NLSRT Memo No. 36

TYPICAL ANTENNA COSTS

I have gathered together a number of cost estimates of various sized antennas working to various frequency limits. these antennas are all of "conventional" design.

Diameter	λlim (λ/16)	Cost	Notes
100 m	1.5 cm	50 M	Krupp via MPIfR
100 m	1.5 cm	39 M	MAN
100 m	1.5 cm	50 M*	NRAO 300 ft (1969)
100 m	2 cm	59 M*	VLBA
100 m	1.3 cm	80 M*	VLBA
100 m	3 cm	91 M	JPl/Ford Aerospace
300 ft	6 cm	6.7M	RSI: old 300-ft
300-ft	6 cm	9.6M	RSI:300-ft steerable in azimuth (restricted elev)
300-ft	6 cm	15.8M*	Fisher (full sky)
450-ft	6 cm	33 M*	scaled from 300-ft RSI value (restricted elev)
450-ft	6 cm	46 M*	scaled from 300-ft Fisher estimate (full sky)
70 m	0.7 cm	45 M*	NRAO 65-m(1972)
70 m	1.5 cm	44 M*	VLBA
70 m	?	29 M*	VLBA (scaled only in size)

All scalings were made assuming a 2.7 exponenental law in size and a 0.7 exponential dependence on frequency based on empirically derived JPL relations.

*Includes 20% contingency

(over)

The above numbers can be roughly fit by the expression:

$$C = k D^{2.7} \gamma^{0.7}$$

with D = 100 M, λ = 1 cm, C = 100 M,

then

$$C = 100 \left(D/100\right)^{2.7} \lambda_{cm}^{-0.7} \ \$M$$

The discussion of recent weeks has not converged on an obvious size wavelength tradeoff. If we consider the short wavelength science to be as valuable as the long wavelength science, then we might consider spending half the money to optimize the telescope for short wavelengths and half for long wavlengths. Assume you can build a telescope of Diameter, D_1 working to wavelength for half of the available money. Then how big an extension can you add for the same amount of money to make the overall size D_2 which works at wavelength λ_2.

This requires that

$$\left(D_2/D_1\right)^{2.7} = \left(1 + \lambda_2/\lambda_1\right)^{0.7}$$

If we take 7mm as the wavelength limit for D_1 and 6 cm for D_2, then

$$D_2/D_1 \sim 2$$

If we have about 60 M to spend then,

$$D_1 \sim 60 m$$
$$D_2 \sim 120 m$$

This might be considered as a compromise between a 100 m antenna good to 2 cm, a 70 m antenna good to 7 mm, and 130 m antenna good to 6 cm (all give or take 10 M or so). All calculations take the wavlength limit as λ/16 which corresponds to a 3 db loss of efficency and half the power in sidelobes. Note that in order to take advantage of the low side lobe level of an unblocked aparture, a surface accuracy much better than λ/16 will be needed.

Note that because of the steep dependence of cost on diameter and relativley small dependence on wavelength, a factor of two increase in diameter requires a tradeoff of a factor of 15 in wavelength limit. A root two increase in diameter (two in area) coressponds to a factor of 3.7 in wavelength.

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