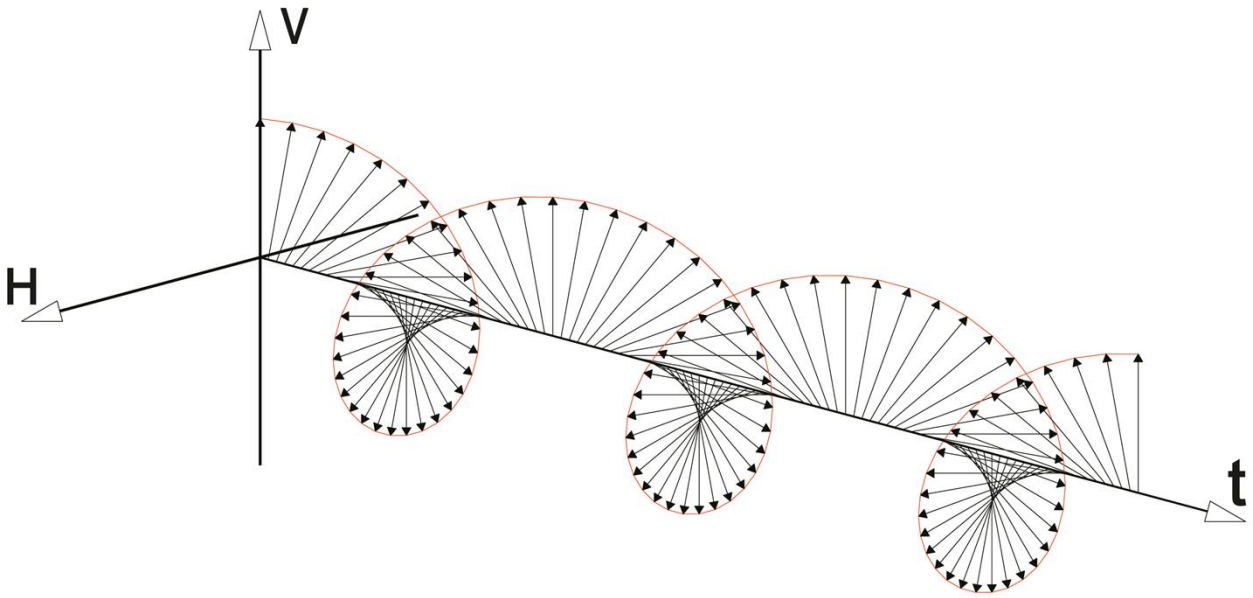
Swedcom

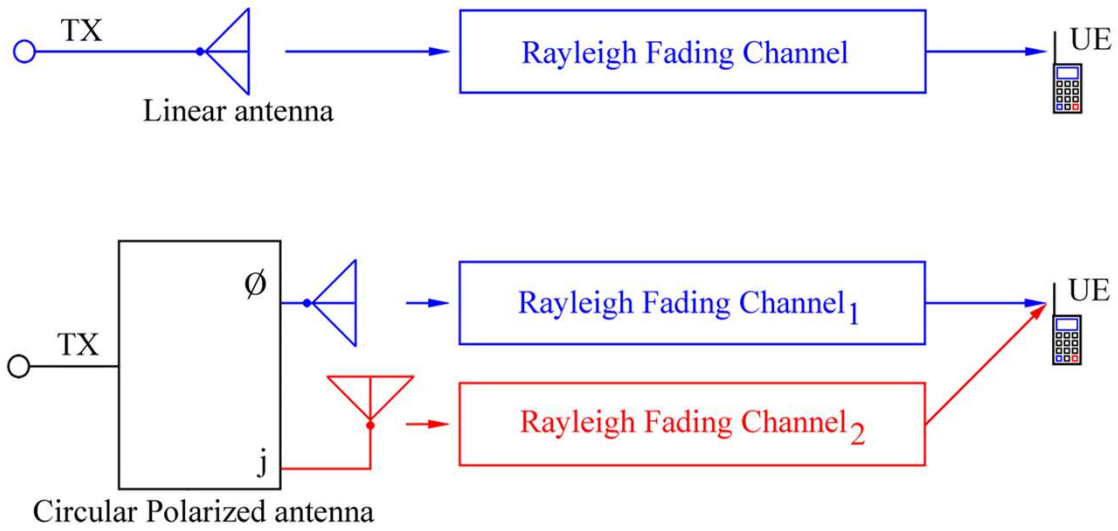
Why Circular polarized antennas?



Experiences learned from installations World wide

- Observed benefits by using CP. Antennas
  - **Fading mitigation**
    - Will compensate for the “nulls” created when using linear (VP/XP) antennas.
  - **Dramatically improve indoor penetration**
    - When used as “macro offloads”, CP. antennas consistently proves to be the preferred choice for increased indoor coverage.
    - Can be installed on rooftops to penetrate down through the roof for excellent indoor coverage
    - Can be set up inside buildings penetrating through the walls for solid outdoor coverage

CPLPA (circular polarized log periodic antenna) in a (Non-Line-of Sight) Rayleigh Fading channel



The diagram assume that the MTSO. is equipped with a linear cross-pole antenna, or a CPLPA. The UEs are, in both cases, assumed to be equipped with a single linear antenna.

The Down-link Question

Is it better to transmit one half of the power in two orthogonal planes than all of the power in one plane?

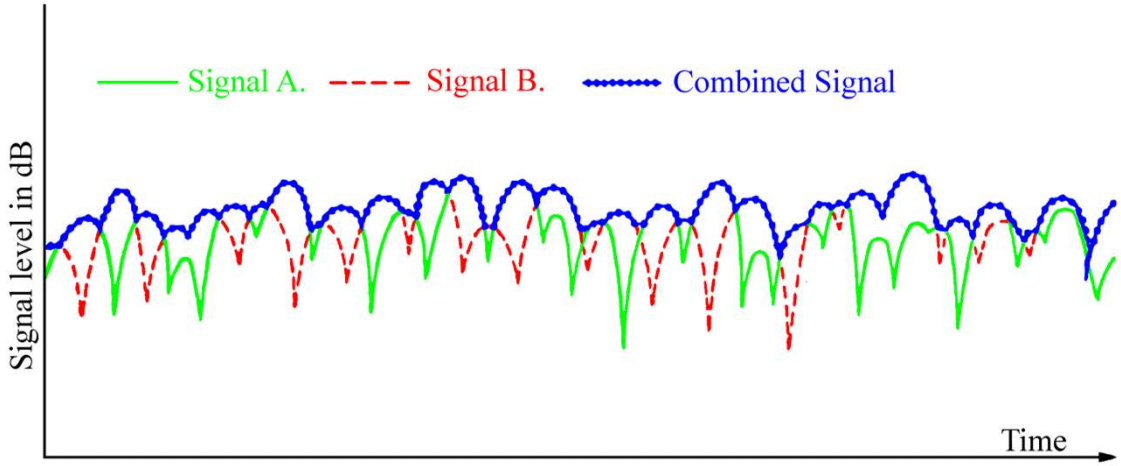
The two orthogonal transmit signals (Ø, j) can be assumed to be "non - correlated" as they are constantly orthogonal to each other and to the antennas. A number of published measuring campaigns are showing low correlation (0 to 0.3) from two orthogonal planes in both non-line-of-sight (Rayleigh Fading channel) and partial non-line-of-sight environments (Rician Fading channel).

In this scenario a substantial **Transmit Diversity Gain** is achieved. **Typically in the order of 4-10 dB compared with linear antennas (VP/XP) dependent on outage rate and fading**

Diversity Gain / Fading mitigation

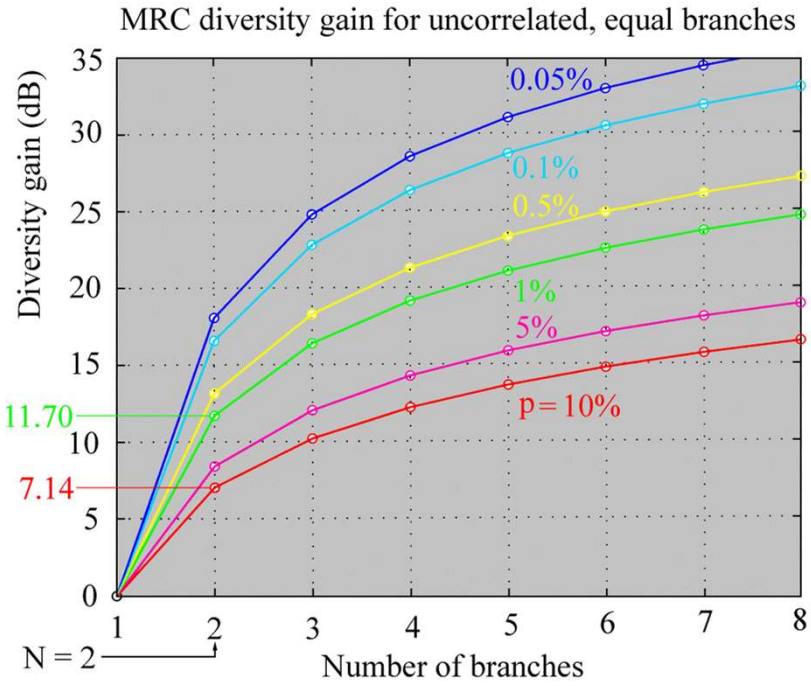
This diagram shows an example of how the fading is mitigated for a two-branch selection diversity system

This shows the advantage of reducing fading by combining two fading signals.



Diversity gain is defined as the improvement in the time-averaged **SINR** from the combined signals of a set of diversity elements, relative to the **SINR** from the best single element In this case, ***CP.*** compared to ***VP./XP***.

The fading of ea. signal is quite deep. The standard deviation of the fading depth is often quoted to be 8 dB, however fading depth up to 10 - 12 dB have been reported in many cities.



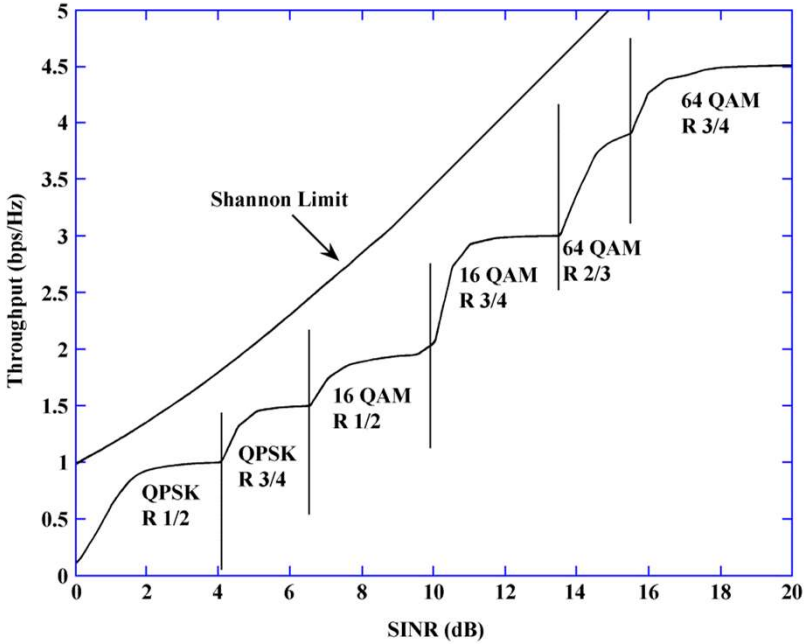
For a Rayleigh fading channel, the MRC diversity gain for un-correlated equal power branches is shown in the diagram.

For the circular polarized antenna (N=2), we find the diversity gain to be 7.14 dB for p=10%

and 11.70 dB for p = 1%, where p is the BLER outage rate.

Circular Polarized antennas are 4.14 dB better than Linear for p = 10% and 8.7 dB better than Linear for p = 1%.

The scenarios described above show that Circular [CPLPA] has more than 60 % higher data throughput capacity than Linear for p = 10% and more than 100 % higher data throughput capacity for p = 1 %.



Downlink Capacity

The UTRAN OFDMA/LTE (3GPP R8) makes use of adaptive modulation and turbo Coding. The throughput increases as the (SINR) increases and follows the trend promised by Shannon's formula:

$$C = \mathrm{Log}_2\,[1+\mathrm{SINR}]$$

From SINR information received from the UEs, the radio base station transmitter may step up the modulation code from QPSK-R ½ to QPSK-R ¾ to 16QAM- R½ to 16QAM-R ¾ etc., with the subsequent increase in data Throughput. An example of Throughput capacity versus SINR is shown in the graph.

CPLPA. In A Practical Network

We earlier assumed that the two Rayleigh fading channels are un-correlated and have equal power in both branches. In an actual practical network, this may not be the case. Although the CPLPA . in the downlink will transmit virtually the same power level in both branches, and can be designed to have very low correlation between branches within the transmit band, the environment may modify this.

Applying *the law of reciprocity*, and from numerous published campaigns measuring reverse link diversity gain for cross pole antennas with MRC in various urban/suburban environments, indicate excellent potential for the CPLPA. Diversity gains are reported to be 5 to 6 dB for p=10%. **which in this case would indicate a 30 to 50 % capacity improvement of CPLPA. potential compared with Linear.**

This increased data download capacity using CPLPA .over Linear may prove very advantageous for a network operator to be ahead of the competition in "fastest download speed" and/or economic savings in network over-builds.