The science of an echo

100 echoes is a pioneering endeavour with the guiding mission to transmit wireless communications signals 'off-planet' into Deep Space. Our base on Earth will be a fully equipped 'broadercast' centre, featuring a communications array capable of delivering a radio signal to one or more coordinate based locations in outer space. These signals will be broadcast at a phase and power sufficient for messages to be detectable at least 1800 light years from Earth.

Our 'broadercast' system will include a number of parabolic transmit antennas (essentially 9-meter satellite dishes), each driven with separate transmit high power amplifiers. These will be connected together to allow them to operate in unison in a coordinated and synchronised fashion. The combined antennas will produce a reinforced Radio Frequency (RF) signal, powerful enough to reach target locations hundreds of light years away.

Until recently, the opportunity for transmitting wireless communication signals 'off-planet' has been limited. These limitations included the complexity and cost of designing, building and maintaining extremely large single-dish transmitter complexes. Another restriction has been creating wireless signals that can be transmitted so that they are detectable and understandable at target locations which are hundreds of light years away from Earth. Not anymore.

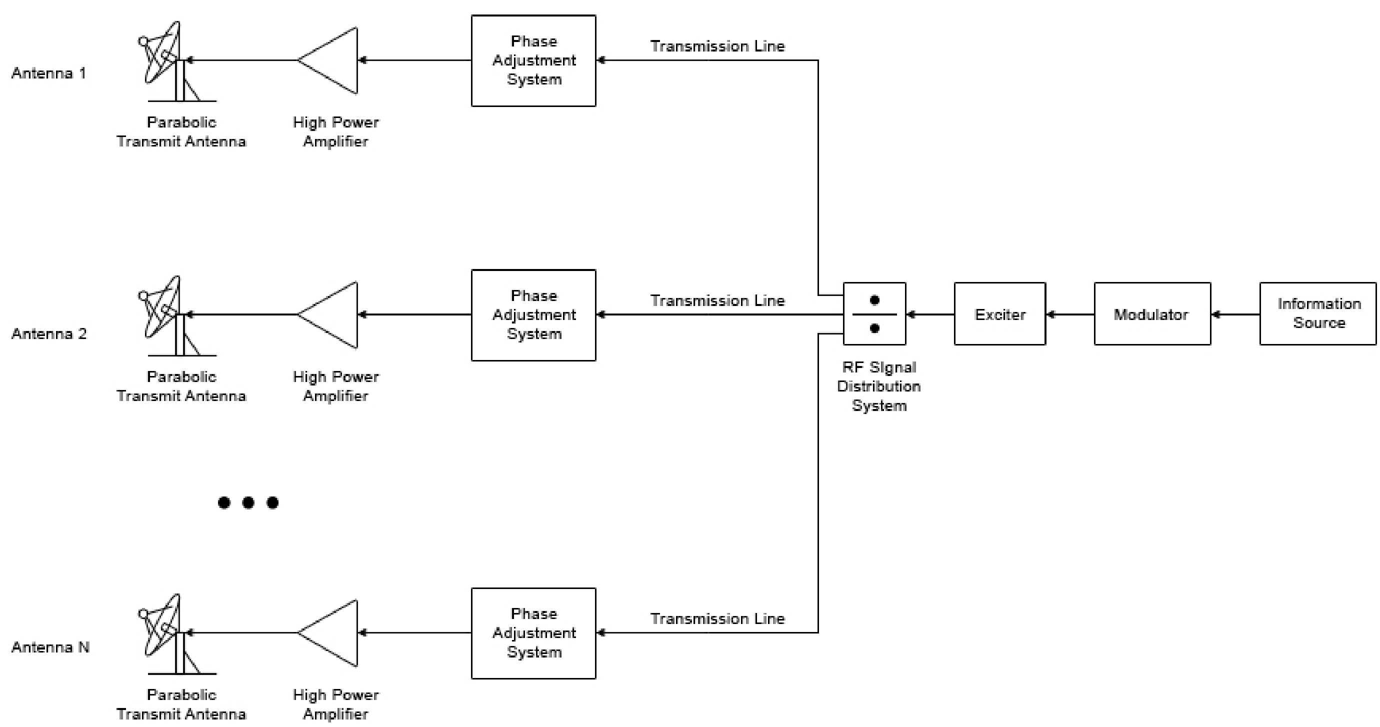
For anyone who has looked up to the stars and believed that they are with reach, your time has come.

The Array-Based Space Transmission System

The intended function of the system is to provide for the transmission of information, as an RF transmission, to very distant receiving stations located in Deep Space. Since the transmission of information via any RF channel is a function of the bandwidth of the channel and the Signal Energy available, a very high RF signal power level is required. The unique features of the envisioned system include the use of a relatively large number of conventional parabolic transmit antennas, driven with separate conventional transmit High Power Amplifiers (HPAs), producing a resulting receive signal level significantly increased in quality through in-phase free-space power combining of each of each of the separate signals.

Figure 1 illustrates the basic architecture of the array-based space transmission system. While only three of the antenna subsystems are illustrated for clarity, the actual number employed in the envisioned system will be one hundred and will be a function of the ultimate desired transmission range.

Figure 1 Phase-Combined High Power Space Transmission System Block Diagram



Signal flow through the transmission system is as follows:

1. The information to be transmitted is coded as appropriate for the desired transmission and will enter the system to be stored in the "Information Source" computational device for the scheduled transmission(s).

2. A Modulator converts the information intended for transmission into the desired RF signal structure. Appropriate modulation formats will be selected through the modulator and may include various forms of Frequency Shift Keying (FSK), Phase Shift Keying (PSK), On Off Keying or Pulse Code Modulation (PCM) as well as combinations of alternatives. Appropriate Forward Error Correction Coding (FEC) will also be applied to the information to assist in distant demodulation functions. The range of potential modulation and coding schemes is very broad and potentially includes new modes which have yet to be fully reduced to practice.

3. The output Intermediate Frequency or Radio Frequency signal generated by the Modulator then passes to the Exciter which generates the actual modulated RF signal.

4. The modulated RF signal then passes through an RF signal distribution that includes RF power dividers, RF amplifiers, and RF transmission lines. The main function of this RF signal distribution system is to provide the resultant modulated RF signal to each of the transmit antenna subsystems for amplification and transmission.

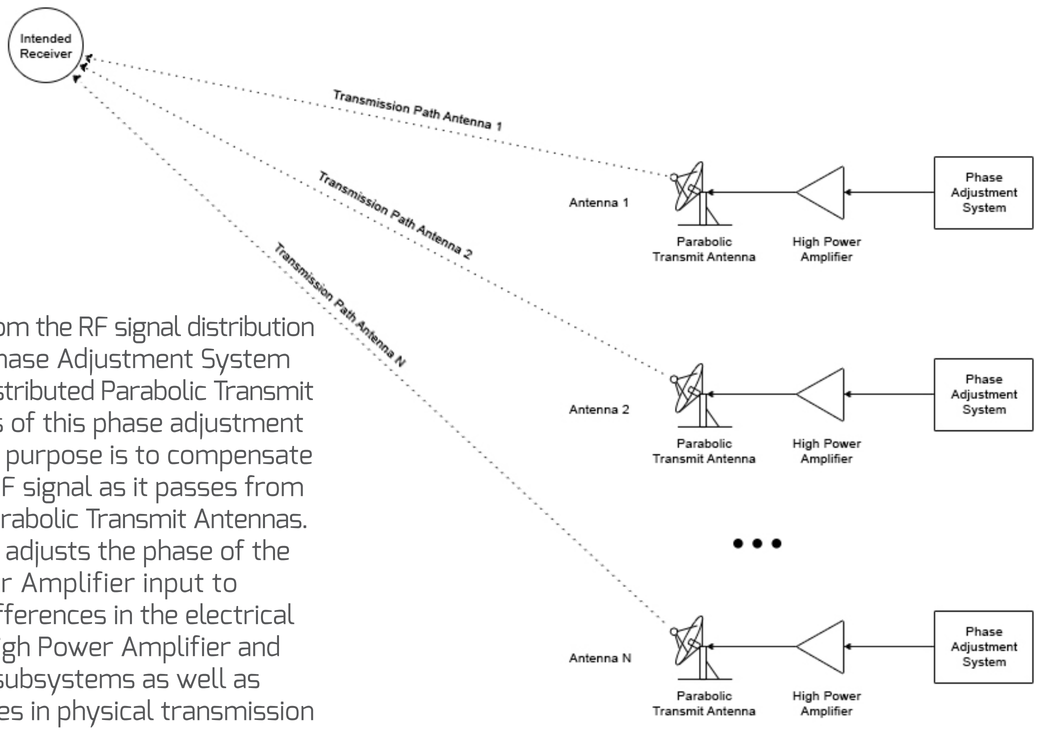
6. The modulated RF signal, having been phase-adjusted, is then passed to the High Power Amplifier (HPA) sub-system where it is amplified for transmission. Various alternative versions of High Power Amplifiers are optionally under consideration for use in the system. These mostly include HPAs based upon Traveling Wave Tubes or Klystron electron tubes, but may also include various Solid State devices such as Solid State Power Amplifiers utilizing devices implemented in GaAs or GaN for high power transmission.

7. The amplified modulated RF signal is then passed to each of the Parabolic Transmit Antennas, in parallel, for transmission to the intended target.

One the of the principal factors in the functionality of such a system is the ability to successfully provide a suitable Signal power level at the receiver location to ensure acceptable quality for reception. The envisioned system provides very high effective signal-to-noise ratio (S/N) levels. This is accomplished by combining conventional parabolic transmit antennas driven by conventional High Power Amplifiers. Typically a single such transmit antenna is employed for space communications functions. The envisioned system increases the resulting transmitted RF power through the use of free-space power combining in which the RF signals from each of the separate transmit antennas are controlled such that they arrive in-phase at the receiver. Due to their phase relationship they take advantage of constructive wave interference and produce a reinforced composite signal, which is the mathematical sum of all the individual contributing signals.

Figure 2 illustrates this phase-combining objective.

Figure 2 Phase-Combining Objective

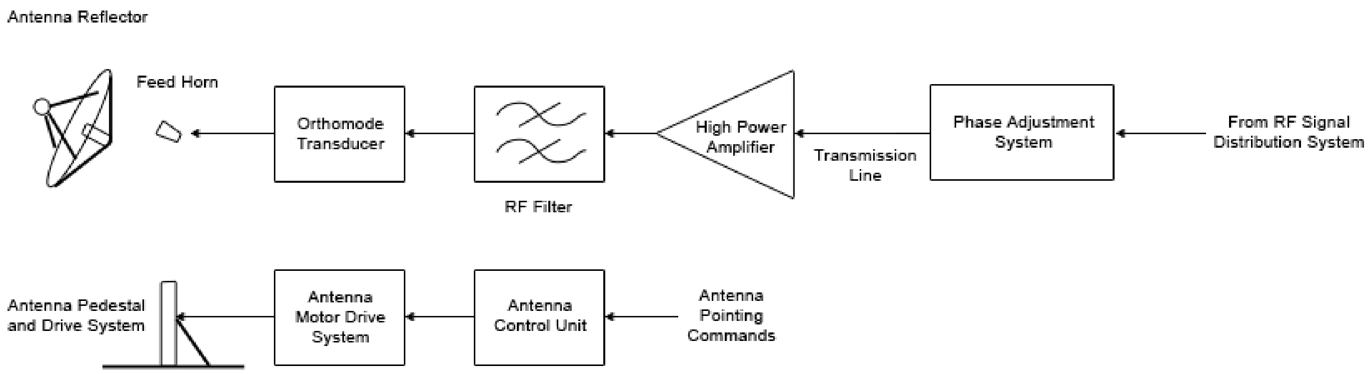


5. The modulated RF signal from the RF signal distribution system then passes to the Phase Adjustment System (PAS) located in each of the distributed Parabolic Transmit antennas. The main purposes of this phase adjustment system are twofold: the first purpose is to compensate for changes in phase of the RF signal as it passes from the Exciter to the individual Parabolic Transmit Antennas. Simultaneously, the PAS also adjusts the phase of the RF signal at each High Power Amplifier input to compensate for any phase differences in the electrical path through the individual High Power Amplifier and Parabolic Transmit Antenna subsystems as well as through very slight differences in physical transmission path to the intended target.

The envisioned system makes use of conventional Parabolic Antennas and High Power Amplifiers to achieve the required transmit RF energy levels. The architecture of the individual Transmit Antennas that make up the array are illustrated in Figure 3.

The modulated RF transmission signal leaving each of the High Power Amplifiers is first Band pass Filtered in the antenna feed assembly. Following the Band pass Filter function the bandlimited RF transmit signal then passes through the orthomode transducer in the antenna feed.

Figure 3 Transmit Antenna Detail



Critical to the successful phase-combining of the modulated RF signals transmitted from each of the Parabolic Transmit Antennas are both the phase stability of the modulated RF signals arriving at the Parabolic Transmit Antennas for transmission as well as accurate control of the phase to correct for transmission path differences. Phase stability in the modulated RF signals arriving at each of the Parabolic Transmit Antennas is accomplished through the design and implementation of the RF signal distribution system. It utilizes individual RF power dividers, amplifiers, phase-shifters, and transmission lines which are carefully electrically matched. This approach provides duplicate copies of the modulated RF signal at each of the Parabolic Transmit Antennas, which are suitably accurate in phase to support the required operational accuracy with limited additional phase adjustment at each antenna.

Correction of RF signal phase differences both through the HPA and antenna RF equipment, as well as on the intended transmit path, is accomplished through the use of the Phase Adjustment System (PAS) associated with each antenna. The phase adjustment range of each of the PAS systems is in excess of 180 Degrees of electrical phase so any required phase angle compensation can be satisfactorily executed.

Each antenna must be separately controlled to ensure that the maximum transmit gain is focused on the desired target. This is accomplished through the use of a networked Antenna Control Unit system which coordinates the pointing angles for each antenna with the desired target. The Antenna Control Units are capable of driving each of the Parabolic Transmit Antennas over its full range of motion to any desired Deep Space target.

The orthomode transducer ensures that the RF energy to be radiated by the transmit antenna exhibits the desired polarization characteristics. Possible transmit polarizations include linear and circular modes. Specific implementations are desired to be selectable for different propagation conditions but selection of exact characteristics will be performed during each operation. The polarized RF signal energy will then be radiated through the antenna feed horn to the Antenna Reflector. Through an RF optical combination of suitable subreflector and primary reflector surfaces, the RF energy will then be focused towards the intended reception target.