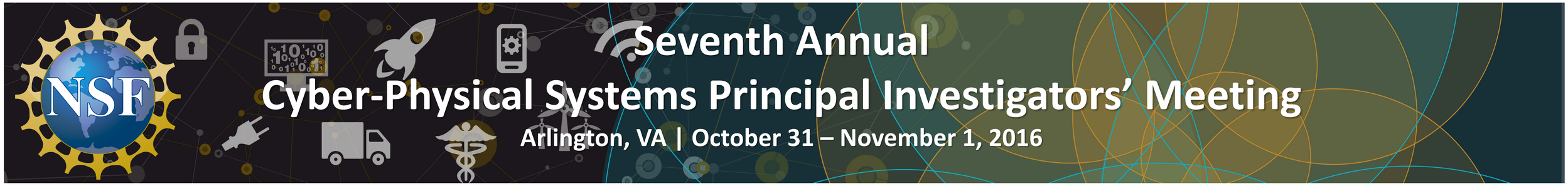

Collaborative: Executable Distributed Medical Best Practice Guidance (EMBG) System for End-to-End Emergency Care from Rural to Regional Center Hospitals

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Challenges:

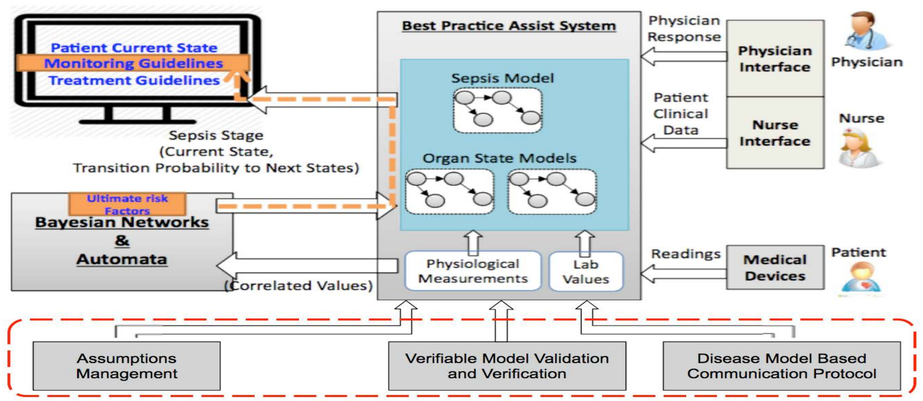
Ensure end-to-end safety and effectiveness of patient care under distributed and mobile environment:

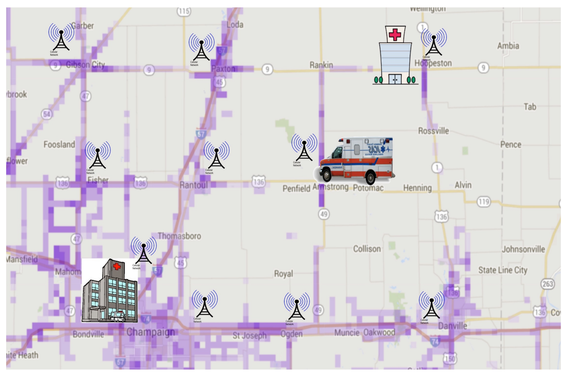
- Executable pathophysiology and best practice models
- Dynamic patient condition monitoring in ambulance under limited and variable bandwidth
- Design verifiable medical guideline models
- Specify, validate and trace assumptions in system design and evolution
- Requirements and Safety Engineering in Medical CPS
- Clinical evaluations for transitioning research results into medical practices

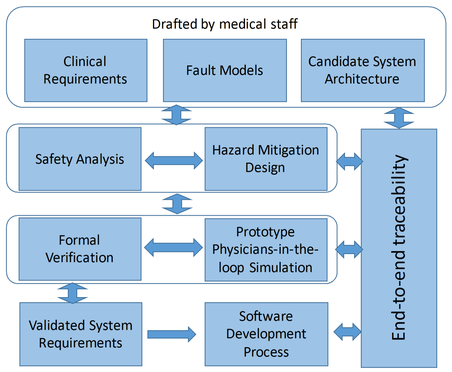
Solutions:

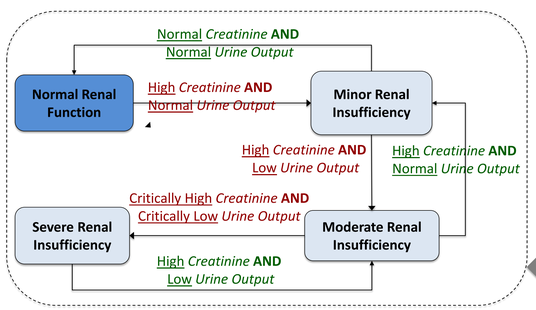
- Organ-centric best practice guidance system (UIUC)
- Pathophysiological model-driven communication (UIUC)
- Clinical validation with Carle and OHSU medical center on high-impact diseases, e.g. sepsis and heart failure (UIUC)
- End-to-end traceability from clinical and system requirements, safety analysis, to design and implementation (UIUC)
- Verifiable and validatable statecharts for disease and treatment models (IIT)
- Statechart model patterns for modeling medical guidelines (IIT)
- Modeling and integrating assumption models with medical cyber-physical system design (IIT)
- We are in the process of extending and integrating two team solutions towards distributed mobile environment. (UIUC & IIT)

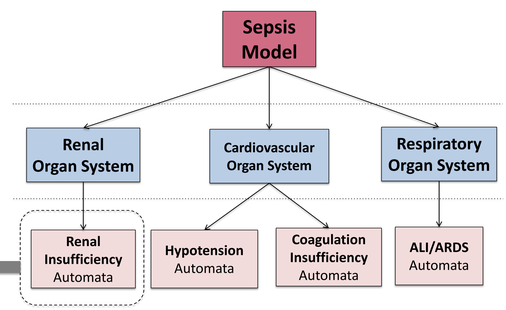
Illinois Institute of Technology
http://gauss.cs.iit.edu/~code/
University of Illinois at Urbana Champaign
https://publish.illinois.edu/mdpnp-architecture/











Scientific Impact:

- Computational pathophysiology [1]
- Bayesian network for early sepsis detection[2]
- Mental workload reduction system designs for medical staff [3]
- Pathophysiology-driven and bandwidth-compliant communication protocols [4]
- Verifiable medical guideline models [5][6]
- Statechart model patterns [6][7]
- Physical environment assumption management [8]

Broader Impact:

- The project improves emergency care for people in rural areas.
- The validated and verified system will serve at central and southern Illinois with 1.2 million people.
- Successful pre-clinical evaluations are recommended for clinical trial.
- The cardiac arrest guidance system is submitted to FDA for the (pre-)approval process.

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[4] M. Hosseini, J. Yu, P. Wu, R. Berlin, S. Ren, L. Sha. A pathophysiological model-driven communication for dynamic distributed medical best practice guidance Systems. Journal of Medical Systems, 2016.
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[7] Chunhui Guo, Zhicheng Fu, Shangping Ren, Yu Jiang, Maryam Rahmaniheris, Lui Sha. pStatecharts: Pattern-Based Statecharts for Modeling Medical Best Practice Guidelines. DATE ,2017. (Submitted)
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