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Command World

C2 Experimentation; C2 Architecture; C2 Modeling and Simulation

Leah Wong and Douglas S. Lange
POC: Douglas S. Lange
SPAWARSYSCEN San Diego
SPAWARSYSCEN
53560 Hull Street
San Diego, CA 92152-5001
619-553-6534/619-553-5322
doug.lange@navy.mil

Jerome Thomas Sebastyn
SPAWAR Naval Reserves Unit 1010

William H. Roof
SPAWAR Naval Reserves Unit 406

Abstract

Command World is an unclassified simulation used to create data for DARPA's Personalized Assistant that Learns (PAL) program. The Command World scenario was expressly designed as a crisis action planning exercise in order to replicate the communications, collaboration, and information requirements inherent in a military domain and to facilitate realistic and relevant communications and collaboration exchanges across an information system network. The development of a robust and unclassified scenario and all of the supporting training artifacts was integral to the program goals of process execution, transfer learning, and the eventual development of a bootstrap ontology for PAL use in a military environment. The PAL program is designed to explore the possibility of creating tools that will assist military planners in their tasks through the use of digital "assistants." By instrumenting the environment over 5 experiments, over 200,000 events were captured. This paper will describe the environment, the data collected, and how the data is being used.

Introduction

Defense Advanced Research Projects Agency (DARPA) has initiated the Personalized Assistant that Learns (PAL) program - a cognitive technology program that offers significant value not only to the military user community, but also to business and academic sectors. The project aim is to spur pioneering research in cognitive information processing - including areas of artificial intelligence (AI), machine learning, knowledge representation and reasoning, machine perception, natural language processing, and behavioral studies. DARPA envisions PAL as an "enduring personalized cognitive assistant" to help decision-makers manage their complex worlds of multiple simultaneous tasks and unexpected situations. [Gunning 2004]

PAL's original focus was as an office assistant tasked with scheduling meetings, handling correspondence and assisting with quarterly reports. The concept behind PAL technology was to lend assistance by observing and interacting with office workers. Commercial software, e-mail and scheduling programs will be adapted for PAL purposes. PAL will augment these functions by adding modules that will train the software to recognize users' preferences, and by adding components that will decide when to interrupt the user with questions. DARPA hopes the research will lead to systems that can reason, learn from experience, take advice and respond intelligently to new situations.

Command World Simulation Exercise

In conjunction with the Naval Postgraduate School (NPS), Space and Naval Warfare Systems Center San Diego (SSC San Diego) was tasked to develop the Command World for performing evaluations of PAL technology in support of transition efforts. One of the Command World objectives is to develop military simulation exercises to support data collection, initially without PAL software, and then with increasingly functional, iterative versions of PAL software, in order to support transition of PAL technologies to a military environment. SSC San Diego with NPS conducted a series of Command World exercises – with each exercise testing and evaluating improved PAL functionality since September 2004.

"Operation CROWN JEWEL" Scenario

Operation CROWN JEWEL is a simulation for producing data for the Command World project. This data is a critical component of assessing the effectiveness of software assistants to support planning and coordination activities. The intent of Operation CROWN JEWEL is to develop baseline data relative to the IM tools used by joint planners in fulfilling their planning responsibilities. DARPA will use this data to support the CALO project. CALO will explore the possibility of creating tools that will assist military planners in their tasks through the use of digital "assistants." Since these assistants must "understand" the planner's tasks and how the planner accomplishes them, Command World contractors conduct a series of simulations where these tasks are studied and parameterized. Accordingly, Operation CROWN JEWEL is a laboratory for this effort.

The simulation has a set of participants, each with organizational roles and responsibilities related to the planning and preparatory work supporting a hypothetical

military operation. The scenario and all related data are unclassified. The scenario assumes that participants are members of a Combatant Commander (COCOM) staff assigned planning responsibilities for an anticipated peacekeeping operation in a fictitious world region. Participants use standard Crisis Action Planning (CAP) procedures in accomplishing the tasks assigned during the scenario.

Participants form a joint planning cell at the (COCOM) headquarters. The planning team's objective is to develop the Commander's Assessment and, based on the scenario "trigger events," to conduct a CAP approach and develop a set of Course of Action (COA) alternatives for executing the CROWN JEWEL mission. The exercise scenario includes a full range of peacekeeping operations (PKO), including monitoring treaty agreements, liaison with the respective belligerent nation leaders (i.e., TOPAZ, CORAL), and conducting humanitarian relief operations. This final task could become extensive in view of a resultant refugee problem and will require support of various International Organizations (IO) and Non-Governmental Organizations (NGO), an extensive mine clearance and eradication operation, food and medical assistance, and security operations.

The Exercise Test Director manages Operation CROWN JEWEL, and introduces events at various times thus affecting one or more actions. The participants did not know the nature and timing of these events beforehand. The Exercise Test Director is also responsible for sending email from (fictitious) non-participants. In accordance with standard planning procedures at most joint commands, the Test Director provides an exercise Battle Rhythm to guide participants. Actions taken during the simulation must be within the confines of the exercise Battle Rhythm and under the direction of the Exercise Test Director who functions as the supervisor of the planning and event execution effort.

Data results from conducting simulation sessions where military officers play participant roles using instrumented email, an online calendar, text editor, web browsers and other software to communicate with each other, to collect information needed for specific tasks, and to produce documents. Each participant has a workstation dedicated to the simulation, but with no connection to the participant's real identity or any other private data. In this fashion, a record of all simulation activity can be captured and distributed without privacy concerns. This captured data includes email activity, calendar edits, files created and edited and directory and subdirectory structures created, web browsing activity, etc.

Participants also engage in work activities related to their normal billet assignments (e.g. admin routines such as travel, etc., web search on status of cities, etc.) as well as duties as part of the CAP planning staff. This requires participants to produce some routine reports at specified times, and to complete other tasks related to their role-play assignments. In some cases, participants collect information and solve problems, thereby requiring them to exhibit realistic web, calendar, and file searching actions as part of the data to be collected. Participants create file and directory structures as appropriate for organizing their tasks. To minimize session "real time," participants have basic data (documents, spreadsheets, etc.) to use in the performance of work activities.

Simulation Domain

The scenario utilized in this exercise is from an actual USJFCOM J7 unclassified exercise, modified to meet the data collection requirements best suited to test the capabilities of CALO during an operational planning event.

The knowledge domain for Operation CROWN JEWEL in the scenario simulation is the CAP process at a COCOM headquarters. Additionally, the knowledge domain will encompass a small set of routine daily tasks that must be balanced with CAP duties by the participants. The scenario and sequence of events are intended as generic in nature and are not intended to be specific to any particular unified command or unified command geographic region. Moreover, the CROWN JEWEL scenario is unclassified and is not intended to represent any particular U.S. operational military plan or potential real world crisis. Rather, the scenario is intended to reflect the operational issues that would confront a COCOM planning staff tasked with preparing for joint or multi-national force operations in its assigned area of responsibility (AOR).

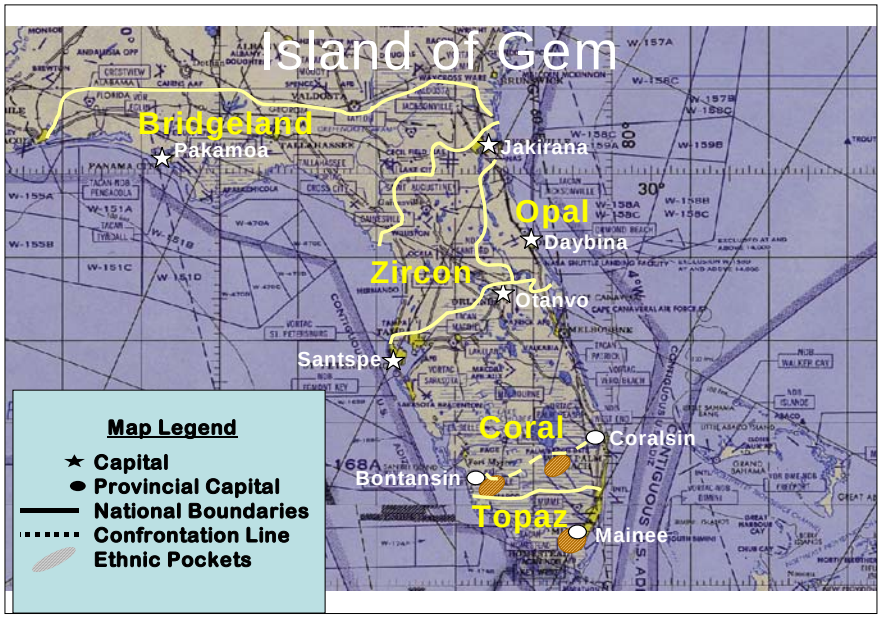
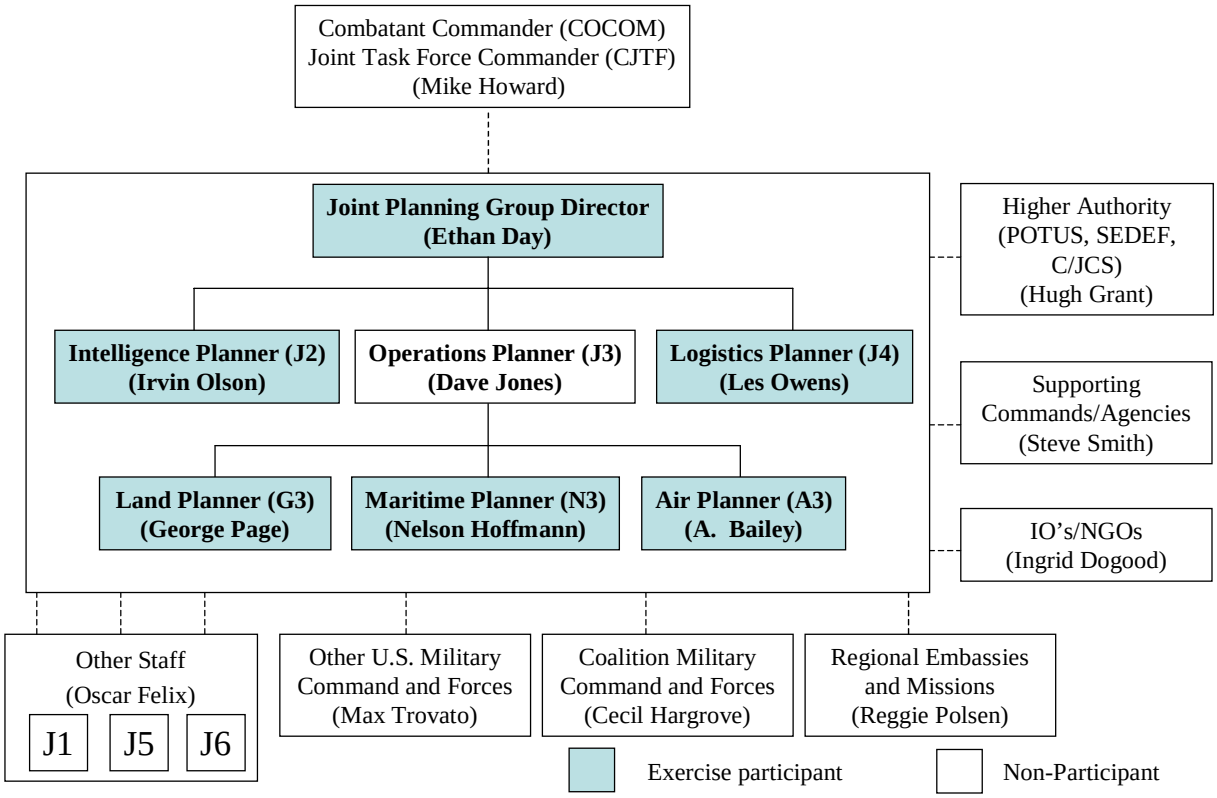


Figure 1: Map of the Island of Island nations of GEM

JOINT PLANNING TEAM STRUCTURE

The planning team is composed of six military officers with experience in joint planning. This will include one intelligence planner, one logistics planner, and three joint force planners (i.e., Land Component Planner, Maritime Component Planner, Air Component Planner), preferably one from each of the major services, U.S. Army, U.S. Navy, U.S. Air Force. The senior member of the team will be the Joint Planning Group Director who will act as both the senior member of the team and exercise mediator among the non-participant roles and corresponding game cues.

Operation CROWN JEWEL
Joint Planning Group Structure



MAJOR TASKS

The planning team will produce the information products generally required at a COCOM headquarters during routine operations as a crisis develops. During Operation CROWN JEWEL, the participants will accomplish the essential step in the first three phase of CAP – Situation Development, Crisis Assessment, and COA Development by accomplishing the following:

- Review of incoming intelligence and other source data
- Commence CAP process for a PKO under COCOM direction
- Prepare and submit a daily Commander's briefing (using slideware) to COCOM; prepare a daily operations summary message (OPSUM)
- Respond to increasing exercise tempo as Operation CROWN JEWEL begins

During Operation CROWN JEWEL, the participants will produce the following products:

- Daily Commander's briefing, OPSUM

- Commander's Assessment message
- A mission analysis based on Chairman, Joint Chiefs of Staff (C/JCS) Warning Order (WARNORD) COA's (e.g., three alternative plans) for executing the mission assigned
- Briefing on recommended COA's
- Major triggering events
- General situational data on scenario
- "Spot" intelligence reports as scenario develops
- Own force data – disposition, location, readiness
- Updated information from open, non-military sources – IO's, NGOs, Media (e.g., CNN), etc.
- Direction from higher authority – intentions, deadlines, requests for intelligence / information (RFI's)
- Planned duration

This simulation spreads four weeks of simulated time over a predetermined number of days of actual data collection. Depending upon the desired Battle Rhythm, the Exercise Test Director may choose to conduct the simulation over a period anywhere from 2.5 contiguous days, to 8 days of intermittent exercise play. The Exercise Test Director will control the time allotted to specific tasks in the CAP process with a simulated Battle Rhythm. This causes the participants to accomplish specific steps in the CAP process while under the simulated conditions of routine AOR operations (exercise scenario start) building to a large-scale multi-national force (MNF) operation. As the scenario simulation progresses it is expected that participants will gradually shift individual orientation and task accomplishment to group collaboration and integrated task accomplishment required by the exercise rigor imposed by the nature of the scenario operation.

SCENARIO PRODUCTS

Products resulting from this scenario consisted mainly of emails, MS Word Documents, MS Excel Spreadsheets and MS PowerPoint presentations. These products resulted from the script stimuli and the form and format of the response data was completely at the discretion of the participant. The form and format of the products resulted from the participants' comfort levels with the available applications and the time allotted to the task. Specific products produced from this joint operation planning exercise include:

- Operations Brief (daily): Status update on force disposition and availability
- Operation Summary (daily): Status update on force readiness
- Commander's Assessment (Phase 1): Situational Development based upon nature of crisis, intelligence reports, force readiness, refining mission concept (e.g. factors of space, time, and resources), and preliminary COA
- Commander's Estimate (Phase III): Mission statement, Situation Update COA (three), COA constraints and additional planning concerns

- "Free play" products: Administrative requests, requests for information (RFI) germane to gameplay

Experimentation

The Command World Exercises were conducted in the Command World lab at NPS. Each participant was provided with a notebook computer networked to a central server where events logged into a database in the Timeline server. The server also provided the participants with Internet access, Microsoft Exchange, and other web services.

All the laptops, servers and users, were connected via Ethernet behind (on the LAN side of) the NetGear router/switch. Firewall protection was provided on the Internet side of the NetGear by the NPS network. Two of the user laptops and the server were connected directly to the local LAN ports on the back of it using network cables. Another network cable was connected from the NetGear to a hub. The remaining user laptops were connected to the hub. The laptops could browse the WWW subject to any restrictions imposed by the NPS network that we used for connectivity to the Internet.

After the initial training briefings in the morning session of the first day, the Exercise Test Director provided the participants with simulation stimuli to generate responses that required the participants to use the hardware and software tools provided by the exercise principals. This offered an opportunity to familiarize with some of the non-standard keystrokes required to log some events, such as saving email attachments to the participants' hard drives. Participants had the opportunity to ask questions and to clarify issues that would be important throughout the conduct of the exercise.

SRI personnel provided NPS personnel and the participants with training pertaining to the CALO instrumentation. Dedicated NPS personnel built and tested the experiment laboratory at the NPS and assisted SRI and the participants throughout the exercise with network and system administration support. NPS and SRI personnel also monitored and archived all instrumented data upon completion of the exercise.

Data Collection

Each participant notebook computer hosted a client that logged all MS Office activities to a central database on the networked CALO server via the following software modules.

FileSystemWatcher (FSW): Monitors the file system and log events when file system changes. The events are logged to a file in the CALO Timeline Server that records all activity in My Documents and the subfolders.

Internet Explorer (IE) Plug-in: Captures user actions in IE and Microsoft file Explorer. It logs navigation and events to the CALO Timeline Server for indexed archival.

MS Outlook: Captures relatively "fine-grained" instrumentation of email, calendar, appointments, and contact transactions by users of MS Outlook. It logs these transactions as CALO events and writes these events to a local file and/or sends them to the CALO timeline server for indexed archival. In this release of CALO software, file attachments must be saved using the CALO drop-down menu from the main page.

Outlook Plug-In: Captures email, contact and appointment events in Outlook and logs the event data to the local file system and to the TimeLine Server via OAA 2.3.0.

Timeline Server: Archives and indexes CALO events sent by FileSystemWatcher and MS Outlook Mail via OAA 2.3.0. and provides search and subscription capabilities across this data.

Timeline Viewer: A simple GUI for searching events stored in the Timeline Server.

Each participant performed tasks associated with the real-world staff position they represented. All participant tasks supported the Joint Crisis Action Planning Model used by US Military personnel assigned to Joint Planning staffs.

It was critical to exercise realism that the participants provided a number of ad-lib events, all unknown to the other participants prior to their injections into the scenario. For example, J2 injected an ad-lib event by reporting a captured TOPAZ soldier carried a chemical protective mask and nerve gas antidote. This generated the appropriate message traffic that would warn peacekeepers of a potential chemical agent or biological threat. Later, J2 again injected an ad-lib event indicating the simultaneous detonation of car bombs near peacekeeping bases.

Each participant injected events pertaining to their area of expertise. J4 reported the crash of an aircraft carrying medical supplies, while N3 reported treacherous sea states caused by the proximity of a hurricane. These and other events represent the type of unplanned stimuli that would generate a flurry of activity throughout the staff.

Experimentation Results

The exercise provided enhancement to coherent and logical information transmission over information system network along with enhancement to processing and storage of information over information system.

Outlook was the primary software tool used by the participants during the exercise. According to the participants, their use of the available software tools broke out as follows:

The collected data from each exercise is summarized in the following tables.

Command World Simulation Exercise #1 Event Data Collection

Event Type	Thru 7/26	7/27	7/28	Totals
OutlookIA TimeLineSearch	171	727	664	1391
OutlookIA	3971	16288	15116	31404
IE_PLUGIN	1171	847	1280	2127
File Events	1156	3609	3080	6689
Totals:	6771	21471	20140	41611

Command World Simulation Exercise #2 Event Data Collection

Event Type	9/14	9/15	9/16	Totals
OutlookIA TimeLineSearch	98	360	772	1230
OutlookIA	3121	13888	28664	45673
IE_PLUGIN	469	552	2185	3206
File Events	318	540	1282	2140
Totals:	4006	15340	32903	52249

Command World Simulation Exercise #3 Event Data Collection

Event Type	1/26	1/28	1/31	2/2	Totals
Calendar:	74	48	100	88	310
Web Browser:	1803	1786	1291	1001	5881
File Browser:	36	137	27	3300	3500
E-mail:	3904	2093	3162	2438	11597
Chat:	610	757	623	534	2524
Track:	41	7	0	1736	1784
Task Start:	252	154	237	241	884
Other:	1035	877	788	858	3558
Totals:	7755	5859	6228	10196	30038

Command World Simulation Exercise #4 Event Data Collection

Event Type	3/9	3/11	3/14	3/16	Totals
Calendar:	57	60	106	135	358
Web Browser:	1490	4940	1817	1558	9805
File Browser:	223	0	478	262	963
E-mail:	8968	6420	3802	5547	24737
Chat:	619	641	562	580	2402
Track:	163	757	295	833	2048
Task Start:	110	88	180	246	624
Data Applications:	48	48	72	99	267
CALO Query:	0	0	4	27	31
Change Applications:	756	348	666	892	2662
Totals:	12434	13302	7982	10179	43897

Command World Simulation Exercise #5 Event Data Collection

Event Type	4/12	4/13	4/14	Totals
Calendar:	204	397	143	744
Web Browser:	3103	4407	1677	9187
File Browser:	807	1401	96	4104
E-mail:	10336	21065	9216	38817
Chat:	1328	3480	2479	7287
Track:	928	3038	747	4713
Task Start:	96	202	62	360
Data Applications:	74	159	71	304
CALO Query:	0	7	0	7
Change Applications:	885	1338	632	2855
Totals:	17761	35494	15123	68378

Use of Data in Learning Capability Development

One of the capabilities being developed in the CALO program is *process execution assistance*. CALO helps the user to perform tasks. In order for CALO to do this, observation of the user's activities is necessary. To test CALO learning algorithms, developers will be able to use Command World data just as if their modules were monitoring the progress of the exercise in real time.

Many of the capabilities for CALO are designed for learning. Most of the testing is being done in an office automation environment where events are plentiful in a real world environment without adding significant risk. However, this means that CALO is learning about a different environment than we are targeting. Another use of the Command World data is to compare the behavior of CALO when provided events from the military environment and indeed determine if the learning being done in the office environment is benefiting use later in the military environment. These tests of *transfer learning* were performed in the last iteration of Command World by researchers from MIT and Oregon State University with the assistance of NPS and SSC SD personnel. Some of the results are published in [Marx+ 2005].

The final use of the data being collected is the eventual development of a bootstrap ontology for PAL use in a military environment. By collecting events and the associated data, we have data that will support knowledge of a crisis action planning situation in a command staff environment.

Summary

In support of data collection for the CALO leaning algorithm development, the Command World exercises, were conducted over eleven days, generated 236,173 logged events. The exercise was a success in that it demonstrated that the scenario scripts were sufficient for the participants to perform the essential CAP tasks, and collected data that

will be useful for further study. It also provided realistic baseline data from a military domain for the test and evaluation of CALO software, once learning capabilities are sufficiently mature to run further tests. The baseline data will be useful in comparing those later results in determining whether efficiency and effectiveness were improved through learning. We had the benefits of having reservists as exercise participants who brought in their experience from both the military and technical environments as they work in technical positions in their civilian careers. Their professionalism, which was demonstrated by freely played their roles in the simulation, contributed to the success of generating large quantity of high quality data.

The collected data is releasable to researchers within the government and those under contract with the government for relevant research.

References

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[Marx+ 2005] Marx, Z., Rosenstein, M., Kaelbling, L., and Dietterich, T, "Transfer learning with an ensemble of background tasks ",NIPS 2005 Workshop on Inductive Transfer: 10 Years Later, 2005.