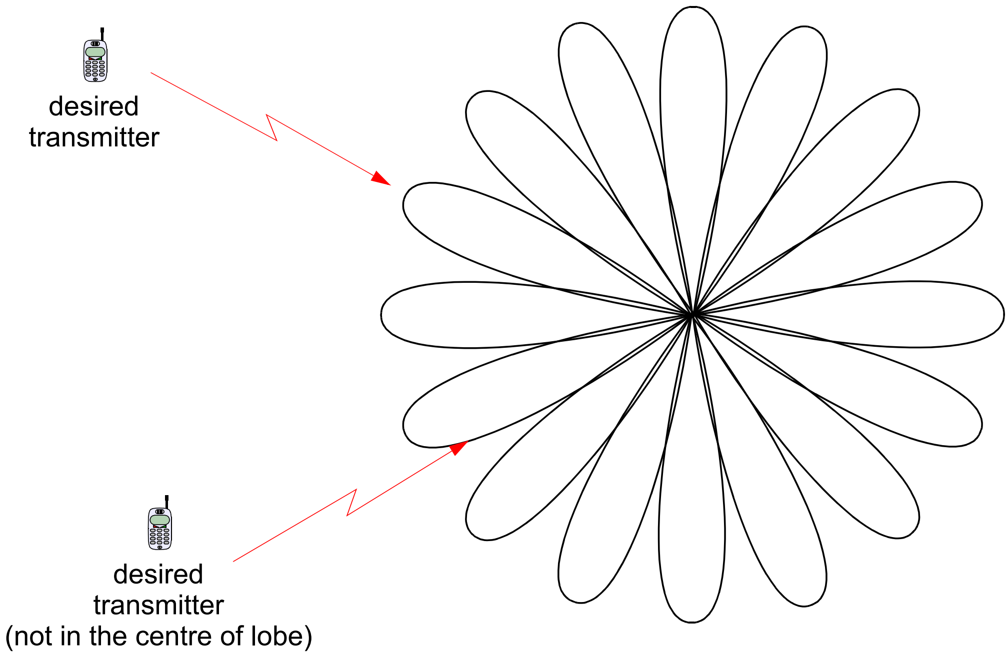
Smart Antenna: Switched Beam

- Predetermined set of beams to choose from



Notes:

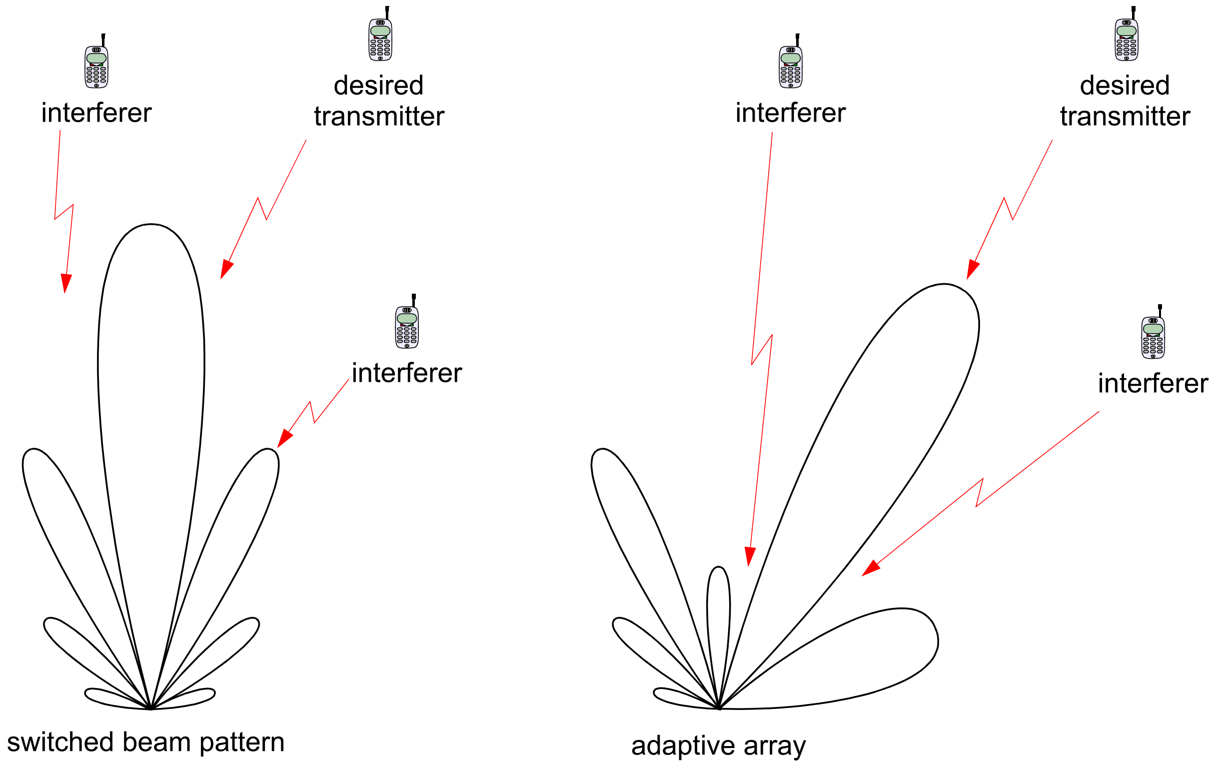
We can classify smart antennas in two main types:

- switched beam antennas
- adaptive beamformer

The first one presents a predetermined set of beams which can be selected as appropriate. The problem of this approach is that the user of interest may not be in the centre of the main beam

Smart Antenna: Adaptive Beamformer

- Adapt radiation pattern to environment: more degrees of freedom



Notes:

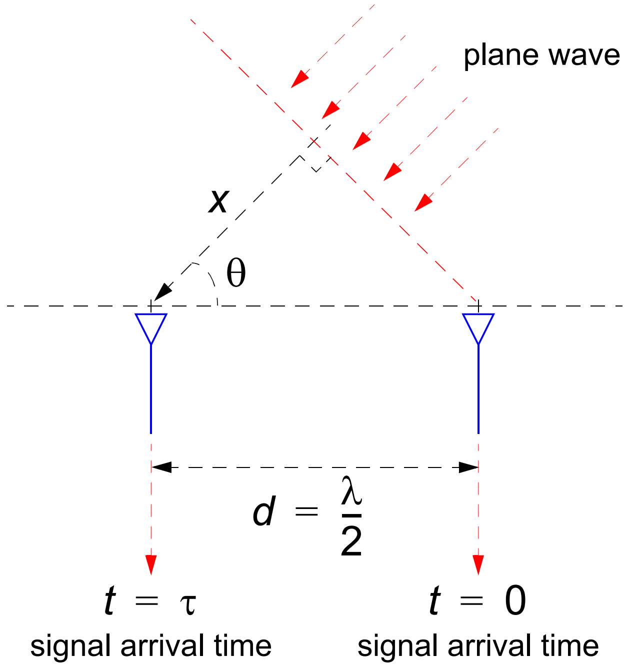
In this slide we can observe the problem of the switched beam pattern, where we are limited to the available predetermined set of beams. In the example shown the user of interest does not lie directly in the middle of the main beam. At the same time, interferers are not located in a radiation null.

However, with the adaptive beamformer we can adapt to the specific conditions of the environments (position of user of interest and of interferers) and generate the required radiation pattern, with a main lobe focusing towards the user of interest and nulls in the direction of the interferers.

Beamforming Principles I

- Two antenna case

$$\tau = \frac{x}{c} = \frac{d\cos\theta}{c} = \frac{\lambda\cos\theta}{c}$$



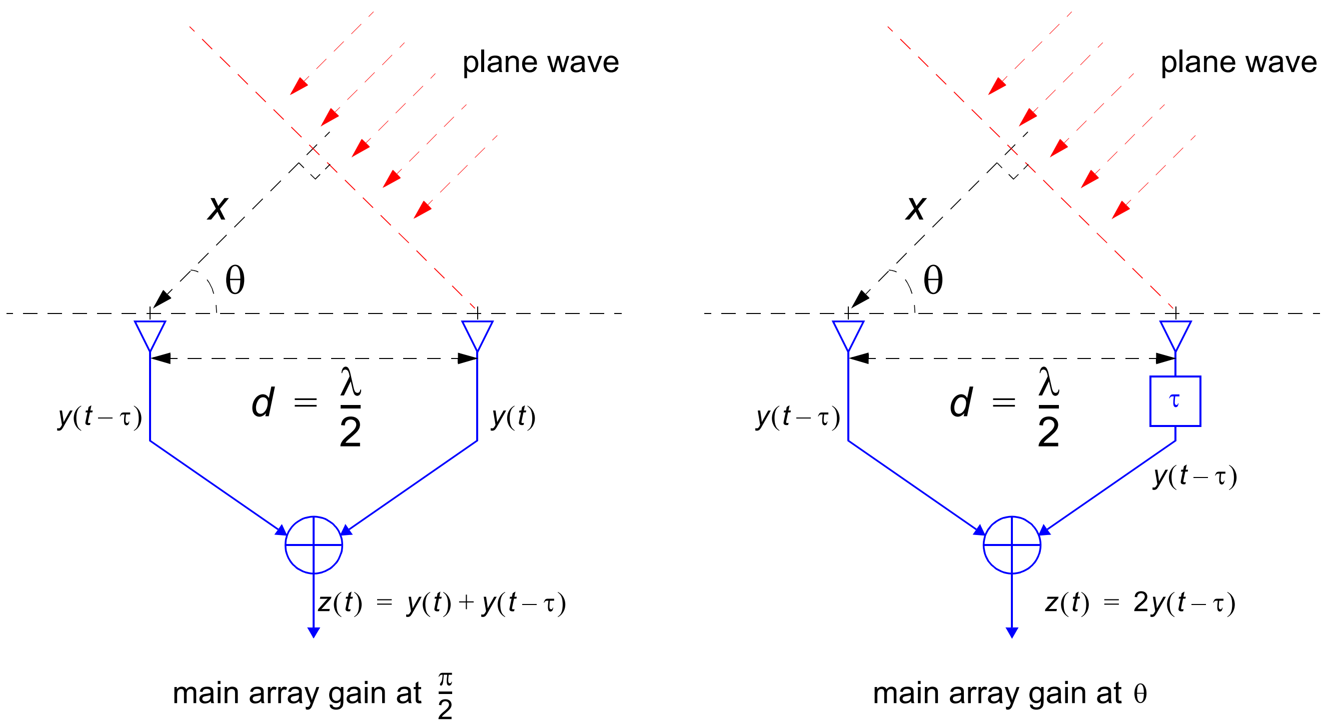
- Combining of output signals will produce different radiation patterns

Notes:

The case above shows a plane wave impinging on a linear array with elements separated a distance $\lambda/2$. We assume the wave reaches the first element at time $t = 0$. The signal reaches the second element at time $t = \tau$, where τ is a function of the antenna separation, the speed of light c and the angle of arrival θ.

The output of the different antennas can be combined to generate different radiation patterns.

Beamforming Principles II



Notes:

This slide shows an example of how by adding a delay element to one of the two antennas we can combine the received signal and increase the power of $z(t)$ (signal after combining).

In the first case the main gain of the array occurs at a direction of $\pi/2$ radians with the horizontal line of the arrays. In this case destructive interference may occur when adding $y(t)$ and $y(t-\tau)$. In the second case the main gain of the array happens at a direction of θ radians with the horizontal line of the arrays. This has been achieved by adding a delay of τ seconds in one of the antennas.