The GL_{2n} Rapoport-Zink space is a moduli space of supersingular \( p \)-divisible groups of dimension \( n \) and height \( 2n \), with a quasi-isogeny to a fixed base point. After the GL_{2} Rapoport-Zink space, which is zero-dimensional, the GL_{4} Rapoport-Zink space has the most fundamental moduli description, yet relatively little of its specific geometry has been explored. We give a full description of the geometry of the GL_{4} Rapoport-Zink space, including the connected components, irreducible components, and intersection behavior of the irreducible components. As an application of the main result, we also give a description of the supersingular locus of the Shimura variety for the group GU(2, 2) over a prime split in the corresponding imaginary quadratic field. (Received August 28, 2018)