

Mars Global Surveyor
Ka-Band Link Experiment Results

David Morabito

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

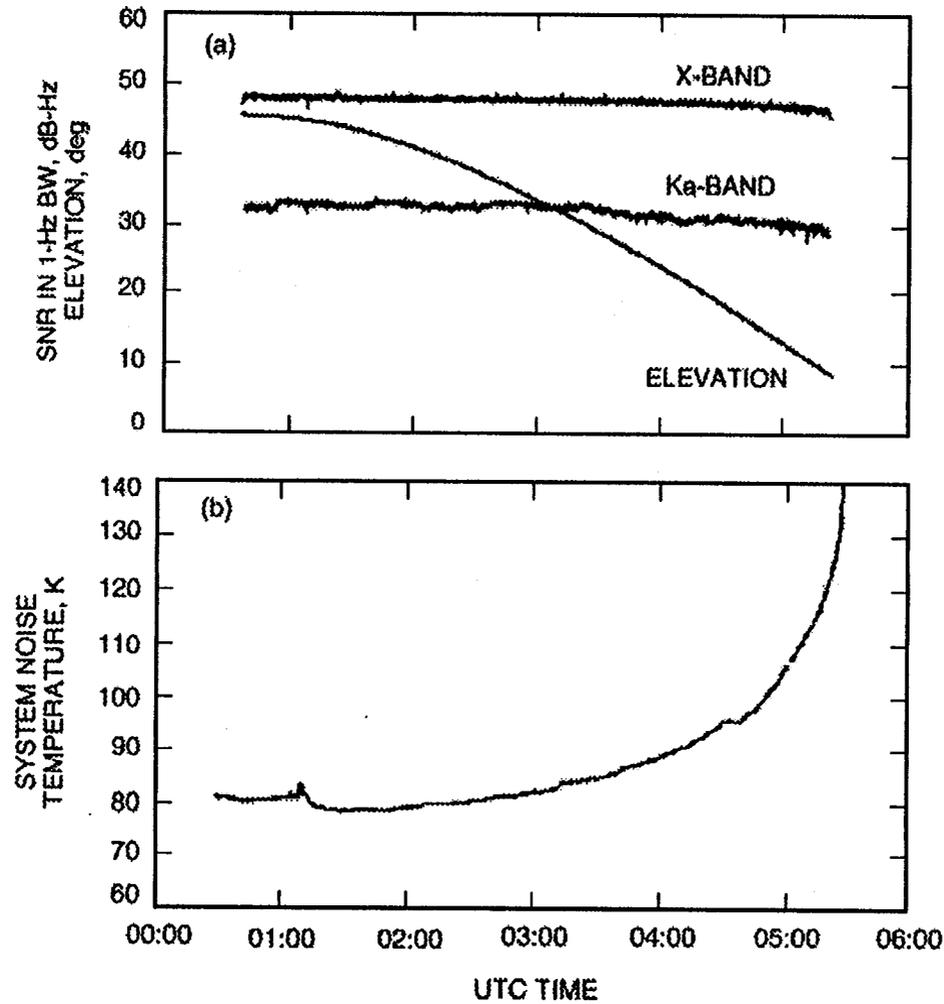
Deep Space Ka-band Link Advantage

- Theoretically Ka-band (32 GHz) has 11.6 dB advantage over X-band (8.4 GHz) as a telecommunications link frequency
- In practice, this advantage is reduced to 6 to 8 dB due to increased atmospheric and amplifier noise at Ka-band and DSN antenna imperfections, which are less significant at X-band
- This link advantage results in spacecraft mass and power savings or in higher data rates
- An analysis of two years worth of Mars Global Surveyor simultaneous Ka-band and X-band data demonstrated this link advantage using a 34-m beam waveguide (BWG) antenna

Deep Space Ka-band Telecommunications

- As link frequency increases, antenna pointing becomes a greater concern
- The use of a 34-m BWG antenna allows for feed equipment to be located in a subterranean pedestal room, “isolated” from outside environmental effects (condensation)
- Signals for deep space links are weaker than those of earth-orbiting satellites and mitigation options will be more limited

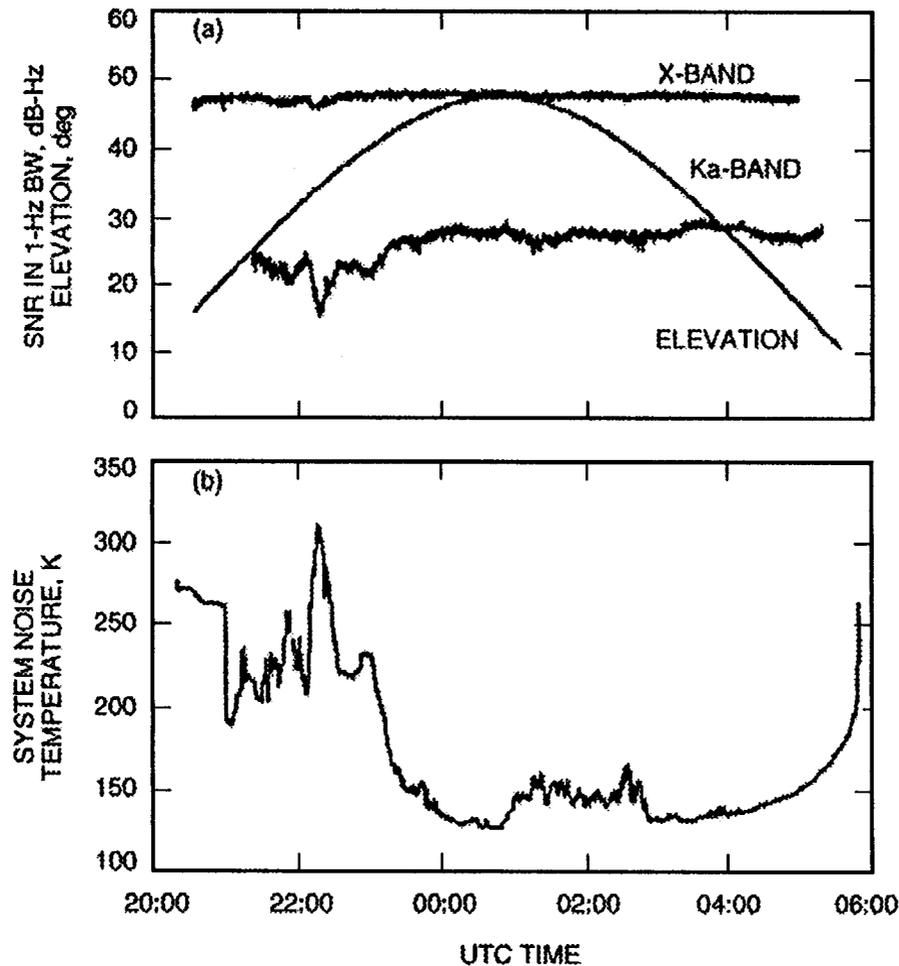
MGS Signal Levels and Ka-band Top for Clear Weather Pass



Ref. Morabito, Butman and Shambayati,
"The Mars Global Surveyor Ka-band Link
Experiment", Published in JPL TMO
Progress Report 42-137, May 15, 1999
(http://tmo.jpl.nasa.gov/tmo/progress_report).

Figure 1. (a) X-band and Ka-band P_c/N_o and elevation angle for experiment conducted on 97-212 and (b) Ka-band system temperature (Top) for 97-212.

MGS Signal Levels and Ka-band Top for Rainy Weather Pass



Ref. Morabito, Butman and Shambayati,
"The Mars Global Surveyor Ka-band Link
Experiment", Published in JPL TMO
Progress Report 42-137, May 15, 1999
(http://tmo.jpl.nasa.gov/tmo/progress_report).

Figure 2. (a) X-band and Ka-band P_c/N_o and elevation angle for experiment conducted on 97-203 and (b) Ka-band system temperature (Top) for 97-203.

MGS Ka-band to X-band Link Advantage

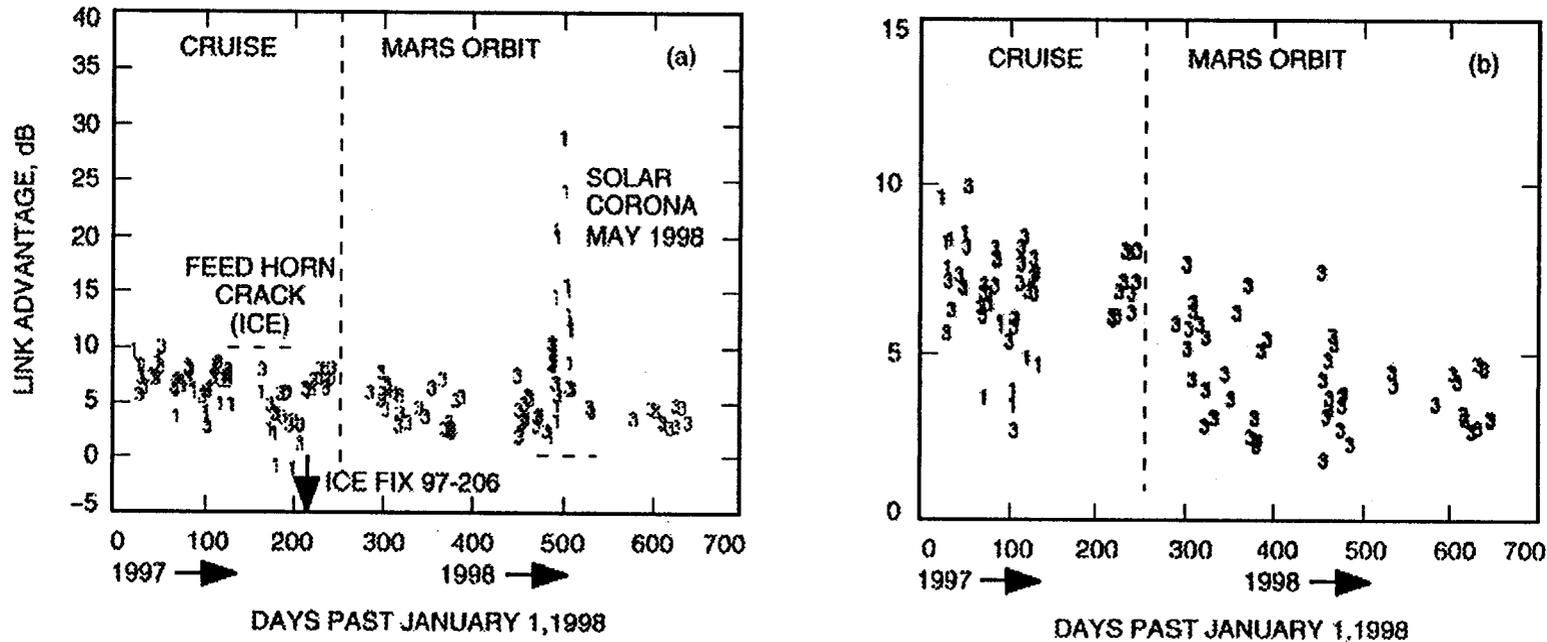


Figure 3. Ka-band link advantage versus day of year, corrected for known equipment deficiencies, for (a) all data and (b) all data except solar corona and the cracked feed horn period with scale expanded. Note that majority of passes during cruise period, link advantage falls between 6 to 8 dB.

Ref. Morabito, Butman and Shambayati,
"The Mars Global Surveyor Ka-band Link
Experiment", Published in JPL TMO
Progress Report 42-137, May 15, 1999
(http://tmo.jpl.nasa.gov/tmo/progress_report).

Conclusion

- A 6 to 8 dB link advantage can be realized by using Ka-band (32 GHz) as a telecommunications link frequency in place of X-band (8.4 GHz)
- This link advantage was demonstrated using two years worth of Mars Global Surveyor simultaneous Ka/X data after correcting for known equipment deficiencies