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Technote: How the World Ends, an Exercise in MBSE

Introduction

The apocalypse is approaching rapidly, according to a wide variety of media outlets. It is therefore the first responsibility of the systems engineering community to model it correctly. In this technical note, published entirely coincidentally on April Fool's Day, we hope to contribute to that important work.

A Structural Model of the End of the World

In Figure 1, we model potentially world-ending threats in terms of three factors, the source or origin of the threat, the nature of the threat, and the target of the threat:

- Threat Origin – we consider the source of threat to be physical in nature, therefore part of the Physical Environment (psychological and spiritual threats are outside the scope of this effort). A partial list of these threat origins is shown in Figure 2 as part properties of different parts of the Physical Environment (they are also specializations of the block Threat Origin). We assign risk of occurrence as a value property of Threat Origin.
- Threat – In Figure 3, we show a variety of threats arising from these origins, ranging from Asteroid Strike to Singularity, the subordination of humanity to artificial intelligence. Coverage, the percentage of humanity affected by an occurrence of the threat, is a value property of Threat, ranging from small for localized emergencies to 1.0 for the entire world. Figure 1 also allows one threat to reference another; we will consider coupled threats later in the paper.
- Threat Target – Many different aspects of human life are vulnerable to threats. Some of these are listed in Figure 4. These same blocks are treated as part properties of the Human Environment and assigned the value property impact, the probability of a terminal outcome on the covered population.

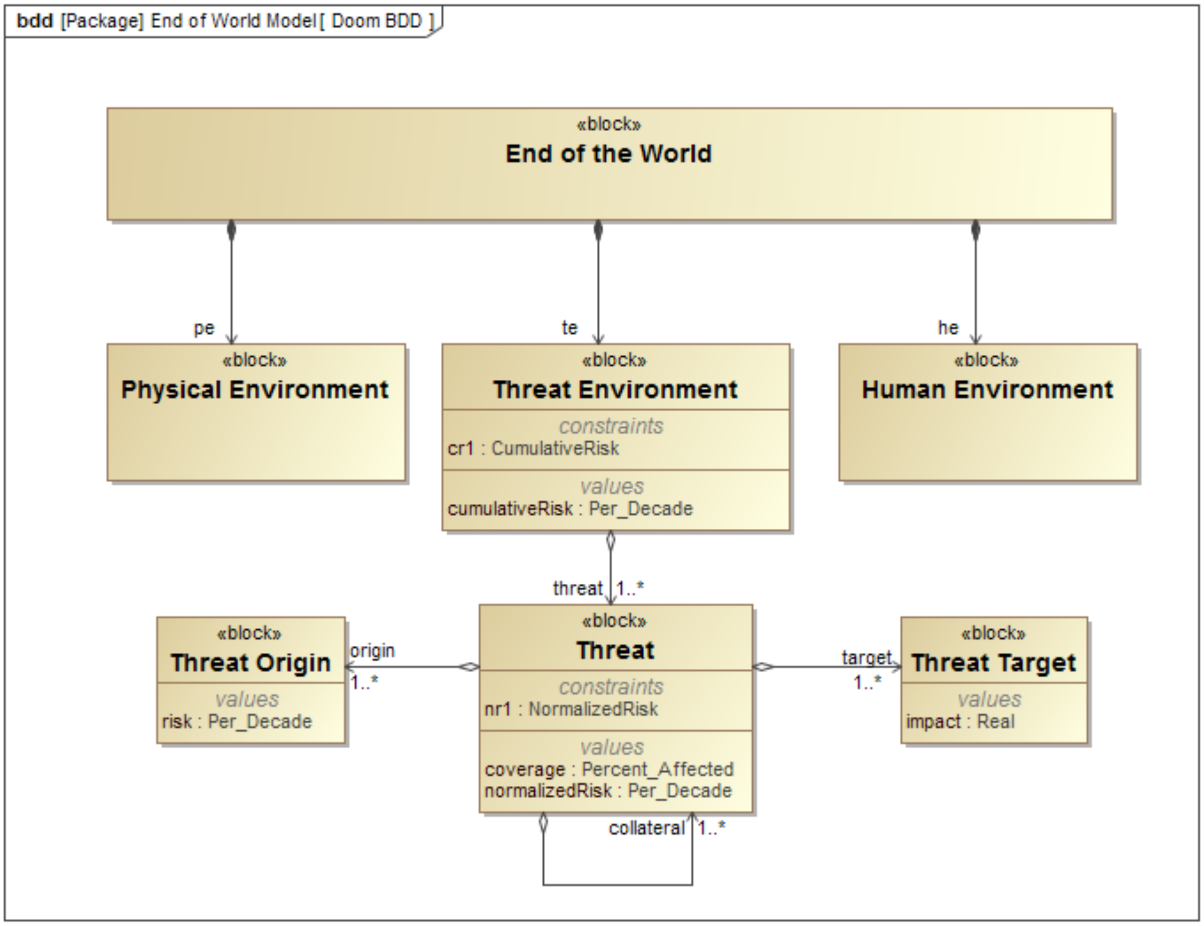

Figure 1 Basic structure of the End of the World

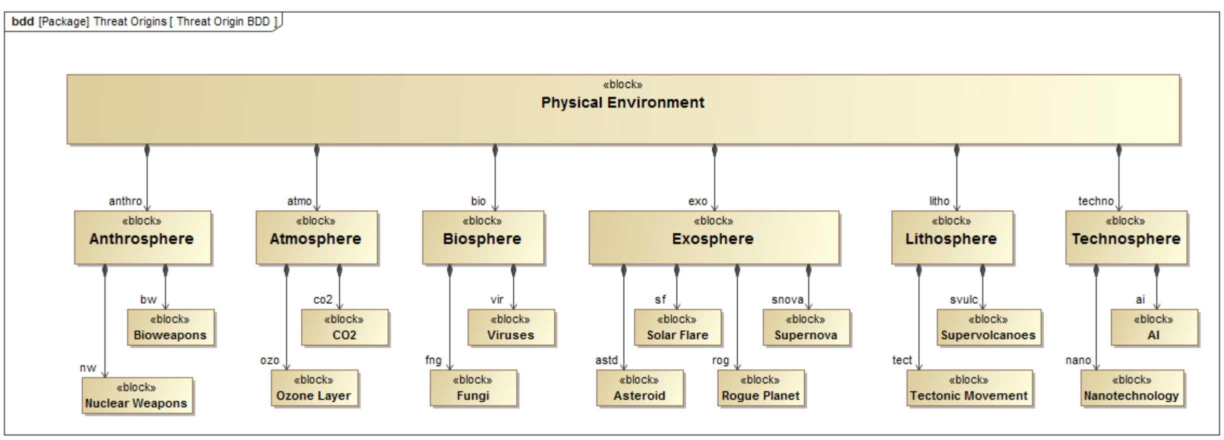

Figure 2 Threat Origins

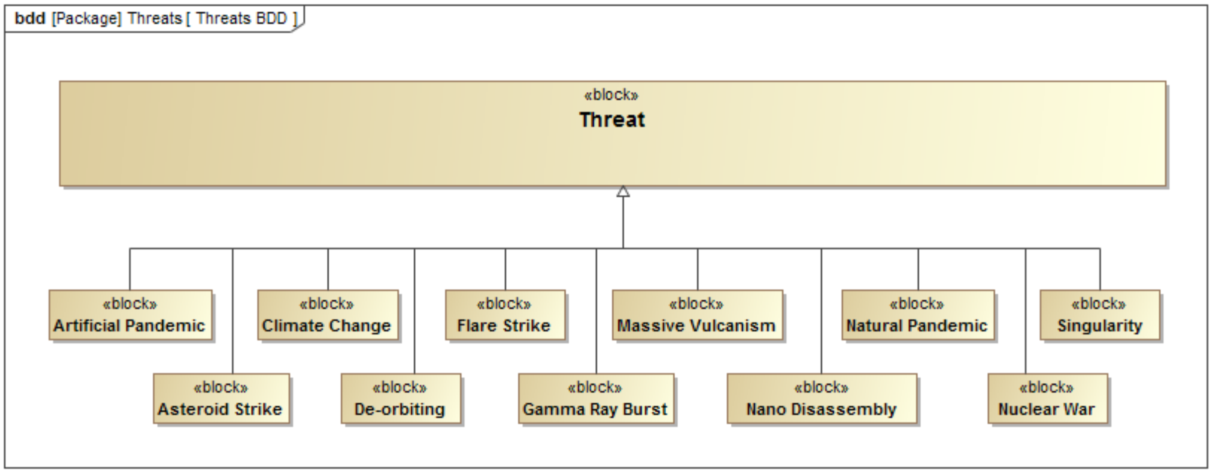

Figure 3 Threats

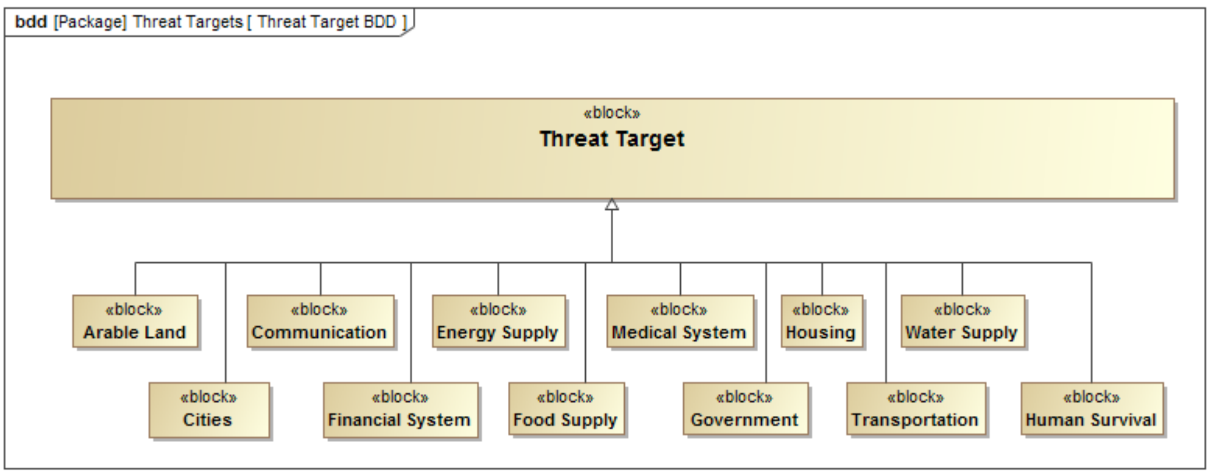

Figure 4 Treat Targets

Estimating the Likelihood

Having specified the possible threats, MBSE also provides means to quantify them. The SysML model created includes parametric diagrams, shown in Figure 5 and Figure 6. In Figure 5, we calculate the normalized risk of a threat, the product of its risk of occurrence, coverage of population and impact. Are model in Figure 1 allows for multiple simultaneous threats using a 1-to-many multiplicity for Threats as reference properties of the Threat Environment. In Figure 6, we sum the normalized risks of the individual threats to calculate a cumulative threat probability.

Each different threat scenario can be treated as a separate instance of this schema. In Figure 7, we consider the impact of bioweapons creating an artificial pandemic overwhelming human medical systems. We have assigned risk, coverage and impact values based on exhaustive research and use ParaMagic, a SysML parametric solver from Intercax, to calculate a cumulative risk 0.00125 (per decade), written back to the instance te01:Threat Environment in Figure 7

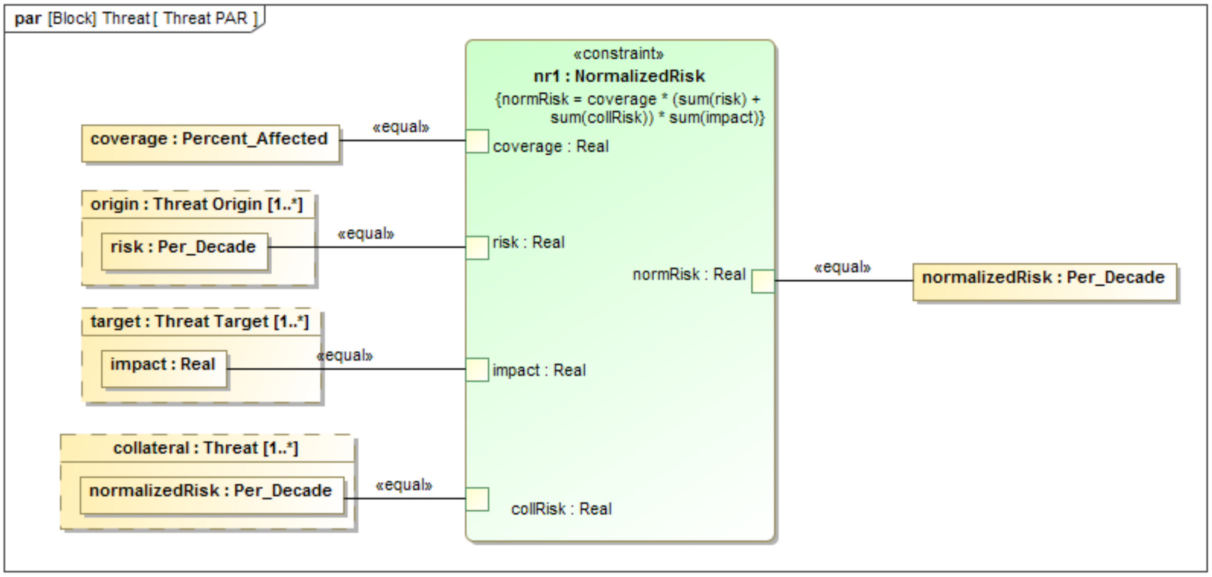

Figure 5 Parametric diagram for calculation of normalized risk in Threat block

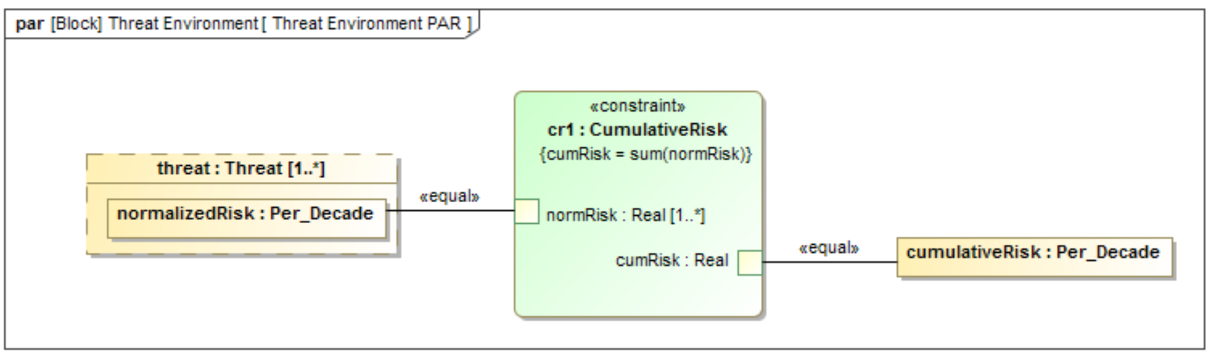

Figure 6 Parametric diagram for calculation of cumulative risk in Threat Environment block

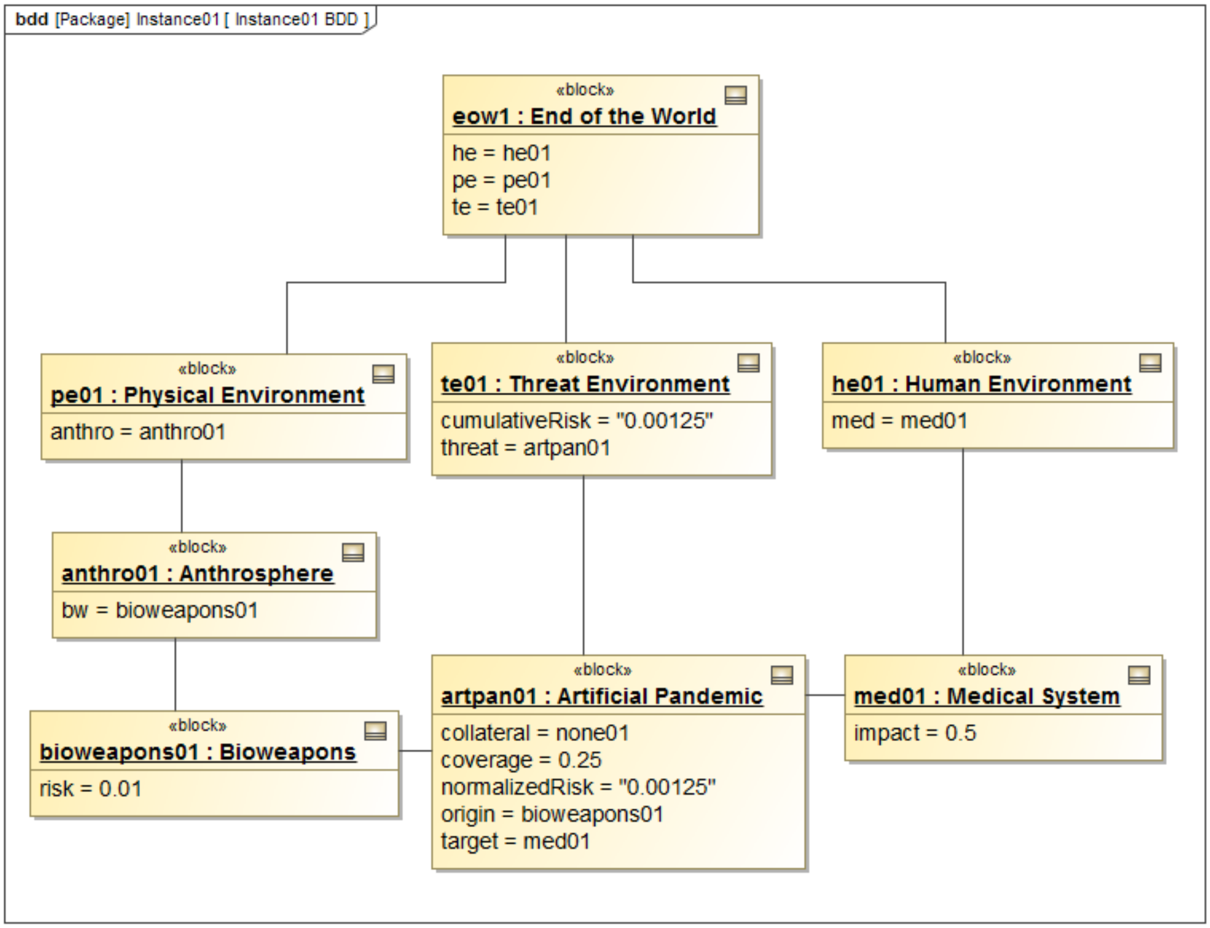

Figure 7 Scenario 1, risk of Bioweapons-created Artiific1al Pandemic

The Closely Coupled Apocalypse

The complex interconnection of many systems is necessary to the functioning of modern society and creates new vulnerabilities. An internal block diagram in Figure 8 shows some of the interactions between parts of the Human Environment that can lead to emergent behaviors of the system under stress. For example, providing food requires not only arable land, but also transportation and a trade economy for efficient distribution. These, in turn, require energy, communication and government to function. Note, however, that these interconnections can also provide resilience to the overall system.

As threat targets are interconnected, so are the threats themselves. For example, even a limited nuclear war may give rise to climate change through global cooling, so both the weapons impact on the target cities and the broader impact on food production must be included in the cumulative risk of the threat environment. Figure 9 shows a solved instance for this scenario, with a higher cumulative risk, 0.026, than in the first instance in Figure 7.

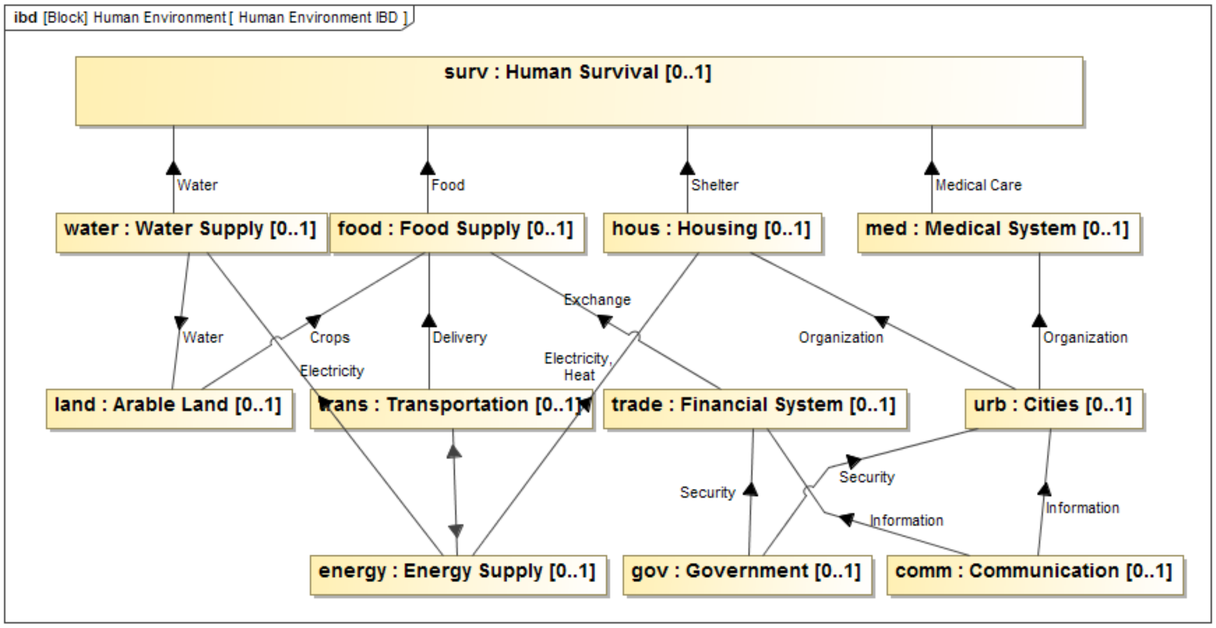

Figure 8 Cross vulnerabilities within the Human Environment

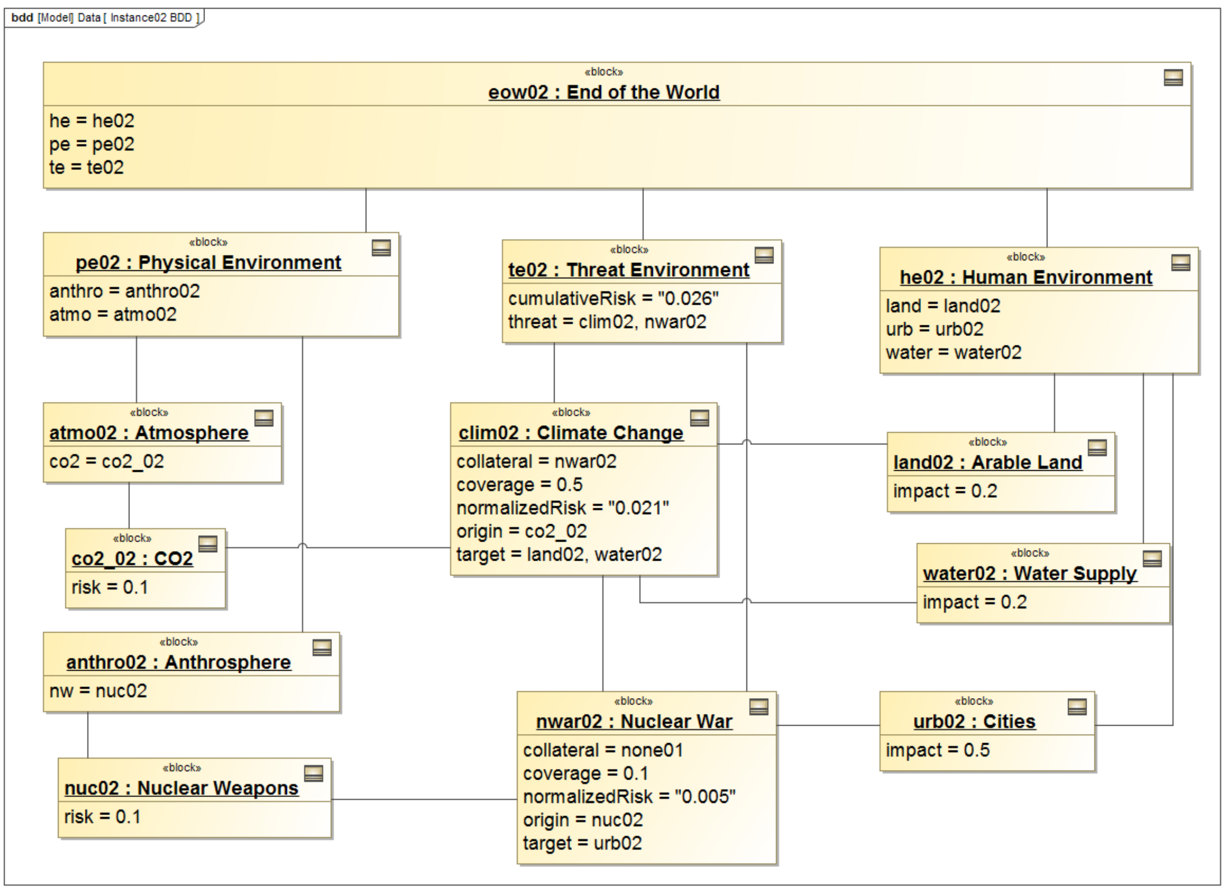

Figure 9 Scenario 2, cumulative risk of limited nuclear war and climate change

Next Steps

By the nature of this investigation, there are no next steps.

About the Author

Dr. Dirk Zwemer (dirk.zwemer@intercax.com) is President of Intercax LLC (Atlanta, GA), a supplier of MBE engineering software platforms like Syndeia and ParaMagic. He is an active teacher and consultant in the field and holds Level 4 Model Builder-Advanced certification as an OMG System Modeling Professional.

He resides in an underground bunker in an undisclosed location.