

CAESAR III DEMONSTRATION SCENARIO



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- **Description of CAESAR III**
- **A Hypothetical Case**
- **Approach**
- **Demonstration**
- **Comments**

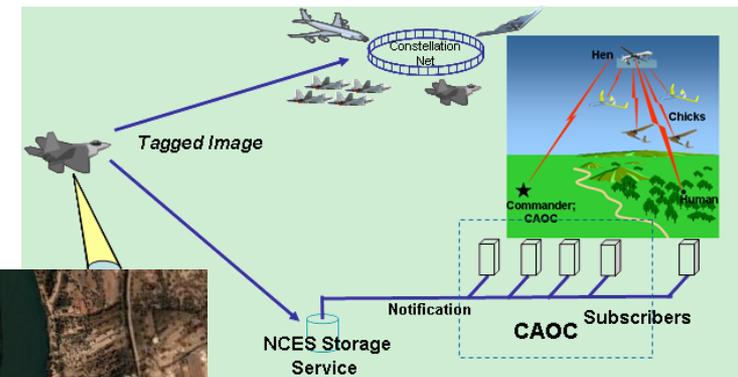
- CAESAR III is an application for the design of information processing and decision making organizations at the operational and tactical levels; it takes into consideration cultural differences
- The design methodology is based on Petri net theory
 - There is an algebra of information sharing and command issuing interconnections
 - The Lattice algorithm computes all organizational architectures that satisfy the constraints
 - Cultural attributes generate additional constraints that reduce further the set of feasible designs
- CAESAR III can also be used to model specific organizational processes and then analyze them through simulation, state space analysis, and invariant analysis



A Hypothetical Case: Evaluation of an organization in a Vignette



- To demonstrate the computational process, a simple example has been formulated
- A tactical vignette, involving an F/A-22 (or F-15E) sensing a potential target during an urban operation, illustrates how Machine-to-Machine integration and the use of innovative distributed ISR would address the challenge of non-traditional ISR contribution in the decision making process
 - The vignette consists of 13 steps, each having:
 - Operational description
 - Technical implementation
 - Technology challenges
 - Steps 9 thru 13 involve organizational decision making



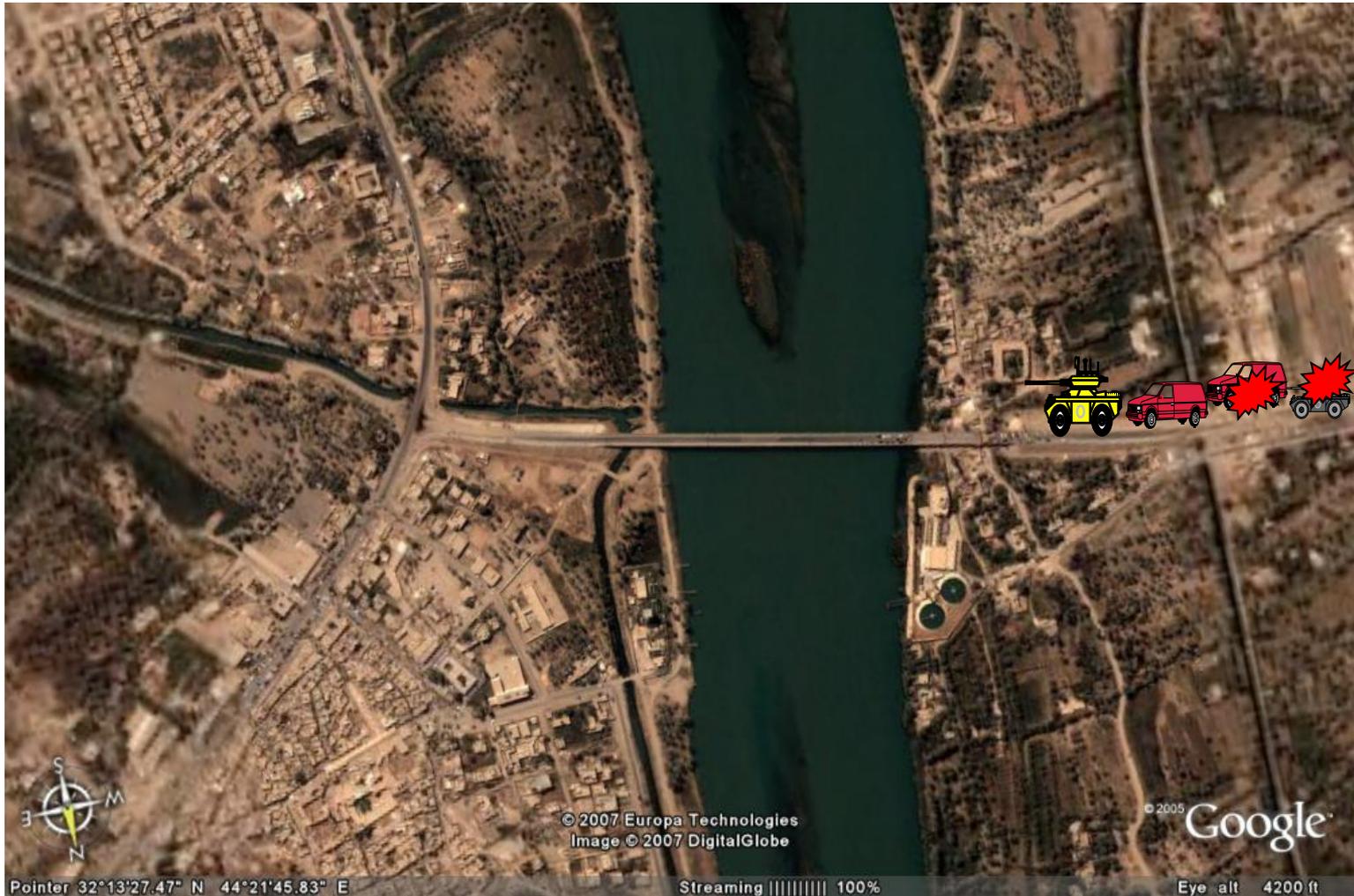
* The vignette is based on a vignette developed by the AF SAB for the Domain Integration study (2005)

A Hypothetical Case

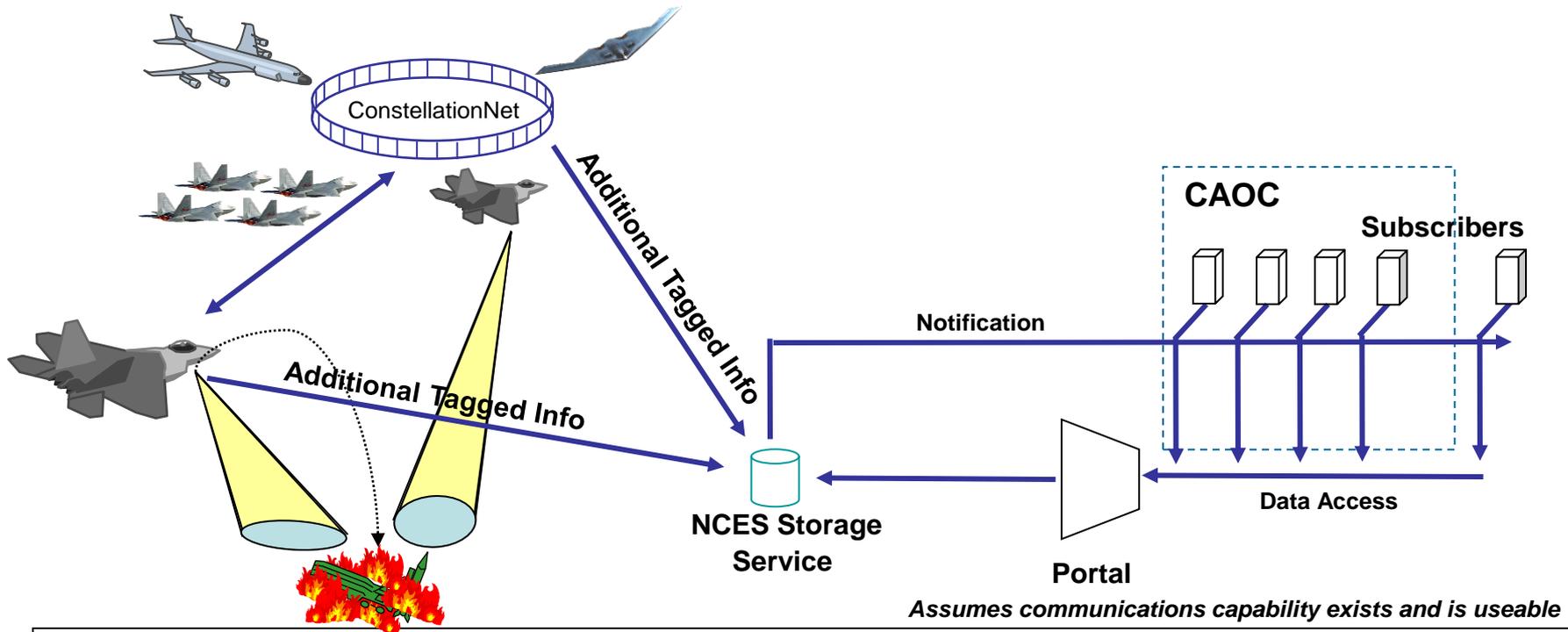


- **The organization conducts BDA and determines that a re-strike is necessary. The re-strike targeting solution is determined, the decision to re-strike is made, the re-strike order is given, the re-strike occurs, and BDA to determine the results of the re-strike is accomplished.**
- **Potential organizational elements, e.g., COD, DTC, SODO, etc., and their activities, e.g., combat assessment, targeting and weaponeering are studied and Data Flow Models are developed to capture the organizational interactions in compliance with AFI 13-1 AOC, Volume 3.**

- Convoy of 4 vehicles attacked
- Two vehicles destroyed
- Two vehicles headed across bridge



9. Target engaged with desired weapon effect as determined by targeting solution and assessment data sent to CAOC



Query for data update supporting weapon effect assessment → Sensor assets (to include non-traditional ISR sensors) convert signal to data → Add metadata → Post metadata & sensor data in storage service; matches posted data with CAOC subscriber → Notifies CAOC subscriber via email → CAOC subscriber accesses data via portal

Organizational Elements Potentially Involved



- **CAOC**

- CAOC Director
- Chief of Combat Operations (CCO)
- Senior Operations Duty Officer (SODO)
- Senior Intelligence Duty Office (SIDO)
- Dynamic Targeting Cell Chief (DTC Chief)
- Ground Track Officer (GTO)
- Attack Coordinator (AC)
- Targeting Duty Officer (TDO)
- Intelligence Duty Officer (IDO)
- ISR Operations Duty Officer (ISR ODO)

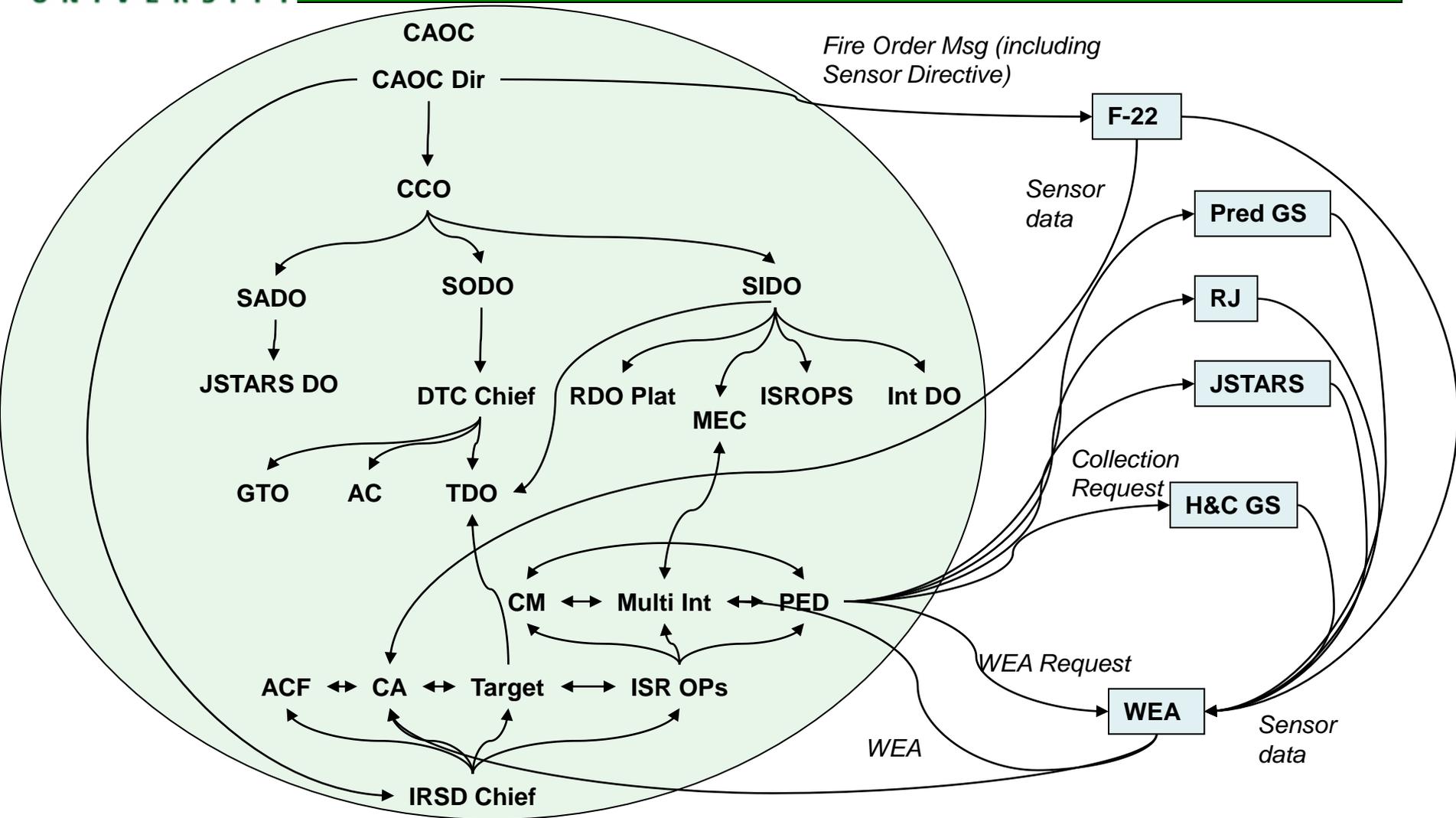
- Chief ISR Division
- Analysis, correlation, fusion (ACF) Cell
- Combat Assessment Cell (CA)
- Targeting Cell
- ISR Operations Cell
- Collection Management (CM)
- Multi-Int Exploitation Cell (MEC)
- Post-Exploit-Disseminate (PED) Cell

- **Assets Involved**

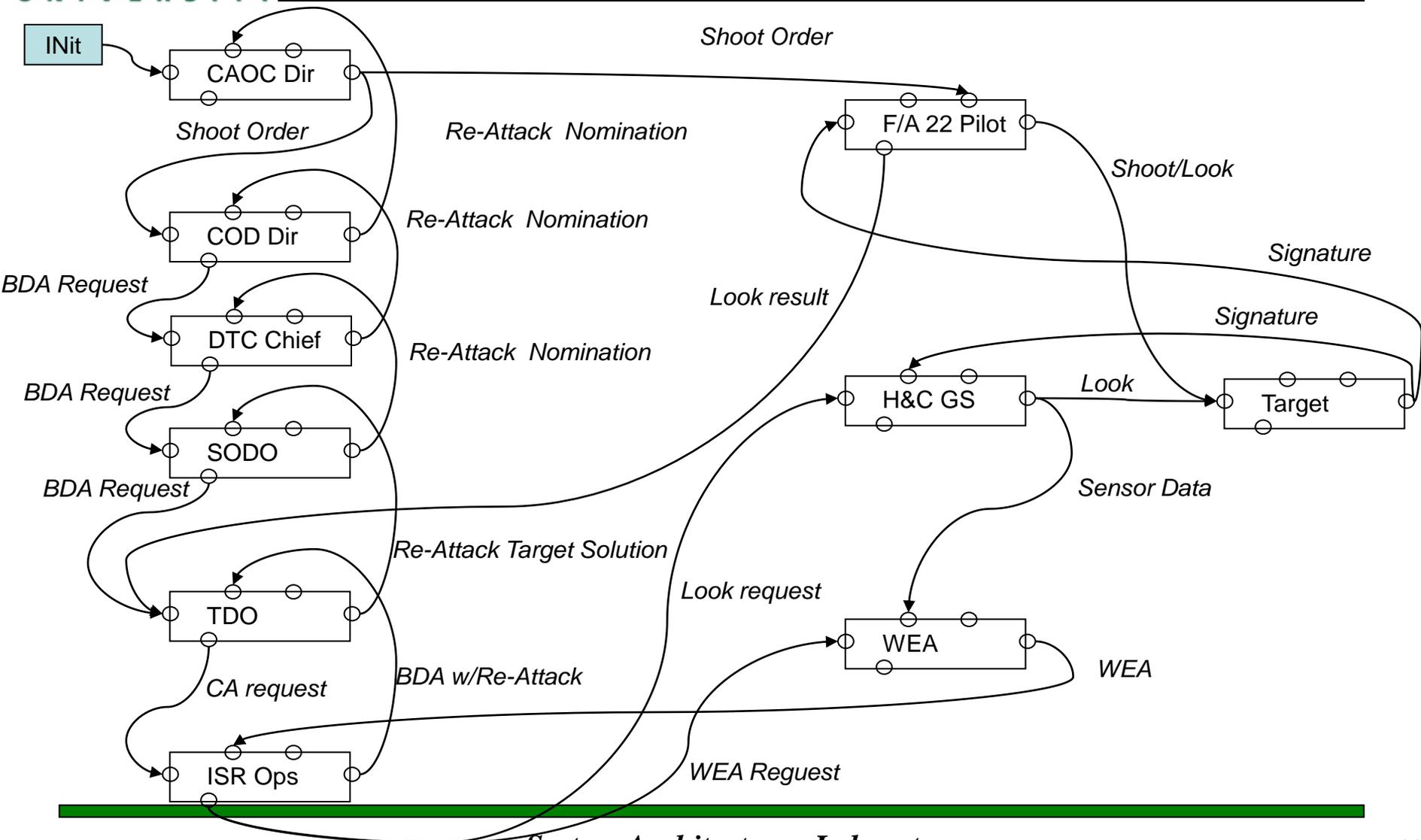
- F/A 22
- Hen and Chicks Ground Station
- Predator Ground Station
- Rivet Joint
- JSTARS

- Also the GIG Weapon Effectiveness Analysis (WEA) service/capability

Organizational Elements



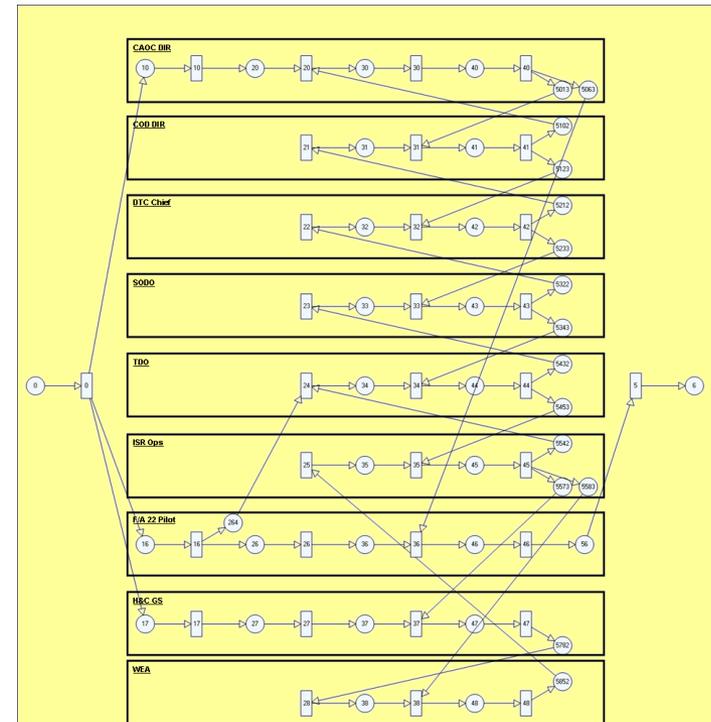
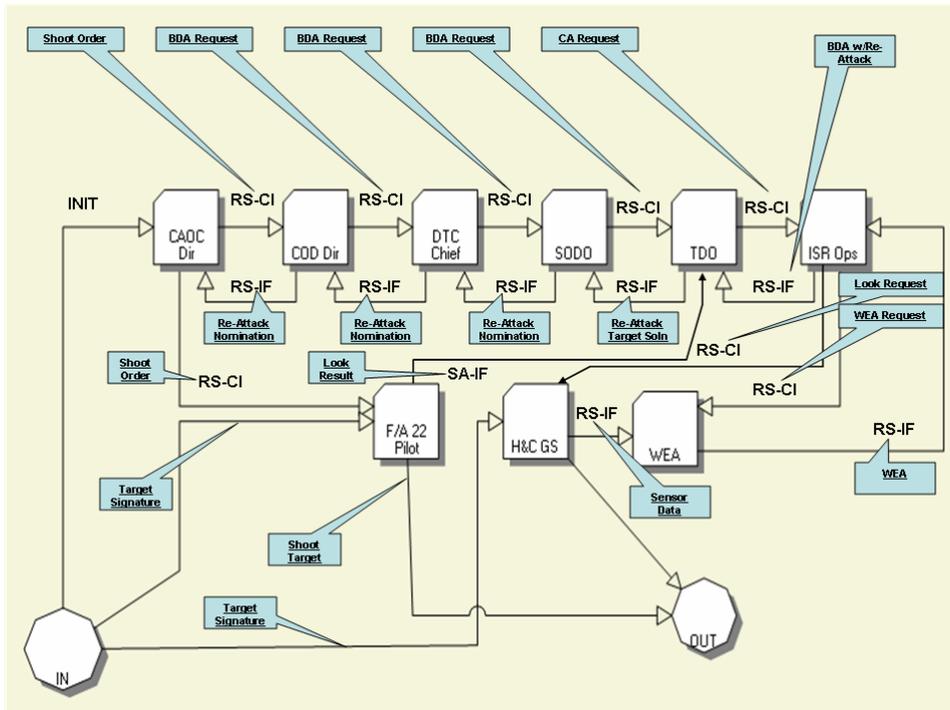
An Organization Model



Converting the Organizational Sketch into CAESAR III Model



- A discrete-event system model (Colored Petri net) is developed using CAESAR III





- **Can we evaluate the behavior and performance of the proposed organization under the situation described in the vignette?**
 - **Can we evaluate the timeliness of the response of the system?**
 - **Can we compare the performance of the system with and without the use of the new (Hen and Chicks) ISR capability?**
 - **Does the H&C capability with its improvement in accuracy of Target Detection, location, Identification, tracking, etc., improve performance of the system? By how much?**

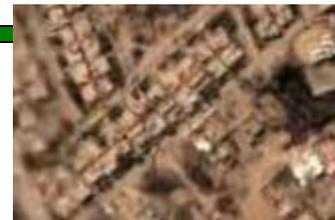


- **Approach: Transform the Petri Net model generated by CAESAR III into a Colored Petri Net Model (Timed)**
 - **Associate attributes with the tokens (and the places that hold them)**
 - **Develop the logic for each stage of each decision maker that uses the “values” of the input tokens to determine the “value” of output tokens**
 - **Associate time delays with the various stages of the Decision makers in the model**
 - **Set of a set of scenarios so that the CPN model can be run in the simulation mode**
 - **Collect and analyze the data generated by the simulations**

Scenario Set Up

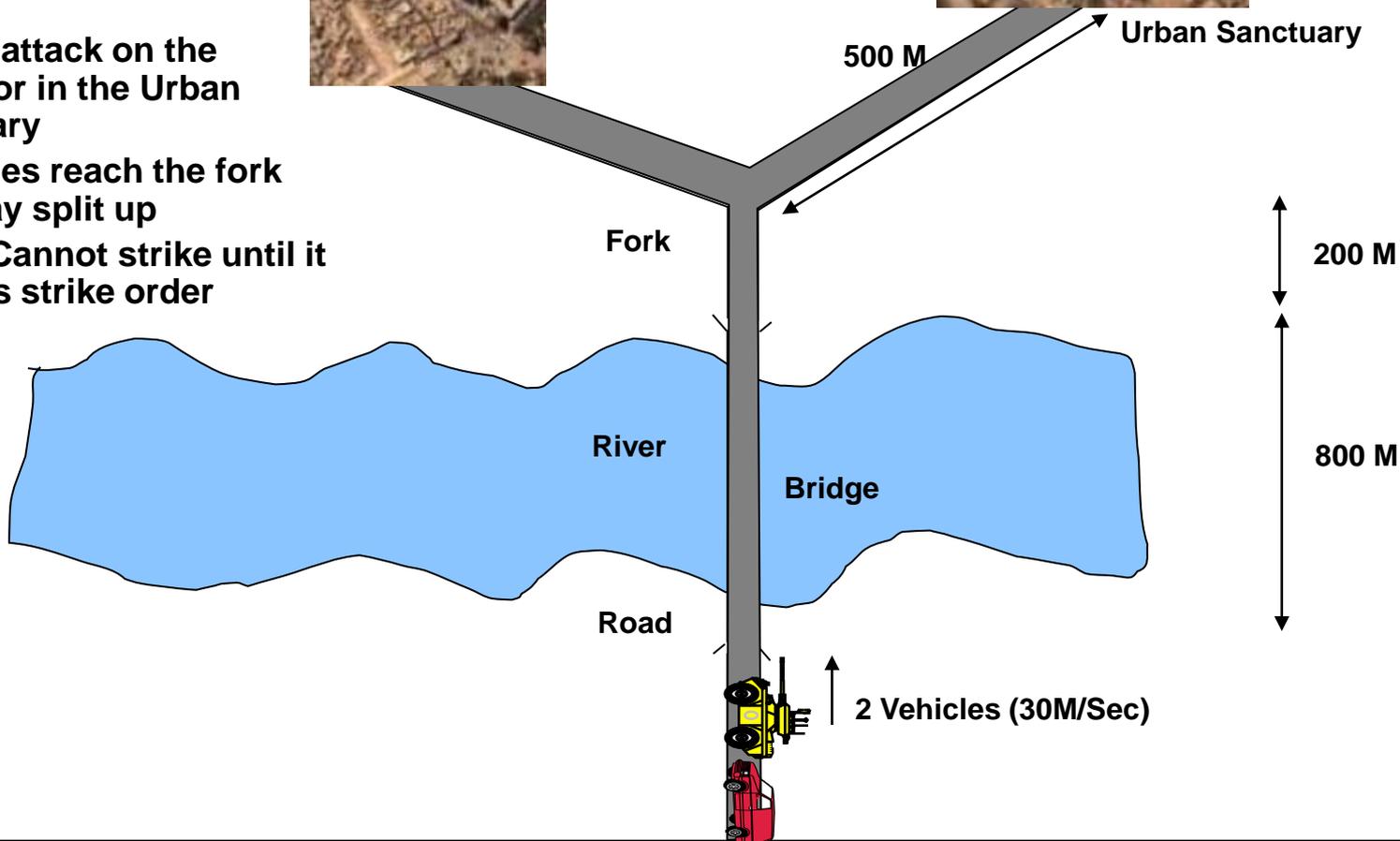


Urban Sanctuary



Urban Sanctuary

- Cannot attack on the Bridge or in the Urban Sanctuary
- If vehicles reach the fork they may split up
- F/A-22 Cannot strike until it receives strike order





- **Input Variables (Independent Variables)**
 - Number of Targets
 - Speed of Targets
 - Distances (Bridge, Fork, Urban Sanctuary)
 - Processing Times for each stage of each decision maker
 - Configuration (No H&C, H&C to ISR only (No Direct), H&C to IRS and Direct to F/A-22)
- **Output Variables (Dependent Variables)**
 - Time delays for attack of each target
 - Distance each target has traveled when attacked
 - Target attacked (Target 1, Target 2,...)
- **Requirements**
 - All targets should be attacked (if approved) before entering the urban sanctuary

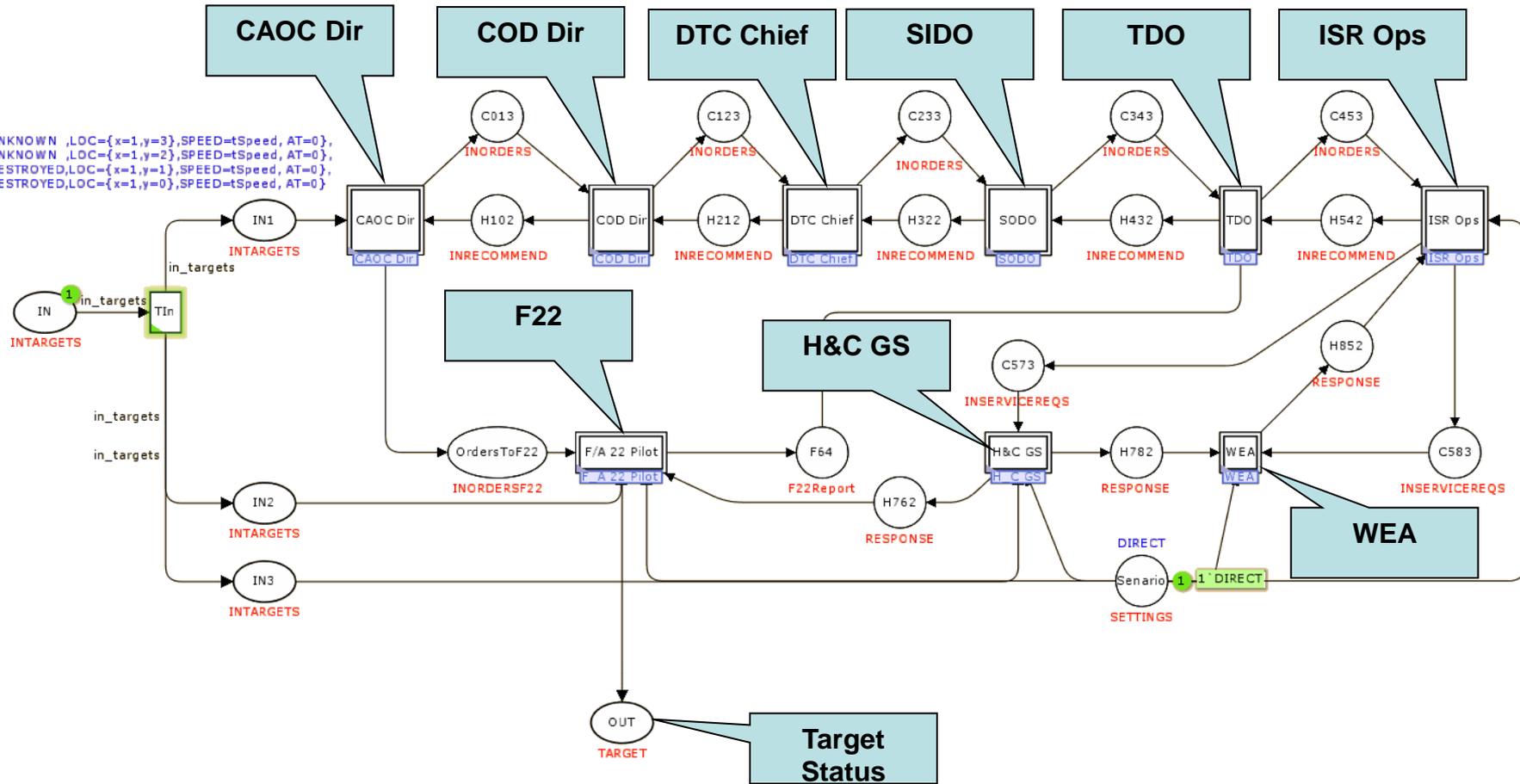
Hierarchical Colored Petri Net Model

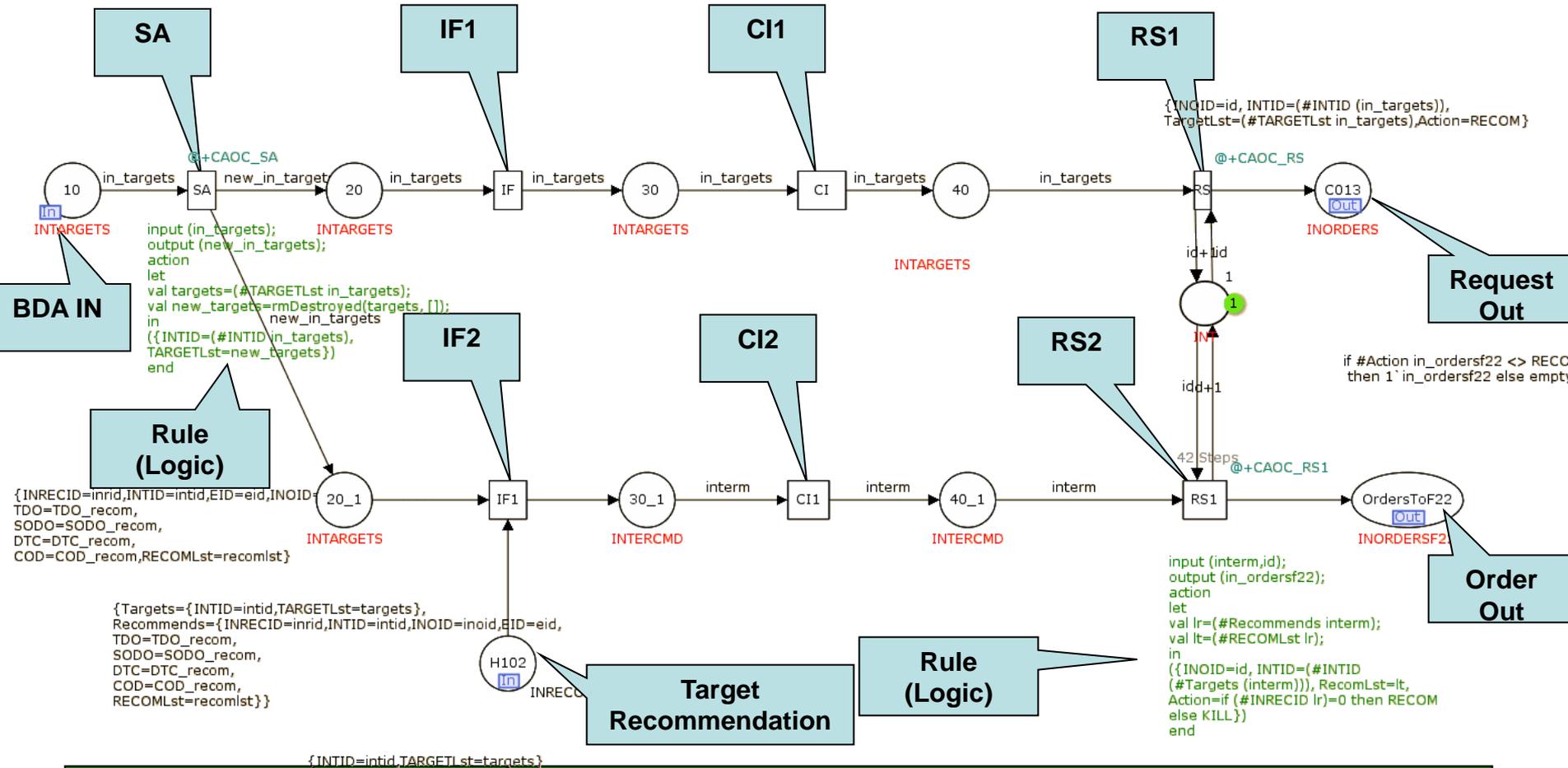


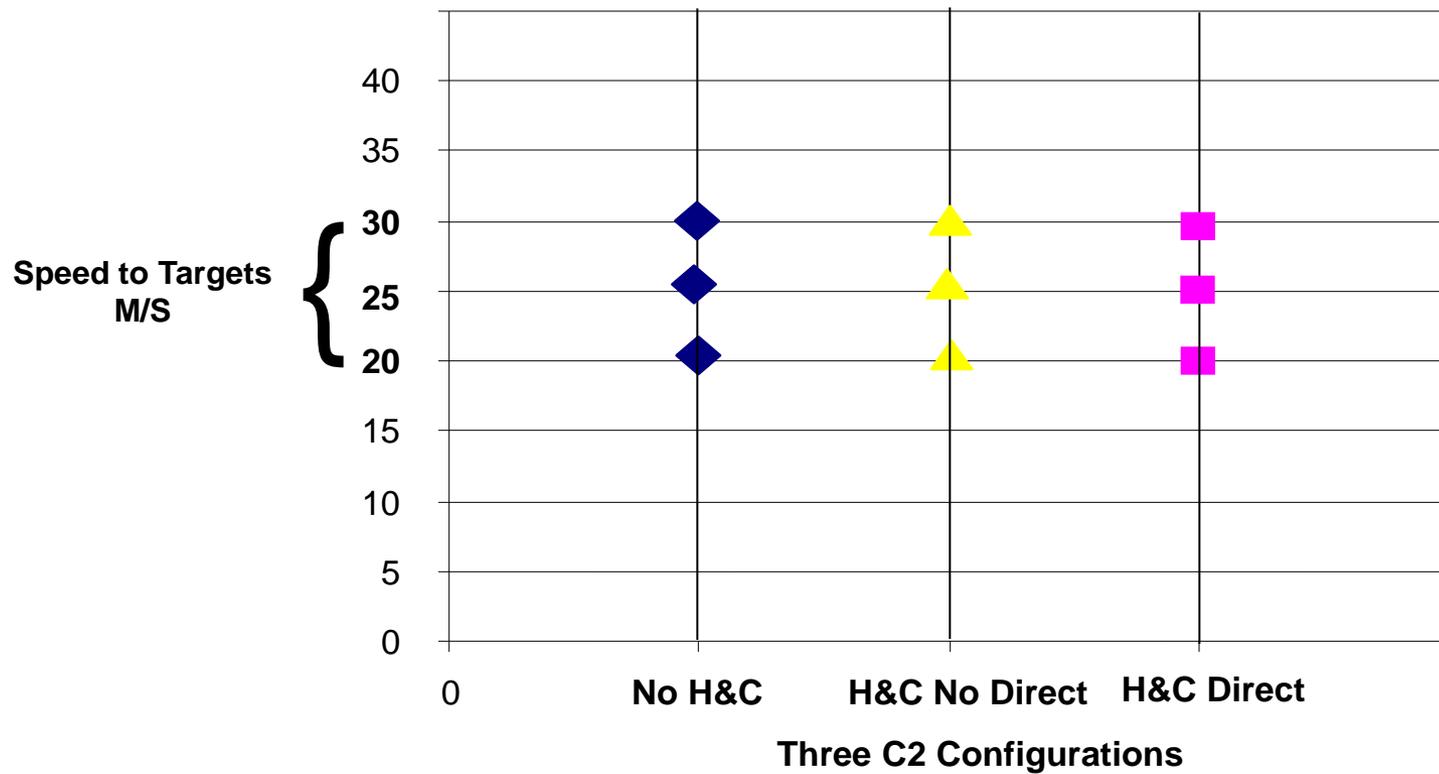
```

1' {INTID=1,
TARGETList=
[
{TID=1,STATUS=UNKNOWN ,LOC={x=1,y=3},SPEED=tSpeed,AT=0},
{TID=2,STATUS=UNKNOWN ,LOC={x=1,y=2},SPEED=tSpeed,AT=0},
{TID=3,STATUS=DESTROYED,LOC={x=1,y=1},SPEED=tSpeed,AT=0},
{TID=4,STATUS=DESTROYED,LOC={x=1,y=0},SPEED=tSpeed,AT=0},
]}

```

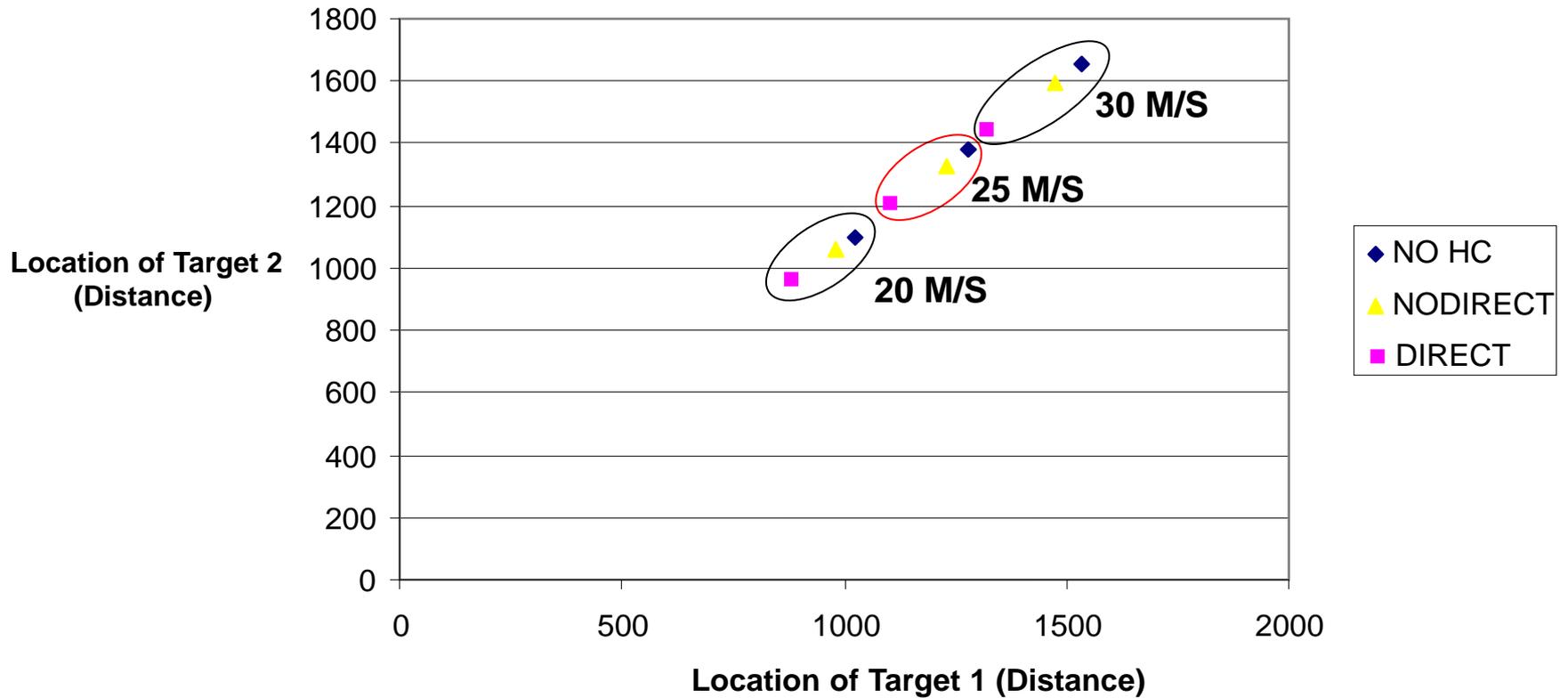






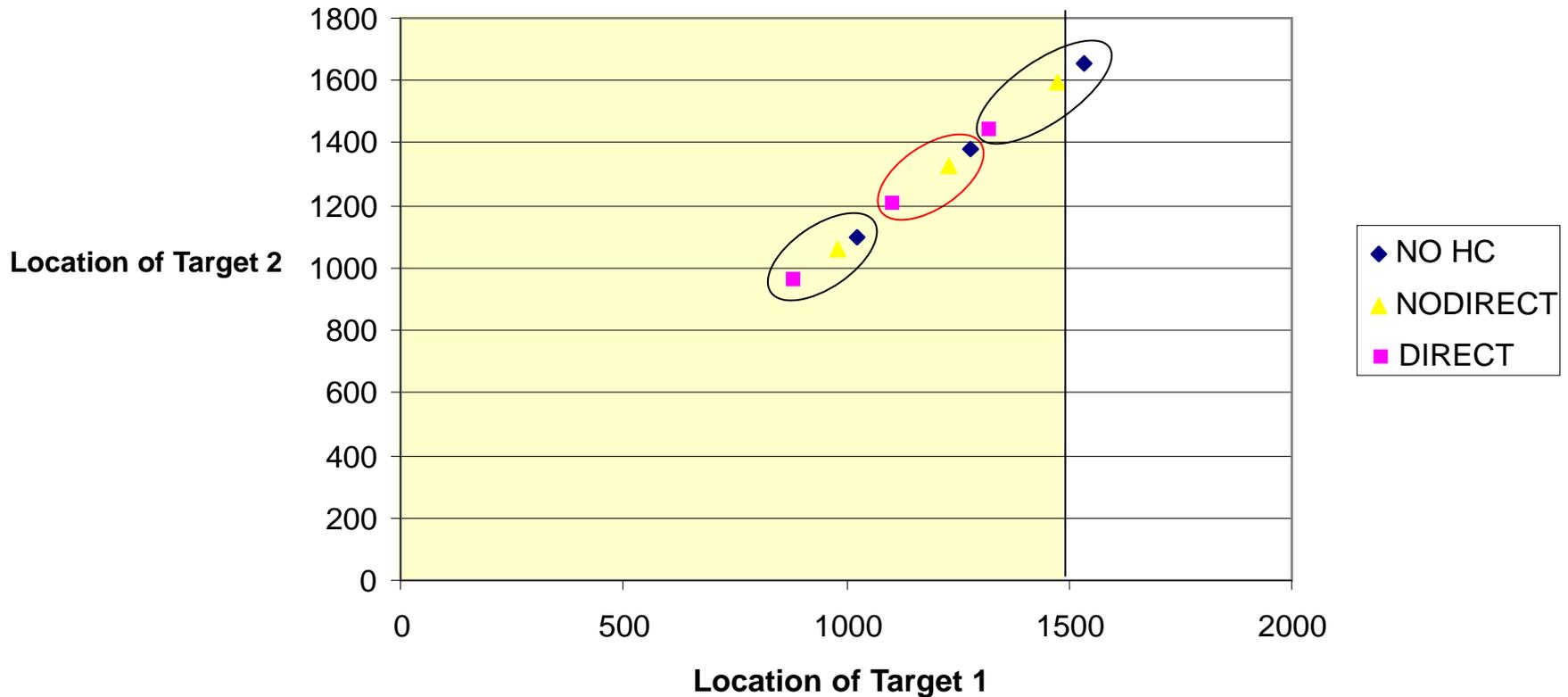


Performance Locus



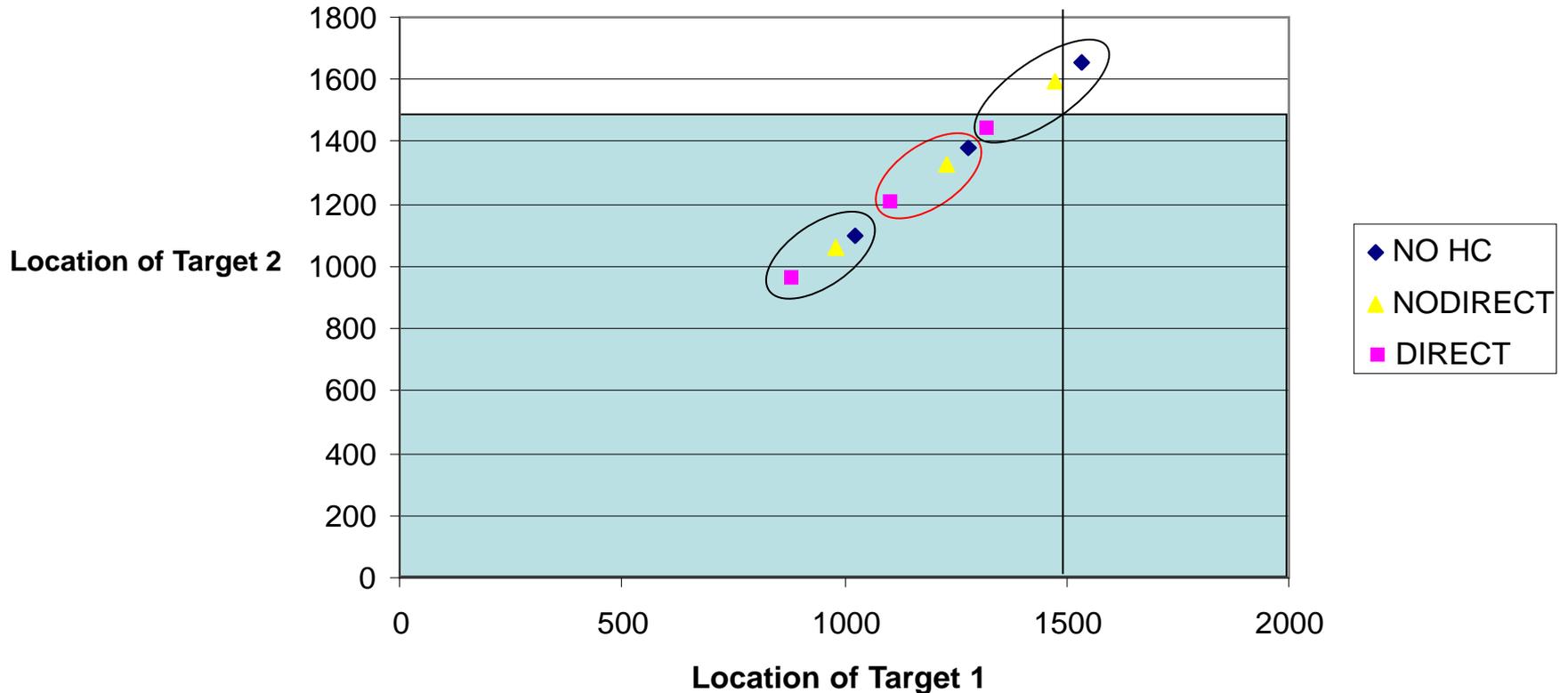


Requirements Locus for Target 1 Added



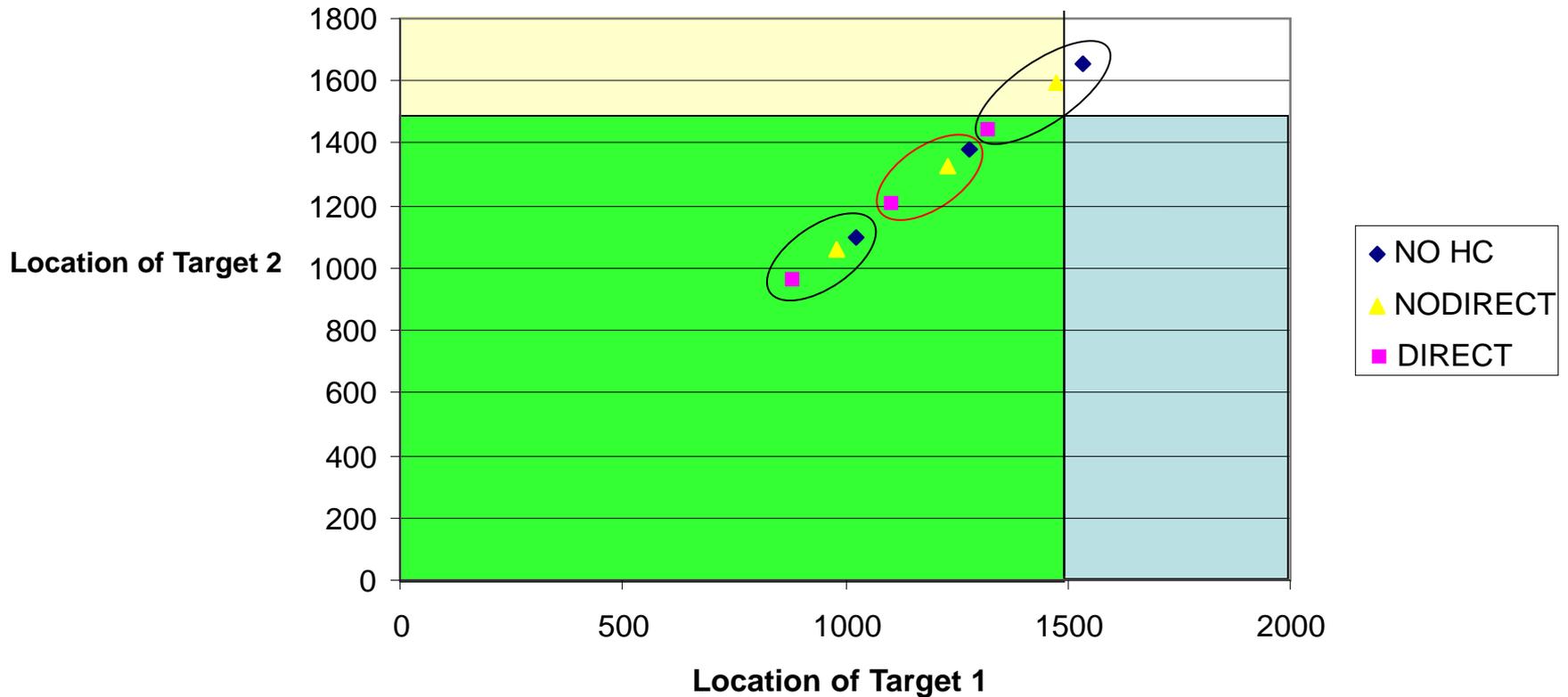
Target 1 re attacked in all cases but one: 30 M/S with no H&C

Requirement Locus for Target 2



Target 2 Re attacked in all cases but two: 30 M/S with no H&C or No Direct

Combined Requirement Locus



Given all situations modeled (18 targets), 15 were Re-struck (83% success)

- **Given the Vignette**
 - **The organization is capable of re-striking all of the targets in all configurations if the Target Speed is 25 M/S or less**
 - **If the target speed is 30 M/S (or more) H&C makes a difference, With Direct connection, both targets are re-struck, with H&C only connected to ISR, the priority vehicle is re-struck, but the secondary vehicle escapes**
- **Adjusting the delay times or changing procedures to allow more parallel processing should improve performance**
- **It is assumed that H&C increases accuracy of location and identification of the target**
 - **Aids ISR in locating and determining the state of the target**
 - **Results in reduced time delay for ISR to complete its task**
 - **If directly connected to F/A-22A, it enables F/A -22A to more quickly Find, Fix, Track, Target, and Fire Weapons**
 - **Improved accuracy provided by H&C is translated into faster reaction time (Important for Time Critical Targets) and thus higher level of performance and effectiveness**

- We have demonstrated a use of the CAESAR III tool for assessing the behavior and performance of organization structures
- The process for performing organizational system analysis has been presented
- The resultant procedure provides a computational test-bed that can be used for experimentation with the organization design and the design of the systems that support that organization
- The process can be done fairly quickly with a small team
 - The demonstrated took about 20 hours to build the organization and the Colored Petri Net model
 - The simple analysis took about 4 hours
 - Building the power point presentation took 8 hours