Architecture for Integrated Medical Model Dynamic Probabilistic Risk Assessment

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Abstract: Dynamic Probabilistic Risk Assessment (DPRA) predicts complex system outcomes based on many initiating event probabilities and a progression of dependencies. The Integrated Medical Model (IMM) predicts astronaut health as governed by medical event probabilities and treatment resources. The next generation software architecture will use DPRA to merge the IMM with other spacecraft probabilistic models, based on four significant requirements.

Objective: To provide a systematic means of creating, documenting, and communicating the Integrated Medical Model Dynamic Probabilistic Risk Assessment software design.

There are six key steps to managing the software architecture process:¹
1) Understanding the significant requirements
2) Creating the architecture
3) Documenting and communicating the architecture
4) Evaluating the architecture
5) Implementing & testing the system based on the architecture
6) Ensuring architectural conformance

The four Significant Requirements are:
1) To implement discrete dependent functions – a progression of dependencies
2) To enable a diagnosis and treatment capability continuum – where the continuum informs both resource utilization and success rate
3) To implement a group exposure event – infectious disease, a solar particle event, or micrometeoroid impact
4) To create inputs & outputs to other PRAs by incorporating “hooks” to the outside world – responding to a CO₂ scrubber failure or activation of the fire control module

Over many Monte Carlo generated instances, Evacuation & Loss of Crew Life outcomes are binned and Crew Health Index is calculated based on simulated time lost due to medical events.²

The architecture selected to meet the four significant requirements is a task queue timeline, to queue up Event Sequence Diagrams (ESDs), spawn dependent functions, update diagnosis capability, move forward in time, pause to look back in time for group events & hooks to the outside, and purposely send hooks to the outside.