

Preparing Classified and Limited Disclosure FINAL Papers

Classified Technical Program

General Information and Instructions

- Please follow all instructions carefully. Omitting any step can jeopardize acceptance of your paper for MILCOM 2001.
- Final papers are due *no later than July 31, 2001*.
- Include your Paper Tracking Number as well as the Session to which you are submitting your paper.
- Hard copy submission of your paper is required. Send three (3) copies of your final paper to MILCOM 2001 Classified Technical Program Security:

**MILCOM 2001 Security
The MITRE Corporation
7515 Colshire Dr.
Mail Stop N120
McLean, VA 22102**

Paper Format Specifications

Prepare your paper using 8-1/2 x 11 in (21.6 cm x 29.9 cm) format. Image area should not exceed 7-1/2 x 9-1/2 in. All tables, charts, scans of photographs, and artwork should be embedded within the text. Papers should be no more than five pages in length.

Top margin	1/2 in
Bottom margin	1 in
Right and left margins	1/2 in
Column layout	2-column, 3-5/8 in per column, justified
Paper title	All caps, centered, 12 pt Times Roman Bold
Headings	All caps, centered, 11 pt Times Roman Bold
Text font	11 pt Times Roman, single space
Figures	Figure number and title go below each figure
Tables	Table number and title go below each table
Page numbers	Centered at bottom of page, 9 pt Times Roman
Abstract	Must be the first paragraph, 11 pt Times Roman Italic

Fonts

The following fonts are considered *base fonts* and you are encouraged to limit your font selections to this list. Using only the specified fonts provides a consistent look to all material in the Classified Proceedings. *Please note that Times/Times New Roman is the preferred font.*

Arial	Helvetica-Italic
Courier	Helvetica-Bold Italic
Courier-Bold	Symbol
Courier-Italic	Times/Times New Roman
Courier-Bold Italic	Times-Bold
Helvetica	Times-Bold-Italic
Helvetica-Bold	Zapf Dingbats

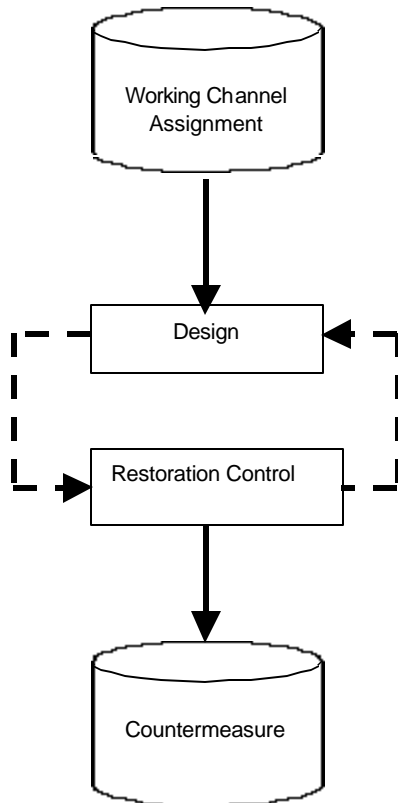
Preparing Classified and Limited Disclosure FINAL Papers

Classified Technical Program

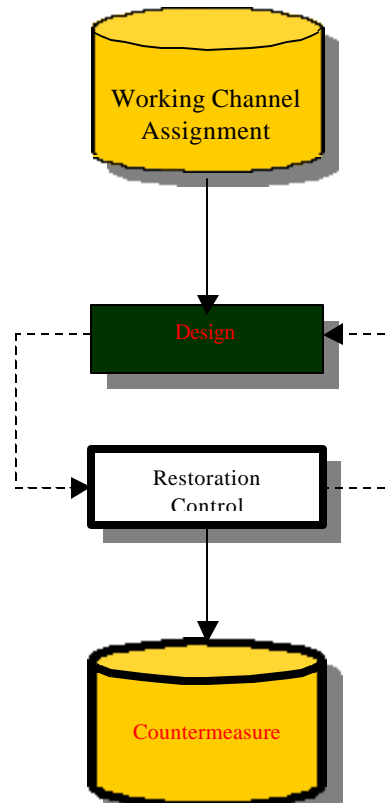
Graphics and Images

- Line selection should be simple (a number 1 line with a number 2 line used for emphasis).
- Shading should be kept at a minimum; use only to show emphasis or flow.
- Text should be sans serif (Helvetica, Arial, etc.), black; do not use color or shadow text.
- Do not submit any hand-drawn artwork or text. Good and Poor art examples are shown below.

Good Artwork



Bad Artwork



Preparing Classified and Limited Disclosure FINAL Papers

Classified Technical Program

Transmittal of Classified Material

Transmit classified material in accordance with the DoD *National Industrial Security Program Operating Manual (NISPOM)*. All required approvals must be submitted with the final manuscript.

Instructions for Marking Classified Papers

Follow the directions carefully. Incorrectly marked papers cannot be published. The Classification Marking Example shows a properly marked document. Format, typing, and instructions for unclassified papers also apply to classified papers.

The first page must reflect the overall classification of the paper and each subsequent page must be marked to reflect the highest classification of the information on that page. Be sure to label all pages that do not contain classified material as unclassified and mark all such portions with (U). Use 11 point Times Roman bold font for the classification markings centered at the top and bottom of the pages.

All of the following information must appear on the first page:

- Title followed by classification of the title in parentheses. All titles must be unclassified.
- Author and the name, city, and state of organization responsible for preparing the paper
- Date of submission
- Derived from, Declassify on, must be placed in the upper right corner of the page

Classification Sources

To complete the "Derived from" line, identify the applicable DD Form 254 or other classification guide. If the source is DD Form 254, include the date and applicable contract number. If the source is a classification guide, identify the guide and its date. If there are two guides, cite both. If there are more than two guides use the phrase "Multiple Sources." Include a bibliography of the multiple sources.

Portion Marking

Mark each section, part, paragraph, subparagraph, or portion to show the level of classification or that a portion is unclassified. Use a capital letter in parentheses: (S), (C) or (U).

The Classification Marking Example shows a properly marked Classified document. For Unclassified U.S. Only documents, mark top and bottom of pages with UNCLASSIFIED/US ONLY and portion mark (U) and (U/JO) as appropriate.

SECRET/US ONLY

**A NULLING ALGORITHM FOR
MULTI-APERTURE MULTIPLE BEAM ANTENNAS (U)**

James W. Marshall
Ann Q. Le

The MITRE Corporation
Signal Processing and Advanced Technology Department
Reston, Virginia
July 8, 1998

Date of Submission _____
Derived from _____
Declassify on _____

(U) ABSTRACT
(U) Several multi-aperture multiple beam antennas (MA-MBA) designs have been proposed for future military communications satellites to satisfy demands for increased nulling resolution against jammers. However, overall network performance can be severely degraded because of spurious nulls that are associated with MA-MBA antennas. In this paper we propose and analyze a nulling algorithm that improves overall network performance by reducing potential performance degradation caused by MA-MBA antenna spurious nulls while providing high jamming resolution. This algorithm also provides wide area coverage for network users near a jammer in support of tactical scenarios. We show that optimized beam weights are a function of individual user optimum beam weights along with proper phase rotation for each beam. Computer simulated results are then provided illustrating performance of this proposed technique versus another nulling algorithm developed for Defense Satellite Communication System (DSCS) Super High Frequency (SHF) satellites.

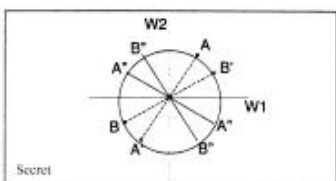
(U) INTRODUCTION
(U) Multiple beam antennas (MBA) are frequently used on military communications satellites especially to receive the uplink signal so that good gain patterns can be developed in the direction of user terminals while simultaneously providing nulls in the direction of uplink jammers. Recently, the use of additional apertures has been investigated as a means of improving the jammer nulling resolution of these MBAs. In addition to improving nulling resolution, the rapidly changing phase gradients across the field of view of these multi-aperture MBA (MA-MBA) can also provide spurious nulls in the gain pattern. These spurious can seriously degrade the overall gain pattern of these antennas especially for scenarios where a number of desired user terminals are in close proximity to the jammer.

(U) Antenna gain patterns for MBAs, in general, are determined by the complex valued multiplication factors, called beam weights, applied to each beam. Many algorithms have been developed for determining these beam weights. These algorithms attempt to achieve good gain toward desired terminals while simultaneously

providing nulls in the direction of jammer terminals. Unfortunately, many of these algorithms do not adequately address the problem of spurious nulls with the result that some user terminals may have lower gain than desired.

(U) METHODOLOGY
(U) Good antenna gain patterns must provide gain toward desired terminals while simultaneously exhibiting nulls in the direction of jammers. This latter requirement can be considered a constraint on the beam weight vector and this constraint can be imposed simply by working in the null space of the antennas response to the jammer or jammers. Consequently the dimensionality of the problem is reduced and gains are determined while ensuring the jammers are nulled. The problem is further constrained such that the norm of the beam weight vector is unity. By appropriate normalization of the basis vectors for the null space, this unity norm constraint applies in both the null space and in the full beam weight space. The remaining problem is to find beam weights in the null space which provide good gains toward the desired user terminals.

(U) The need for beam weight phase rotation can be understood by first considering the special case of real beam weights and then extending the problem to include complex valued beam weights. Consider a two dimensional problem without a jammer as shown in Figure 1.



Secret

Figure 1. (U) Two Dimensional Example with Real Weights
(U) As shown in Figure 1, two weights must be selected, W1 and W2. Because there is constraint on the norm of the

1

SECRET/US ONLY

This paper sample is unclassified. Security markings are for illustration purposes only.

Preparing Classified and Limited Disclosure FINAL Papers

Classified Technical Program

Headings, Subheads and Captions

Place the marking before the first word of a heading, subheading or caption. This marking must indicate only the classification of that item except when a second-level heading is included in the first line of a paragraph. In this case, the marking must show the classification of the paragraph.

Lists are marked as follows:

- a. (U) Items preceded by letters
- b. (U) Items in list preceded by numbers
 1. (S) This subordinate portion contains (SECRET) information
 2. (C) This subordinate portion contains (CONFIDENTIAL) information

Footnotes

Mark each narrative footnote with its own classification preceding the footnote.

Illustrations

Within a box, fully enclose each illustration, photograph, figure, graph, drawing, chart, table and similar display material, and clearly show its classified or unclassified status. Do not abbreviate. Place the classification marking in the lower left corner of the box.

Figure Captions

Use a letter in parentheses to indicate the classification of a figure caption. Place the classification marking between the figure number and first word of the caption. Type the caption centered below the image area.

Figure 1. (U) Sample Caption

Tables

Use a letter in parentheses to indicate the classification of a table title. Type the table number and title below the table on one line with the classification marking between the number and first word. Type the table classification of the table itself in the lower left corner of the table.

Table 1. (U) Sample Title

References

Place the classification of the document after the title when referencing classified sources.

No identifier is required after the title when referencing unclassified sources.

Final papers are due July 31, 2001

Frequently Asked Questions

Q. How will I know if my paper was received?

A. You will receive a confirmation email when your paper is received.

Q. I have submitted two different versions of my paper. How do you know which one to use?

A. You will print the date on the first page. When a newer version arrives, all previous versions will be removed from the review process. Please indicate your Paper Tracking Number.

Q. If I have questions regarding my paper or forms, who can I contact?

A. Email: lap@mitre.org or call 703-883-7273. Always refer to MILCOM 2001 and the Paper Tracking Number that you were assigned.

Q. Due to sponsor sensitivity, I am submitting an unclassified paper for inclusion in the Classified Technical Program. How should I handle the markings?

A. Prepare your paper according to the directions for formatting classified papers, and submit a hard copy as for the Classified Technical Program.