Invention Title:	How to Build a Cheap Phased Array Antenna
Invention Summary:	A single A-D converter services multiple antennas in an array. DSP is used to form an array and remove errors. Phased arrays can also be used to create directional nulls.
Invention Description:	See below. Voltage samples from several arrays are switched to the input of a fast A-D converter.
Invention Commercial Value/Customers:	Very, very, large. Also works for other industries, such as broadcast TV or surveillance.
Invention Differences:	compared to conventional steered phased arrays, cost is the main advantage.

Method to Make a Phased Array Antenna on the Cheap

Phased array antennas have an ability to form directional beams, for either receive or transmit.
But they are expensive, primarily because of a need to separately process signals from several antennas. More elements are required for more gain, which increases cost.

In prior art, the 4 antennas together make a phased array by combining their signals with different electrical delays. For the array to be steerable, the phase (delay) between the antennas and combining network must be dynamically adjustable (not cheap).

Fig 1 is a block diagram of an innovative receive array, but the block diagrams can be modified for a transmit array or a transmit/receive array. A single A-D converters services multiple antennas in an array. A set of 4 horn antennas are shown on the right side, receiving a wave front. In Fig 1 all 4 signals are down-converted to be in the sampling frequency range of an A-D converter's input. A Sample/Hold (S/H) circuit saves instantaneous voltages from each of the down-converters, and the voltages are sampled by electronic switch feeding a high speed A-D converter. The speed of the A-D converter must be at least twice times the bandwidth (Nyquist sampling theorem) times the number of antennas in the array. Thus, if the RF bandwidth was 40MHz, and there were 4 antennas, the A-D's sampling rate would need to be >320MHz.

The A-D converter must work faster, but modern A-D converters, using massively-parallel lower-speed converters are very low cost and currently used in the front end of STBs and CMs.

DSP is used to form an array and remove errors. The DSP operates on the 4 interleaved time samples to separate them by antenna. The DSP also adjusts for timing errors, differences in down converter frequency response, and adds variable individual delays before mathematically combining the 4 signals. The variable delay allows beam steering.

Fig 2 is a similar block diagram but with cable lengths between the down converters and the A-D converters. The delay is adjusted to match the switch speed.

In an ideal embodiment (not illustrated) the 4 electrical delays can be supplied by the DSP before combining. This would remove the 4 variable lengths.

Note that applications are more than wireless data service access. For example this idea would also work for improved broadcast TV reception.

As mentioned above the single A-D can be replaced by a D-A, and elements turned around to make a transmit array.

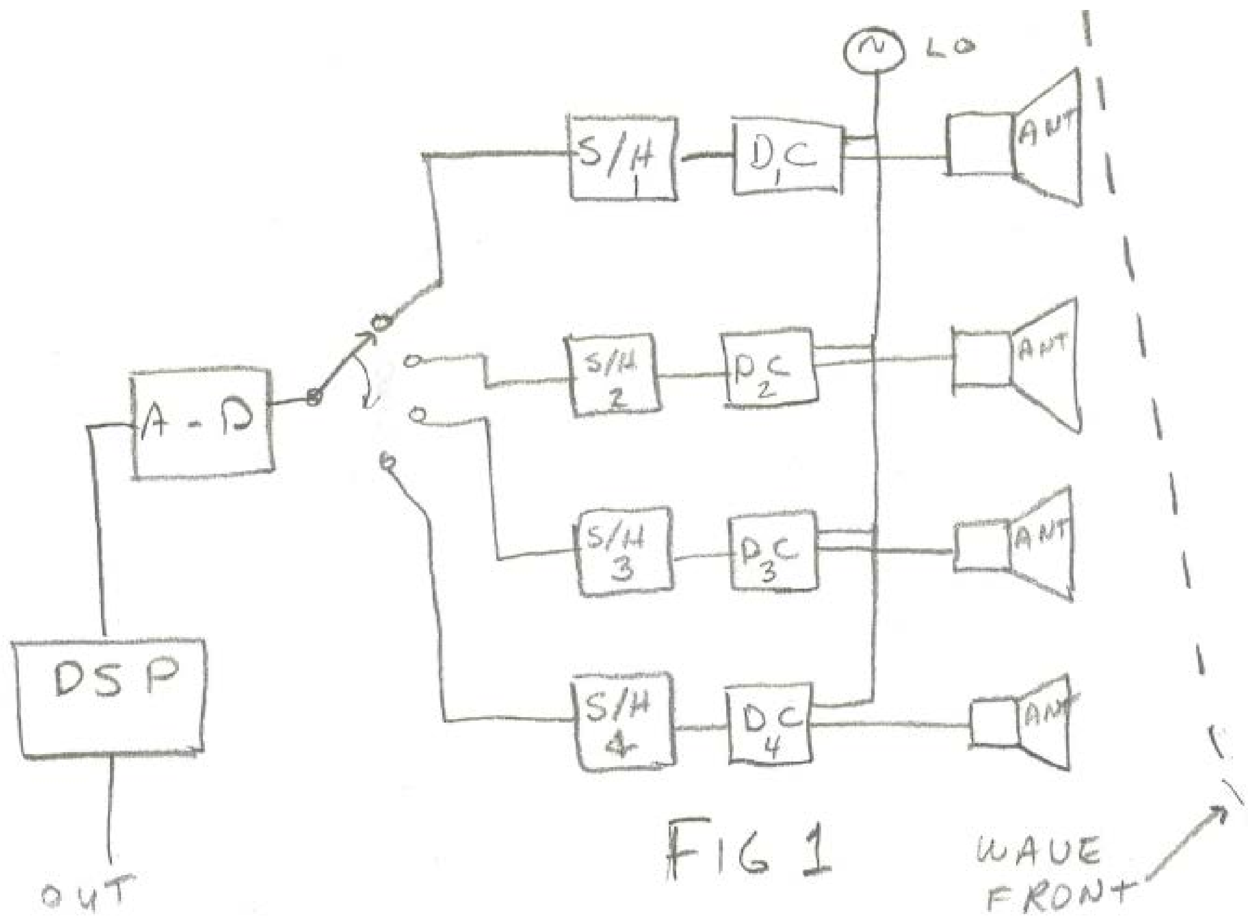

FIG 1

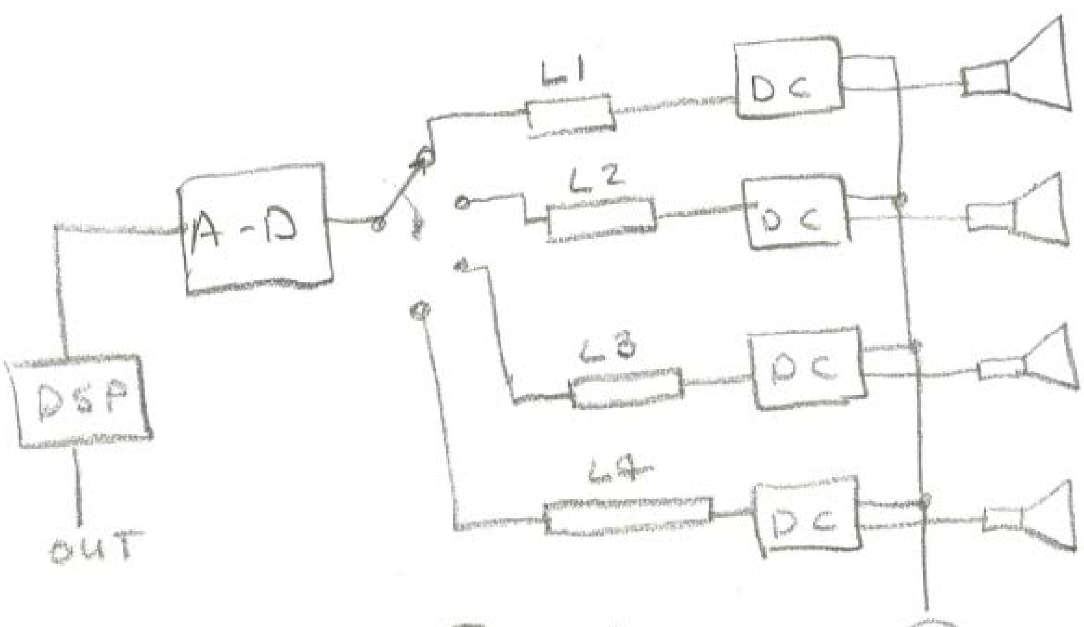

FIG 2

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