

6.1A DESIGN CONSIDERATIONS FOR HIGH-POWER VHF RADAR TRANSCIVERS: DISTRIBUTED VERSUS SINGLE LARGE TRANSMITTER

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Many factors enter into the choice of using a single large transmitter versus a number of smaller units in clear-air radar systems. Surprisingly, simple economic considerations seem not to be an important factor, since best current estimates of transmitter costs suggest a linear relationship in terms of watts/dollar in the kilowatt to megawatt peak power range. Feedline costs in large arrays have also been cited as favoring distributed over single transmitters. However, when all the extra costs of a distributed system are considered (transmitter shelters, phase controllers, etc.) the higher cost of high-power feedline is not a very significant factor. Feedline attenuation may be a consideration at frequencies of several hundred MHz and above for very large arrays (200 x 200 meters), however at 50 MHz the calculated loss for a simple branch feed driven by an 800 kW peak power transmitter located at one edge of a 200 x 200 meter array is only about 0.7 dB. When considering single transmitter/feedline economics, it is interesting to note that the average to peak power percentage rating for flexible low-loss foam and air dielectric cable is about 18% at 50 MHz and about 5% at 400 MHz. This suggests that at lower VHF transmitter duty factors of about 15% would best utilize the capacity of a given transmission line.

The above considerations do not apparently favor one approach over the other in choosing the number of transmitters for use in a clear-air radar system. However, other less obvious factors which involve operating strategy are important in the distributed/single transmitter question. It is very desirable from a number of scientific standpoints to obtain continuous data over extended periods (weeks to months). For most research installations this requires safe, reliable, unattended system operation. Most large transmitters with peak power ratings over several hundred kilowatts are not operated unattended, primarily because of potential catastrophic failure modes. Such failure might destroy an expensive transmitter tube or lead to a station fire without the intervention of on-site personnel. In contrast, if the same average transmitter power is divided between a number of smaller, distributed transmitters, catastrophic failure of one unit would be much less serious. In fact, if the number of distributed transmitters is fairly large (about 16 or more), loss of several units may not significantly reduce data quality. Thus, distributed transmitters should provide a safer, more reliable system with respect to one using a single large transmitter.

Ease of repair and the cost of spare parts also favors using multiple transmitters since entire transmitters can be replaced by a spare unit in a distributed system. Experience with 50 kW peak power transmitters has shown that one spare for about ten operating units is reasonable to ensure continuous operation. Spare parts thus constitute only about 10% of the total transmitter cost in this approach. For a single large transmitter another complete system (spare cost = 100%) would be required for equivalent back-up. Most large transmitters also require a certain amount of routine servicing which may seriously affect data continuity. In a distributed system newly serviced units can be swapped with units needing service with minimal data loss.

If the clear-air radar system uses a scanning antenna beam, distributed transmitters can be electronically phased at low power input levels whereas

branch feeding an array from a single large transmitter requires high power phase switching. The cost of high-power phase switches could be a major consideration in choosing between distributed and single transmitter systems. A final consideration involves the inherent modular structure of a distributed system. When building a large system this modular structure allows valuable early operation with a small part of the final system. Additional modules can be added over time until the system is complete.