

Veil V-RAM Technology

Evaluation of Veil Rights Assertion Mark Technology

Report of Findings Executive Summary

NationalTeleConsultants®

Project N3683-A

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Executive Summary

National TeleConsultants has performed an evaluation of technology provided by Veil Interactive Technologies to embed a Rights Assertion Mark (RAM) within a video signal to identify the video program as containing copyrighted material. The RAM would indicate to a downstream recording device that it should inspect the Copy Generation Management System (CGMS-A) data in the vertical blanking interval of the video signal to determine the copying activities authorized by the copyright holder. Presence of a RAM without corresponding CGMS-A data would imply tampering with the video signal had occurred and recording could then be disabled.

The technology evaluation examined three aspects of the Veil RAM (V-RAM) system:

- Vulnerability of the V-RAM signal to video impairments

Video containing the V-RAM signal was subjected to various impairments that may be encountered in normal program distribution as well as impairments designed to circumvent V-RAM detection. V-RAM detection rates for the impaired video were compared with V-RAM detection rates for unimpaired video.

- Probability of false detection of a V-RAM signal

An analysis of the probability of falsely detecting a V-RAM signal in unencoded video was undertaken to ensure that the system would provide an acceptably low probability of false detection. The CE industry has requested a false detection rate of a one in one trillion [false detection probability of 1×10^{-12}] and the content industry has countered with a false detection rate of one in one hundred million [false detection probability of 1×10^{-8}]. This analysis was performed on samples of unencoded broadcast video received off-air from five different networks over a five-week period.

- Visibility of the V-RAM signal

Visibility tests were performed using three different large-screen progressive-scan display technologies. Forty-six viewers from eight organizations participated in the tests.

Summary Results

- **V-RAM Signal Detection**

The following table contains the results of the detection tests. Higher V-RAM detection numbers indicate greater immunity to the video impairment indicated. Some video impairments resulted in unwatchable images. Only results yielding generally acceptable pictures are reported in this summary table.

Video Impairment	V-RAM Detections
None (Baseline)	26 (100%)
Impairment A	25 (96%)
Impairment B	24 (92%)
Impairment C	22 (85%)
Impairment D	21 (81%)
Impairment E	18 (69%)
Impairment F	17 (65%)
Impairment G	18 (69%)
Impairment H	26 (100%)
Impairment I	11 (42%)
Impairment J	25 (96%)

- **False Detection Probability**

A statistical analysis of over 880 hours of unencoded off-air video was performed to estimate the probability of a V-RAM detection occurring when a V-RAM detector is presented with unencoded video. The analysis was performed by Dr. David O. Siegmund and Dr. Guenther Walther of the Department of Statistics at Stanford University. Dr. Siegmund is Chairman of the Department of Statistics and Dr. Walther is an Associate Professor of Statistics.

The statistical analysis was performed using several techniques to model the data and estimate the false detection rate. The results of these analyses are summarized in the following table:

False Detection Rate Estimates

Analysis Model	False Detection Rate	Average Unique Content Duration Before False Detection
Independence Model	$< 3.4 \times 10^{-42}$ per Frame	$> 3 \times 10^{32}$ Years
Markov Chain (Empirical Transition Probabilities)	$< 1.2 \times 10^{-24}$ per Frame	$> 9.5 \times 10^{14}$ Years
Markov Chain (Estimated Transition Probabilities)	$< 1.2 \times 10^{-13}$ per Frame	$> 9,500$ Years

All of these results exceed the false detection rate of one in 100 million [1 in 10^8] proposed by the content providers and the false detection rate of one in one trillion [1 in 10^{12}] requested by the Consumer Electronics industry.

- **V-RAM Signal Visibility**

During each visibility test a viewer was shown 35 ten-second clips. Each clip was presented twice; once with V-RAM encoding and once without V-RAM encoding. The order of presentation of the encoded and unencoded versions of each clip was randomly selected and was not known to the viewer. The viewers were asked to identify the version of the clip containing the V-RAM signal and to rate its level of visibility. Most viewers participated in two visibility tests: one in which the video source was a broadcast video server and one in which the video source was a DVD player.

During the visibility tests a total of 3,045 clip comparisons were performed by 46 viewers representing eight organizations. In 2,175 (71%) of the comparisons the viewers indicated that there was no perceptible difference between clip versions, i.e. no visibility of the V-RAM signal. In 870 (29%) of the comparisons the viewers indicated a perceptible difference between clip versions presumably caused by the presence of the V-RAM signal in one version of the clip. Viewers correctly identified the clip containing the V-RAM signal in 434 of the 870 comparisons or 49.9% of the time. This is very close to the 50% result that would be expected from random selection of the clips.

The visibility test results were further analyzed by video source (uncompressed server or DVD) and by display type (HD-ILA, LCD, or DLP). In these test subsets the percentage of comparisons in which the viewer perceived a difference between clip versions and correctly identified the clip containing the V-RAM signal was in the range of 49.3% to 52.8%.