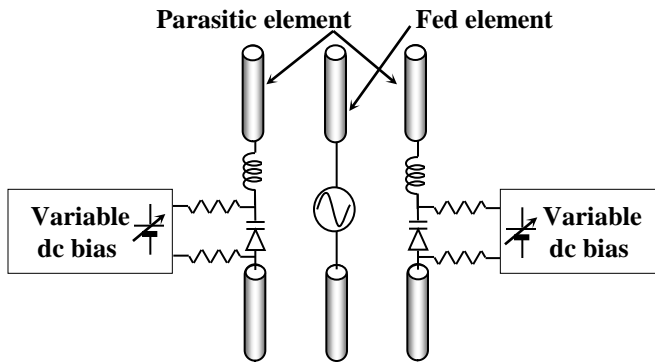


Electronically Steerable Parasitic Array Radiator antenna

What is ESPAR antenna?

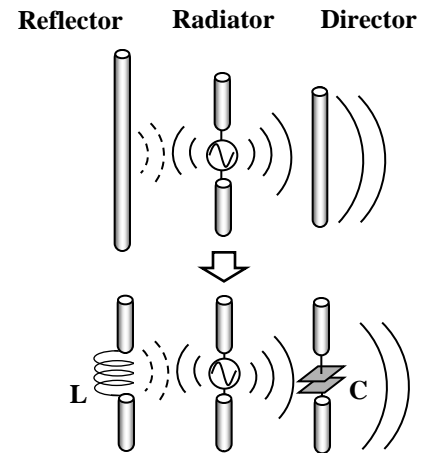


Beamforming by electromagnetic mutual coupling between elements

Advantages over phased array

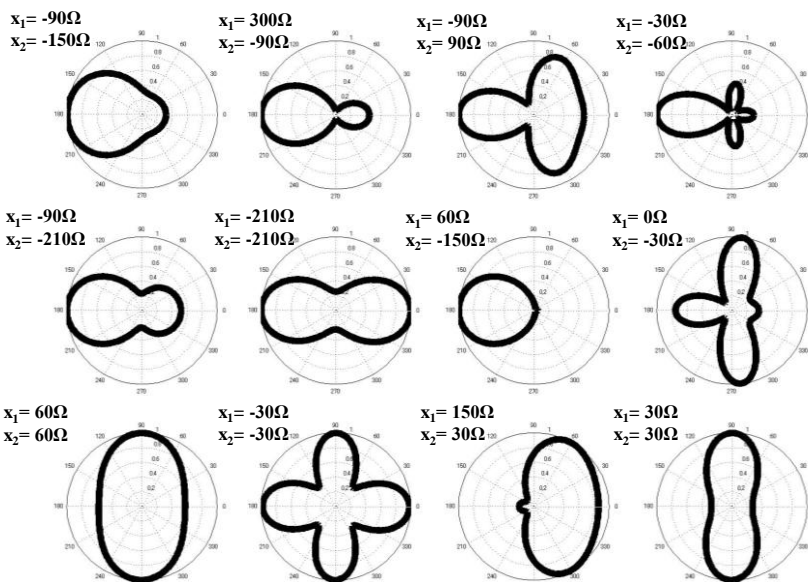
- Smaller size
- Lower consumption power
- Lower fabrication cost

Idea for beam steering

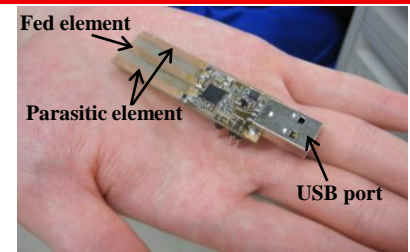


$$x_1 = \omega L - \frac{1}{\omega C_1} \quad x_2 = \omega L - \frac{1}{\omega C_2}$$

Azimuthal directivity patterns of 3-element ESPAR antenna for a variety of dc bias



3-element ESPAR antenna on a USB circuit board

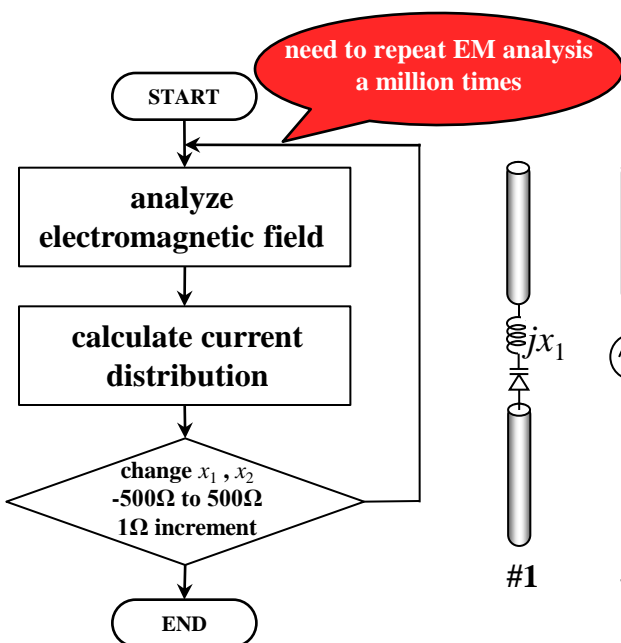


Prospective applied system

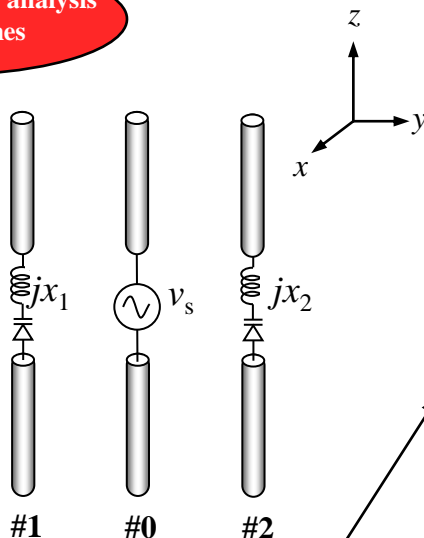
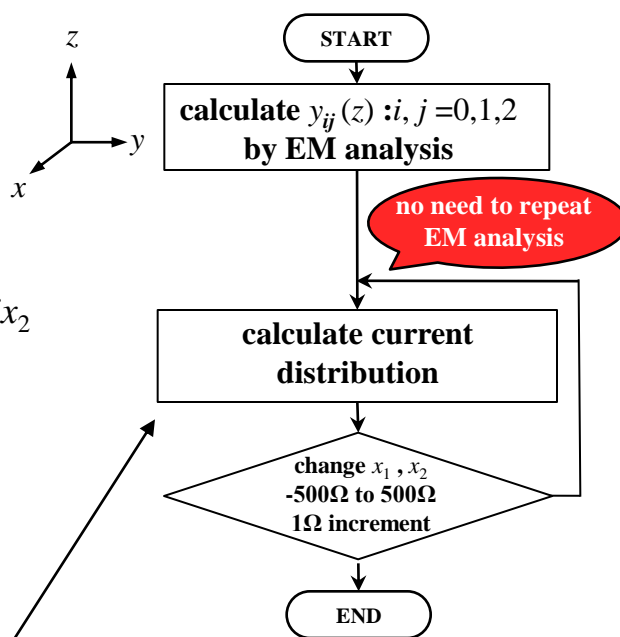
- Wireless secret key generator and sharer
- SDMA for ad-hoc network
- Direction-of-arrival finder

Fast calculation method of RF current distribution on antenna elements for variation on loading reactances

Conventional method



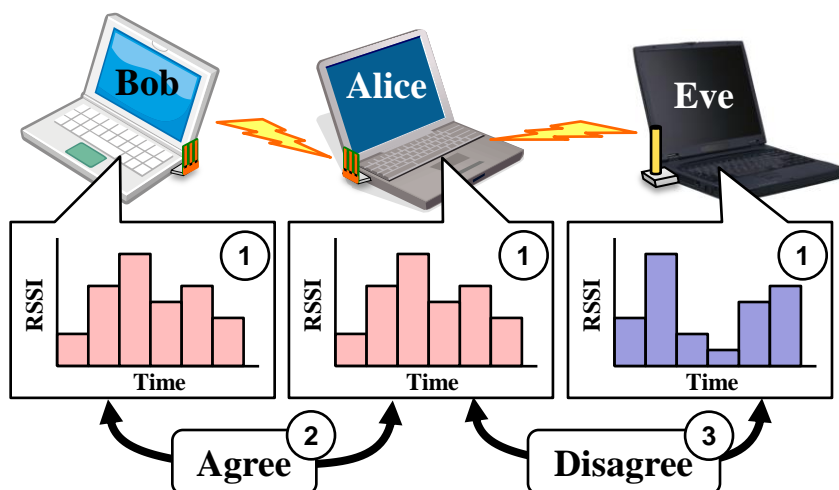
Proposed method



$$\begin{bmatrix} i_0(z) \\ i_1(z) \\ i_2(z) \end{bmatrix} = V_s \begin{bmatrix} y_{00}(z) & y_{01}(z) & y_{02}(z) \\ y_{10}(z) & y_{11}(z) & y_{12}(z) \\ y_{20}(z) & y_{21}(z) & y_{22}(z) \end{bmatrix} \left\{ \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & jx_1 & 0 \\ 0 & 0 & jx_2 \end{bmatrix} \begin{bmatrix} y_{00}(0) & y_{01}(0) & y_{02}(0) \\ y_{10}(0) & y_{11}(0) & y_{12}(0) \\ y_{20}(0) & y_{21}(0) & y_{22}(0) \end{bmatrix}^{-1} \right\}$$

Application example

Wireless Secret Key Generator and Sharer



- ① **How can RSSI deviate?**
Thanks to ESPAR antenna's variable directivity
- ② **How Alice and Bob's RSSI agree?**
Because of wave propagation reciprocity
- ③ **Why Eve cannot guess the key?**
Because of wave propagation's strong location dependency

RSSI profile makes a key