**Possible Modifications to The Current Space EVDT Code**

( **BOLD**: I will make the changes before I finish my project, Green: Already implemented)

**Major:**

* Change the propagator functions (main\_propagator, TwoBP\_J2\_analytic, TwoBP\_J2\_analytic\_car\_state) to the more accurate analytic propagator, SGP4. The high-fidelity integration propagation methods will not be timely efficient at all. The result of this change is that the detected conjunction events will be more realistic. I can’t estimate how will the number of conjunctions detected will change though.
* **The CARA\_process, Technology\_model, and Decision\_model currently use a variable corresponding to the “next orbit determination update time” for each event which loops constantly until the time of closest approach (TCA) of the event is passed. The concept and algorithm on how this variable is defined should be examined.**
* Utilize more realistic initial covariance matrices for the SSA providers. Either by getting direct sample data from the providers themselves, or by using the historic TLE data. The cross diagonal elements in the covariance matrix (negative correlations between positions and velocities) are essential for keeping the covariance matrices small after long period propagations.
* IF the radar cross-section (RCS) values for the secondary space objects were available, the NASA software should be used to estimate the size and mass of the secondary object. The size will be used in calculating the conjunction Hard Body Radius (HBR) which drastically changes the Pc value (thus the more accurate the HBR value, the better) and the mass is used in the Collision Consequence NASA function to calculate the number of generated debris pieces in case of collision.
* The covariance propagator code (Cov\_prop\_TH) is currently using the concept of relative orbital motion to extract a state transition matrix that can be applied on the initial covariance matrix and propagate it to the desired final time. HOWEVER! The theory approximations are not met when the errors become very large when you propagate the covariance using this method for 7 days (for long periods of time, you might end up with errors in the order of 100s of kilometers in the in-track direction). As an alternative, it is better for the CADET method to be implemented as the covariance propagator.
* The Vulnerability model is subject to a lot of change. Until now I couldn’t do a proper economic analysis to value the NASA satellites effectively based on their scientific application. These need to be modified. Moreover, I have given arbitrary values to the secondary objects based on the fact that whether they are active payloads or not, and what is their RCS size. In case the RCS value is available, a function (based on statistical analysis) can be proposed that can output the cost of payload, based on its mass and size.
* Currently the code is only using 2 types of NASA Pc calculation codes: 1- 2D Foster method, and 2- Max Pc Frisbee method. The former has assumptions that have to be met before it can be used (Dilution, …), otherwise, different type of Pc calculation codes should be used, such as 3D, Monte Carlo. An additional code can be written to decide if using a 2D Pc calculator would suffice or not. The latter is again using the 2D Pc calculation but with considering only one available covariance matrix.
* **Modify decision model so it will consider the outputs of the vulnerability model as inputs and the decision on mitigation is influenced by the value of the collision (also take into account the collision consequence).**
* **The SpaceEVDT needs to be completely modular so it will be able to later add the maneuvers inside the space catalogue.**
* The decision model can implement two types of actions generally. Either task the objects as high priority to the SSA providers and request more accurate and frequent observations, or, it may decide on an mitigation action (either maneuvering or changing the attitude for drag differential or even contacting the secondary object’s O/O if possible). Since these mitigations actions will change the orbits, it is best that they be implemented on the space catalogue and then enter a new SpaceEVDT loop.
* Right now no interviews are conducted with the NASA CARA officers and the actual mitigation action taking process is a question mark. If an interview was made, it is better to implement the results of the discussions in the code.

**Minor:**

* The TCA for the events is assumed constant after the event detection, this is while when you have new estimated states of the objects, you should have different TCA’s!
* In case the propagator was changed, the first MOID filter should be changed and also the differentiation between the mean orbital elements and the instantaneous element should be made throughout the program.
* **The Screening box multiplier in the conj\_assess function is arbitrary and should be based more on the sensitivity analysis.**
* **Have the possibility to have an ellipsoid screening volume instead of a box.**
* **The idea behind auxiliary distance should be discussed with the professors or should be based on a scientific document.**
* **Detection times for the conjunctions are currently EXACTLY 7 days before the TCA. There should be random distribution with a mean value of 7 days prior for the detection time of the conjunction events.**
* Orbit determination of the two space objects in conjunction are assumed to be simultaneously. This is not realistic; however, it is possible to argue that the concept is correct for only generating the conjunction data messages (CDMs).
* **Fractions of values of the NASA satellites should be given to them based on their main scientific applications.**
* **Cost of commercial SSA provider usage should be a better estimate of the real world. Including the budget that NASA CARA has for requesting the commercial ones.**
* **Add a new function outside of the decision and technology model to be able to select the next observation time more random and realistic.**