



COBRA GOLD 2007

MACHINE LANGUAGE TRANSLATION DEMONSTRATION REPORT

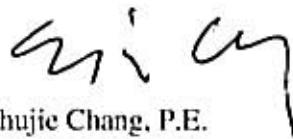


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This report provides observations and limited user feedback on English – Thai two way speech to speech machine language translation systems captured during Exercise COBRA GOLD 2007. The observations and recommended improvements to the translation systems reported herein are those of the U.S. Marine Corps Forces, Pacific Experimentation Center (MEC) staff and do not necessarily represent the formal position of the U.S. Marine Corps or the Department of Navy.

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September 2007

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EXECUTIVE SUMMARY

This report provides the U.S. Marine Corps Forces Pacific (MARFORPAC) Experimentation Center (MEC) observations on the employment of a two-way, speech to speech (2WS2S) English – Thai machine language translation (MLT) system. The system was deployed on two platforms; an HP Ipaq PDA and a Dell laptop both running MS Windows operating systems. The technology was demonstrated at Exercise COBRA GOLD ‘07 (CG07) in the Kingdom of Thailand from 8 to 18 May 2007. The users were from MARFORPAC and a US Navy Reserve Operational Health Support Unit (OHSU) in support of the Medical Civic Action Program (MEDCAP), Dental Civic Action Program (DENCAP) and Veterinary Civic Action Program (VETCAP) portions of the CG07 Humanitarian Civic Assistance Program (HCA). MEDCAP, DENCAP and VETCAP are all referred to jointly as ‘MEDCAP’ throughout this report.

The MLT system was intended to augment the bilingual Thai human interpreters supporting the MEDCAP mission. There were enough interpreters to provide the mission with sufficient human interpreter support such that the MLT systems were not employed except in a handful of “forced” situations. In all of these cases only the laptop version of the MLT system was employed. The PDA version was deemed too slow and inaccurate by the users to integrate into the fast paced patient treatment process.

Despite the relatively limited amount of use, most members of the MEDCAP team acknowledged the potential utility of MLT systems in certain portions of the MEDCAP process. Most recommended Triage as the best, safest point for the capability. Any miscommunications generated in triage would likely be discovered and resolved when the patient was interviewed by the doctor through a human interpreter. The doctor interview, diagnosis and in some cases treatment is deemed the most important step in the patient treatment process and as such should be afforded the most human interpreter support. Using an MLT capability in this way would focus a limited resource of human interpreters where they are most needed, paired up with a doctor.

A major observation made in the course of CG07 is the potential benefit of employing indigenous monolinguals in an “MLT Interpreter”, or M-Terp, role but matching him up with an English speaking user and a MLT system. This “user team” would enjoy all the benefits the current teaming of English speaker and human interpreter do throughout the development of a relationship and would also increase their proficiency with the MLT system, both individually and as a team. Perhaps the biggest benefit this employment method would incur is the mitigation of regional and cultural dialectical shifts that the current generation of 2WS2S MLT systems are unable to resolve. While this concept was not exercised in CG07 it is highly recommended that it be integrated into the MEDCAP and other HCA missions in Exercise COBRA GOLD 2008.

The potential benefit for the Marine Corps is the mitigation of specific language and dialect requirements on human interpreters. While systems cannot replace a fluent, bilingual human, it can augment them when they are in limited supply. For example, a Marine Expeditionary Unit (MEU) is ordered into a remote region of Thailand where only the rare Dialect X of Thai is spoken. If bilingual speakers of Dialect X and English are also rare but bilingual speakers of Dialect X and Bangkok Thai are common, an English – Thai MLT system can be used to facilitate communication between an English speaker and a Thai speaker who can then communicate with the Dialect X speaker. Employed effectively, this could be a significant force multiplier.

Throughout the exercise all interactions with the MLT systems were logged. Additionally, several hours of interaction were recorded with a human interpreter mediating. All of this language data were provided to the developer.

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INTRODUCTION

Purpose

The purpose of the Machine Foreign Language Translation Systems (MFLTS) demonstrations in Exercise COBRA GOLD 2007 (CG07) was three-fold:

1. Gauge relative maturity/readiness of English – Thai two-way speech translation in the medical domain
2. Employment and linguistic data collection for further development of the English – Thai two-way speech translation capability
3. Demonstrate various MFLTS capabilities to operational forces

Technology Description

Several technical and functional approaches to translation were demonstrated in various domains; two-way text-to-text (2WT2T) in the command and control (C2) domain, one-way speech to speech (1WS2S) in medical and force protection domains, and two-way speech-to-speech (2WS2S) in the medical domain. Six specific translation capabilities were demonstrated and/or employed at CG07.

1. Call-a-Translator (CAT). CAT is a translation call center service. Users call a CONUS-based call center where they are connected with a Thai – English interpreter. Users then conduct a human interpreter-mediated conversation with a Thai local.

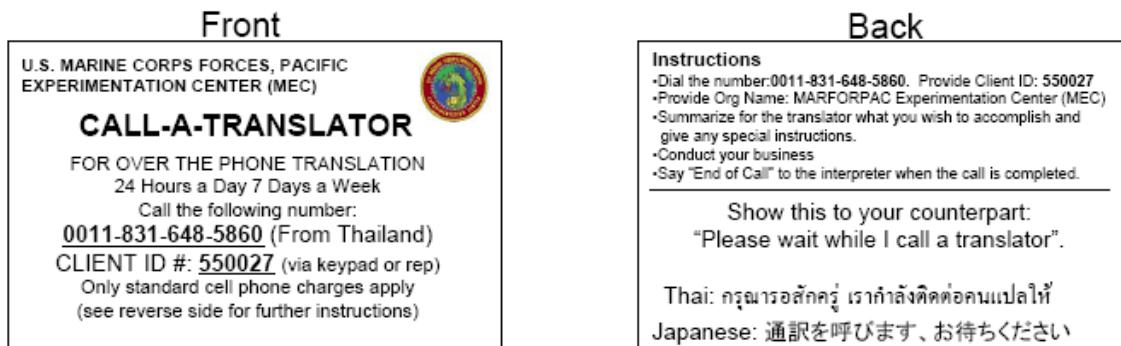


Figure 1. CG07 CAT Card

2. Coalition Chat Line + (CCL+). CCL+ is a (2WT2T), network-based, multi-lingual instant messenger MT capability. It provides users the ability to “chat” in their own language with speakers of multiple other languages. Each user sees the other user’s input translated into their respective language.

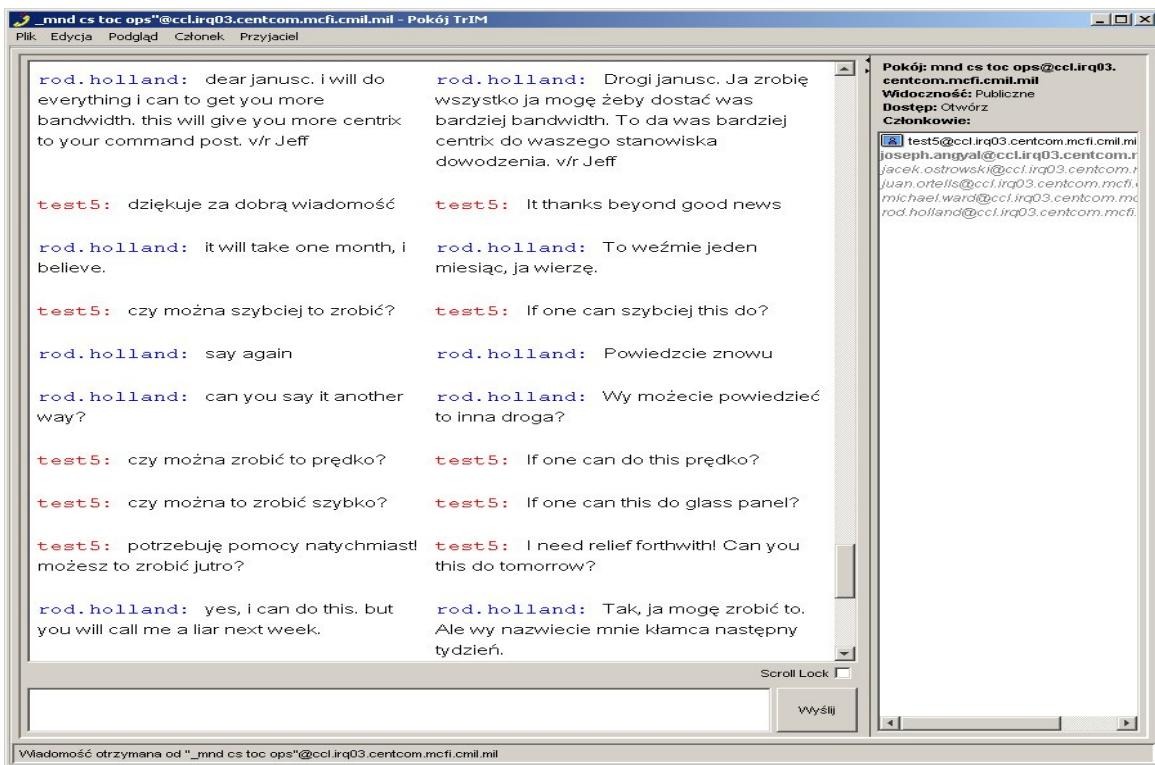


Figure 2. Coalition Chat Line +

3. Phraselator P2MX. The P2MX is a one-way foreign language communication device. It is primarily suited to issuing commands and conveying information to non-English speakers but can also be used to elicit simple responses to simple questions. It is a rugged MS WinCE portable digital assistant (PDA) that utilizes automatic speech recognition (ASR) to identify a spoken English phrase and play the corresponding pre-translated, pre-recorded phrase in the target language, in this case Thai.



Figure 3. Voxtec Phraselator P2MX

4. Voice Response Translator (VRT). The VRT is a one-way foreign language communication device. It is primarily suited to issuing commands and conveying information to non-English speakers but can also be used to elicit simple responses to simple questions. It is a rugged, low power device with a hands-free, eyes-free, voice activated interface that utilizes ASR to identify a spoken English phrase and play the corresponding pre-translated, pre-recorded phrase in the target language, in this case Thai.



Figure 4. IWT VRT

5. TransThai PDA (TTPDA). The TTPDA is a two-way speech to speech communication system on a Hewlett-Packard Ipaq personal digital assistant (PDA) running MS Windows PocketPC operating system. It enables an English speaker and Thai speaker to communicate effectively within limited medical and tourist domain vocabulary sets when a human interpreter is not available.

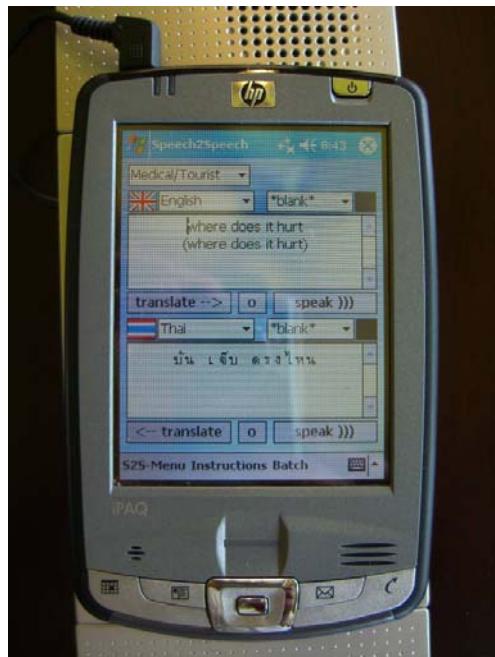


Figure 5. TransThai PDA mounted to external speaker

6. TransThai Laptop (TTL). The TTL is a two-way speech to speech communication system on a Dell Inspiron 9300 laptop running the Microsoft Windows XP operating system. It enables an English speaker and Thai speaker to communicate concepts of moderate

complexity effectively when a human interpreter is not available. The system is designed for “eyes free” use. A mouse is used to indicate what language is being spoken (left click for English, right click for Thai). A microphone is used for enhanced input and external speakers for enhanced output.



Figure 6. TransThai Laptop with peripherals as employed in CG07

Exercise Objectives

- To demonstrate MLT’s real and potential utility in an operational medical mission.
- To estimate the level of maturity of this particular English – Thai MLT system.
- To collect technical, use, language and domain data for the continuing development of MLT capabilities.

Participants

CTF HQ

Combined Task Force Headquarters participants included MEC staff and the MARFORPAC Force Medical Officer and Force Dental Officer.

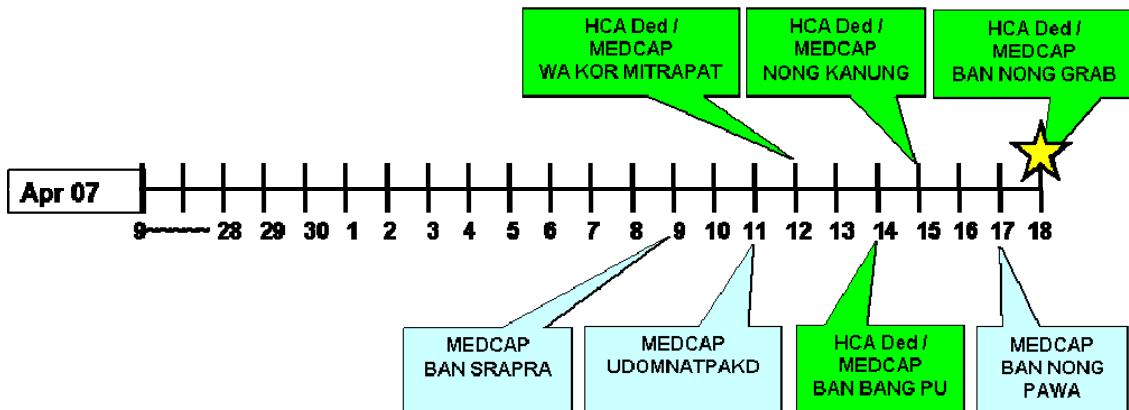
MEDCAP

MEDCAP participants included a team of about 80 doctors, dentists, veterinarians, and medical personnel from U.S., Japan, and Singapore. The approximately 55 U.S. participants were sourced predominantly from Operational Health Support Unit (OHSU) Camp Pendleton, part of the Navy Reserve Medicine Team.

EXECUTION

This section provides details regarding technology employment and data collection methods used. Execution followed the schedules below.

Dates	Event/Milestone
14 APR	MEDCAP user training at Camp Pendleton

Table 1. Execution schedule.**Figure 7. MEDCAP Schedule.**

Employment

CTF HQ, Jomtien Thailand

All of the above MLT capabilities were demonstrated at the CTF HQ in Jomtien. A display table was set up for exercise participants to get hands on knowledge of each.

MEC personnel at CTF HQ engaged the MARFORPAC Force Medical and Dental Officers and bi-lingual Thai interpreters to judge the speech recognition and translation accuracy for medical and dental oriented questions and, where the questions elicited answers more than “yes” or “no”, Thai responses on the 2WS2S systems.

MEDCAPs

Each MEDCAP was conducted at a new site each day. The sites were all rural elementary schools. Separate stations were setup for each MEDCAP functional area. These stations were usually physically separated, often in different classrooms or administrative or cafeteria spaces. Triage was usually conducted outdoors under a building overhang or in tents with large patient waiting areas nearby. The image below is an example of the typical layout.

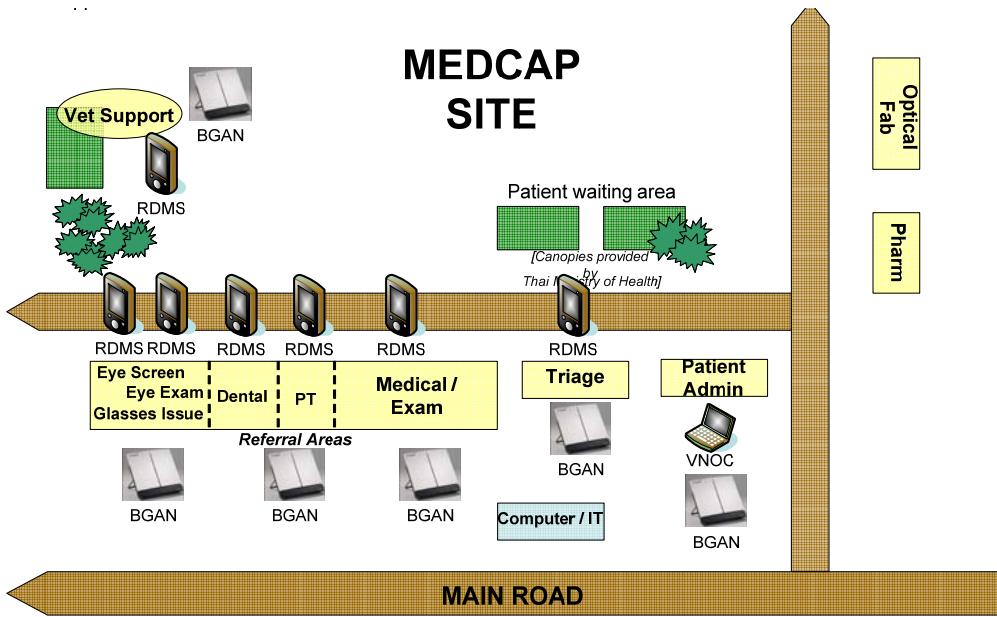


Figure 8. Example of MEDCAP site layout.



Figure 9. Patient Triage



Figure 10. Patient Triage Interview w/TTL

During pre-exercise mission analysis, only the CAT, TTPDA and TTL were determined to have potential utility for the MEDCAP mission. These capabilities were made available to the MEDCAP unit for employment in the course of their mission. A member of the MEC staff was on site each day to assist in the employment of the MLT capabilities.

The MEDCAP unit was staffed with between 20 and 25 interpreters each day. This high ratio of interpreter to non-Thai speaker meant there was little requirement for MLT capabilities that are intended to augment interpreters in their absence, not replace them. As a result and due to the level of dialog required for a typical patient – care giver interaction it was determined that the one-way foreign language communication devices such as the P2 and VRT would not be adequate. It was decided, however, that patient interviews with the two-way devices would be attempted.

Fielding and Training

The MEDCAP equipment sets included four TTPDAs and six TTLs throughout CG07. The equipment was transported to Thailand by MEC personnel as airline baggage. It was accounted for and maintained by MEC personnel throughout the exercise.

Prior to deployment, approximately four hours of familiarization training was provided to the MEDCAP unit in two two-hour shifts. The short duration was due to unit imposed time constraints. A bilingual English – Thai speaker was on hand at the training to provide users feedback on translation intelligibility and accuracy.

Demonstrating the systems during a MEDCAP typically involved MEC personnel working with the MEDCAP unit leadership on a daily basis to determine a suitable time, station and user per that day's patient load and site layout. Employment was focused on three primary users throughout the exercise to capitalize on the training-through-use learning curve that is inherent in MLT. Two of those users were doctors in the General Medicine station and one was a Triage nurse. These users deemed the TTPDA too slow and inaccurate and would only work with the TTL systems. As a result no data was collected for the TTPDA system in the MEDCAP mission. One TTPDA was taken by the MFP HCA Operations Officer to communicate with his driver and conduct day to day coordination. He did not receive training on the system. His use of the TTPDA was minimal and essentially unsuccessful. For this reason and also because a single user is not a sufficient sampling, his standardized survey feedback is not included in the Results section. One observation he made, however, is included in the Recommendations section regarding place names.

Evaluation Data Sources

CTF HQ, Jomtien

In the TTL 2WS2S judgment exercises American medical and dental officers asked a bilingual Thai speaker medical or dental questions, respectively. The Thai speaker judged the translation accuracy and intelligibility as “Good”, “Fair”, “Bad” or “Very Bad”. If the question was eliciting an answer more than “yes” or “no” the Thai responded in Thai and the translation into English was judged for its accuracy and intelligibility on the same scale. For the purposes of this report that scale was summarized into “Effective”, “Ineffective” and, for the questions with no Thai answer, “NA”. These rankings were made for 136 medical phrases and 71 dental phrases and were collected in spreadsheet format.

There was some conceptual redundancy between medical and dental questions, such as duration of pain, but because the sessions were unscripted and conducted with two English speakers and multiple Thai speakers there was very little vocabulary or phrasing redundancy for the same concept.

MEDCAP

User Questionnaire: A survey form was distributed to MLT users at the end of the exercise. Appendix A shows the questions asked and, where multiple choice, the possible answers.

Interviews and Observations: MEC assessment personnel interviewed mainly MEDCAP personnel and the two medical officers listed above. A MEC analyst was present at each

MEDCAP site observing and occasionally participating in the MEDCAP process by conducting basic triage interviews to gain a more in-depth understanding of the mission's requirements.

RESULTS

This section provides the results of the effectiveness, suitability and mission impact of the two-way speech to speech English – Thai systems used in CG07.

MEDCAPs

For the majority of the MEDCAPs the Thai patient load saturated the process flow. As a result, MEDCAP personnel, necessarily, relied on the most efficient means they had to communicate with the Thai patients, the human interpreters.

Table 2 compiles and summarizes responses from TTL user surveys. Survey questions were grouped into “Suitability”, “Effectiveness” and “Training”. The users’ responses were summarized into positive, negative and N/A responses based on the nature of the answer. The percentage of positive, negative and N/A responses was calculated for each grouping.

The Effectiveness of the technology is determined by the technology’s ability to perform as intended to enhance a user’s ability to accomplish a mission. Suitability includes the usability of the software, issues and required maintenance actions, interoperability/compatibility issues and training and documentation.

While the results should not be considered conclusive based on the extremely limited sample size of three responses, they do provide an indication of the current and, most importantly, potential military utility of the technology.

Survey Type	Surveys Completed
TTL	3
TTPDA	1

Table 2. User Surveys Completed

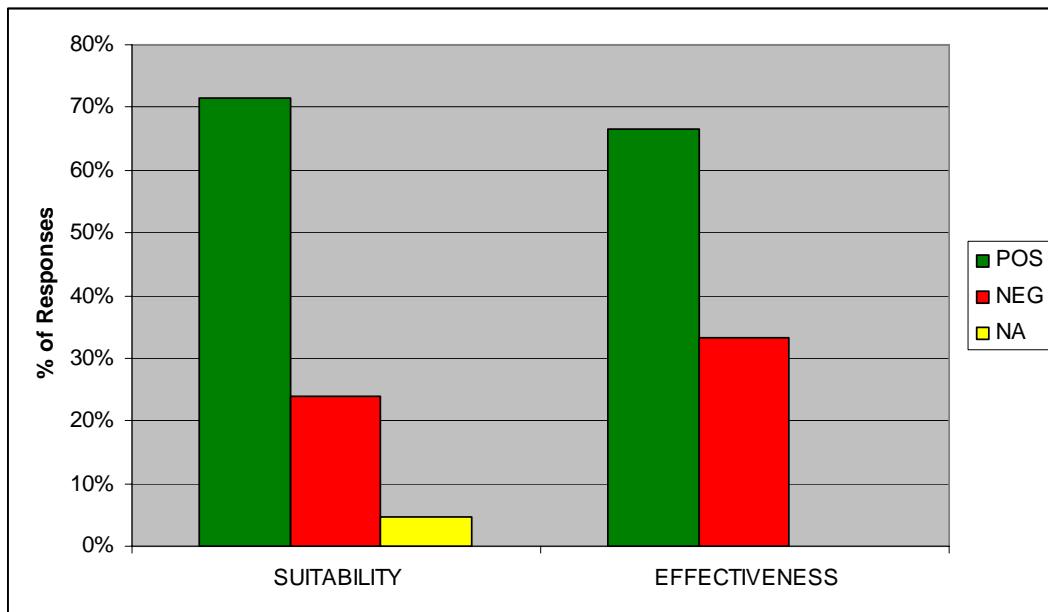


Table 3. Summary CG07 MLT User Survey Responses for TTL

CTF HQ

Table 4 summarizes the translation effectiveness judgments conducted at CTF HQ Jomtien. While the English > Thai translation quality was significantly better than Thai > English in both medical and dental domains; the quality of either should not be described as adequate for operational use. Typically a loose benchmark of “80% accuracy” is used when deciding if a translation capability is adequate. According to the CTF HQ judgments, the Thai system comes closest in the medical domain with a 72% accuracy rating. A contextual rating could be conducted however, to determine what phrases in the unacceptable 28% are necessary and what phrases in the acceptable 72% are not necessary.

A significant observation that can be made looking at the raw data is how frequent the question does not require more than a “yes” or “no” answer for both domains. This indicates the potential utility of a one-way capability despite user reluctance to be limited.

While these samples are not exhaustive they can be described as typical for patient triage and diagnosis.

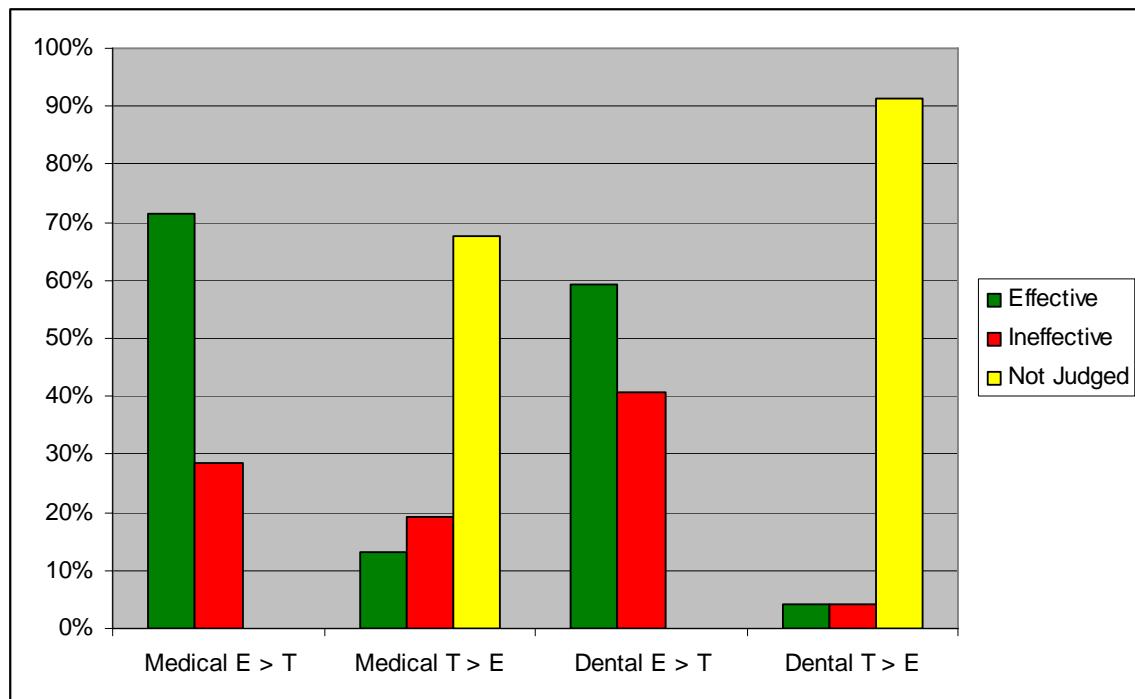


Table 4. CTF HQ TTL Translation Effectiveness Judgments

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

CG07 provided an essential window into the employment considerations for MLT. It is rare to have the opportunity to insert MLT into a real world operational mission. Not only is the real world mission required but it must also be conducted with a target language for which a MLT capability is of sufficient maturity. Despite the less-than-anticipated amount of use, important lessons were learned about the integration of this capability into both individual and unit-level tactics, techniques and procedures.

The availability of interpreters at the CTF HQ made an informal, limited assessment of translation accuracy by U.S. personnel and Thai speakers. While very limited, this and the recordings made at the MEDCAPs were a significant contribution to the MFLTS development effort.

Three major issues prevented a successful integration of MLT into the MEDCAP mission to the extent that would have allowed conduct of a formal assessment;

- lack of pre-deployment training time
- the concurrent integration and assessment of a separate technological capability during the mission
- an overabundance of interpreters during mission execution.

The first issue was result of time limitations with the employment of a USN Reserves medical unit as the MEDCAP unit. The unit had a significant amount of work to prepare itself and its personnel for the deployment. The second issue could have been mitigated with the resolution of the first issue but it still should be taken into account with future assessment opportunities. Specifically, the “technology overload” factor should be evaluated when determining what efforts to undertake with a unit.

The third issue, availability of interpreters, will always have a direct effect on the use and perceived utility of MLT in any given mission. The maturity of MLT is such that, interpreter trustworthiness aside; the human interpreter will be preferred over the machine. The employment of 20+ Thai interpreters throughout the MEDCAP mission meant English speakers rarely had to wait very long, if at all, for the assistance of a human interpreter. Many of the medical personnel indicated anecdotally that they saw the potential utility for MLT in situations where human interpreters were not available. The pressures of processing large amounts of patients through a unit that was not entirely familiar with each other or the mission and, at the same time, integrating another new technology kept them from embracing the MLT capability and “trying to make it work”.

When the MLT systems were used a significant issue was the rural-ness of the patients. The systems were developed using speech data collected with relatively educated people from Bangkok who speak a dialect that is noticeably different to Thai speakers. The patients’ relative lack of education and familiarity with technology also prevented many of them from being comfortable enough using a microphone and laptop to speak; even when patients listened to and

indicated they understood the instructions they typically did not speak in a manner the system could comprehend.

Recommendations

Observation: MLT systems developed for a specific dialect can often not handle speakers of other dialects within the same language.

Discussion: The major learning point from CG07 was in the area of MLT employment tactics, techniques and procedures. As noted above, a significant hindrance was the dialectical difference. It was noticed, however, that while they occasionally had difficulty, the Thai interpreters were always able to communicate with the rural patient in Thai. This specific group of interpreters was made up of university-age men and women going to school in Bangkok. As such, they were relatively well versed with technology and, when asked to work with the system (in the few spare minutes they had) were able to communicate speaking Thai through it. A major hurdle for the MLT technical community is not only picking the right language on which to focus development but also the right dialect. It has also been noted in other efforts that varying accents in a target language for which minimal linguistic data has been collected can have an adverse effect on the Automatic Speech Recognition (ASR) engine.

Recommendation: When using a MLT system in an area where it is known varying dialects will be encountered users should employ a MLT Interpreter (M-Terp) in a “user team”. This person does not have to speak English but he must speak the dialect on which the MLT system is focused and must be able to communicate effectively with the local target dialect speakers. Pairing a M-Terp with a MLT machine enables that individual to continuously get better at communicating with the machine just as we expect the English speaker to do. This creates a much more desirable use environment than attempting to explain to each new patient (or any other high-volume target language user situation) what the machine is and how to speak to it. This method will also completely mitigate the fear-of-technology issue encountered with low-tech, rural target language users.

Observation: High-ambient noise environments affect perceptions of effectiveness.

Discussion: The MEDCAP mission is, by its nature, a high ambient noise environment. Hundreds, if not thousands, of local people are cycling through an area typically intended for much smaller crowds. These areas are often indoors with multiple conversations occurring simultaneously in close quarters. High quality, close-talking microphones are often able to overcome such environments through technology (although refer to the M-Terp observation above regarding issues of having many, rapidly changing, rural, low-tech users wear a close talking microphone). Speaker performance and output sound quality, however, are a significant factor in users' perception of the system. If a user cannot hear the output he often defaults to an attitude that the system doesn't work. This was especially noticeable with elderly patients with deteriorated hearing. The laptops used in CG07 employed standard OEM sound cards and peripheral speakers were plugged into the laptops to increase the volume. While these speakers were often loud enough to hear that something was playing, the sound quality was distorted to the point that, in a high ambient noise environment, the synthesized speech was unintelligible.

Recommendation: Improve the quality of the audio output and integrate speakers designed for speech over music in any MLT-specific hardware. When employing the M-Terp User Team concept discussed above a single ear headset could be employed to assist the User Team in hearing the synthesized output.

Observation: The translation process was often flawed whether from inaccurate ASR or translation.

Discussion: The Thai MLT systems that were employed in CG07, as well as most MLT systems in existence today, are not mature enough to get the translation correct the majority of the time. Users communicating directly with an indigenous target language speaker (i.e. not in the user team concept from above) must be able to abort the translation process as soon as an error is recognized. If the error is recognized after the target language user has been presented with an incorrect translation the user must be able to easily forestall any issues that could arise from the miscommunication. If the user team concept is employed the team members should be more familiar with the potential mistakes, perhaps seeing repeating errors, and can easily overcome translation errors through the human dynamic.

Recommendation: Ensure all MLT systems include the ability to abort a translation process at any time once it has begun. Systems should include a way to easily tell the target language user to disregard the last translation such as a pre-recorded phrase that can be quickly accessed.

Observation: The TTPDA system was unable to accurately include proper names of places in translations.

Discussion: While not a significant issue encountered in the medical domain, most conversations typically involve proper names, either of an individual or a place.

Recommendation: MLT systems must be able to discern when a proper noun has been used and pass that through as the concept that it is rather than attempt to translate it.

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APPENDIX A



MLT SYSTEM ASSESSMENT USER QUESTIONNAIRE
Your feedback on your use of machine translation technologies is critical in the continued development and refinement of this revolutionary capability. The development community and the Warfighters that follow thank for your time and effort!



Form Completion Date: _____

What DEVICE did you use: _____

Where did you use the DEVICE: _____

Please indicate the types of missions you were conducting when using the DEVICE:

- | | | |
|---------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------|
| <input type="checkbox"/> Foreign Internal Defense (FID) | <input type="checkbox"/> Unconventional Warfare (UW) | <input type="checkbox"/> Special Reconnaissance (SR) |
| <input type="checkbox"/> Direct Action (DA) | <input type="checkbox"/> Psychological Ops (PSYOP) | <input type="checkbox"/> Civil Affairs (CA) |
| <input type="checkbox"/> Counterterrorism (CT) | <input type="checkbox"/> Counter proliferation (CP) | <input type="checkbox"/> Information Operations (IO) |
| <input type="checkbox"/> Counter drug Operations (CD) | <input type="checkbox"/> Humanitarian Assistance (HA) | <input type="checkbox"/> Security Assistance (SA) |
| <input type="checkbox"/> Humanitarian Demining (HD) | <input type="checkbox"/> Coalition Support (CS) | <input type="checkbox"/> Noncombatant Evacuation NEO |
| <input type="checkbox"/> Cbt Search and Rescue (CSAR) | <input type="checkbox"/> Peacekeeping (PKO) | <input type="checkbox"/> Special Activities |
| <input type="checkbox"/> Other (specify): _____ | | |

How many times have you used the DEVICE?

Once

2-5 Times

More Than 5 Times

How many total hours of mission usage would you estimate are included in this evaluation?

List date, time of day, number of hours of used, weather conditions, lighting conditions, and mission for each employment of the DEVICE included in this evaluation (to the best of your memory)?

Please indicate specific functions you performed using the DEVICE (check all that apply):

- | | | |
|-------------------------------------------------|--------------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Checkpoint operations | <input type="checkbox"/> Crowd control | <input type="checkbox"/> Force Protection |
| <input type="checkbox"/> Medical care/treatment | <input type="checkbox"/> Commercial transactions | <input type="checkbox"/> Liaison |
| <input type="checkbox"/> Other (specify): _____ | | |



MLT SYSTEM ASSESSMENT USER QUESTIONNAIRE
Your feedback on your use of machine translation technologies is critical in the continued development and refinement of this revolutionary capability. The development community and the Warfighters that follow thank for your time and effort!



1. How do you rate the overall ease of use of the DEVICE?

Excellent Good Fair Poor Unsatisfactory

2. How do you rate the hardware's performance and reliability?

Excellent Good Fair Poor Unsatisfactory

3. How do you rate the software's performance and reliability?

Excellent Good Fair Poor Unsatisfactory

4. How confident are you that the DEVICE accurately translated your message?

Very Somewhat Not Sure Not Very Not at All

5. How do you rate the speed of the translation provided by DEVICE?

Excellent Good Fair Poor Unsatisfactory

6. How do you rate the ruggedness and survivability of the DEVICE?

Excellent Good Fair Poor Unsatisfactory

7. How do you rate the training provided on the use of the DEVICE?

Excellent Good Fair Poor Unsatisfactory

8. Did you experience any maintenance problems or malfunctions?

Often (more than twice) Occasionally (once or twice) Never

9. What is your opinion of the value of DEVICE to your unit?

Must Have Some Value Not Sure Little Value No Value

10. How do you rate the DEVICE Training?

Excellent Good Fair Poor Unsatisfactory

11. What improvements would you make to the training?



MLT SYSTEM ASSESSMENT USER QUESTIONNAIRE

Your feedback on your use of machine translation technologies is critical in the continued development and refinement of this revolutionary capability. The development community and the Warfighters that follow thank for your time and effort!



COMMENTS

Briefly explain any maintenance problems or malfunctions you experienced.

Was there anything you feel needs improvement?

Do you have any suggestions on the hardware configuration (placement of buttons, etc.)?