Abstract
We present a new design of the hat-fed reflector antenna for satellite communications in the Ku-band (10.75-14.50 GHz), where a low reflection coefficient, high gain, low sidelobes and low cross polar level are required. The hat feed has been optimized by using the Genetic Algorithm (GA) through a commercial FDTD solver, QuickWave V2D, together with an own-developed optimization code. The Gaussian vertex plate has been applied at the center of the reflector in order to improve the reflection coefficient and reduce the far-out sidelobes. A parabolic reflector with rim-shape focus has been designed for obtaining nearly 100% phase efficiency. The antenna's reflection coefficient is below -17 dB and the radiation patterns satisfy the M-x standard of sidelobe level envelope for earth stations over a bandwidth of 30%.

Hat feed antenna optimization
• QuickWave V2D was called by the GA to optimize the hat feed.  
• The optimization goals are minimized reflection coefficient and maximized aperture efficiency (which can be divided into the relevant sub efficiencies): 
  \[ e_{ap} = \text{apo} + \text{epo} \]  
• The F/D ratio was chosen to 0.255 corresponding to a subtended half angle of \( \Theta = 89^\circ \).  
• The hat-feed is presented as a chromosome consisting of genes representing the dimensions to be optimized.  
• Each solution from an optimization is given a fitness value based on its characteristics and the fittest solutions are forming a pareto front.

Optimization results
• The reflection coefficient is < -17 dB in the band.  
• The efficiency is < 2.5 dB in the band.

Gaussian vertex plate
• Reduces multiple reflections between reflector and feed.  
• Improves the reflection coefficient.  
• Less diffraction at the hat edge reduces the sidelobe levels.

Reflector radiation pattern measurement
• The hat feed was measured in anechoic chamber, with a 53 cm diameter ring focus reflector antenna (\( R_0 = 6.8 \) mm).  
• The co- and cross polarization in the 45 degree plane is presented with the sidelobe envelope requirements for earth stations according to the ETSI EN 301 standard and the M-x nomenclature defined by Eutelsat.

Parameters of the hat feed to be determined by the optimization. Illustration of pareto front with individuals represented by red dots. The curved lines marks different fitness values in the GA optimization.