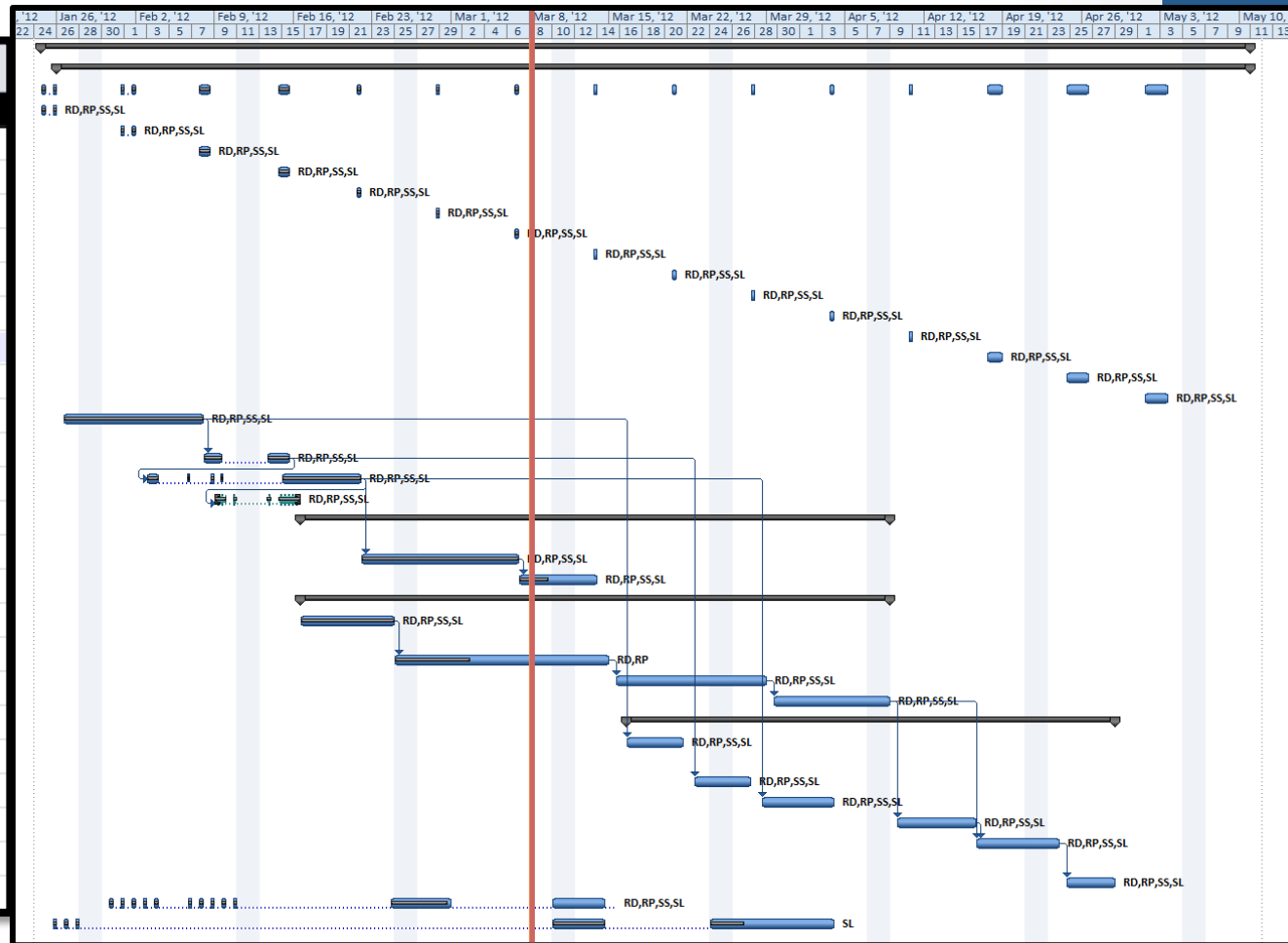 - Airspace Restrictions
  - Moving weather systems
- What about UAS?
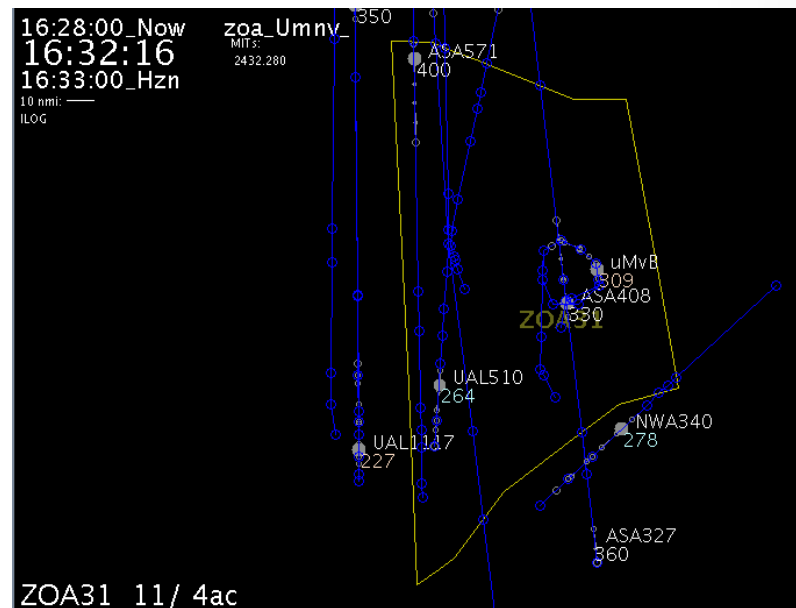
airspaceAnalyzer
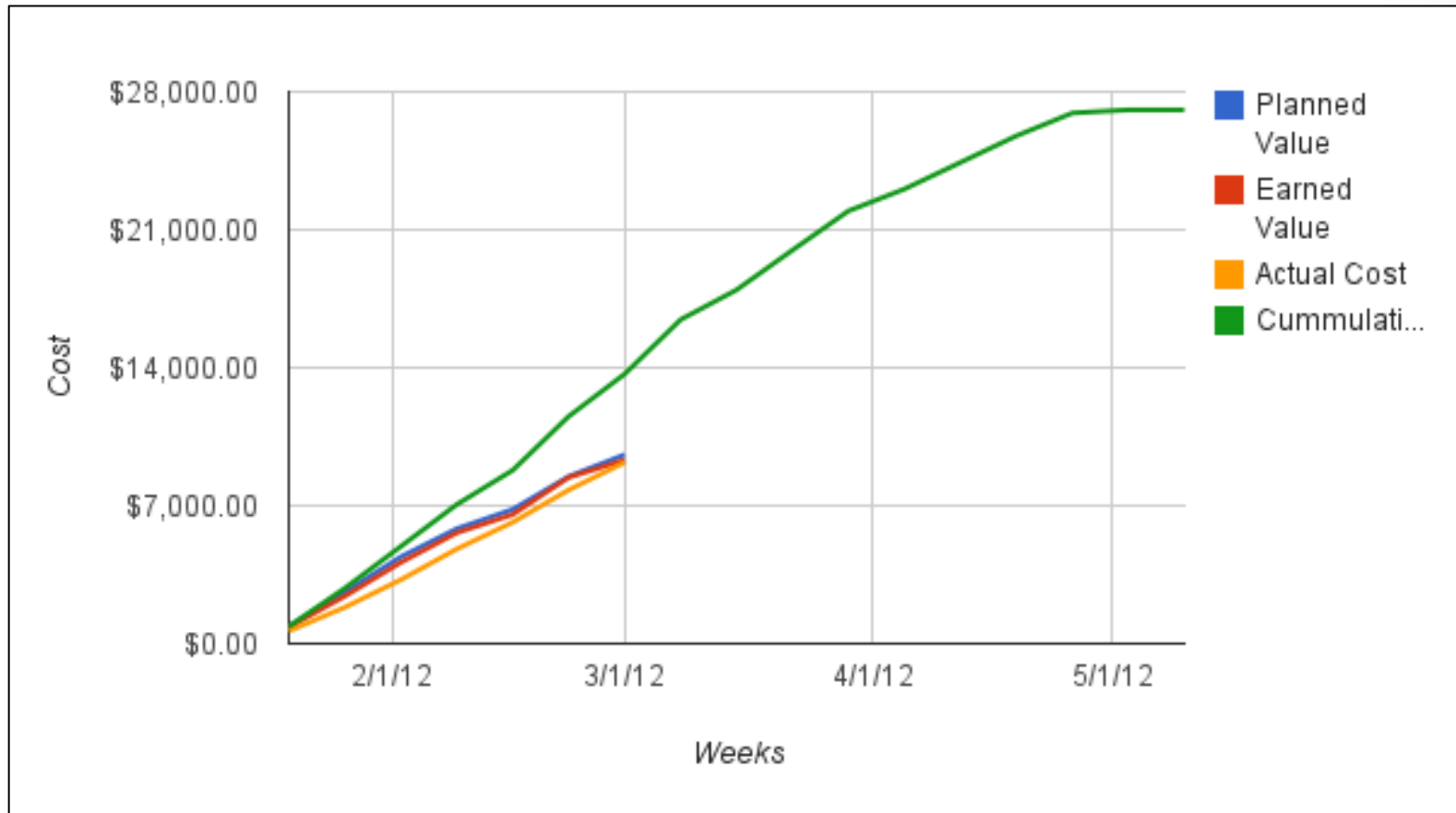Sample Display

airspaceAnalyzer – Adaptation for UAS

- Tool can be used to evaluate the impact of a specific UAS loss of link procedure on sector complexity and controller workload

- Specific metrics can be gathered to evaluate the increase in controller workload if UA goes lost link

  - Lateral separation effort

  - Vertical separation effort

  - Lateral spacing effort

  - Vertical spacing effort

- Some maneuver uncertainty can be modeled by adjusting the amount of protection required for UA (e.g. increase from 5 NM to 10 NM in En Route airspace)

Schedule

Earned Value Management

Next Steps

- Continue meeting with Sponsor
- Complete proof of concept & develop predictability model
- Adapt scenarios for airspaceAnalyzer
- Introduce our models to sponsor's UAS Team for feedback
- Start documenting our methodology and assemble our report

Questions?