**DARPA-SN-26-50**
**Future Program Announcement**
**Special Notice DARPA-SN-26-50**
**Virtual-Integrated Twin for Autonomous Lifesaving (VITAL)**
**Defense Advanced Research Projects Agency (DARPA)**
**Biological Technologies Office (BTO)**

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**BACKGROUND:**
The purpose of this Special Notice (SN) is to provide public notification of additional research areas of interest to the Defense Advanced Research Projects Agency (DARPA) Biological Technologies Office (BTO), specifically for the forthcoming Virtual-Integrated Twin for Autonomous Lifesaving (VITAL) program.

When released, the solicitation will be made available at https://sam.gov/.

**PROGRAM GOALS:**
The VITAL (Virtual-Integrated Twin for Autonomous Lifesaving) program aims to develop continuously updating computational models of the cardiovascular system that integrate patient data with biological physics to predict outcomes in real time. The vision of VITAL is to enable future providers and clinicians to assess treatment options for acute and chronic pathologies.

VITAL plans to establish a foundation for causal, prediction-driven decision support using high-fidelity (HF) digital twins that explicitly represent the physical, biochemical, and anatomical dynamics governing cardiovascular physiology. HF models will be developed and benchmarked as the baseline predictive reference across static, chronic, and acute regimes. For each regime, the program intends to quantify computational speed, forecast horizon, predictive accuracy, uncertainty bounds, data requirements, sensitivity to parameter estimation, segmentation error, and measurement sparsity. A core program outcome is a rigorous characterization of HF model capability limits, providing evidence-based guidance on when HF models are suitable as foundational technology and where fundamental limitations remain.

While HF models provide the strongest mechanistic fidelity and causal interpretability, reduced-order models (ROMs) derived from HF dynamics are better suited for real-time responsiveness and continuous updating, particularly when coupled to streaming sensors. Through systematic verification, validation, and uncertainty quantification, VITAL aims to determine when and where different modeling approaches—HF models, ROMs, and measurement-driven inference—are reliable and appropriate.

VITAL plans to establish an Image-to-Physics-to-Twin pipeline that automatically integrates multimodal clinical imaging—such as magnetic resonance imaging, computed tomography, computed tomography angiography, and ultrasound—with sparse physiological and biochemical measurements to construct patient- or archetype-specific high-fidelity digital twins. Segmented anatomy is translated into vascular networks, organs, and injury geometries spanning chronic and

acute conditions. Localized three-dimensional injury-site solvers capture bleeding and impedance dynamics, while whole-body 0-dimensional and 1-dimensional physiology models propagate global responses such as shock.

Finally, VITAL will pursue a systematic reduction of HF models into fast, continuously updateable, mechanism-preserving surrogates using artificial intelligence techniques that are explicitly physics- and physiology-aware. These ROMs are trained against HF dynamics and structured to retain vascular coupling and injury–treatment feedback, enabling continuous state and parameter estimation under sparse and noisy sensing.

VITAL is a two-phase program. Phase 1 establishes technical credibility through the development of HF models and rigorous quantification of their performance limits. Phase 2 evaluates the performance tradeoffs associated with HF-to-ROM transitions, including scalability, real-time execution, and intervention-forecasting accuracy. DARPA strongly encourages teaming to ensure the breadth of expertise required to achieve VITAL's objectives.

**DARPACONNECT:**
For those new to DARPA or national security, DARPA makes available a free, comprehensive resource via DARPAConnect on how to do business with the agency. In addition to DARPA 101 materials, relevant preparatory modules include "Making the Most of a Proposers Day" and "Understanding DARPA Broad Agency Announcements." Registration and access are free at http://www.darpaconnect.us/.

**ADMINISTRATIVE:**
This Special Notice does not constitute a formal solicitation for proposals. This notice is issued solely for information and program planning purposes and is not a Request for Information (RFI). Since this is not an RFI, DARPA will not accept any submissions against this notice. Interested parties to this notice are cautioned that nothing herein obligates DARPA to issue a solicitation. NO CLASSIFIED INFORMATION SHOULD BE INCLUDED IN ANY COMMUNICATIONS IN RESPONSE TO THIS SPECIAL NOTICE.

Please e-mail VITAL@darpa.mil if you wish to be added to our blast list for future program updates (i.e., Proposers Day announcement, Program Solicitation publication).