

SMART ANTENNA SYSTEMS

(an overview)

Antenna Engineering

Smart Antenna Array:

- antenna array with a digital signal processing capability to transmit and receive in an adaptive and spatially sensitive manner.

“Smart” >> digital signal processing facility

USAGE

Applications to:

- cellular and wireless networks
- radar
- electronic warfare (EWF) as a countermeasure to electronic jamming
- satellite systems

WHY SMART ANTENNA ARRAYS?

- Higher Capacity
- Higher Coverage
- Higher bit rate
- Improved link quality
- Spectral efficiency
- Mobility

Elements of a Smart Antenna

- number of radiating elements
- a combining/dividing network
- control unit

Aim :

- to maximize the antenna gain in the desired direction
- to minimize the gain in directions of interferers

Types of Smart Antennas

Switched lobe (SL):

(also called “switched beam”)

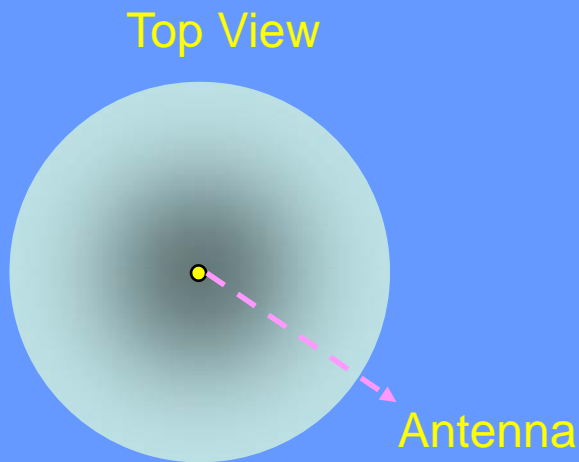
- simplest technique
- comprises only a basic switching function between separate directive antennas or predefined beams of an array

Types of Smart Antennas - cont'd

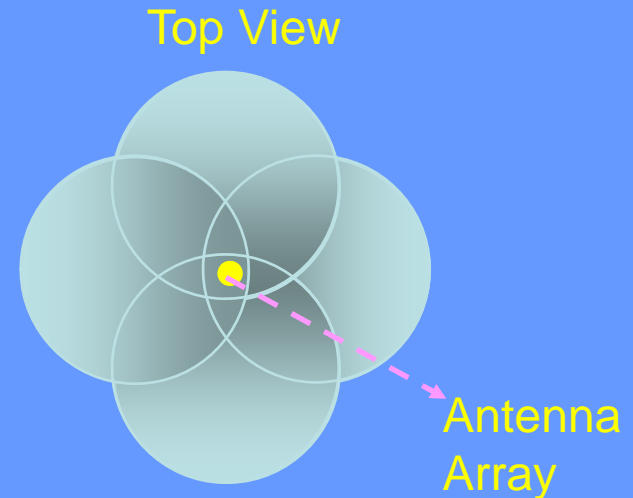
Dynamically phased array (PA):

- continuous tracking can be achieved by including a *direction of arrival* (DoA) algorithm for the signal received from the user
- can be viewed as a generalization of the switched lobe concept

Conventional Antennas & Arrays

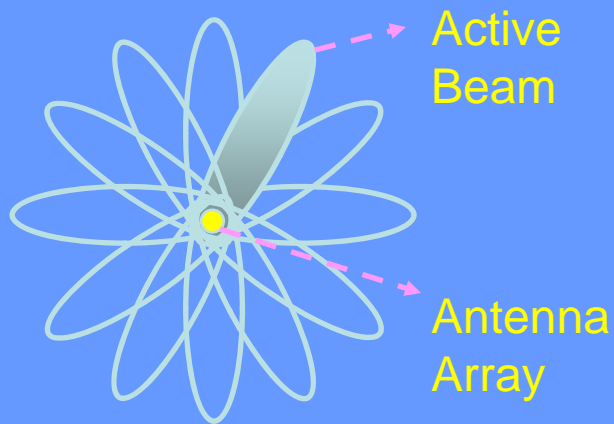


Omnidirectional

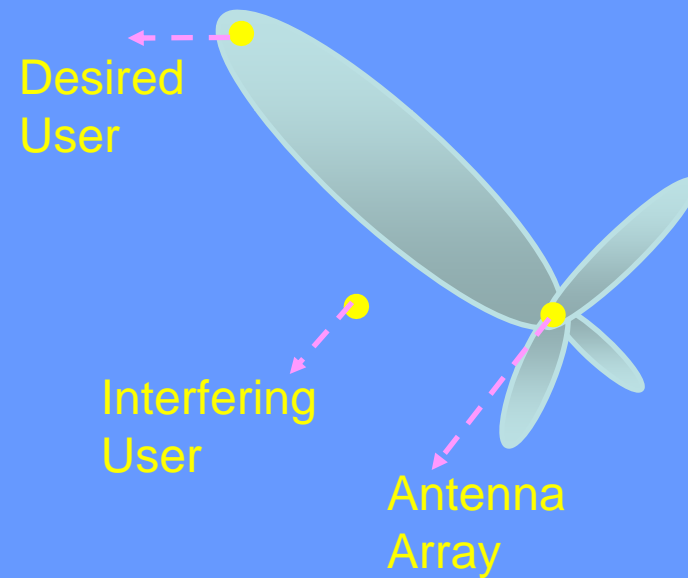


Sectorized

WHY SMART ANTENNA ARRAYS ARE SUPERIOR TO CONVENTIONAL ANTENNAS



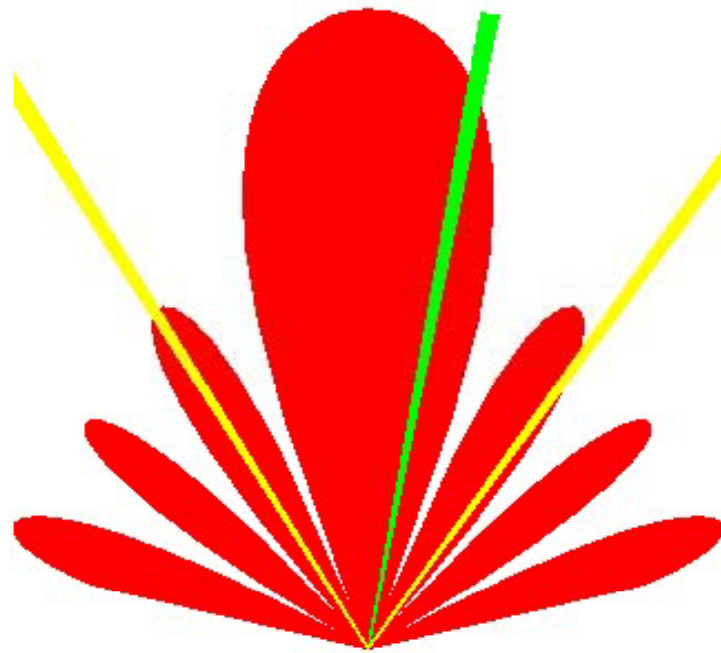
Switched Beam System



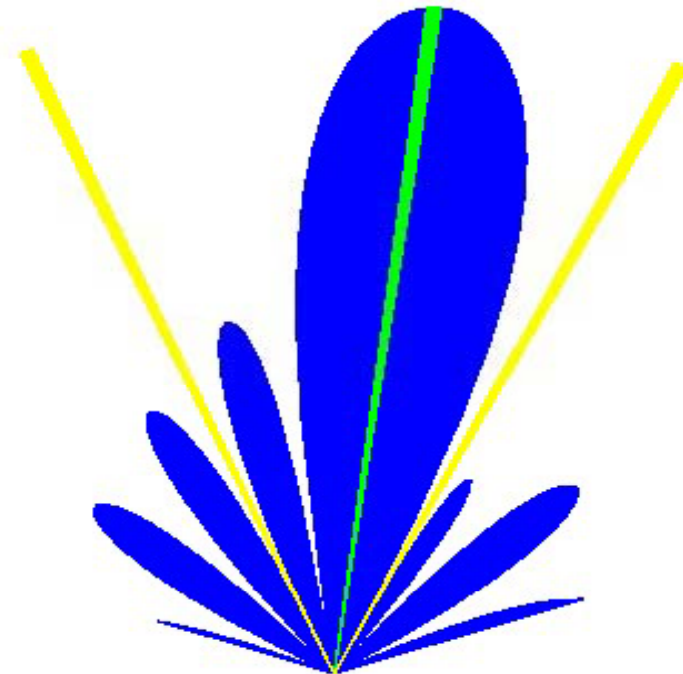
Adaptive Array

Interference Rejection Comparison

Switched Strategy

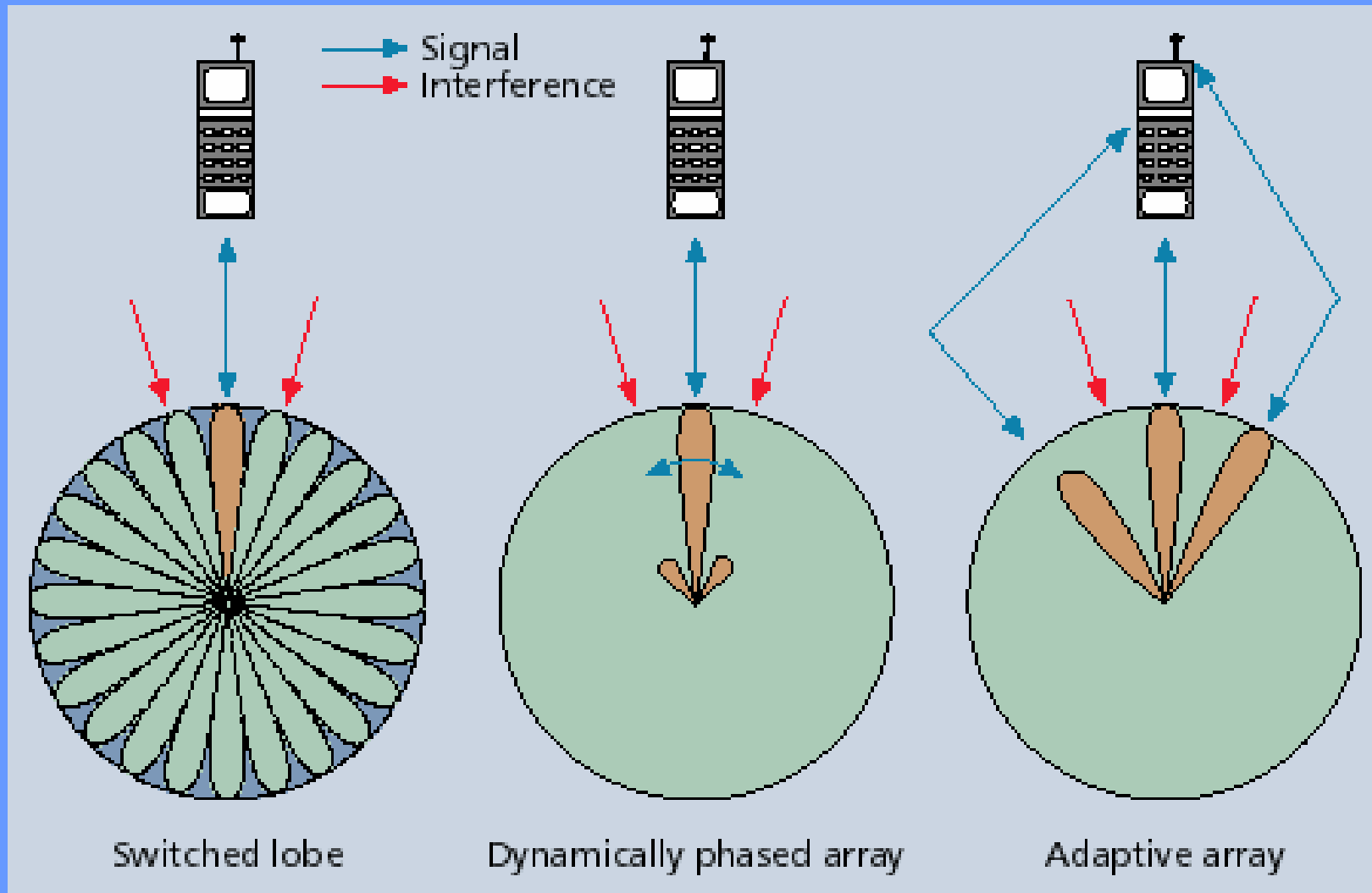


Adaptive Strategy

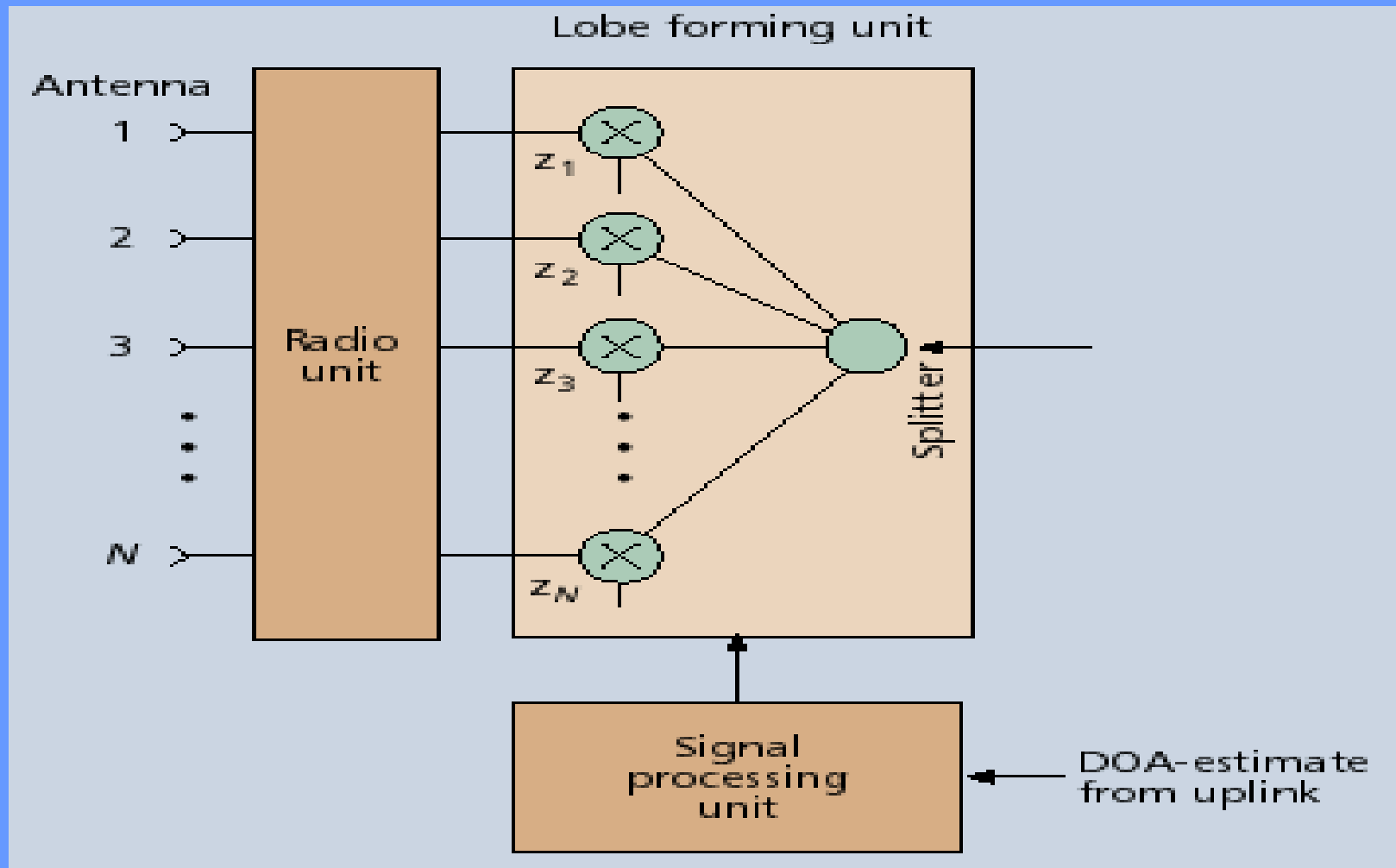


- Desired Signals
- Co-channel Interfering Signals

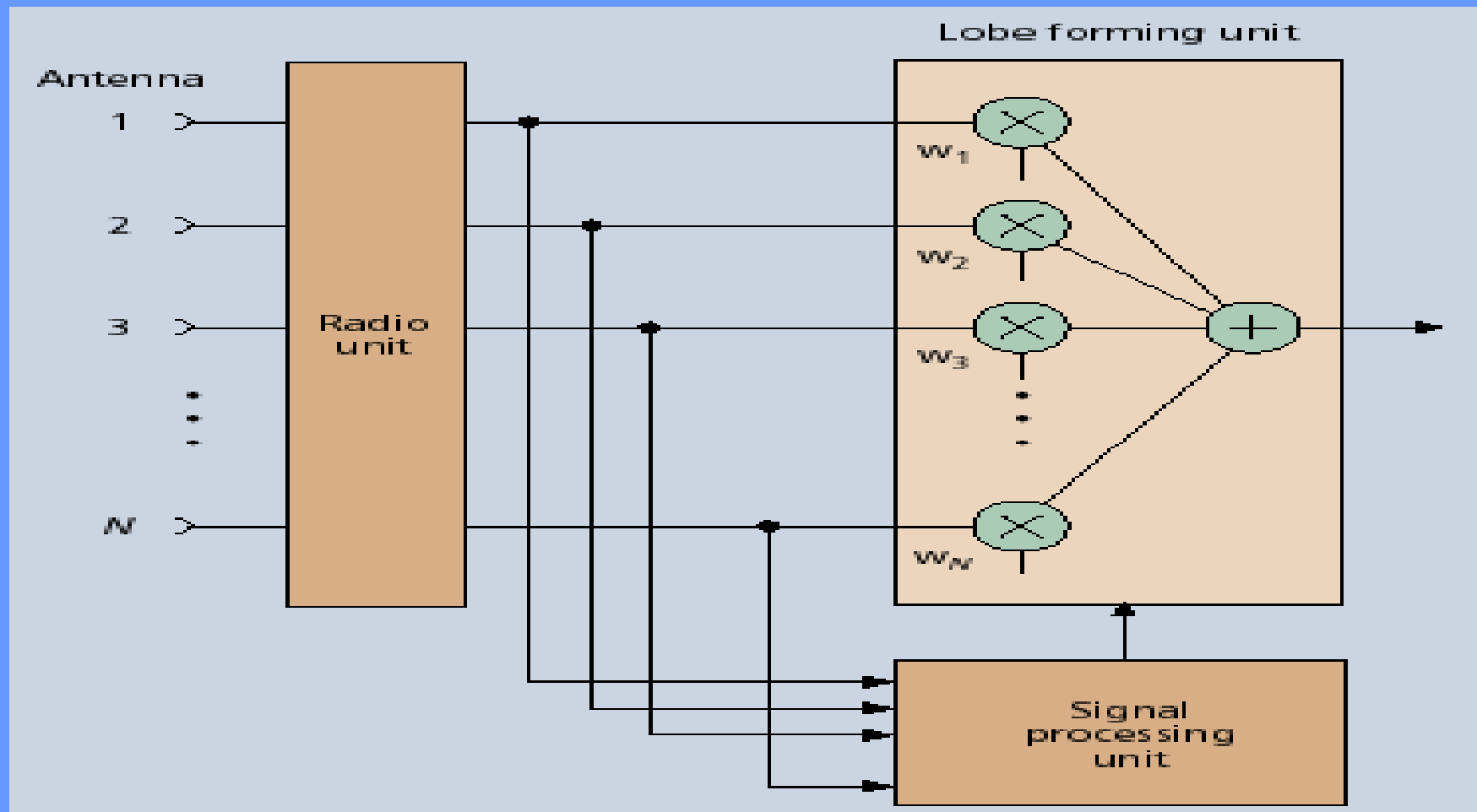
TYPES (summary)



Transmission Part



Reception Part



Smart Antennas for Base Stations

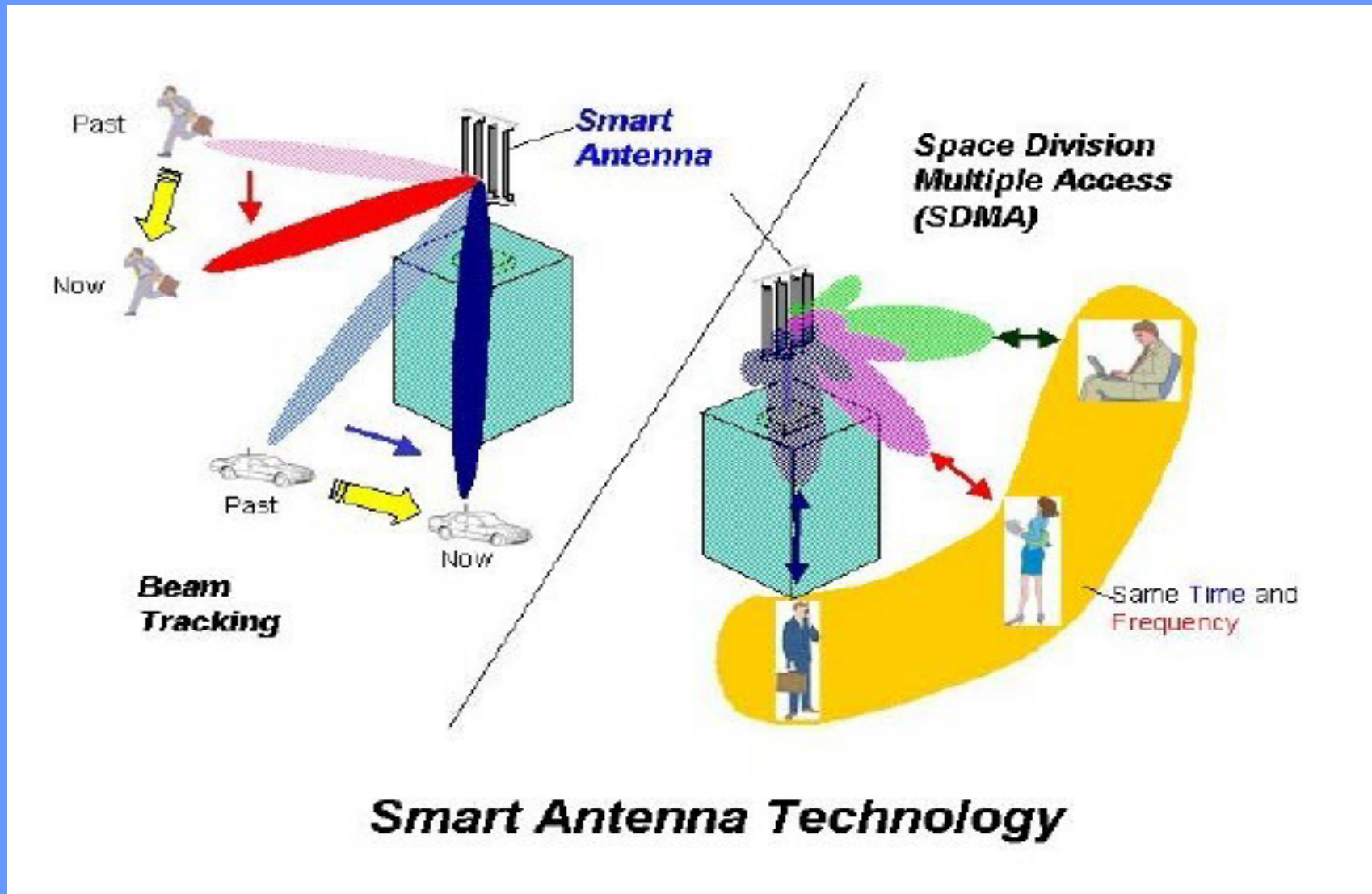
- the idea of smart antennas is to use base station antenna patterns that are not fixed, but adapt to the current radio conditions
- can be visualized as the antenna directing a beam toward the communication partner only

SMDA

(Space Division Multiple Access)

- more than one user can be allocated to the same physical communications channel simultaneously in the same cell
- separated by *angle* only
- in a TDMA system, two users will be allocated to the same time slot and carrier frequency at the same time and in the same cell

SDMA (Space Division Multiple Access)



Comparison of Switched Beam Antenna Adaptive Arrays

Criteria	Switched Beam	Adaptive Array
Integration	<ul style="list-style-type: none">• Easy to implement• Low cost	<ul style="list-style-type: none">• Transceiver complexity• High cost• Less hardware redundancy
Range/ Coverage	<ul style="list-style-type: none">• More coverage compared to conventional systems• Less coverage compared to adaptive array	More coverage compared to switched beam system
Interference Rejection	<ul style="list-style-type: none">• Difficulty in distinguishing between desired signal and interferer• Does not react to the movement of interferers.	<ul style="list-style-type: none">• Focusing is narrower• Capable of nulling interfering signals