

5/16/2016

MEMORANDUM FOR: AFIT/ENG
ATTENTION: MAJ STONE

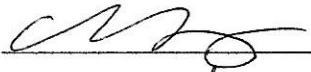
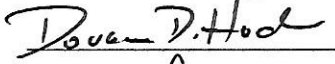
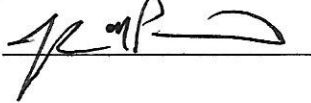
FROM: 2D LT MICHAEL BENTLEY (GE-17M)

SUBJECT: Thesis Prospectus: *Enabling Efficient Satellite Automation*

1. The goal of this research is to demonstrate the feasibility of applying Stochastic Context Free Grammars (SCFGs) to satellite command and control operations. The Air Force Space and Missile Systems Center is attempting to reduce redundancy and leverage commonality in the Air Force's satellite ground systems. One method of doing so is porting legacy systems onto a common ground system and automating routine functions. This research is one part of determining ways to make porting and automation faster and less expensive for the Air Force.
2. Previous work in the field of computational linguistics has demonstrated that SCFGs can be used to simplify the process of automating a task. Additional research in activity recognition has shown that SCFGs are an effective method of characterizing observed data. There are currently no examples in the literature of SCFGs being used in the field of satellite automation.
3. Existing satellite command and control data will be gathered from the Naval Research Lab; Kirtland, AFB; and the United States Air Force Academy. This data will be the basis to build and test a tool chain that can interpret raw data into a SCFG. A specific satellite system will be analyzed first to determine if the approach is viable. Once I have demonstrated the feasibility of this technique for the first system, I will expand to any other satellite systems for which I have data. My research will be successful if I can demonstrate that the intermediate structure of routine satellite operations is similar or the same across multiple platforms within the same orbital category, e.g. GEO, HEO, LEO. A potential risk to this research is that I will be unable to acquire sufficient data. However, I am already in the final stages of acquiring data for three satellite systems and hope to acquire two more. Another risk is that I may find there to be little or no common intermediate structure to similar commands in different satellite systems. If this is the case, SCFGs will not be a useful method of enhancing automation and I will need to consider alternative approaches.
4. My expected results are a SCFG that characterizes the intermediate structure of routine satellite operations. I intend to show a parser that can successfully interpret commands from satellite logs using this grammar to identify high-level operations being performed. The correctness will be shown by identifying the activity being performed. I will also provide a measure of how much the intermediate structures of the same activities overlap between satellite systems.
5. Through this research, I am attempting to develop a method of removing much of the redundancy in automating satellite operations and porting. A SCFG that can represent the intermediate structure of routine satellite commands could save the Air Force millions of dollars in software development. It would also help SMC/AD to determine the practicality of porting the Air Force's many legacy satellite systems onto a modern, common ground system.

6. Proposed thesis committee:

- a. Maj Alan Lin, Chair / Thesis advisor
- b. Dr. Douglas Hodson, Committee member
- c. Maj John Pecarina, Committee member

 (signature)
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7. Sponsor: SMC/AD

- a. Name: Maj James Townsend
- b. Title: Branch Chief (Acting)
- c. Organization: 3548 Aberdeen Ave SE, Kirtland AFB, NM 87117
- d. Section or Division: Ground Systems Development Branch
- e. Office Symbol: SMC/ADGD
- f. Telephone number: (505) 853-3794
- g. E-mail address: james.townsend@us.af.mil

8. ASYS-535 is providing the foundational understanding of Air Force space systems. CSCE 586 has given me the necessary background in algorithms to develop an efficient parser for this thesis. CSCE 689 has familiarized me with distributed environments, not only to understand their advantages, but also their limitations. CSCE 593, 693, and 793 have been preparing me to take on the sizable software design project this thesis will require. The parser or tool chain that I will be implementing to read satellite logs will be one of the largest pieces of my thesis. Going forward, I will need to learn existing tools for reverse protocol engineering and generalized parsing. This will be accomplished through self-study. I have already travelled to Kirtland AFB to meet my sponsor and visit the Multi-Mission Satellite Operations Center (MMSOC). I plan to travel to the Naval Research Laboratory's Blossom Point Tracking Facility in June to collect data and see their Neptune ground architecture in-person.



MICHAEL BENTLEY, 2D LT, AIR FORCE
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1st Ind, AFIT/ENG

MEMORANDUM FOR AFIT/ENG

I approve/disapprove the above thesis prospectus and thesis committee. This prospectus will be maintained in the student's file. The thesis should be prepared in accordance with the AFIT Thesis Guide. Good luck!

SAMUEL STONE, Maj, USAF
Chief, Electrical Engineering Division
Department of Electrical and Computer Engineering