Some Key Points on JAS Architecture and Capabilities

1. A global environment, circumscribing the planet, is supported for space, air, naval assets, and communications.
2. JAS has an ”event stepped” architecture that records every event at the precise time it occurs rather than a time stepped architecture as found in STORM and JICM that reports what occurred during hours-long periods of time.
3. The model has simulated communications networks that are easy to establish and carry the information to and from the sensors and units operating in the scenario. These networks and the information on them are vulnerable to both kinetic and nonkinetic attacks resulting in delays in delivery and potentially the loss of the information. Deception can also implant errors and believable disinformation in the system.
4. Adaptive Computer Agents: There are currently over 150 different types of agents configured from a standard Basic Scenario Element (BSE) with five basic capabilities. These basic agent capabilities are tailored for the over 150 agent types using plug-ins and doctrinal and TTP rules:
    - Managing assigned and ordered **Resources**,
    - Moving and/or maintaining the **Platform(s)** of the entity/unit,
    - **Communicating** with superiors, subordinates, and others they are linked to,
    - Understanding the information received from **Sensors** from local eyeballs to overhead,
    - Conducting **Command and Control** appropriate for the echelon and mission of the entity including the planning and operations of their assigned missions in each scenario at higher levels or the following of higher-level orders and the reactions to various situation at lower levels.
5. The agents’ rules (if-then-else) reside in data that can be changed by the user without requiring code changes.
    - The Agents also have access to a Knowledge Base that provides details on how a given task is performed and reflects doctrinal differences among participants in the scenario.
    - The agents can likely be upgraded with AI or as a minimum provide data to train AI with since there are few war games at the campaign level and we currently do not collect enough data from them to repeat them or simulate them (see the 2-page handout, “Simulation Supported Wargaming at the Campaign Level.”)

6. During pauses in the simulation, human war gamers can substitute for selected agents and receive the same data as the that agent. After assessing the information, they can change orders, priorities, and other factors. When the simulation resumes, other agents execute the changes in the same manner as those coming from the original agents as their meta-data is the same.
7. The loss of communications and the information on them degrades the Common Operational Picture and the status of friendly forces causing the "fog and friction of war" and forcing "Decision making under Uncertainty" by both computer agents and human war gamers.
8. JAS is "data driven," and almost all capabilities (weapons, vehicles, human factors, logistics, can be changed in data by the user.
    - Note that any changes from the baseline require a new scenario ID be recorded. But JAS saves only the changes in the modified baseline both minimizing data storage and creating a sequential history of changes in that scenario from its baseline to each iteration.
9. Land attrition in JAS is weapon type oriented and each has a basic kill-rate against engaged targets that it can damage at user-settable ranges.
    - These are enhanced or degraded by target acquisition factors (terrain, weather, and day night which can be overridden by available sensors and night vision devices), modified by the state of the force (exposed, in defilade or cover, moving, stationary and changing from exposed to in cover takes time), personal protection such as bullet-proof vests, helmets, and other futuristic protection minimizes casualties, and human factors such as training, experience, leadership and morale affect weapons' effectiveness, suppression, and breakpoints (unit stops in attack or retrogrades or abandons a defensive position).
    - The results are computed over a minute long engagement which can be interrupted by indirect fire and units joining or leaving the engagement. Initial results were compared with JCS casualty rates and tuned to match them for large scale combat. This is very different from JICM, in which all direct fire weapons in a brigade are aggregated over an hours-long time step. Likewise on artillery fire, the result of every volley was computed against the particular target type and the current state of the target.
10. Other domain attrition in JAS generally follows that of the detailed weapon employment and effects of the Air Force and Navy models of the time (STORM and ITEM) and used most of the data tables used by STORM.
11. JAS is "analyst oriented." Labor saving tools such as drag and drop of units onto maps, cut and paste allows weapons, platforms and even whole units and facilities, e.g., air bases to be duplicated, moved, and modified even among

scenarios, selections from pull-down menus can be updated by the user, some error detection/automated correction is available, and help is incorporated into the human computer interface.

- Whenever JAS software updates were made, they were accompanied by data that “transformed” old scenarios into ones that ran on the new code without reentering data saving hours, if not days of data reentry.

12. Video replay is available for all elements in the scenario at various map and icon scales, aggregations, and speeds (faster or slower) appropriate to the users’ needs, e.g., slow motion for aircraft faster for terrestrial units. The display is interactive and when paused allows searches for specific units and querying their status.

13. Jas allows the option to have civilian noncombatants in the battle space as they are in most modern conflicts. These civilians can be organized into villages, refugee camps, urban blocks, etc. with adaptive computer agents providing leadership and information. Rules can cause the population to react to events and information/disinformation to cause their shift among friendly, neutral, and hostile including to the point of supporting the enemy from not providing information to “changing sides” from civilian to the enemy force.

14. JAS does not require that combat commence upon the start of the scenario, e.g. each side can order global “weapons tight” or release selective units and self-defense is automatic.

    - JAS offers pre-conflict preparation of the battle space, various competitive options, and slow or fast escalation to full-scale warfare including raids, blockades, missile attacks, etc.

    - JAS also simulates preemptive and limited conflict and support of surrogates by either or both sides. Disaster Assistance is a valid mission and JAS has also conducted a Noncombatant Evacuation Operation (NEO) within a Strategic Scenarios as an excursion.

15. Integrated CBRNE (WMD) with DTRA algorithms and visible clouds in replay moving with the wind (growing, and then dissipating). Includes surrogate small nuclear devices and Electromagnetic Pulse (EMP) detonations.

16. JAS has an internal process model that can be employed for a variety of purposes from the generation of municipal electricity (requiring facilities, workers, resources, and transmission lines) to training camps (requiring equipment, recruits, trainers and support personnel, and time) to produce different levels of combat proficiency all data driven.

17. JAS tracks all personnel, weapons, munitions, and fuel, reorders them as needed/directed, and records their status until final disposition.

- Other resources, e.g., water and food can be tracked and almost anything else can be defined and added or consolidated as bulk cargo to consume the available transport.
- The consequences when resources are not available, are tailored to the standard effects, e.g. units with vehicles without fuel or their correct fuel type cannot move and weapons with no or the wrong caliber of round cannot fire.

18. The oceans, major canals, and some large rivers have an underlying Triangular Integrated Network (TIN) that allows ships to travel these bodies of water without running aground and as with ground can select their own routes.
19. JAS was separately funded to develop a Commanders' Behavior Model (CBM) that is based on crisp and fuzzy logic rules, game theory, and a simple simulation that projects the probability of success in battle given perceptions of each force (ground truth could be very different). It also allows some level of personality in commanders employing by assigning the relative importance of casualties, supplies, and mission completion in fuzzy logic. Despite being funded by the Defense M&S Office and tested, the CBM was never employed in a major scenario.
20. JAS was mandated to be DoD High Level Architecture (HLA) Protocol compliant meaning that it could federate with other HLA models. Since we tried to make JWARS as complete as possible (a mile wide and a foot deep), we used HLA to federate vertically (rather than horizontally) and do so with more detailed Mission-level models such as the Joint Forces Semi-Automated Forces (JSAF) and Engineering-level models such as Air Defense Missile Engagements when needed both to improve the data used at the Campaign level in JAS and provide a complete combat context in which the more detailed models could be used for training or analysis.