ACTS and the History of Fade Mitigation

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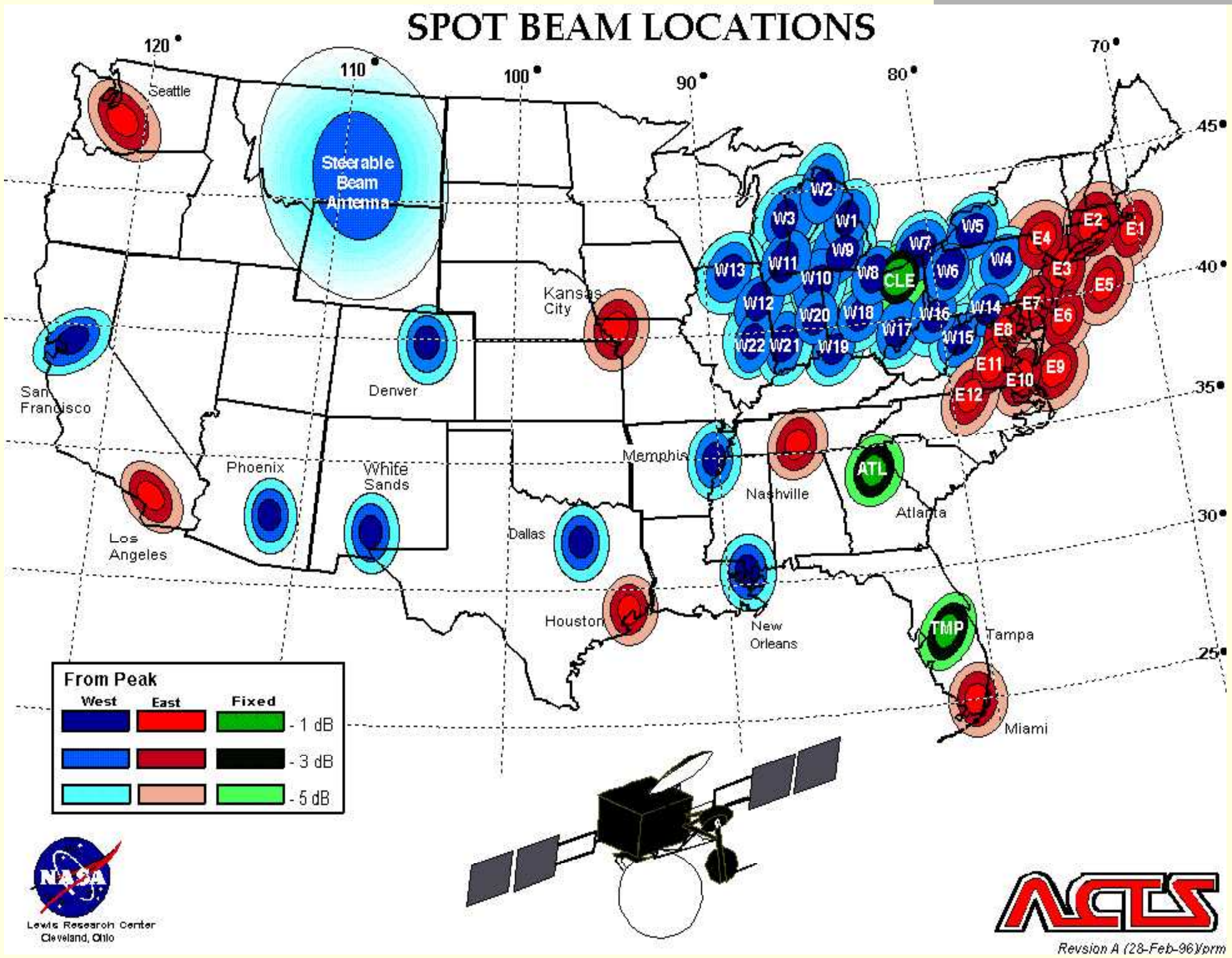
ACTS Coverage



Satellite Specs
2-m uplink
3-m downlink
G/T = 18 dB
Power= 46/11 W

ACTS Fade Compensation

- ACTS operated as a TDMA system that provided longer time slots for user terminals affected by weather.
- ACTS performed fade compensation via two features: rate reduction and coding
- The rate ½ convolutional coding provided 4 dB improvement and a four-fold rate reduction provided 6 dB, a total improvement of 10 dB
- In summary, a terminal with adverse atmospheric conditions used four times more resources (TDMA slots) than otherwise
- In addition to the above mode (baseband processor), ACTS also operated in the satellite switched TDMA (SS/TDMA) mode
- In the SS/TDMA mode it provided 6 dB of improvement by increasing amplifier power by about 6 dB (11 W to 46 W)

ACTS Fade Detection

- The decision process that determined the need for compensation in real time made use of the downlink signal quality
- The downlink signal quality estimation was made by each user terminal and transmitted to the network manager
- In response to the user terminal request, network manager would have sent a command over ACTS back to the terminal instructing the terminal to reduce burst rate and invoke coding
- In the same time, the network manager would have instructed ACTS baseband processor to switch rate and invoke coding for the affected terminal

Cumulative Distribution of BER for User Terminal

Courtesy of Roberto Acosta, NASA Glenn RC

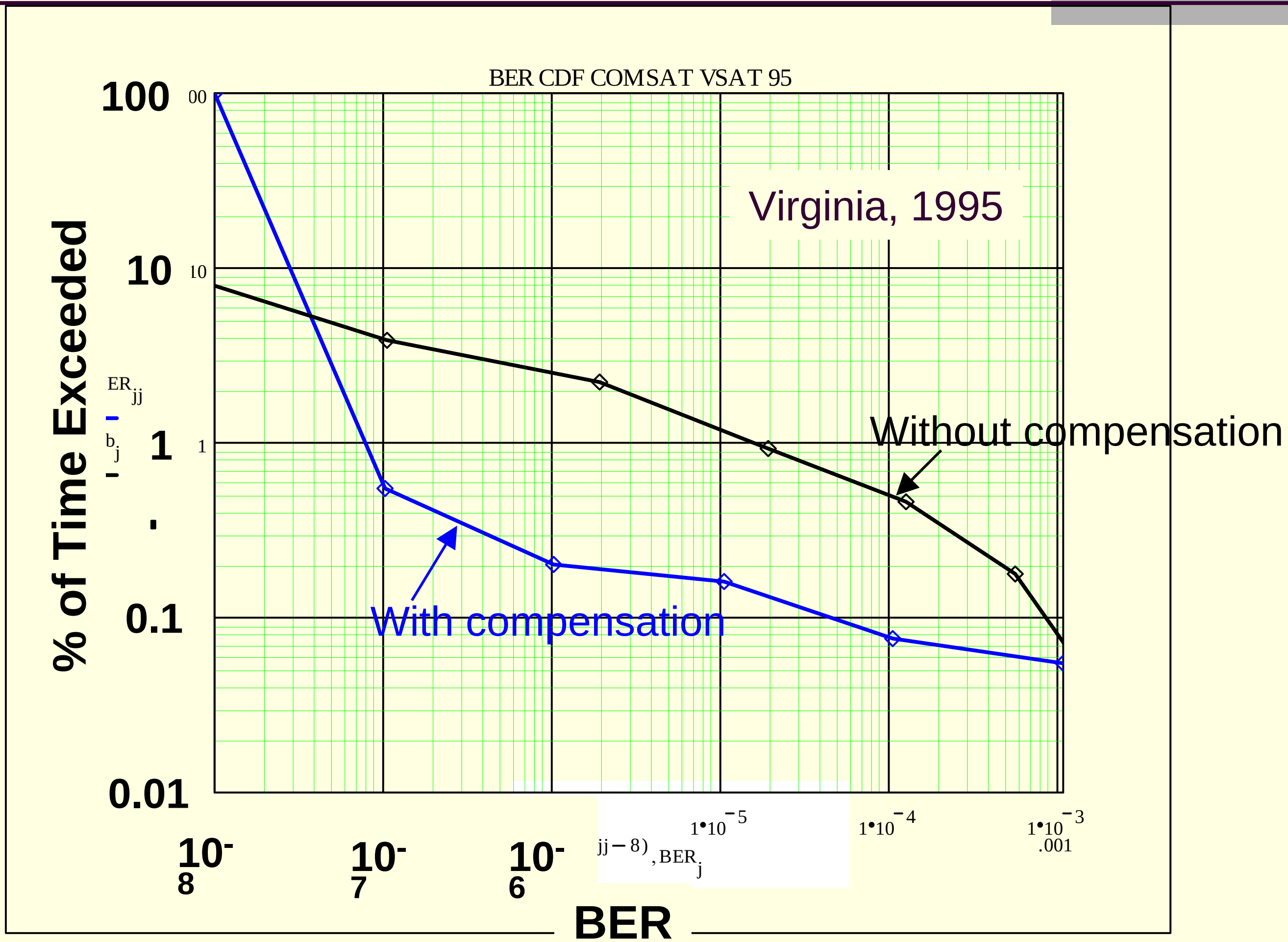


Figure 3 - Compensated vs. Uncompensated BER CDFs

ACTS Lessons

Reference: S. Johnson and R Acosta, "T1 VSAT Fade Compensation Statistical Result," Proceedings Sixth Ka-Band Utilization Conference, pp. 23 – 29, My 31 – June 2, 2000

- The experiment showed the ACTS fade compensation technique complies with its design specification
- The 10 dB adaptive link margin reduced the outage rate by a factor of ten in the region of interest (BER = 10^{-6})
- The fixed margin of 3 dB in the downlink and 5 dB in the uplink was adequate for most rain fades
- The method used to estimate the SNR of the ACTS T1 VSAT had limitations and nonlinearities (large error standard deviation up to 2 dB)
- The SNR detection system must be able to detect SNR values in less than 0.25 s to compensate for fades greater than 10 dB

Fade Detection Options

- **Closed Loop (Terminal Based)**
  - Each user terminal determines its fade protection needs
  - Example: ACTS and uplink Spaceway
  - Pros:
    - Fade compensation applied only to the terminal in need
  - Cons:
    - User terminal has to detect fades
    - Communications with network manager through the satellite is required

- **Open Loop (Location Based)**
  - Fade compensation is provided to a Location, e.g., station, or beam
  - Example: Spaceway downlink and DSN
  - Pros:
    - Proactive rather than reactive
    - Less demanding of user terminals
    - Suitable for fast changing channels
  - Cons: blanket decision is made for a group of terminals