PROCEEDINGS OF ISAP '92, SAPPORO, JAPAN

RECONFIGURABLE BEAM ANTENNA FOR INTELSAT SATELLITE APPLICATIONS

T.NOGUCHI, I.NAITO, H.OHHASHI, Y.KOBAYASHI, A.LINDLEY*, W.ENGLISH*
Mitsubishi Electric Corporation, Kamakura, Kanagawa, JAPAN
*INTELSAT, Washington DC., USA

1. INTRODUCTION:

Reconfigurable multi-beam antennas radiate multiple contoured beams whose beam shapes can be changed according to the desired coverage shapes. The new reconfigurability concept proposed by INTELSAT(1) provides a high degree of flexibility without requiring more BFN components. A large BFN is split into smaller subBFNs which are combined by a switching arrangement at the beam input ports. The switching components control the relative power fed to each subBFN. Thus, a large beam is split into smaller sub-beams. These sub-beams may be combined in a number of ways only limited by the number of states of the switching network to form useful beam shapes. Since the subBFNs consists of fixed components, they must be optimized for all selected useful beams simultaneously. Because of the sufficient beam reconfigurability with simple configuration, this reconfigurability concept is expected to be useful for future communications satellite applications.

2. DESIGN OF RECONFIGURABLE BFN:

In the design of reconfigurable antenna system, we considered the actual INTELSAT-VII C-band coverages. The reconfigurability of zone δ and zone γ beams and hemi beam which illuminates the coverage defined by combining two zones, which are defined as shown in Figure 1, was considered. The other two zone coverages α and β defined in Figure 1 are taken as the isolation areas. The antenna considered in this design consists of a single offset paraboloidal reflector whose aperture dia. is 2.44m, an array of 50 feed horns with polarizers and an associated reconfigurable BFN. To obtain the efficient and simple reconfigurable BFN system, 3-subBFNs and a variable BFN configuration was selected for this system based on the tradeoff study. The fixed subBFN was designed to realize the low dispersion characteristics by adopting the suitable hybrid couplers with the appropreate length of transmission lines.(2) The variable BFN which consists of 2 coaxial tarnsfer switches and 2 hybrid couplers provides 2 states, i.e.,(i) Normal mode : zone δ and zone γ beams are generated, (ii) Combined hemi mode : combined hemi beam is generated. The excitation coefficients to provide above three beams effectively can be optimized simultaneously by using general minimax algorithm.(3)

3. ANTENNA PERFORMANCE:

Figure 3 shows a picture of the developed reconfigurable BFN. This BFN can be operated in 4GHz frequency band with circular polarization. The excitation coefficients of the BFN were measured directly at the output ports for each states and the low dispersion characteristics were confirmed. After assembling the BFN and the reflector system on the fixture, the secondary radiation pattern for each beam was measured by near field antenna measurement (NFAM) facility. The measured radiation contours are shown in Figures 4 thru 6 for each beam, respectively. The resulting measured antenna performance is summarized in Table 1, with the calculated performance based on the measured excitation coefficients of the BFN, as the reference. As shown in the figures and table, zone δ, zone γ and hemi beams were provided by simultaneous optimization with sufficient performance, and the measured radiation patterns showed good agreement with the calculated ones. Therefore, the validity of this reconfigurability concept was verified.

4. CONCLUSION:

New reconfigurability concept using subBFNs were proposed, and verified its validity by confirming that the measured performance of the developed reconfigurable BFN shows good agreement with the design.

REFERENCES:

(1) P.Balling, et al.,"Flexible/reconfigurable 6/4GHz antenna beam technology development", JINA '90, July 14, 1990

(2) I.Naito, et al.,"A design procedure of low dispersion BFNs", ICAP '91, April 17, 1991

(3) K.Madsen, et al.,"A nonlinear minimax optimization program not requiring derivatives", IEEE Trans. Antennas Propagat., vol. AP-25, pp.454-456, 1977

This paper is based on work performed, in part, under the sponsorship and technical direction of International Telecommunications Satellite Organization(INTELSAT). Any views expressed are not necessarily those of INTELSAT.

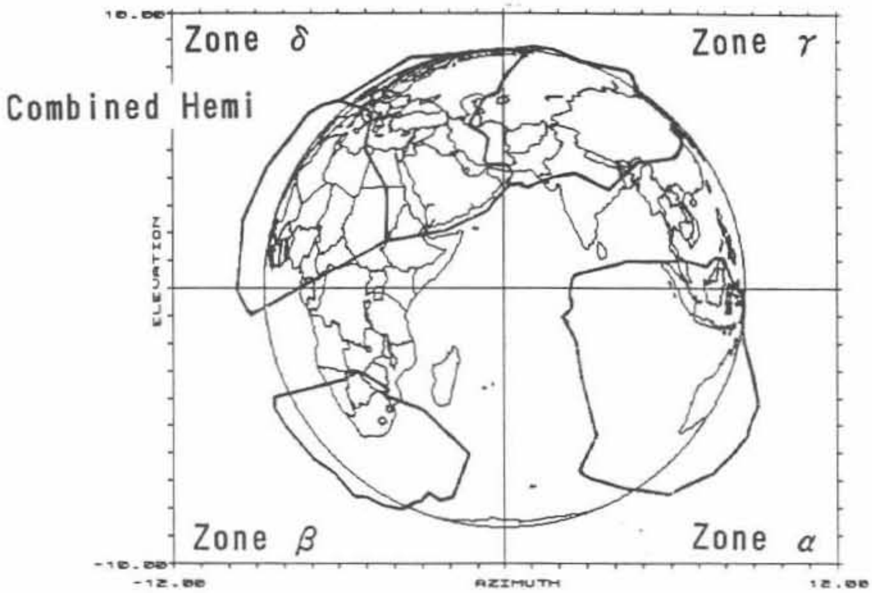

Figure 1. Coverage Definition

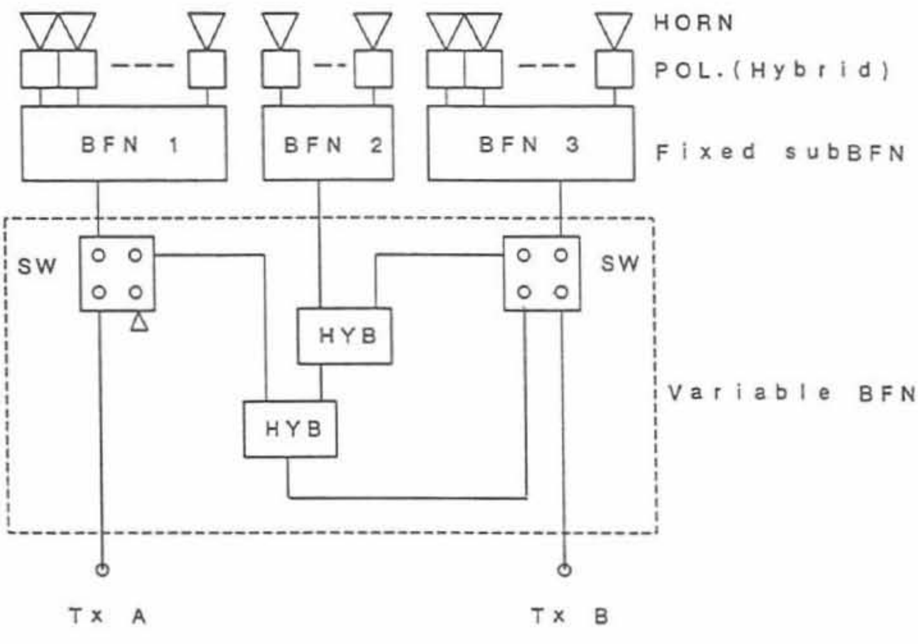

Figure 2. Blockdiagram of Reconfigurable BFN

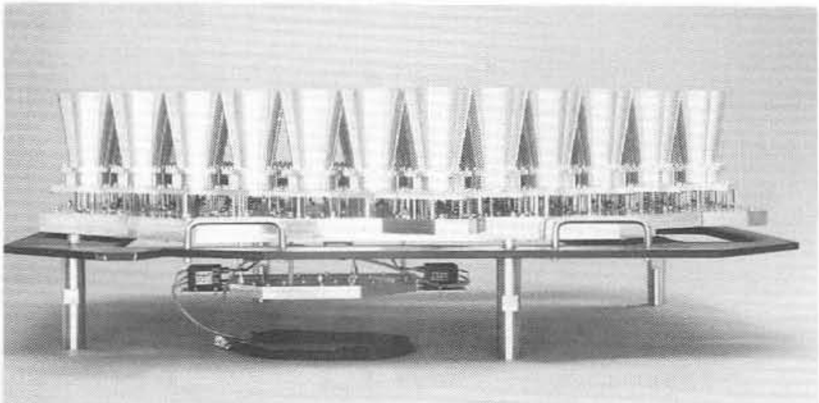

Figure 3. Developed Reconfigurable BFN

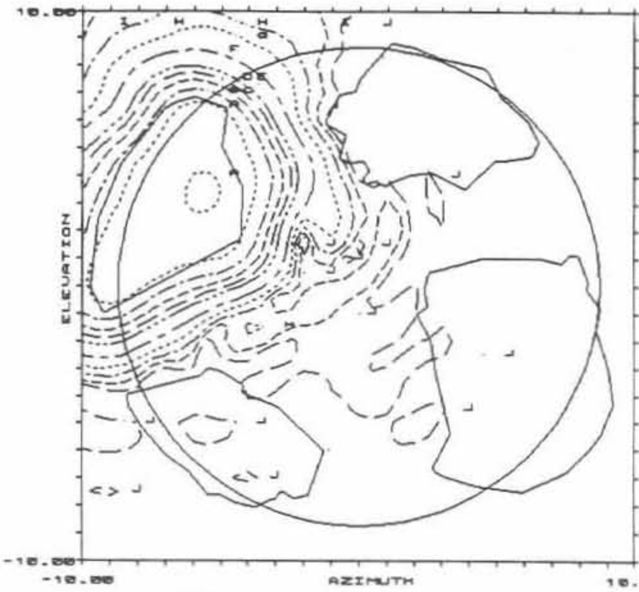

Figure 4. Zone δ Beam

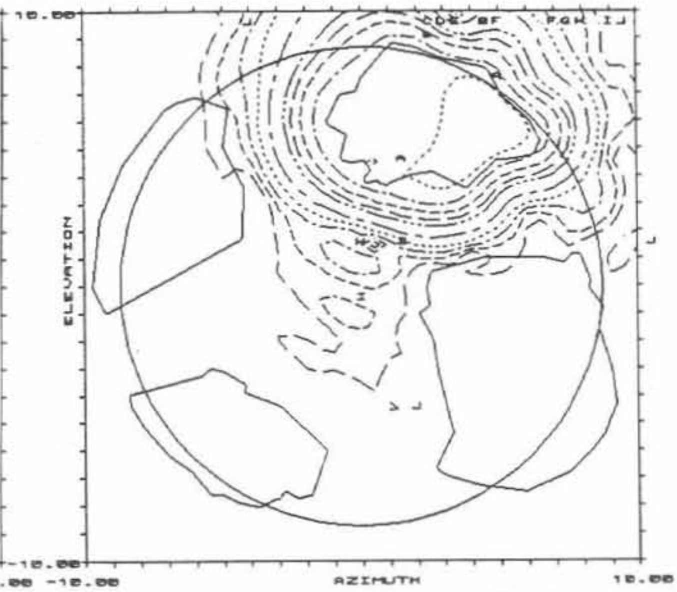

Figure 5. Zone γ Beam

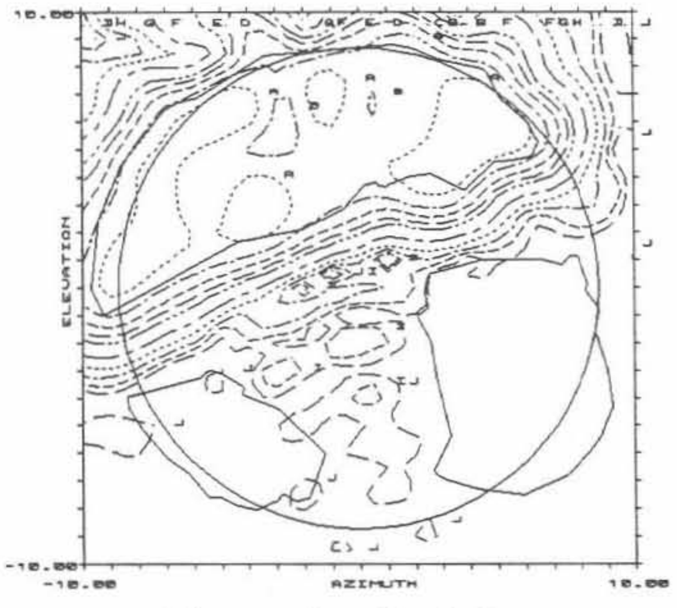

Figure 6. Hemi Beam

Frequency : 3.8875GHz
Polarization : LHCP
Contours : A = −2dB
B = −4dB
C = −6dB
D = −8dB
E = −10dB
F = −15dB
G = −20dB
H = −25dB
I = −30dB
J = −35dB

Table 1. Measured Antenna Performance Summary

		Zone δ Beam	Zone γ Beam	Hemi Beam
Frequency/Pol.		3.7 − 4.075 GHz / LHCP		
No.of Elements		22	22	50
EOC Gain	Cal.	24.5dBi	24.7dBi	18.7dBi
	Meas.	24.3dBi	24.6dBi	19.1dBi
Sidelobe Isolation	Cal.	27.8dB	28.0dB	27.2dB
	Meas.	24.4dB	26.5dB	25.3dB