



## ➤ Metal Vapor Arcing Risk Assessment Tool

Lyndon B. Johnson Space Center, Houston, Texas

The Tin Whisker Metal Vapor Arcing Risk Assessment Tool has been designed to evaluate the risk of metal vapor arcing and to help facilitate a decision toward a researched risk disposition. Users can evaluate a system without having to open up the hardware. This process allows for investigating components at risk rather than spending time and money analyzing every component. The tool points

to a risk level and provides direction for appropriate action and documentation.

*This process was written by Monika C. Hill of The Boeing Company and Henning W. Leidecker of Goddard Space Flight Center for Johnson Space Center.*

*Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457(f)), to The Boeing Company. Inquiries concern-*

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*Refer to MSC-24300, volume and number of this NASA Tech Briefs issue, and the page number.*

## ➤ Performance Bounds on Two Concatenated, Interleaved Codes

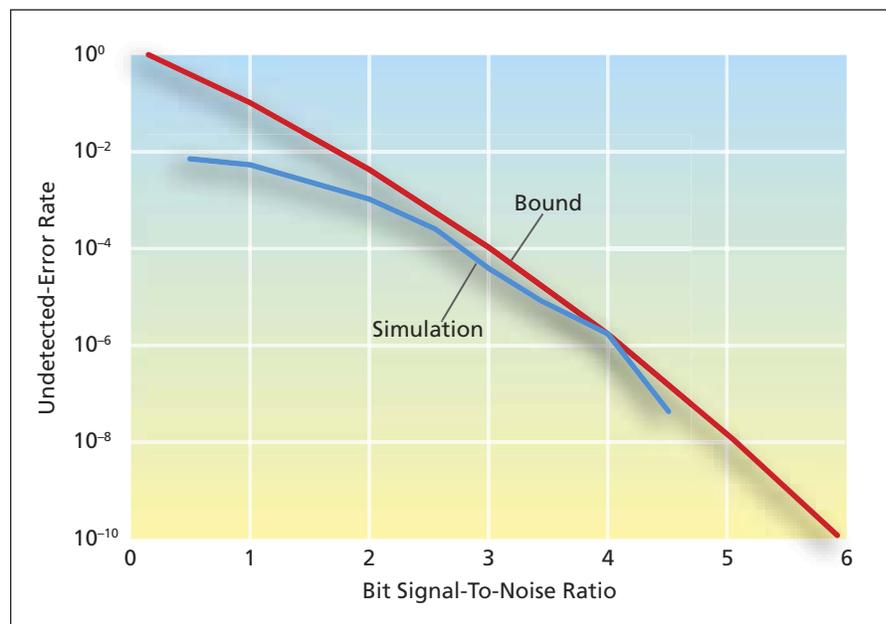
**It is now possible to calculate tight bounds at high SNR.**

NASA's Jet Propulsion Laboratory, Pasadena, California

A method has been developed of computing bounds on the performance of a code comprised of two linear binary codes generated by two encoders serially concatenated through an interleaver. Originally intended for use in evaluating the performances of some codes proposed for deep-space communication links, the method can also be used in evaluating the performances of short-block-length codes in other applications.

The method applies, more specifically, to a communication system in which following processes take place:

- At the transmitter, the original binary information that one seeks to transmit is first processed by an encoder into an outer code ( $C_o$ ) characterized by, among other things, a pair of numbers  $(n, k)$ , where  $n$  ( $n > k$ ) is the total number of code bits associated with  $k$  information bits and  $n-k$  bits are used for correcting or at least detecting errors. Next, the outer code is processed through either a block or a convolutional interleaver. In the block interleaver, the words of the outer code are processed in blocks of  $I$  words. In the convolutional interleaver, the interleaving operation is performed bit-wise in  $N$  rows with delays that are multiples of  $B$  bits. The output of the interleaver is processed through a second encoder to obtain an inner code ( $C_i$ ) characterized by  $(n_i, k_i)$ .
- The output of the inner code is transmitted over an additive-white-Gauss-



The Undetected-Error Rate of one of the coding/decoding communication systems studied in this research was determined by computational simulation and is compared here with the upper bound on the undetected-error rate calculated by the present method.

ian- noise channel characterized by a symbol signal-to-noise ratio (SNR)  $E_s/N_o$  and a bit SNR  $E_b/N_o$ .

- At the receiver, an inner decoder generates estimates of bits. Depending on whether a block or a convolutional interleaver is used at the transmitter, the sequence of estimated bits is processed through a block or a convolutional de-interleaver, respectively, to

obtain estimates of code words. Then the estimates of the code words are processed through an outer decoder, which generates estimates of the original information along with flags indicating which estimates are presumed to be correct and which are found to be erroneous.

From the perspective of the present method, the topic of major interest is the

performance of the communication system as quantified in the word-error rate and the undetected-error rate as functions of the SNRs and the total latency of the interleaver and inner code. The method is embodied in equations that describe bounds on these functions. Throughout the derivation of the equations that embody the method, it is assumed that the decoder for the outer code corrects any error pattern of  $t$  or fewer errors, detects any error pattern of  $s$  or fewer errors, may detect some error patterns of more than  $s$  errors, and does not correct any patterns of more than  $t$  er-

rors. Because a mathematically complete description of the equations that embody the method and of the derivation of the equations would greatly exceed the space available for this article, it must suffice to summarize by reporting that the derivation includes consideration of several complex issues, including relationships between latency and memory requirements for block and convolutional codes, burst error statistics, enumeration of error-event intersections, and effects of different interleaving depths.

In a demonstration, the method was used to calculate bounds on the per-

formances of several communication systems, each based on serial concatenation of a (63,56) expurgated Hamming code with a convolutional inner code through a convolutional interleaver. The bounds calculated by use of the method were compared with results of numerical simulations of performances of the systems to show the regions where the bounds are tight (see figure).

*This work was done by Bruce Moision and Samuel Dolinar of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-44652*

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## ➤ Parameterizing Coefficients of a POD-Based Dynamical System

**This parameterization enables accurate prediction of temporal evolution of certain flow dynamics.**

*Goddard Space Flight Center, Greenbelt, Maryland*

A method of parameterizing the coefficients of a dynamical system based on a proper orthogonal decomposition (POD) representing the flow dynamics of a viscous fluid has been introduced. (A brief description of POD is presented in the immediately preceding article.) The present parameterization method is intended to enable construction of the dynamical system to accurately represent the temporal evolution of the flow dynamics over a range of Reynolds numbers.

The need for this or a similar method arises as follows: A procedure that includes direct numerical simulation followed by POD, followed by Galerkin projection to a dynamical system has been proven to enable representation of flow dynamics by a low-dimensional model at the Reynolds number of the simulation.

However, a more difficult task is to obtain models that are valid over a range of Reynolds numbers. Extrapolation of low-dimensional models by use of straightforward Reynolds-number-based parameter continuation has proven to be inadequate for successful prediction of flows.

A key part of the problem of constructing a dynamical system to accurately represent the temporal evolution of the flow dynamics over a range of Reynolds numbers is the problem of understanding and providing for the variation of the coefficients of the dynamical system with the Reynolds number. Prior methods do not enable capture of temporal dynamics over ranges of Reynolds numbers in low-dimensional models, and are not even satisfactory when large numbers of modes are used.

The basic idea of the present method is to solve the problem through a suitable parameterization of the coefficients of the dynamical system. The parameterization computations involve utilization of the transfer of kinetic energy between modes as a function of Reynolds number. The thus-parameterized dynamical system accurately predicts the flow dynamics and is applicable to a range of flow problems in the dynamical regime around the Hopf bifurcation. Parameter-continuation software can be used on the parameterized dynamical system to derive a bifurcation diagram that accurately predicts the temporal flow behavior.

*This work was done by Virginia L. Kalb of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15131-1*

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## ➤ Confidence-Based Feature Acquisition

**Selective acquisition of data values enables higher classification performance at lower cost.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Confidence-based Feature Acquisition (CFA) is a novel, supervised learning method for acquiring missing feature values when there is missing data at both training (learning) and test (deployment) time. To train a machine learning classifier, data is encoded with a series of input features describing each item. In some applications, the training data may have missing values for some of the fea-

tures, which can be acquired at a given cost. A relevant JPL example is that of the Mars rover exploration in which the features are obtained from a variety of different instruments, with different power consumption and integration time costs. The challenge is to decide which features will lead to increased classification performance and are therefore worth acquiring (paying the cost).

To solve this problem, CFA, which is made up of two algorithms (CFA-train and CFA-predict), has been designed to greedily minimize total acquisition cost (during training and testing) while aiming for a specific accuracy level (specified as a confidence threshold). With this method, it is assumed that there is a non-empty subset of features that are "free;" that is, every instance in the data set in-