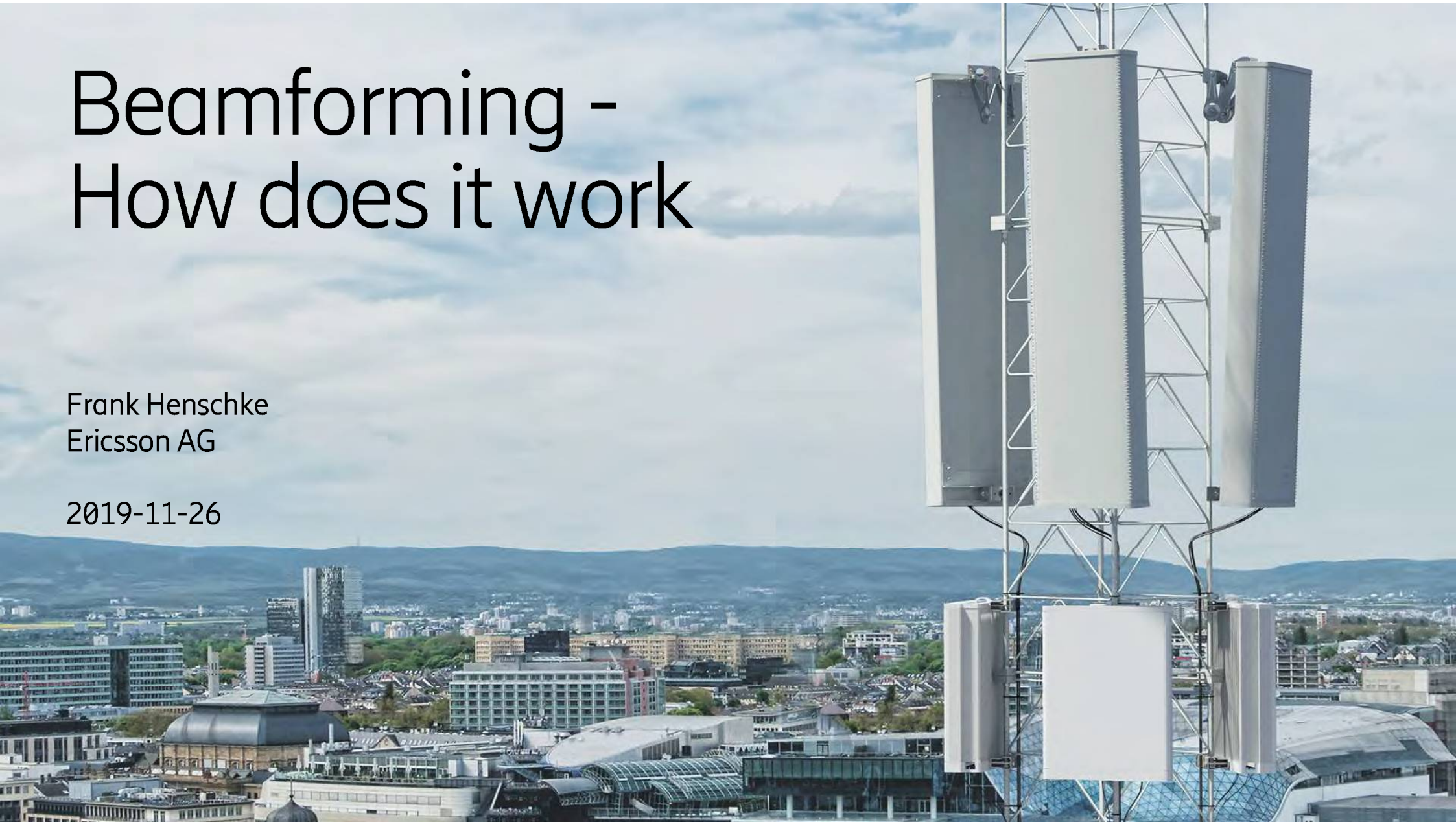# Beamforming - How does it work
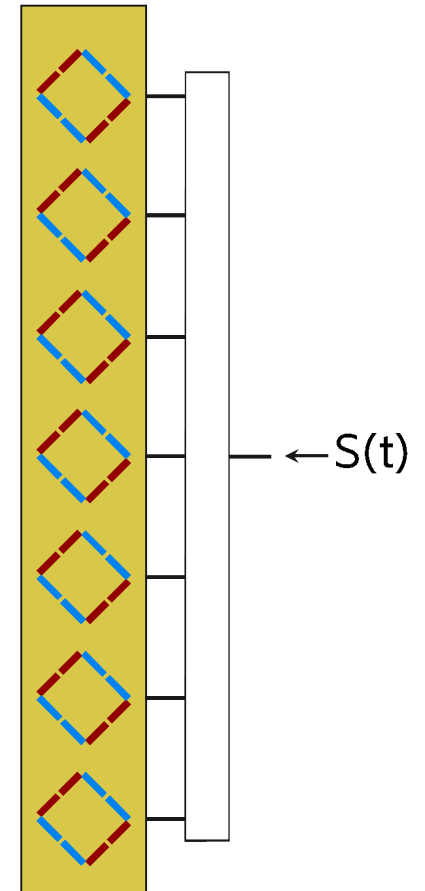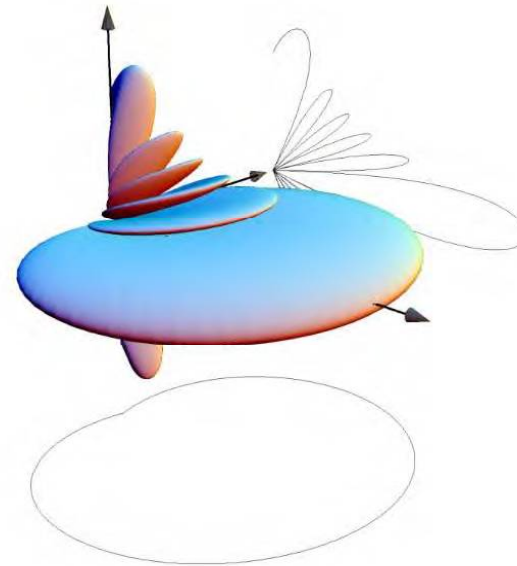
Frank Henschke
Ericsson AG

2019-11-26

Antenna, so far...

— Antenna are provided with antenna diagrams ("beams")
— Each antenna has its own beam diagram
— Antenna with Electrical tilt are provided with multiple beam diagrams, one for each tilt
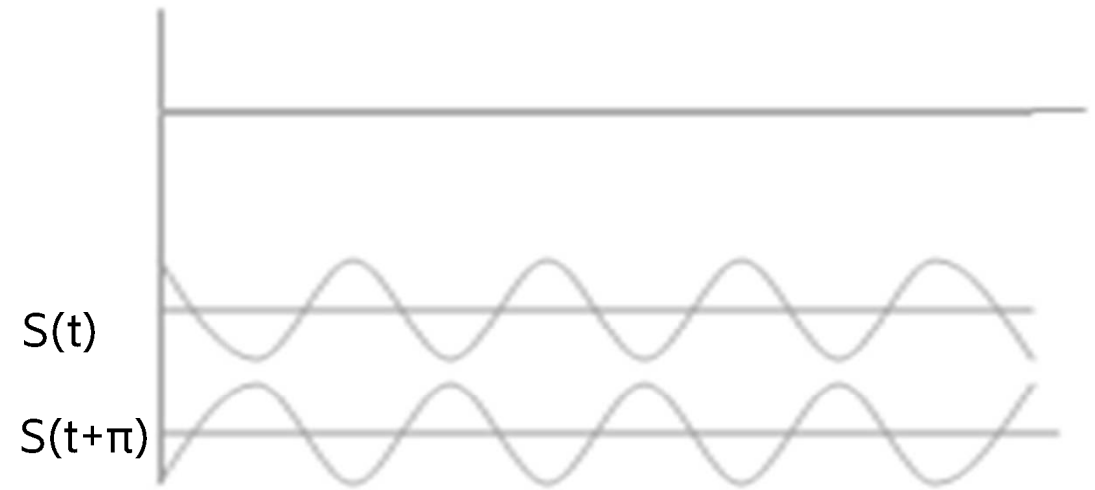— But what is behind beam shape and beam direction?
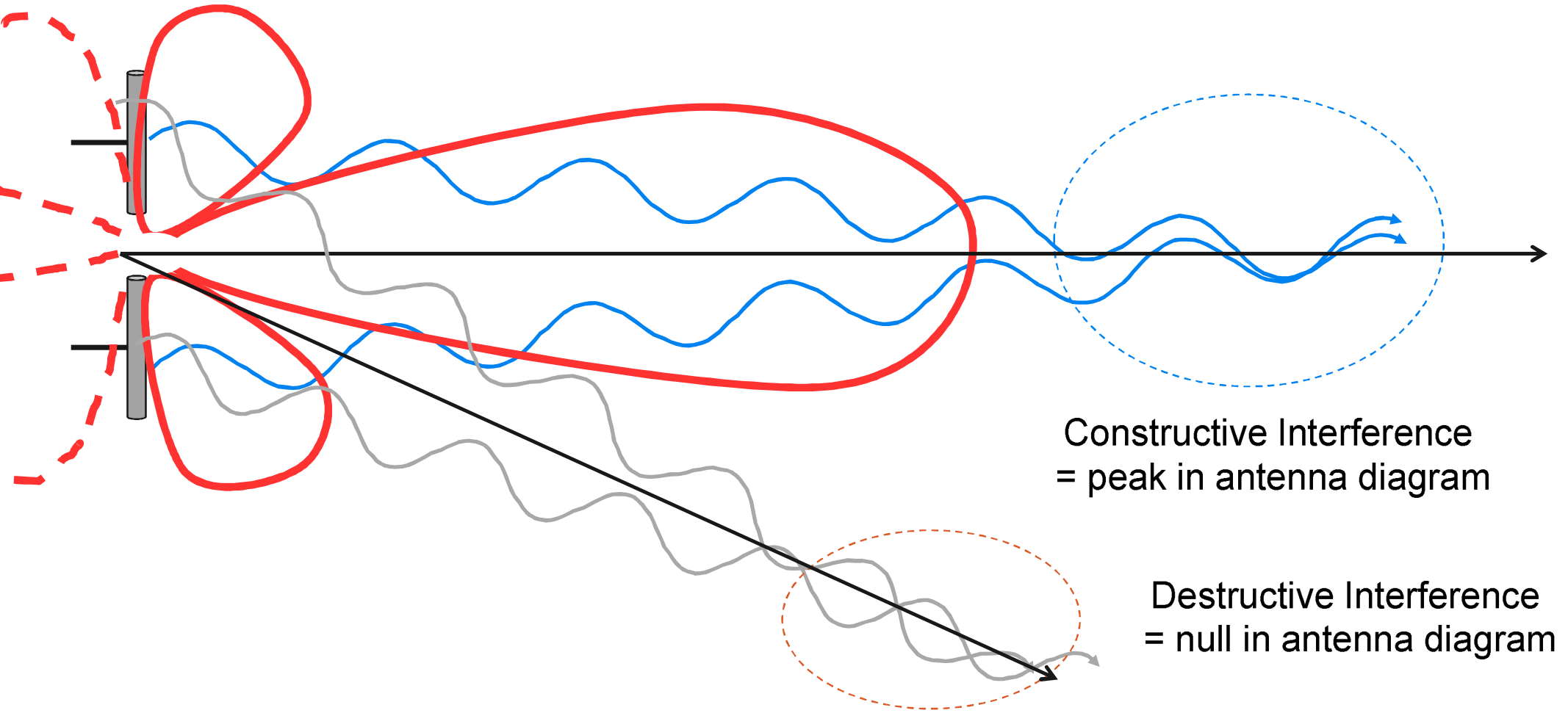
$\leftarrow S(t)$

Interaction between electromagnetic waves

Constructive

Destructive

S(t)

S(t)

S(t)
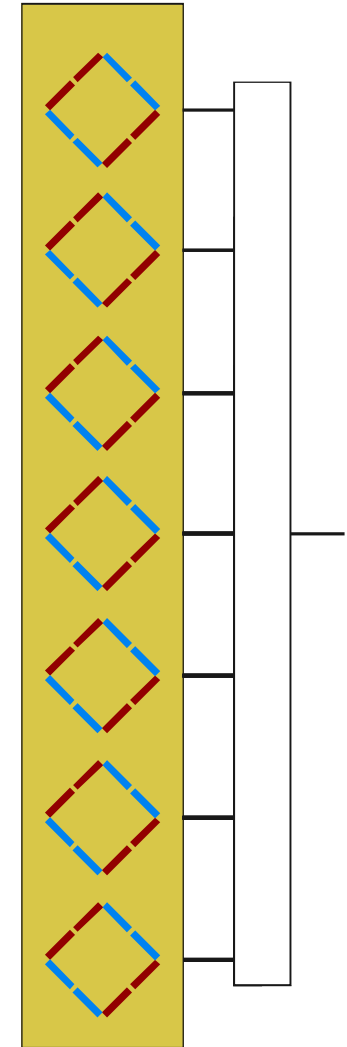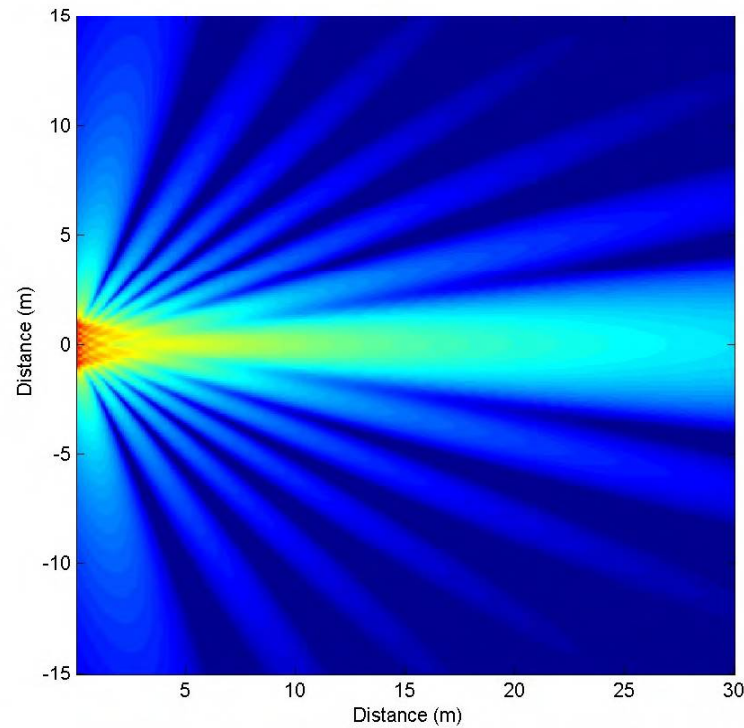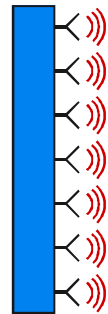
S(t+π)
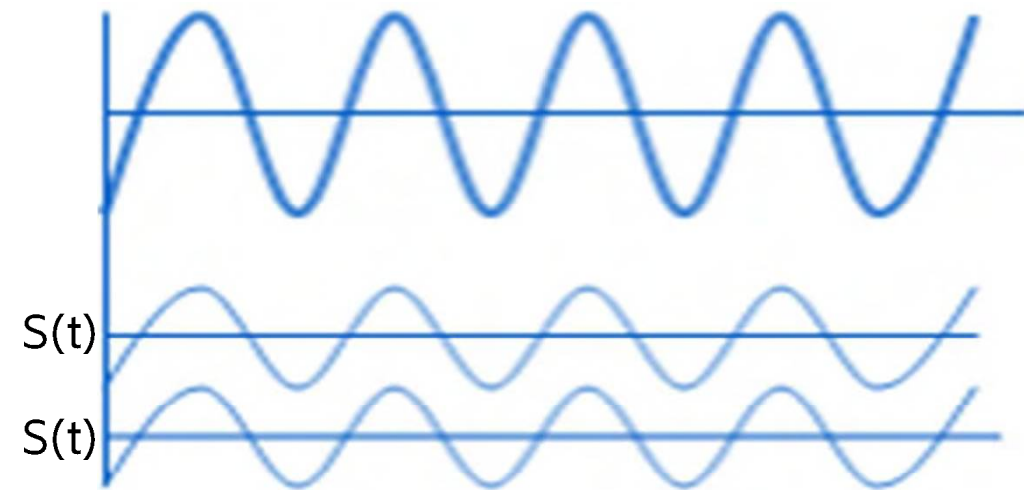
Directional Properties

Constructive Interference
= peak in antenna diagram

Destructive Interference
= null in antenna diagram

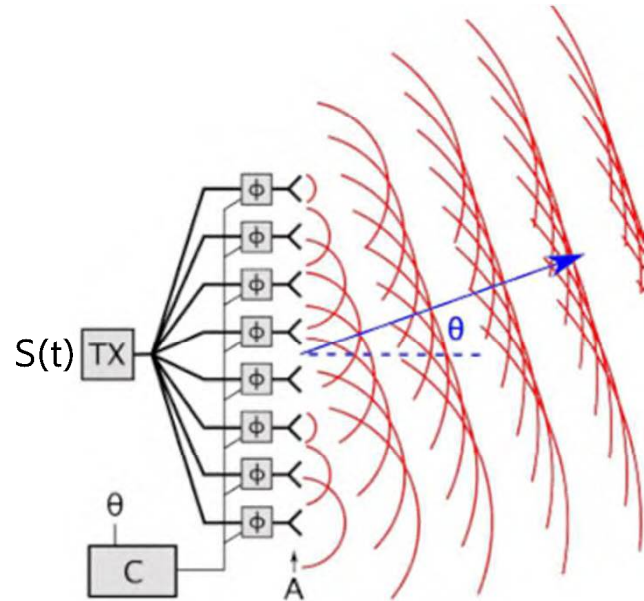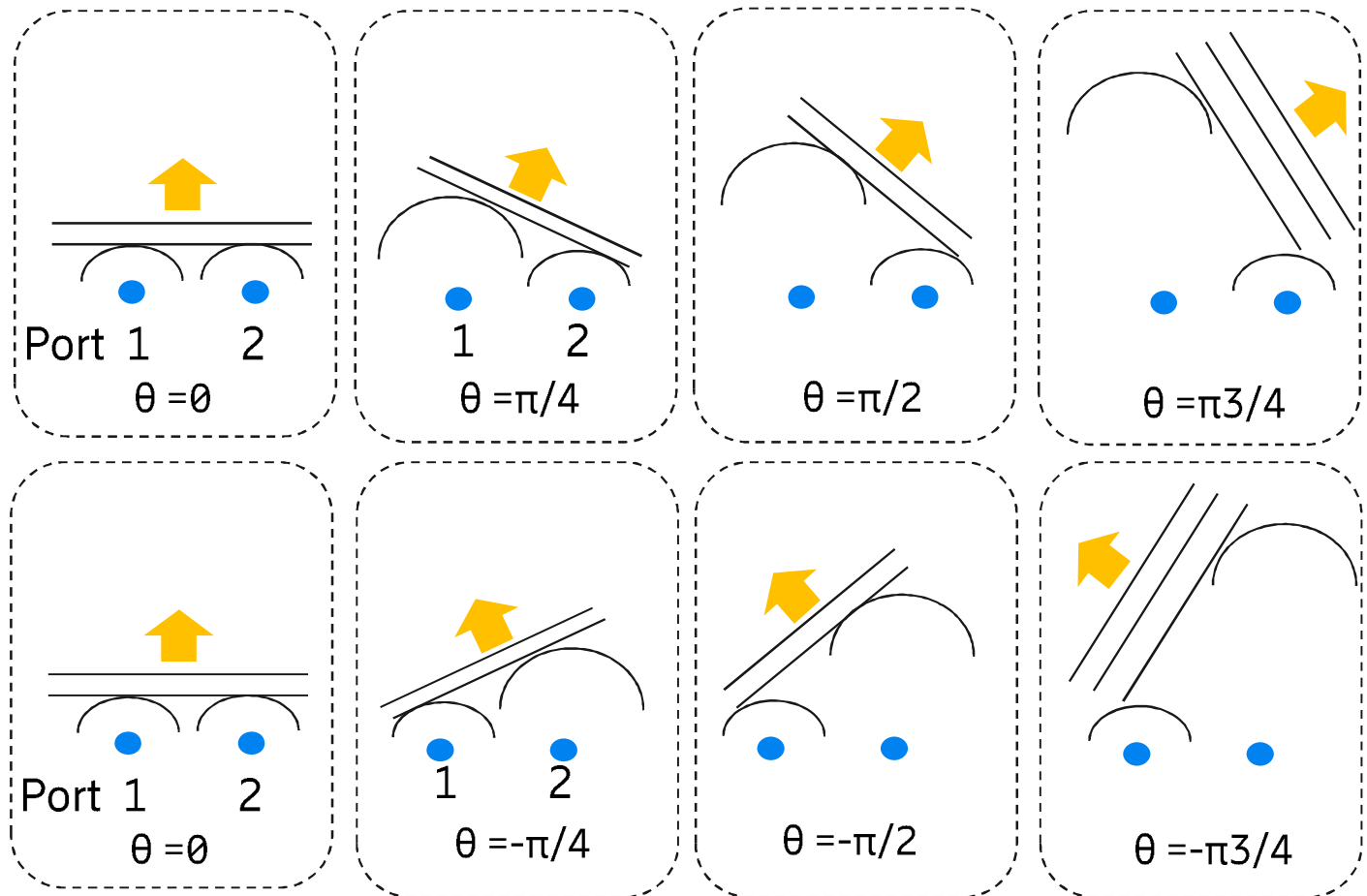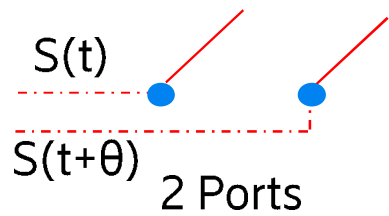# Behind the beam shape

— The higher the number of elements:
  — The narrower the beam
  — The higher the antenna gain

Behind the beam direction

Phase shift between antenna dipoles defines the direction of the beam

Beamforming

— By splitting the antenna in subarrays and sending the same signal with proper amplitudes and phases to the different subarrays it is possible to dynamically change both beam shape and beam direction

— With beamforming both amplitude and phase are part of the baseband signal processing in the radio node => the radio node decides both beam shape and beam direction

— By placing multiple arrays of subarrays next to each other the radio node can steer both beam shape and beam direction in both vertical and horizontal domains