A countable, dense-in-itself dense P-set

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In 1998, during the Topology Conference in Gyula, A. V. Arhangel'skii asked the following question:

Does there exist a compact separable space without isolated points, whose countable dense subset is a P-set?

We shall present a ZFC example with the required properties. The main tool for the construction is the familiar Hechler poset for adding a dominating real.