Fragmentation events and large scale small-sat deployments are a significant threat; because of the sudden creation of many new objects posing potential risks to existing satellites, and the fact that current surveillance systems require laborious human intervention to identify and catalog these new objects. In the tracking community, the spontaneous appearance of new objects is referred to as birth, whereas spawning refers to the appearance of new objects generated by previously existing ones, such as a fragmentation event or small-sat deployment. In this dissertation, two well known random finite set (RFS) filters are extended via mathematical derivation, aimed at performing initial orbit determination (IOD) of objects generated by spawning events. A Zero-Inflated Poisson (ZIP) spawn model is presented and a predicted cardinality expression for general spawn model configuration, capable of implementation via Partial Bell Polynomials, is derived for the Cardinalized Probability Hypothesis Density (CPHD) filter using a measure-theoretic approach. Generalized Labeled Multi-Bernoulli (GLMB) filter developments achieve a closed-form solution to the multi-object Bayes recursion capable of jointly estimating a spawned object’s state and ancestry. Linear simulations demonstrate fundamental filter developments; the ZIP spawn model is shown to outperform other conventional models with the CPHD filter and multiple generations of spawn object ancestry are accurately estimated with the GLMB filter. Finally, non-linear simulations specific to Space Situational Awareness (SSA) IOD demonstrate the filters’ efficacy, which include: fragmentation event and small-sat deployment scenarios, homogeneous and heterogeneous radar network observations, and spawning events that occur in and out of sensor field of view. This research shows that on-line multi-object IOD in the presence of spawning is possible within the RFS paradigm, and establishes a foundation upon which further SSA improvements can be investigated.