

## Encoding of Multispectral Imagery for On-Board Compression

**Goal:** Develop algorithms/software to facilitate efficient on-board compression of multispectral images.

**Why:** Software capable of efficient multispectral image compression is currently unavailable for near-term missions.

### Introduction:

Cameras flown on-board future planetary landers and rovers will have the ability to acquire images through a variety of optical filters. When images of the same scene are acquired through multiple filters (often referred to as "multispectral" imaging), specialized image compression software is usually used to exploit the additional redundancies that exist between spectral bands. We have developed a spectral encoder/decoder to serve as a modular add-on to existing single-band spatial/statistical compression software (e.g., ICER, JPEG)(Figure 1). Our motivation is to provide multispectral capabilities to entrenched systems designed for single-band compression. Our module facilitates both lossy and lossless image compression. Careful attention has been paid to minimizing memory requirements for on-board use (e.g., no more than two spectral bands must be stored in memory at any given time during the encoding process).

### Single-Band Encoder:

Compression results for Pathfinder imagery were generated by applying the spectral encoding module in conjunction with JPL's ICER software. ICER is the single-band image compression software that will potentially be flown on the 2001 and 2003 Surveyor missions.

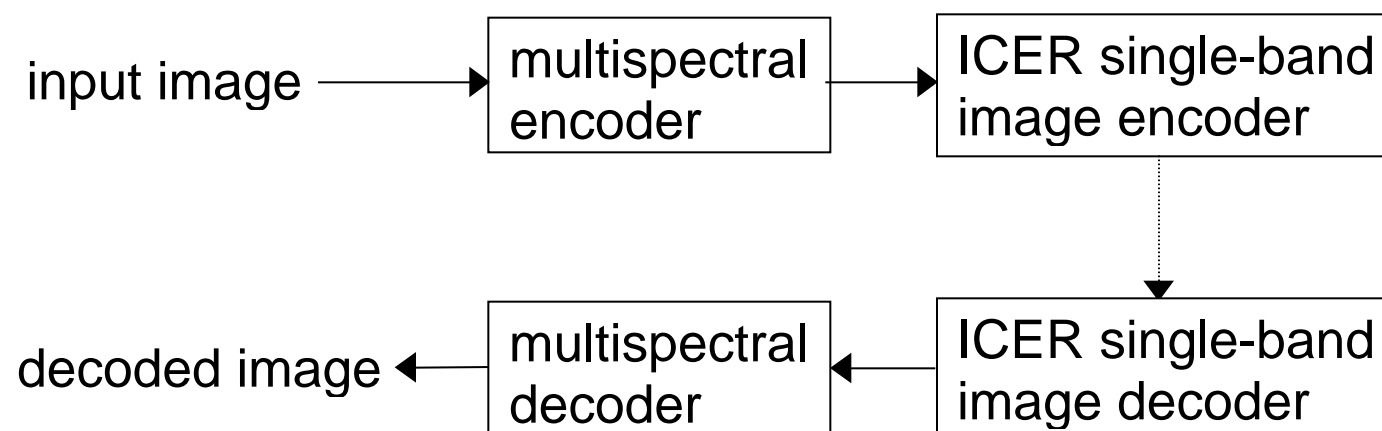


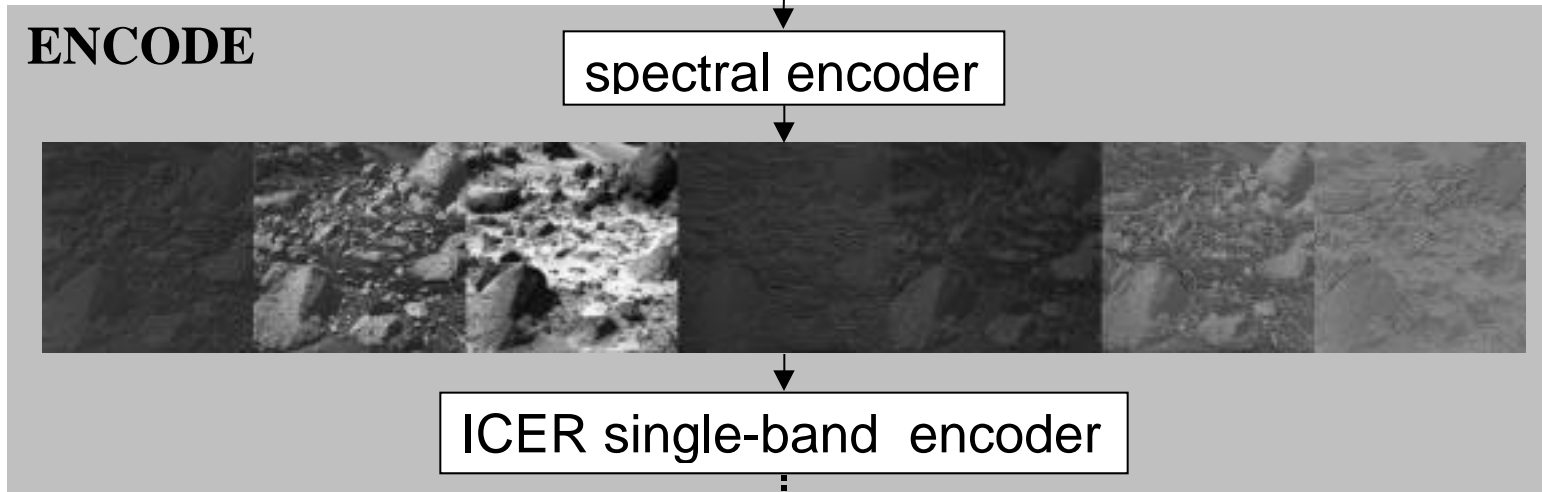
Figure 1. Operational schematic for the proposed add-on

# Lossless Image Compression Example

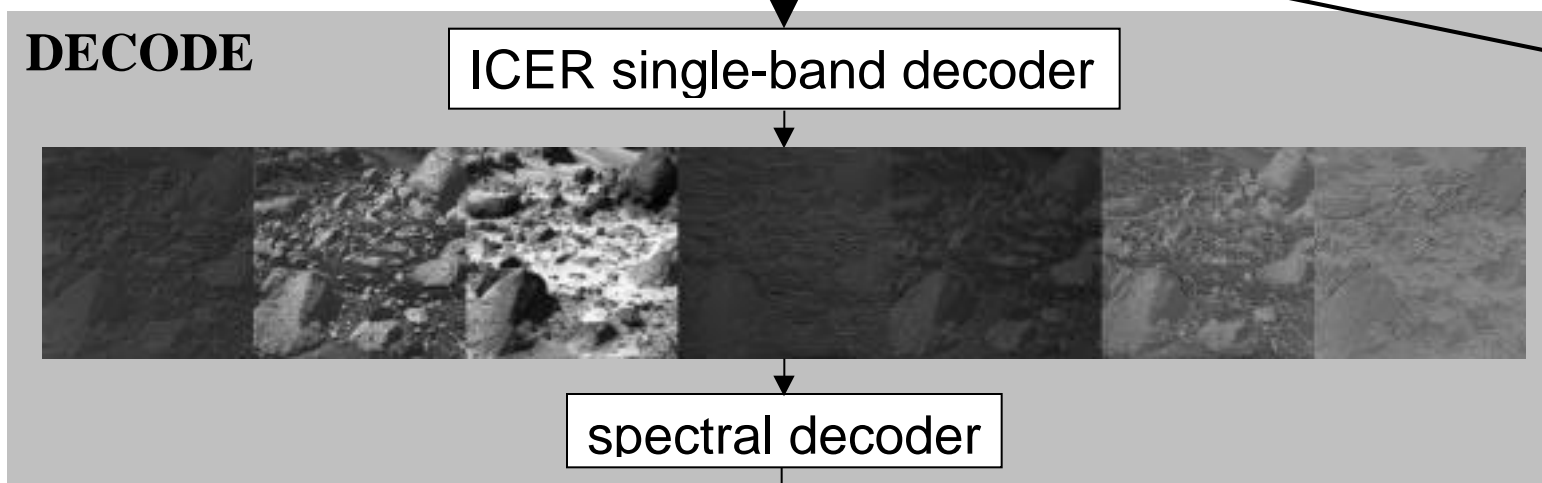
**With** Spectral Encoding

Original Image (file size = 444416 bytes)

**Without** Spectral Encoding



Transmit **297666 bytes**



Transmit **331406 bytes**



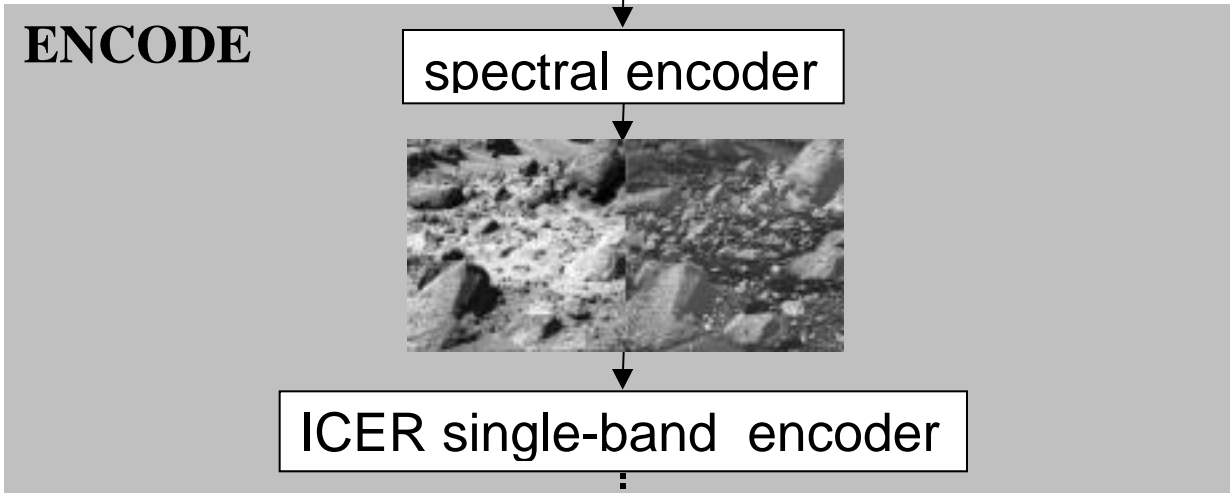
**33740 bytes saved (~10%)**

# Lossy Image Compression Example

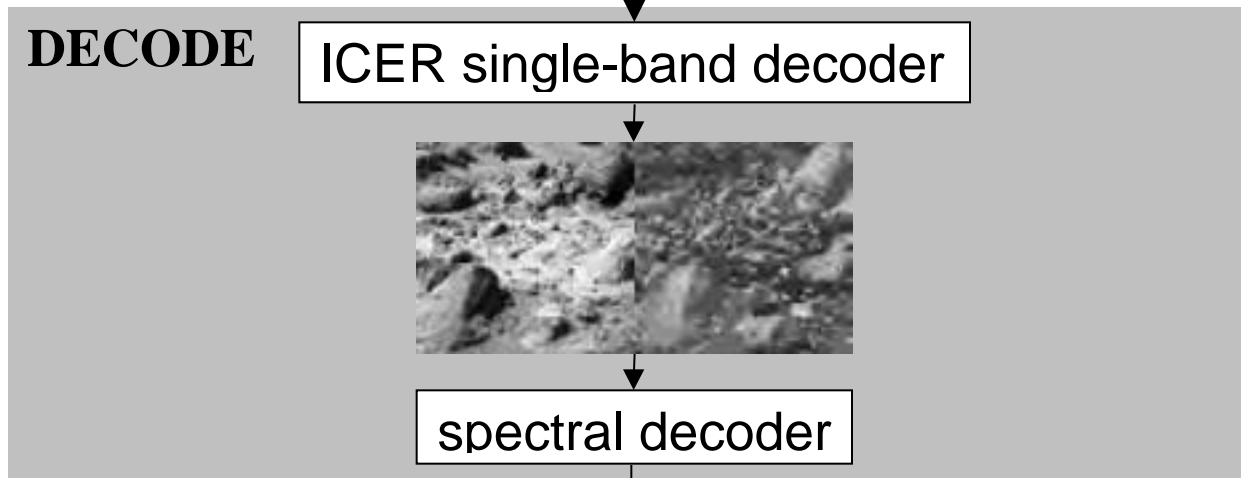
**With** Spectral Encoding

Original Image (444416 bytes, 256 graylevels)

**Without** Spectral Encoding



Transmit 2142 bytes (Compression Ratio = 206)




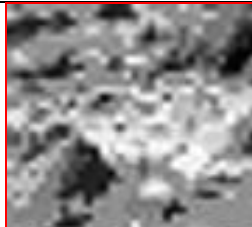
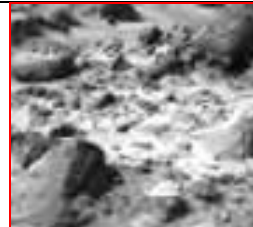
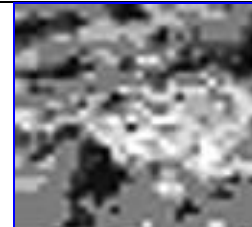

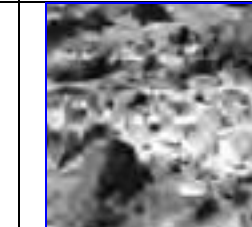
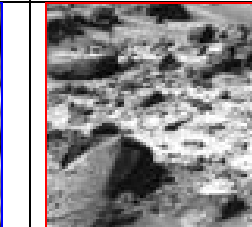
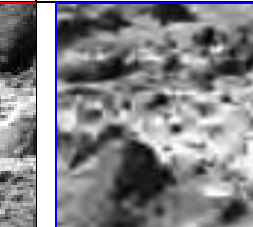
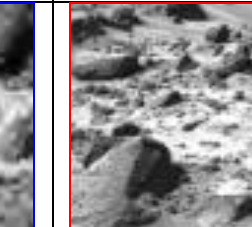
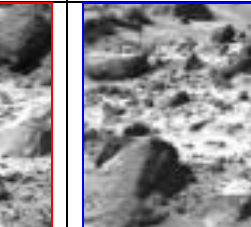



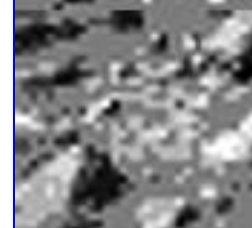

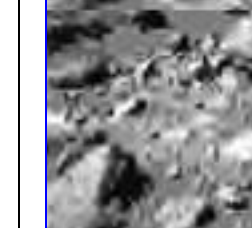
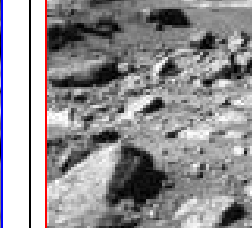
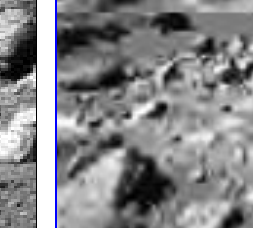
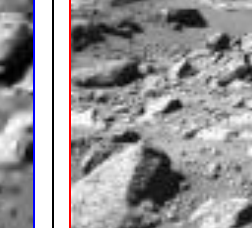
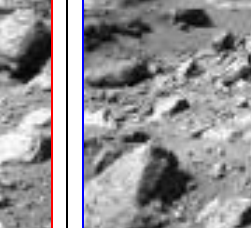



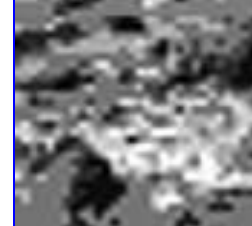

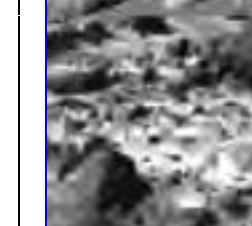
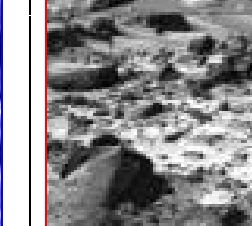
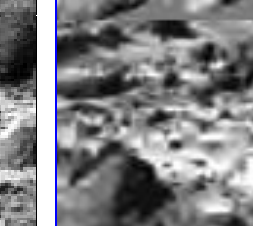
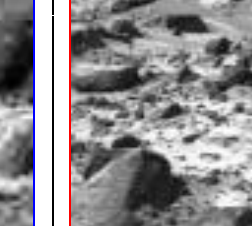
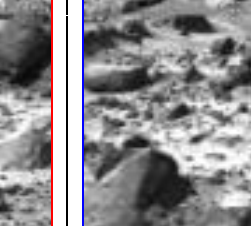



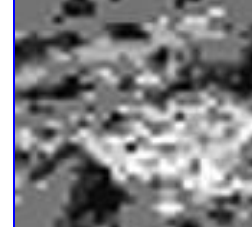

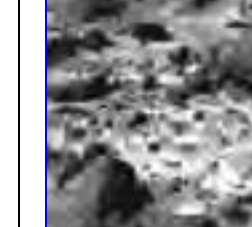

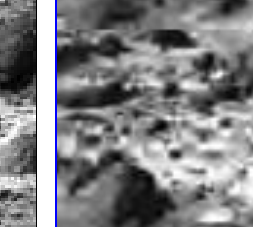
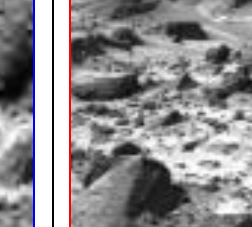
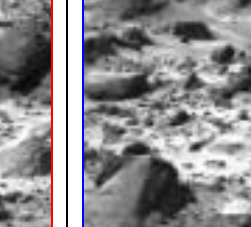



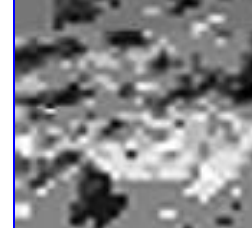



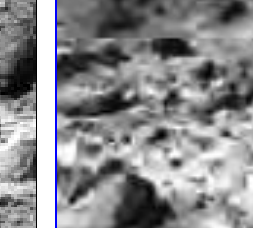
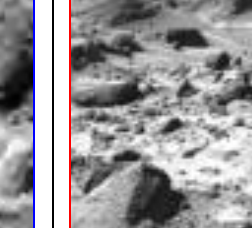
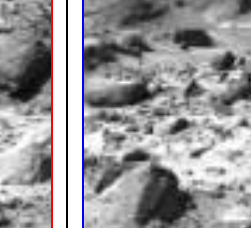



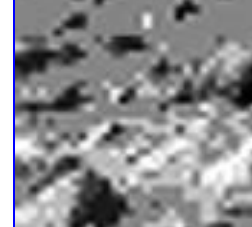



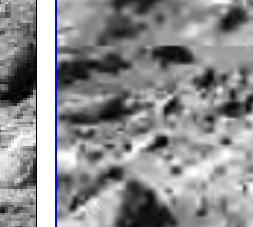
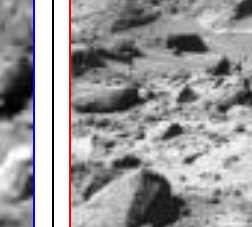
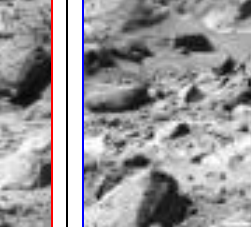



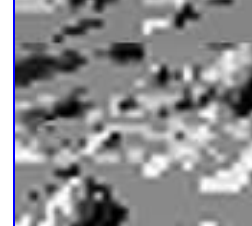



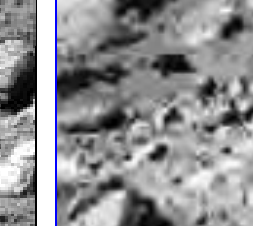
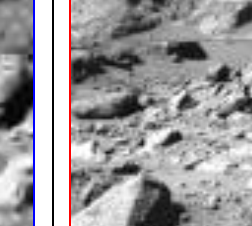
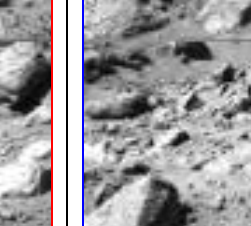
Distortion (RMS graylevel error) = **25.01**



Distortion (RMS graylevel error) = **37.43**

## Comparison of Distortion at Various Compression Ratios

**(Red = Spectral + ICER, Blue = ICER alone)**

(nm)	Original	A (cr=496)	B (cr=206)	B' (cr=206)	C (cr=100)	C' (cr=100)	D (cr=50)	D' (cr=50)	E (cr=30)	E' (cr=30)
670										
440										
965										
750										
600										
530										
480										

## Rate-Distortion Plot of 7-band Pathfinder Image

Rate-distortion plot for 7-band Pathfinder image shown in adjacent panel. Letters correspond to columns in image figure and represent compression to the same compression ratio by ICER and ICER+SPEC. At the maximum ICER compression ratio (206), the SPEC+ICER RMS distortion is about 1/3 less than that of ICER alone. ICER+SPEC reaches the same RMS error at a compression ratio of about 500. Thus SPEC+ICER allows either more spectral and spatial information to be returned at a given compression ratio or the same information at a much higher compression ratio.

