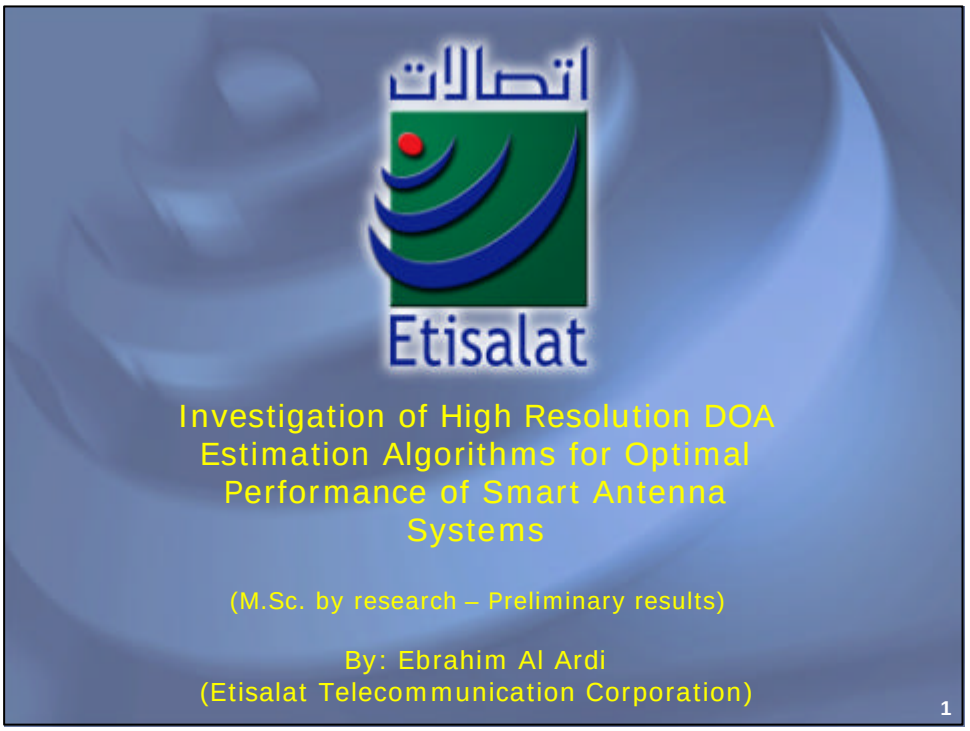
اتصالات
Etisalat
Investigation of High Resolution DOA Estimation Algorithms for Optimal Performance of Smart Antenna Systems
(M.Sc. by research – Preliminary results)
By: Ebrahim Al Ardi
(Etisalat Telecommunication Corporation)
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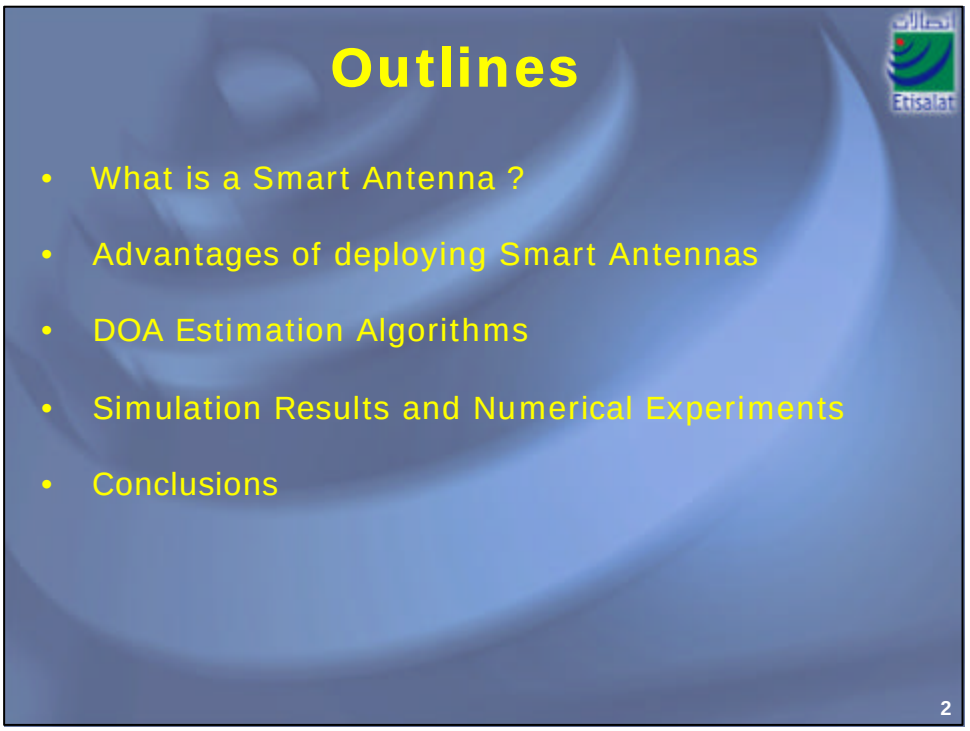
Outlines
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• What is a Smart Antenna ?
• Advantages of deploying Smart Antennas
• DOA Estimation Algorithms
• Simulation Results and Numerical Experiments
• Conclusions
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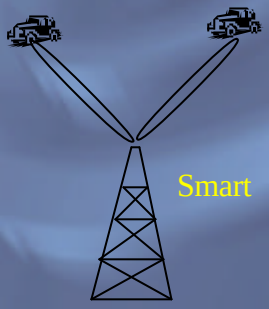
What is a Smart Antenna ?



Smart

Not Smart

- Array of antennas (Linear, Circular, Planar)
- DSP (Digital Signalling Processing)

  (1) Direction Estimation

  (2) Adaptive Beam-forming

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Advantages of deploying Smart Antennas

- Enhancement of coverage range
- More power efficient
- Improvement of system capacity
- Increasing the chances for the application of new services

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DOA Estimation Algorithms

MUSIC Algorithm:

- High-resolution algorithm
- Produces its output as spectrum of power
- Time consuming

Root MUSIC Algorithm:

- Based on polynomial roots solving
- Applicable for Uniform Linear Arrays only

ESPRIT Algorithm:

- Reduces the computational time compared to MUSIC
- Based on dividing the sensor array into sub-arrays

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Simulation Results and Numerical Experiments (1)

Parameters that affect the performance of the DOA Algorithms:

- Spacing between the array elements
- Angular separation between the incident signals
- Number of samples taken for the incident signals
- Signal-to-Noise Ratio
- Number of array elements

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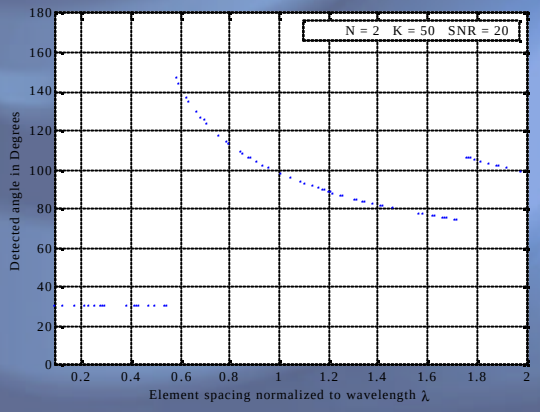
Simulation Results and Numerical Experiments (2)

Effect of increasing the spacing between the array elements



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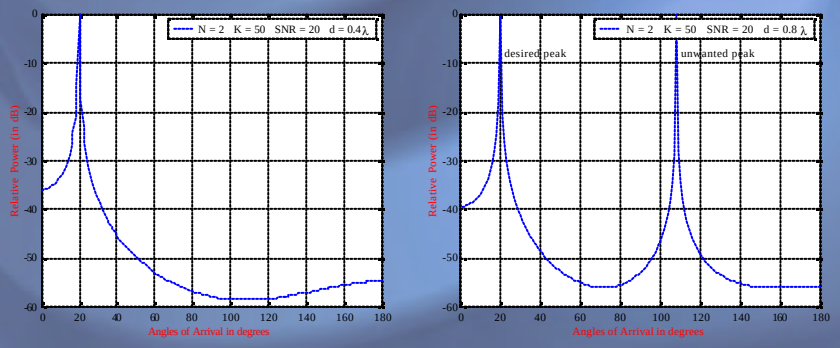
Simulation Results and Numerical Experiments (3)

Effect of increasing the spacing between the array elements



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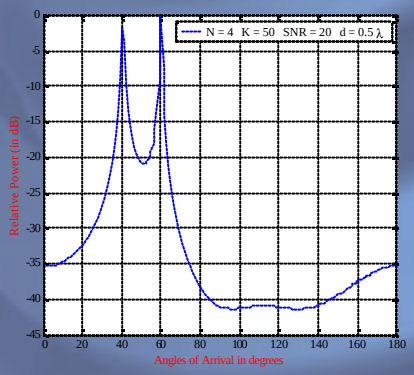
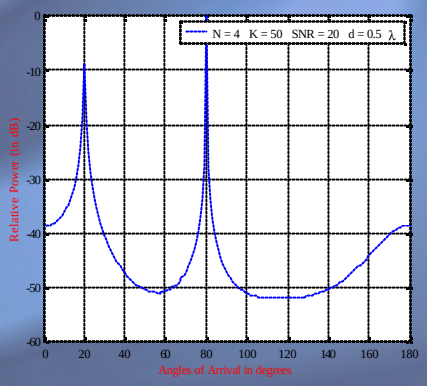
Simulation Results and Numerical Experiments (4)

Effect of increasing the angular separation between the incident signals



(a) Incident angles = 40º and 60º



(b) Incident angles = 20º and 80º

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Simulation Results and Numerical Experiments (5)

Effect of increasing the angular separation between the incident signals

f_{Exact}	f_{ESPRIT}	Df
40º 60º	40.58 º 60.47 º	0.58 º 0.47º
20º 80º	19.99 º 80.05 º	0.01º 0.05º

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Simulation Results and Numerical Experiments (6)

Effect of increasing the number of samples taken for the incident signals

K	Radial amplitudes of the roots	Radial distance to the unit circle
50	1.06 1.03 0.92	0.06 0.03 0.08
500	1.01 1.01 0.98	0.01 0.01 0.02

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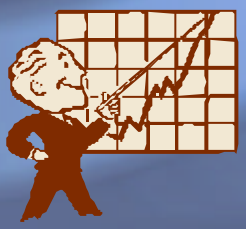
Simulation Results and Numerical Experiments (7)

Effect of increasing the number of array elements and SNR

The effect of increasing the number of array elements and Signal-to-Noise (*SNR*) ratio has also been investigated and it was found that the performance of the algorithms improves when more elements are used and when the *SNR* is increased



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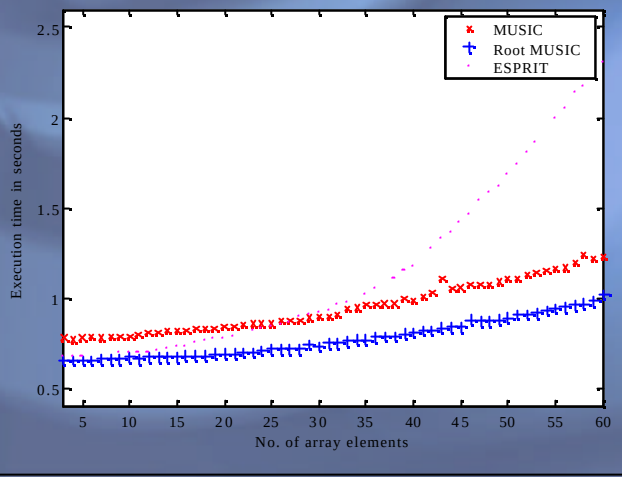
Simulation Results and Numerical Experiments (8)

Computational Time of the Algorithms



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Conclusions

- ETISALAT participates in, and encourages, the research efforts by establishing programs that concentrate in the research and evaluation of new challenging services and technologies
- Performance evaluation of high-resolution DOA estimation algorithms including MUSIC, Root-MUSIC and ESPIRIT has been carried out
- Performance of the three algorithms improves by using more elements in the sensor array and more samples of the incident signals, as well as increasing the signal-to-noise ratio and angular separation between the incident signals.

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Conclusions

- Different simulations showed that MUSIC algorithm takes more time to produce accurate results when fewer elements are used in the sensor array. However, as the number of array elements increases, the computational time of ESPRIT algorithm starts to increase drastically especially when a large number of samples of the incident signals is used.
- Using element spacing for the sensor array up to 0.5λ allows the detection of all possible angles of incidence. However, using larger values for the element spacing will lead to the detection of signals arriving only at larger angles of incidence (i.e., approaching normal incidence).

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Thanks

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