



Application of Proven Parallel Programming Algorithmic Design to Aggregation/De-aggregation

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Outline of Presentation

- **Problem and Background**
- **Assessment of Aggregation Dynamics**
- **Various Approaches**
- **Issues in Aggregation Modeling**
- **Multi-resolution, Multi-perspective Modeling (MRMPM)**
- **Definitions & Current Practice**
- **A New Perspective**
- **Development Test-Bed**
- **SCAR Assets & Capabilities**
- **Conclusions**

Problem and Background

- **Long History and “Paper Trail”**
- **Much of it definitional**
- **Early work done in effort to conserve compute cycles**
- **Now, HPC-enabled simulations raise other issues**
- **A quick review of work from the literature**
- **This short tour is not to be considered exhaustive in any manner**

Assessment of Aggregation Dynamics

- **Paul Davis, PhD, the RAND Corporation**
 - Well-known scholar in the field
 - (no relation to the co-author)
- **Define and develop a dynamic model?**
- **Asserts that one can construct something on the order of the Lanchester models, *modulo* a number of additional factors**
 - High-level strategy
 - Overall C² procedures
 - Relative time scale/resolution
- **Aggregate entity is different from sum of its parts**
- **Atomic physics easy by comparison**

Base Model Approach

- **Paul Gustavson, Synetics Advanced Technology Sys.**
- **Working in HLA simulation environments**
- **Assume compute resource conservation paramount**
- **Issue: switching between high and low res components**
- **Base Object Models are potential facilitators**
- **Used for rapid construction and modification**
- **Looks at implementation issues for definitional genesis**

Issues in Aggregation Modeling

- **Paul Reynolds, PhD, University of Virginia**
 - (you don't have to be named Paul to get cited by us, but ...)
- **Excellent paper in defining and understanding Ag-DeAg issues**
- **Technical issues**
 - Teleportation
 - Chaining
- **Issues of great interest, but perhaps of less moment**
- **Result of model switching**
- **What it maintain some semblance of both?**

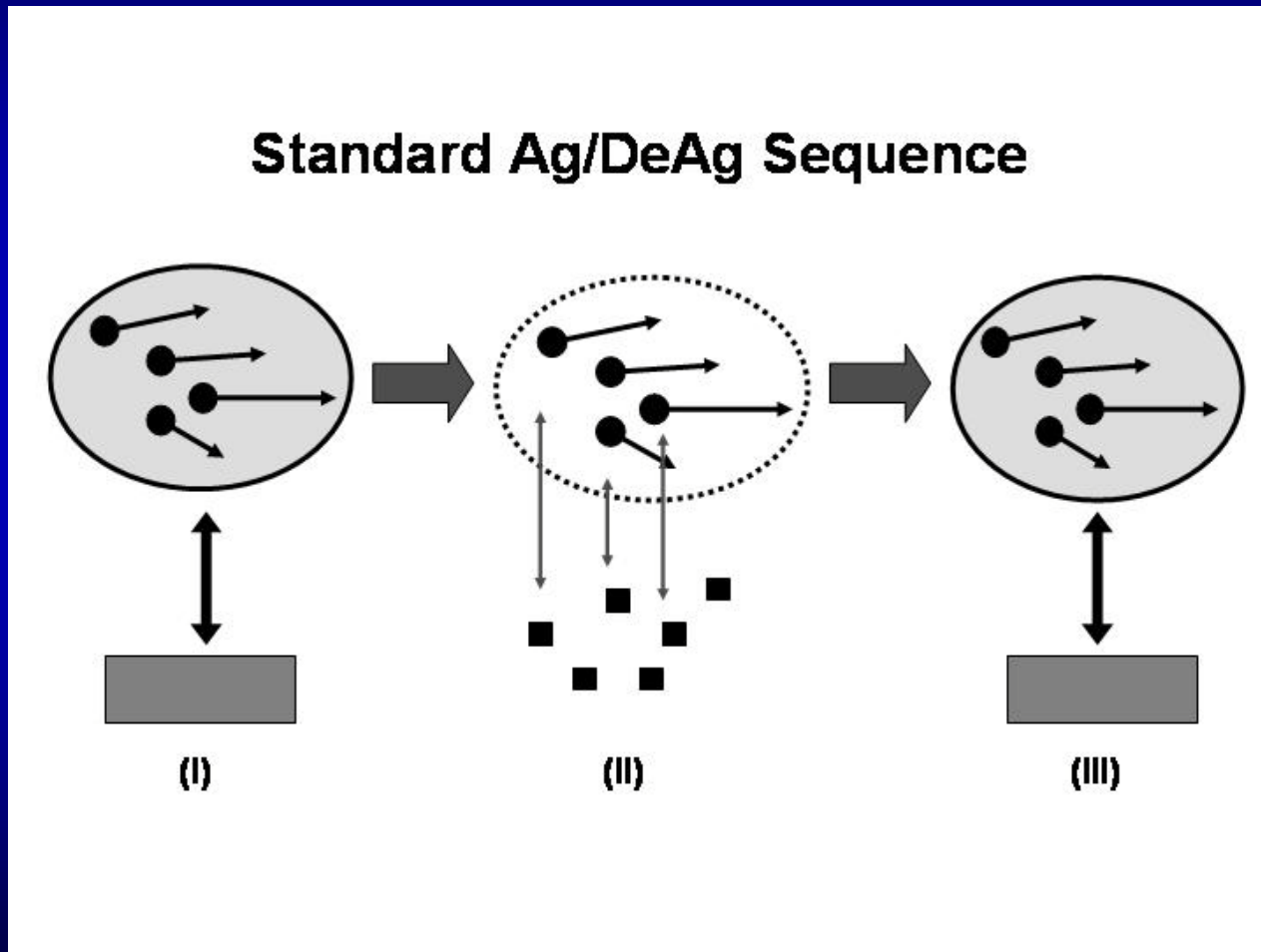
Multi-resolution, Multi-perspective

- **J.H. Bigelow, PhD, Colleague of Paul Davis**
 - Breaks the “Only cite Pauls!” rule, but co-author is a Paul
- **Good overview of essential issues**
- **Complex simulation using**
 - Simultaneous
 - Overlapping
 - Covering variety of resolutions
- **Neither Hi- or Lo-Res Models are adequate**
- **Describe different components**
- **Model uncertainties are essential**
- **Validation IS essential**
- **Gets the inquiry out of the “save the cycles” mode**

Definitions & Current Practice

- **Simulations view collective entities in different ways**
- **Following chart shows “Platoon” viewed as:**
 - **Single entity: tank platoon**
 - **Collection of four tanks**
- **First issue: semantics of the representations**
- **As example, state variables**
 - **Number of aggregated entities**
 - **Health/status of unit**
 - **Location and movement**
 - **Dispersion**
 - **Objectives (C2)**

Schematic Ag/De-Ag Configuration



Definitions & Current Practice

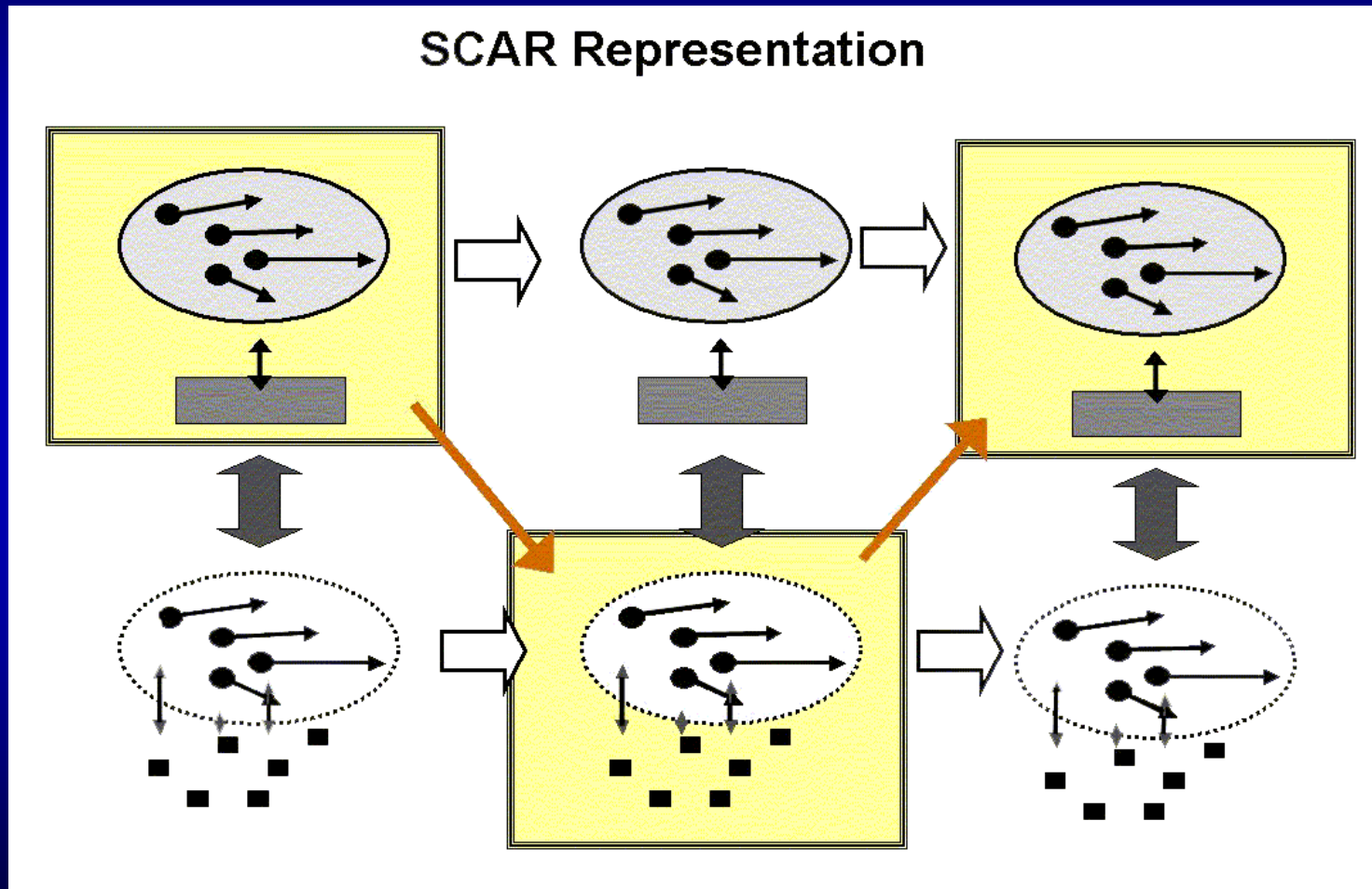
(continued)

- **Resolution switching shown in diagram**
- **Flow of mode change**
 - Aggregate model
 - Entity model (required by lower echelon modeling)
 - Aggregate model (low level no longer required)
- **Some characterizations apply to all levels**
 - Status
 - Location and movement
 - C2
- **Issues:**
 - Translations
 - External interactions

A New Perspective

- **Advances in High Performance Computing (HPC) demand and enable new approaches**
- **Fundamental reason requiring dual representations to provide optimal simulation**
- **Both can and should be maintained in single, over-all simulation framework**
- **HPC approach shown on following chart**
 - Both representation maintained at all times
 - Only one in control at any one time
 - Control representation responsible for updating other
- **Easy to attach changes in state to other level**

Multiple resolutions with alternating control (the SCAR picture)



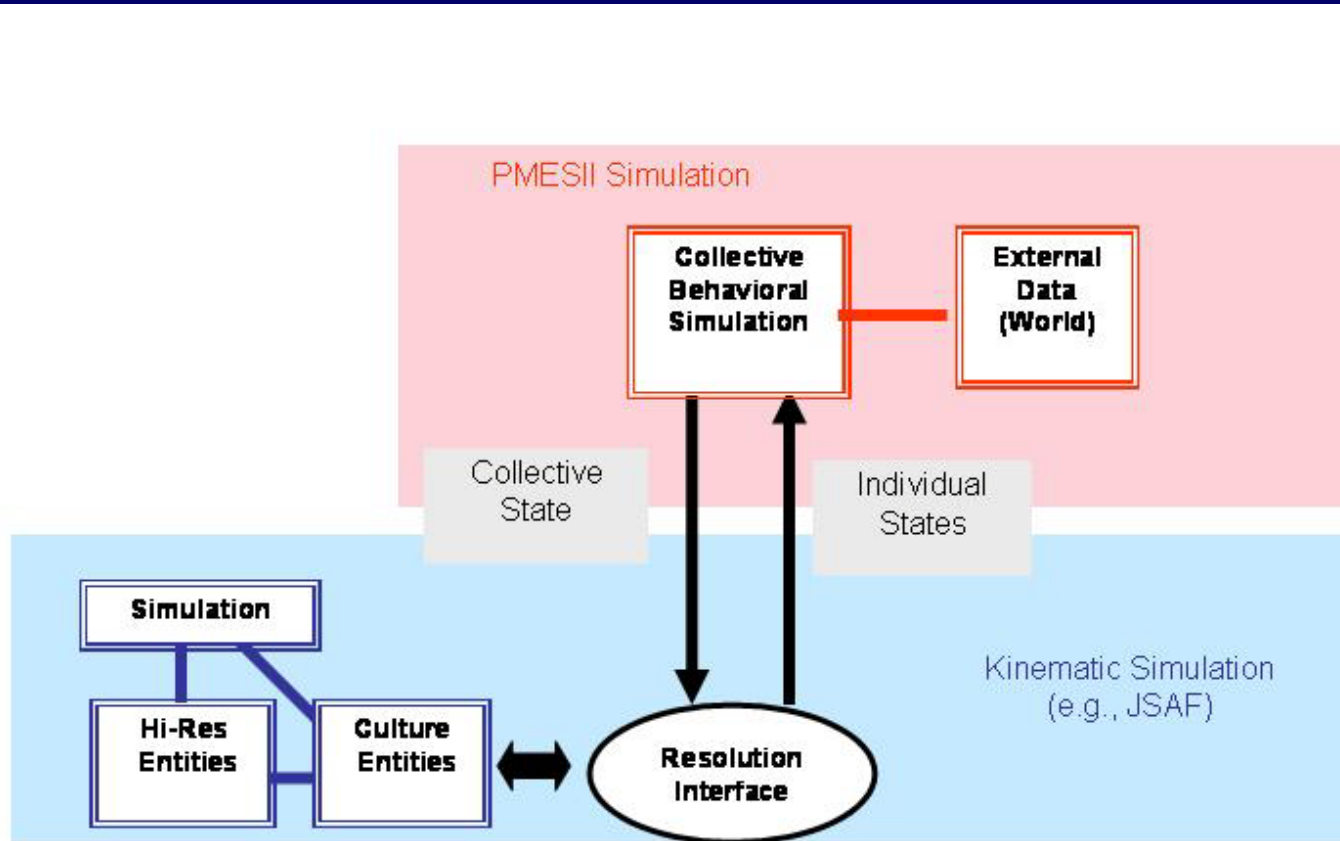
Simultaneous Consistent Alternative Representations- SCAR

- **Consistency of perceived state**
- **Assessment of Aggregation Dynamics**
- **Scale transcendent components critical**
- **Each resolution contains information needed by sim**
- **Probabilistic/aggregate approaches inadequate for assessing failure probabilities**
- **SCAR runs both, one of which is dominant, the other is subservient**
- **HPC enables all additional simulation burdens**

Development Test-Bed

- **Many areas to be addressed**
- **Small initial incremental changes well advised**
- **Use PMESII as generator of test data**
 - **Political Military Social Economic Information Infrastructure**
 - **JFCOM experience with programs**
- **Figure on next slide indicates hybrid sim**
 - **Entity level simulation**
 - **PMSEII “aggregation” of culture**
- **Mismatch of resolution**
- **Must maintain consistency**
- **Crowd behaviors are example**

Schematic Behavioral \Leftrightarrow Constructive Integration



SCAR Assets & Capabilities

- **SAF simulation and PMSEII operate independently**
- **SAF sends aggregated data to PMESII**
- **PMSEII sends population movements and densities back to SAF simulation**
- **SAF issues orders to make simulation conform to PMESII directives, e.g. a crowd should gather at point of IED detonation**
- **Reaction values of individuals need to be tuned, e.g. angry crowd goes toward explosion, timid crowd flees**
- **JFCOM and others need this capability**

Conclusions

- **Ag-DeAg still very important**
- **Asymmetric Warfare and Urban Battlespaces**
- **Many activities making excellent use of HPC technologies and capabilities**
- **Ag-DeAg issues will migrate from cycles saving to interoperability facilitation**

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