

DARPA SHREDDER CHALLENGE

Fiscal Year 2012 Report

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1 BACKGROUND

Section 2374a of Title 10 of the United States Code authorizes the Secretary of Defense, acting through the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)), and the Service acquisition executive of each military department, to conduct programs to award up to \$10 million in cash prizes to recognize outstanding achievements in basic, advanced, and applied research; technology development; and prototype developments that are potentially applicable to the military missions of the Department of Defense (DoD) (see Appendix A). ASD(R&E) delegated authority under 10 U.S.C. § 2374a to the Director of the Defense Advanced Research Projects Agency (DARPA) to conduct the Shredder Challenge.

This report describes DARPA's FY 2012 activities under the delegated prize authority and the Shredder Challenge.

Today's troops confiscate remnants of destroyed documents in war zones, and reconstructing them is a daunting task. DARPA held the Shredder Challenge to stimulate new technological solutions to the problem of reconstructing handwritten, shredded documents.

The Shredder Challenge called upon participants to piece together a series of shredded documents using any means available, including manual methods, computerized methods, and crowd sourcing. Five one-sided handwritten documents were shredded into more than 10,000 pieces, and the images of the shredded pieces were posted online. Document subject matter and the degree of shredding were varied to present problems of increasing difficulty. To complete each problem, participants provided answers to questions embedded in the content of reconstructed documents, with the intent of mirroring the problem facing an intelligence analyst with a similar task. Competitors were awarded points according to an established rubric for successfully reconstructing documents and to a sufficient degree that they could answer embedded questions.

DARPA announced the Shredder Challenge on October 27, 2011, via the DARPA website, Facebook page, and Twitter feed with an end date of December 16, 2011, if no competitor completed the Challenge before then.

The Shredder Challenge website received approximately 9.6 million hits and 8,981 registrants. Participants used a variety of methods including manual methods, textual analysis, statistical methods, and crowd sourcing to produce a solution. On December 2, 2011, DARPA announced the winner, a San Francisco-based team called "All Your Shreds Are Belong to U.S." The team correctly completed all five problems and solved the puzzles, winning the \$50,000 prize. The winning team spent nearly 600 man-hours developing and custom-coding computer-vision algorithms to suggest fragment pairings to human assemblers for verification.

The Shredder Challenge successfully produced innovative document reconstruction technologies that combined computational, algorithmic, and human-oriented approaches. It increased the understanding of potential vulnerabilities inherent to document-shredding practices within the information security and military communities. Top teams provided a very well-received demonstration of methods and results for DARPA and interested practitioners.

2 PROGRAM GOALS

The goal of the DARPA Shredder Challenge was to accelerate technological solutions and problem-solving techniques enabling the reconstruction of shredded documents at the tactical edge.

Specifically, the program goals were to:

- Identify and assess potential capabilities that could be used by warfighters to more quickly obtain valuable information from confiscated, shredded documents.
- Gain a quantitative understanding of potential vulnerabilities inherent to the shredding of sensitive U.S. National Security documents.

DARPA managed the Shredder Challenge to meet these goals using the prize authority.

3 PRIZE AUTHORITY UTILIZATION

To execute the DARPA Shredder Challenge, participants were challenged to reconstruct five shredded documents and were awarded points commensurate with the difficulty of the reconstruction. The Challenge simulated the problem faced by today's warfighters of reconstructing destroyed documents in war zones. The Shredder Challenge leveraged social networking for a timely solution of this complex technical problem by opening the competition to the widest number of participants. The \$50,000 prize created the required incentive. Prize authority made it possible to work with thousands of individuals, most of whom had never worked with DoD. The competition would not have been possible using standard authorities such as contracts, grants, or cooperative agreements.

4 CASH PRIZES AWARDED

On December 2, 2011, the winning team "All Your Shreds Are Belong to U.S." from San Francisco, California, was awarded \$50,000 as the first team to reconstruct five documents and solve the puzzle. The top ten teams are listed in Appendix B.

5 SOLICITATION AND EVALUATION METHODS

The DARPA Shredder Challenge was announced on October 27, 2011, in a web feature posted on the DARPA homepage and reported in national media and social media outlets such as *Wired*, *ABC News*, and *Popular Science*. To complete each problem, participants submitted reconstructed documents and answers to puzzles within the shredded content.

Puzzles were correctly solved by 125 teams, and 41 teams solved more than two puzzles. Successful teams used computational, crowd-sourcing, and human assembly. Points were awarded per puzzle as follows: puzzle 1 = 2 points; puzzle 2 = 4 points; puzzle 3 = 8 points; puzzle 4 = 12 points; and puzzle 5 = 24 points. The team with the highest score, "All Your Shreds Are Belong to U.S." received \$1,000 per point for a total prize award of \$50,000.

Appendix C shows the original and reconstructed documents submitted by the winning team, "All Your Shreds Are Belong to U.S."

6 RESOURCES

The DARPA Shredder Challenge was conducted online and was organized by Government staff members and support contractors.

Prize funds were drawn from the Program Elements (PE) and projects as follows:

PE	Project	Title	FY11	Total
0602303E	IT-02	Information & Communications Technology	\$50,000	\$50,000

7 TECHNOLOGY TRANSITION

The DARPA Shredder Challenge was a successful demonstration of the potential of an integrated human-machine approach to solve large, complex problems that would be nearly impossible by any other means. DARPA discussed the results with several organizations within the law enforcement, military, and intelligence communities including the Federal Bureau of Investigation Questioned Documents Unit, Army G2 Document and Media Exploitation, and Sandia National Laboratories.

8 CONCLUSION

The DARPA Shredder Challenge achieved its goals and stimulated interest in the programs and projects of interest to the DoD science and technology community. The event attracted a large pool of nontraditional participants. The varied methods used have potential implications for problems generally considered unsolvable by conventional means. This result promises to inspire a new class of problem solving approaches in areas important to National Security.

APPENDIX A

PRIZE AUTHORITY STATUTE

The prize authority statute, section 2374a of U.S. Code Title 10 was amended by Section 257 of the National Defense Authorization Act of 2006 and Section 212 of the National Defense Authorization Act of 2007 as follows:

§ 2374a. Prizes for advanced technology achievements

(a) Authority. The Secretary of Defense, acting through the Director of Defense Research and Engineering and the service acquisition executive for each military department, may carry out programs to award cash prizes in recognition of outstanding achievements in basic, advanced, and applied research, technology development, and prototype development that have the potential for application to the performance of the military missions of the Department of Defense.

(b) Competition requirements. Each program under subsection (a) shall use a competitive process for the selection of recipients of cash prizes. The process shall include the widely-advertised solicitation of submissions of research results, technology developments, and prototypes.

(c) Limitations.

(1) The total amount made available for award of cash prizes in a fiscal year may not exceed \$10,000,000.

(2) No prize competition may result in the award of more than \$1,000,000 in cash prizes without the approval of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

(d) Relationship to other authority. A program under subsection (a) may be carried out in conjunction with or in addition to the exercise of any other authority of an official referred to in that subsection to acquire, support, or stimulate basic, advanced and applied research, technology development, or prototype projects.

(e) Annual report.

(1) In general. Not later than March 1 of each year, the Secretary shall submit to the Committee on Armed Services of the Senate and the Committee on Armed Services of the House of Representatives a report on the activities carried out during the preceding fiscal year under the authority in subsection (a).

(2) Information included. The report for a fiscal year under this subsection shall include, for each program under subsection (a), the following:

(A) A description of the proposed goals of the competitions established under the program, including the areas of research, technology development, or prototype development to be promoted by such competitions and the relationship of such areas to the military missions of the Department of Defense.

(B) An analysis of why the utilization of the authority in subsection (a) was the preferable method of achieving the goals described in subparagraph (A) as opposed to other authorities available to the Department, such as contracts, grants, and cooperative agreements.

(C) The total amount of cash prizes awarded under the program, including a description of the manner in which the amounts of cash prizes awarded and claimed were allocated among the accounts of the Department for recording as obligations and expenditures.

(D) The methods used for the solicitation and evaluation of submissions under the program, together with an assessment of the effectiveness of such methods.

(E) A description of the resources, including personnel and funding, used in the execution of the program, together with a detailed description of the activities for which such resources were used and an accounting of how funding for execution was allocated among the accounts of the Department for recording as obligations and expenditures.

(F) A description of any plans to transition the technologies or prototypes developed as a result of the program into an acquisition program of the Department.

(3) Suspension of the authority for failure to include information. For each program under subsection (a), the authority to obligate or expend funds under that program is suspended as of the date specified in paragraph (1) if the Secretary does not, by that date, submit a report that includes, for that program, all the information required by paragraph (2). As of the date on which the Secretary does submit a report that includes, for that program, all the information required by paragraph (2), the suspension is lifted.

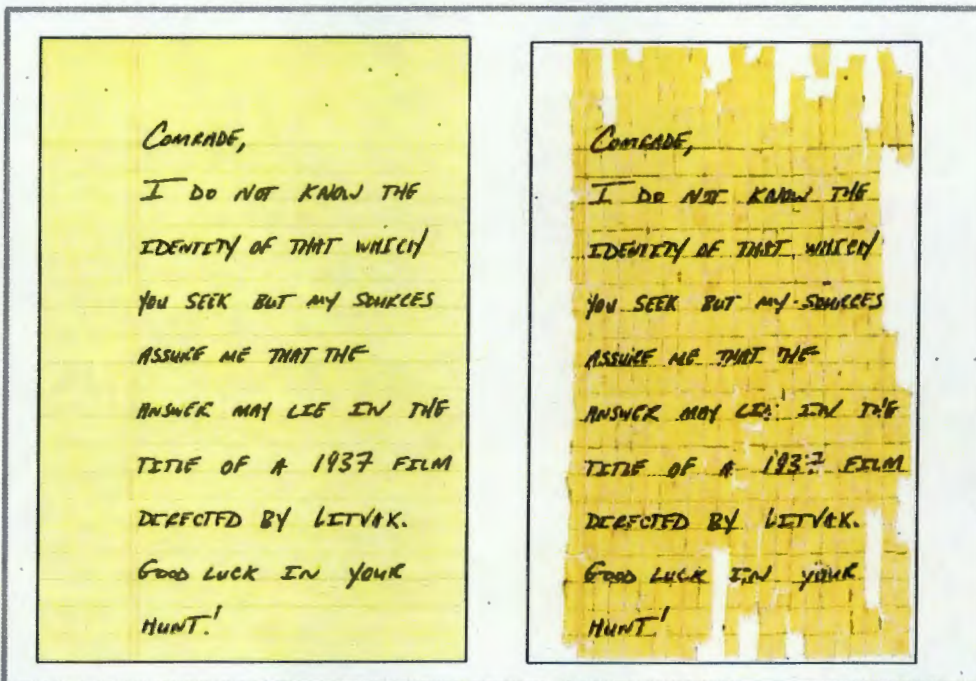
(f) Period of authority. The authority to award prizes under subsection (a) shall terminate at the end of September 30, 2013.

APPENDIX C

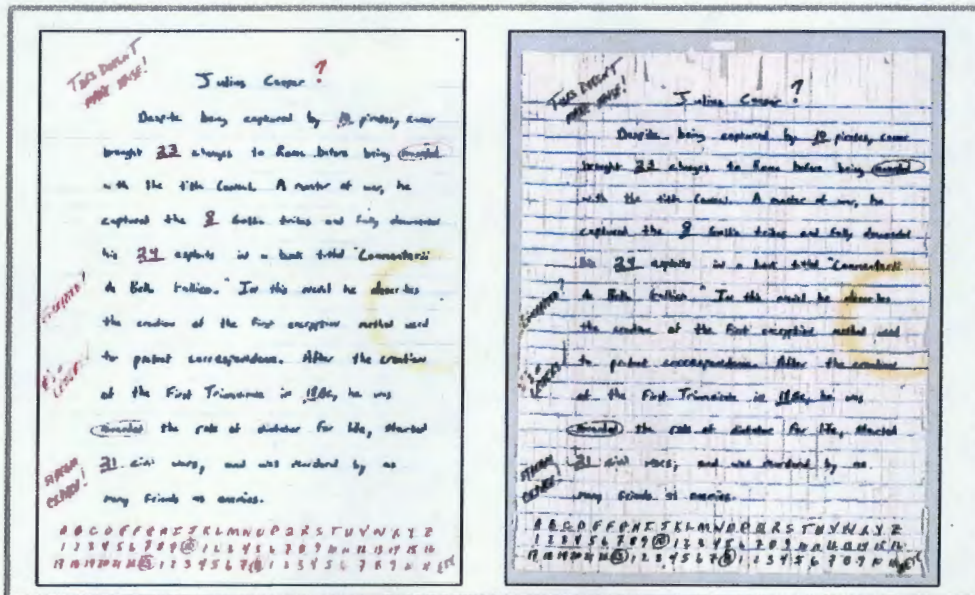
SHREDDER CHALLENGE PUZZLES

Original and reconstructed documents submitted by the winning team, "All Your Shreds Are Belong to U.S."

Puzzle 1



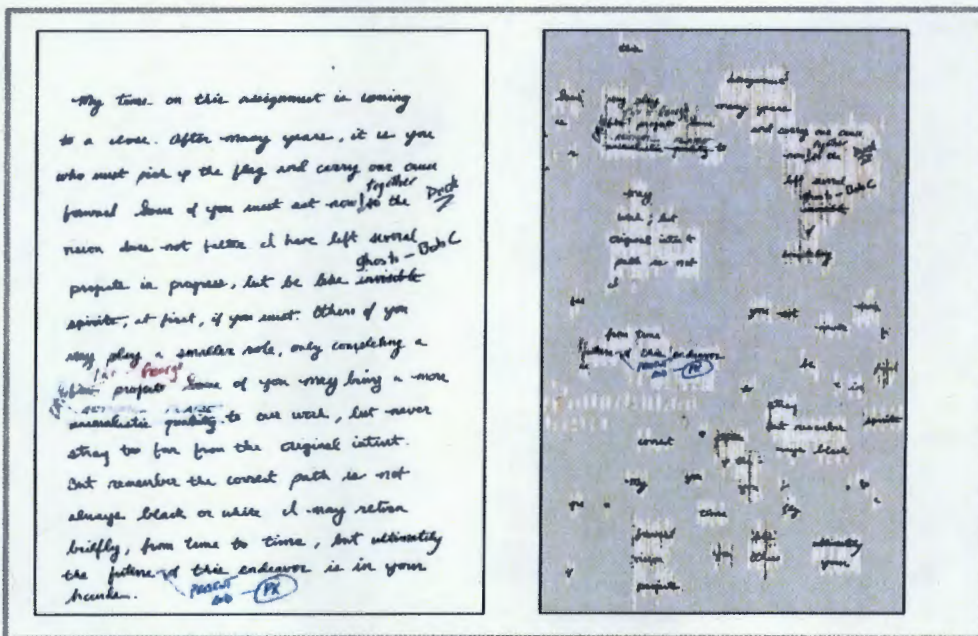
Puzzle 2



Puzzle 3



Puzzle 4



Puzzle 5, Page 3 of 3

<p>TEAM A 3:25M Subject X punches into DDEP code and later a card reads a call over DDEP code. Subject begins to type a message into phone.</p>	
<p>TEAM B 3:26M Subject Y punches into DDEP code and later a card approximately 25 meters from Subject X. Subject Y comes down again and appears to press button.</p>	<p>3:25M Subject X punches into DDEP code and later a card reads a call over DDEP code. Subject begins to type a message into phone.</p>
<p>TEAM A 3:26M Interrupted Card transmission appearing to be finished.</p>	<p>3:26M Subject Y comes down again and appears to press button.</p>
<p>TEAM A 3:30M Subject X reports DDEP code being set on Patent. Subject appears to be in a hurry and is being around frantically.</p>	<p>3:26M Interrupted Card transmission appearing to be finished.</p>
<p>TEAM B 3:31M Subject Y reports DDEP code being set on Patent. Subject appears calm and even smiling as he talks Subject X directly.</p>	<p>3:30M Subject X reports DDEP code being set on Patent. Subject appears to be in a hurry and is being around frantically.</p>
<p>TEAM A 3:37M Subject X moves with a Museum Art #11, heads towards Paul Observatory, walking around Cabinet before he sets up back at the final being building he reaches under the canopy. Subject Y appears across the code while the building.</p>	<p>3:31M Subject Y reports DDEP code being set on Patent. Subject appears calm and even smiling as he talks Subject X directly.</p>
<p>TEAM B 3:38PM Subject Y enters building Subject X. Subject Y makes some looking down the street that he was in the morning and assumes a random position.</p>	<p>3:37M Subject X moves with a Museum Art #11, heads towards Paul Observatory, walking around Cabinet before he sets up back at the final being building he reaches under the canopy. Subject Y appears across the code while the building.</p>
<p>TEAM A 3:41M The museum staff notices that not with Subject X the morning onto the final being building and converses briefly with Subject Y. The U/I appears to make a short phone call and a working ball suddenly smashes into and demolishes the building occupied by Subject Y. Subject X and U/I appear to be shouting and congratulating themselves.</p>	<p>3:38PM Subject Y enters building Subject X. Subject Y makes some looking down the street that he was in the morning and assumes a random position.</p>