



CAESAR III: Organization Design and Analysis

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Adversary Behavioral Modeling
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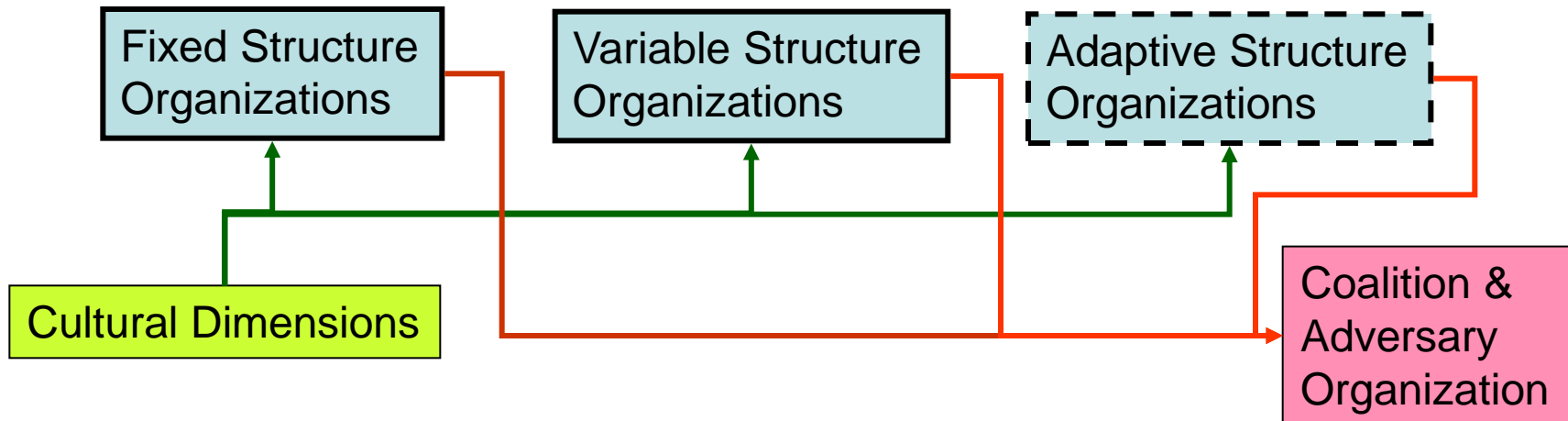


- **Description of CAESAR III**
- **Coalition and Adversary Modeling**
- **A Hypothetical Case**
- **Approach**
- **Comments**

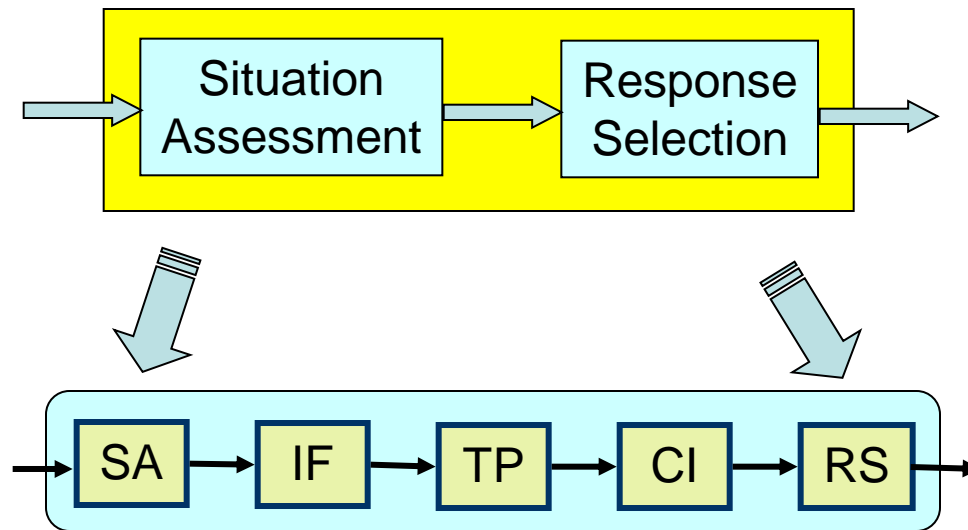


- **CAESAR I was created in 1987 to design and evaluate the organizational structure of command centers conducting tactical tasks**
- **CAESAR II addressed in 1994 adaptive organizations at the operational and tactical level and became a suite of tools for supporting command centers.**
- **CAESAR III (2006) is now an application for the design of decision making organizations at the operational and tactical levels; it takes into consideration cultural differences in coalitions and of adversaries**
- **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 is designed to address three problems:
 - Fixed organization design
 - Variable structure organization design
 - Adaptive structure organization design
- The suite includes SEAT, the System Effectiveness Analysis Tool, that computes and visualizes performance measures (MOPs) and effectiveness measures (MOEs)



- A five stage, model was postulated as an extension of the stimulus – response model:

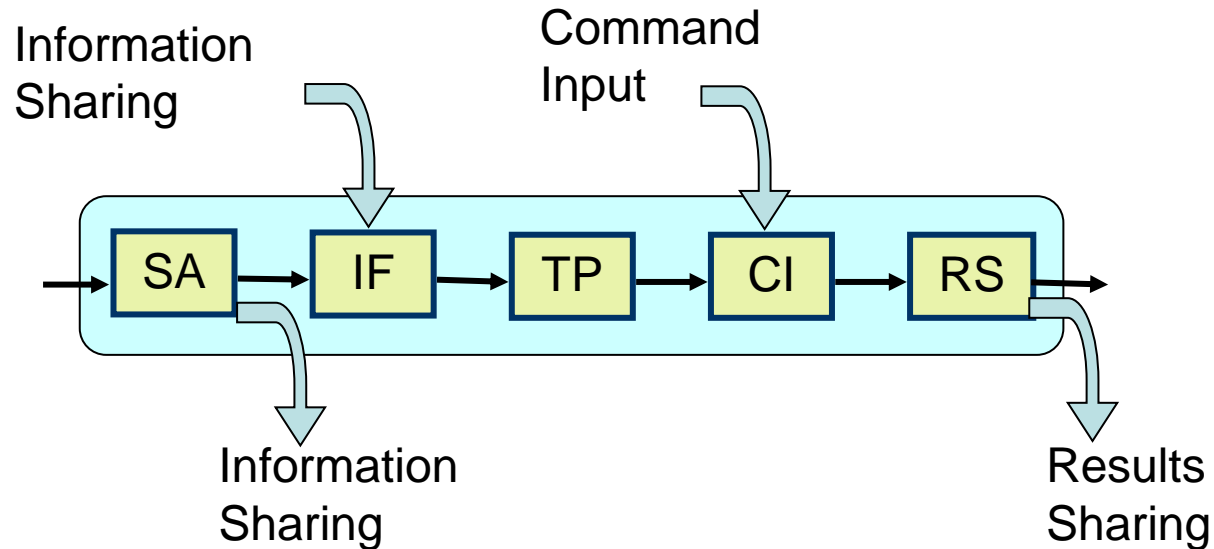


IF: Information Fusion
 TP: Task Processing
 CI: Command Interpretation

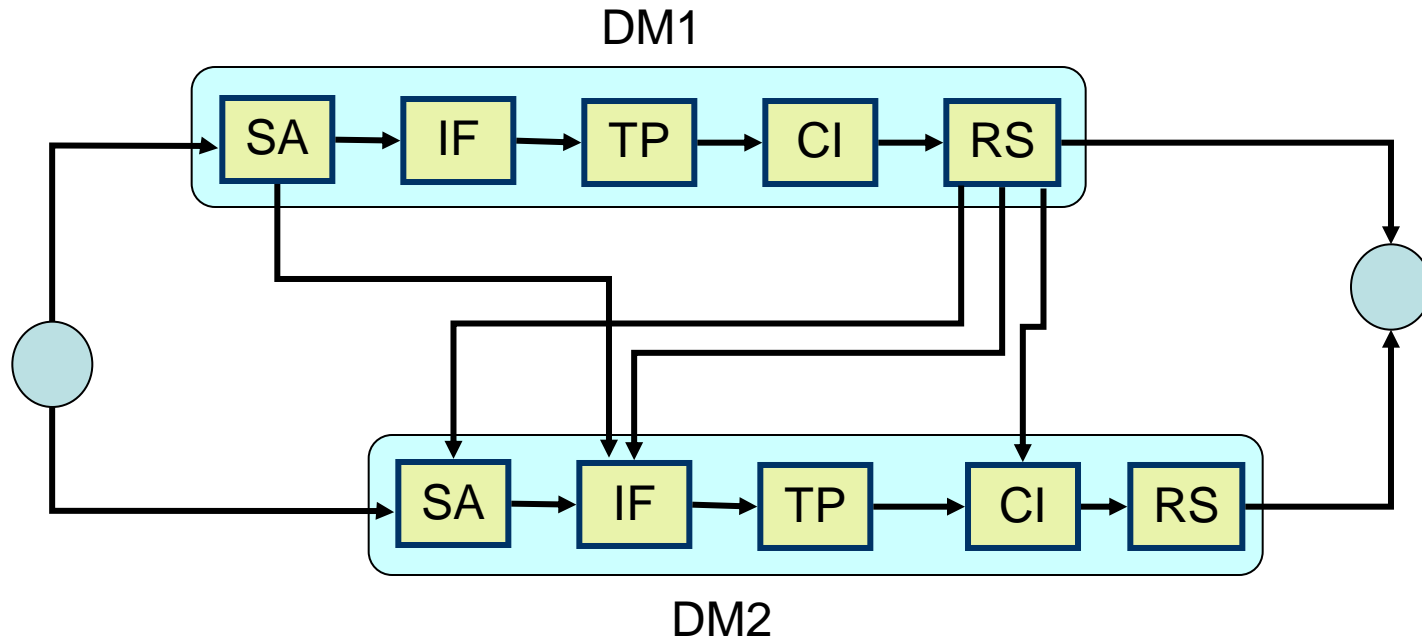
The Interacting DM Model



- The additional stages were necessary for creating different types of interactions among decision makers



Two Interacting DMs



Possible information flows from DM1 to DM2
Corresponding ones (not shown) from DM2 to DM1



- A set of structural constraints has been established that all organizations must satisfy
- Domain/Problem specific constraints can be added
- For a given number of DMs, the algorithm determines all possible organizational structures that meet the constraints
- The algorithm does this in a constructive way – not by enumeration
- The algorithm is based on the invariant theory of Petri Nets
- The solution set has the structure of a Lattice with the minimally connected organizations as the lowest solutions and the maximally connected ones as the highest ones.
- Since a Petri net formulation is used, the model is executable; consequently, it can be used to analyze performance

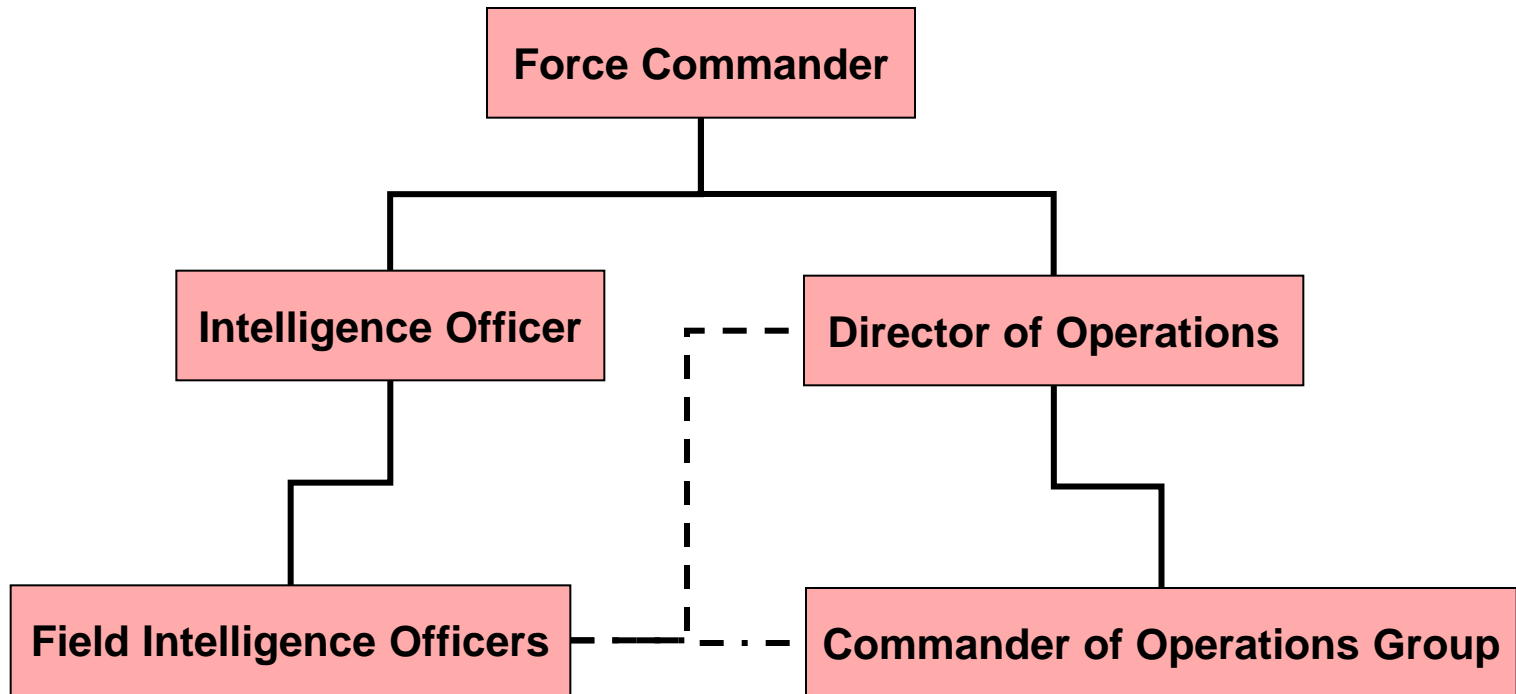
Adversary Modeling: A Hypothetical Case



- To demonstrate the computational process, a simple example has been formulated
- Intelligence from the field has informed Blue that the Adversary (Red) has organized a force to conduct operations in a distinct part (a province) of the Area of Responsibility
- Intelligence has also indicated that the leadership group consists of six persons:
 - The Force Commander
 - The Director of Operations
 - The Commander of the Operations group
 - The Intelligence Officer
 - Two Field Intelligence Officers with different AORs



Intelligence Analysts suggest the following command structure



- Based on the organizational relationship chart, we can specify the interactions between the Decision Makers
 - The Field Intelligence Officers interact with the environment and send their “Situation Assessment” to the Intelligence Officer.
 - The Intelligence Officer fuses this information and sends his “Assessment” to the Force Commander.
 - Based on the information received, the Commander “directs” the Director of Operations who develops a Course of Action
 - The Director of Operations in turn “directs” the Commander of Operations who develops a plan based on the COA and executes it.
 - The variable links are introduced into the problem based on the type of interactions that usually exist in command and control organizations. They may or may not exist in the Red group.
 - **Cultural attributes are used to determine probable links.**

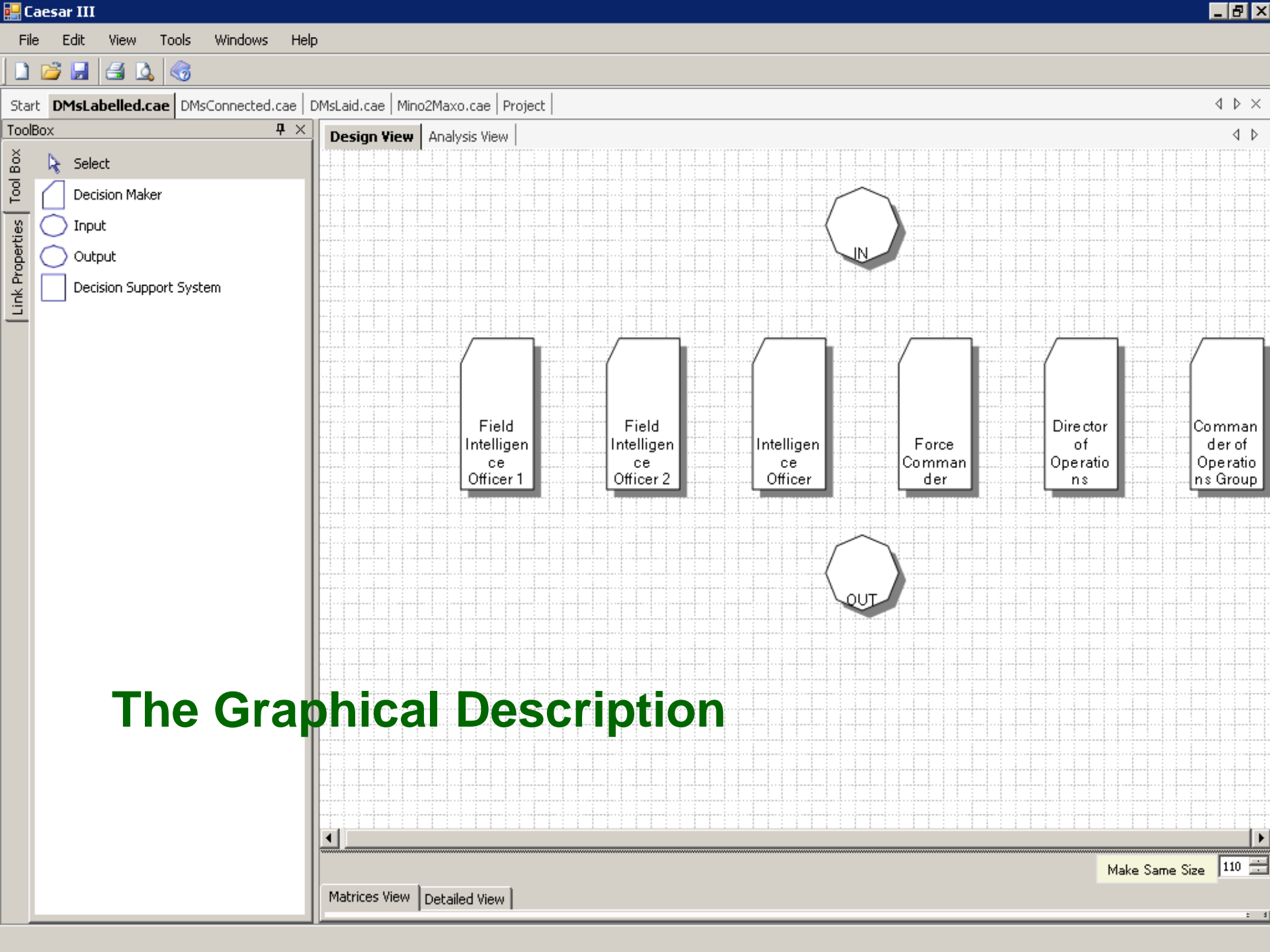
The Problem and the Approach



- Can we infer the possible organizational structure of the Red Force and their information exchanges so that we can focus our ISR assets to the right targets?
- Approach: Design all feasible organizational structures that meet the specific constraints of the problem
- Apply Red's cultural attributes to determine (plausible) organizational structures that he may be employing
- Apply Blue's cultural attributes to obtain a baseline so as to compare with Red's structures
- Determine high value ISR targets for Blue

Number of Allowed interactions by type

	# SA to IF	#RS to SA	#RS to IF	#RS to CI
Blue	2	0	1-3	2-3
Red	2-4	0	1-5	2-4



The Graphical Description



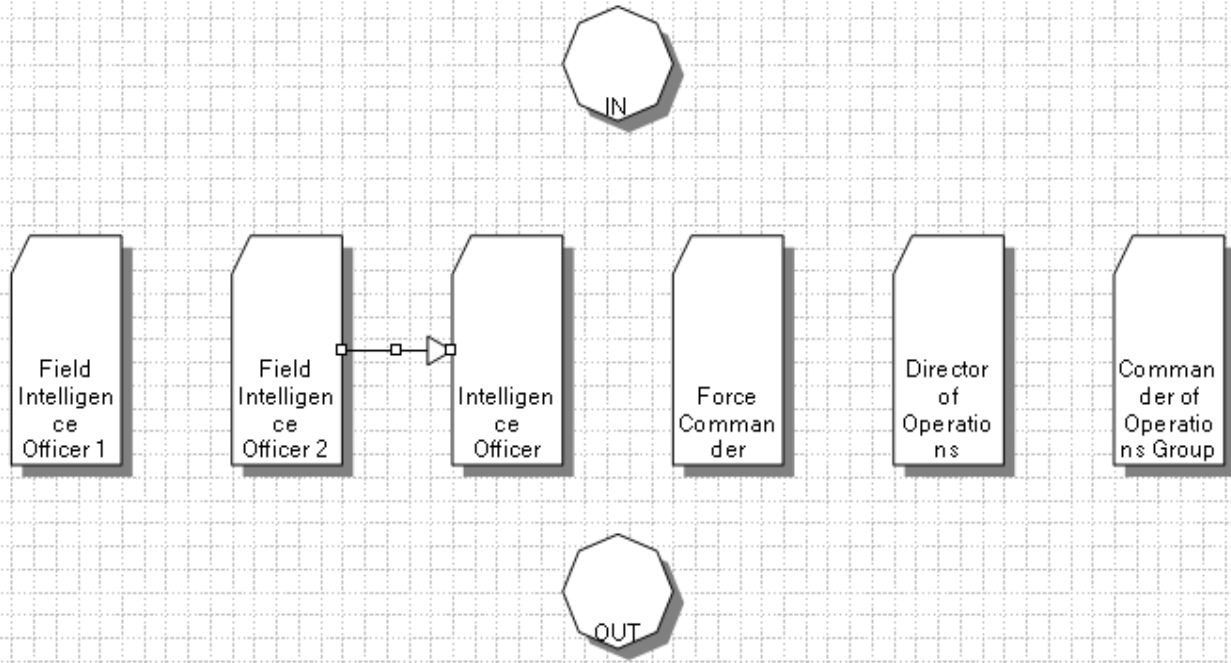
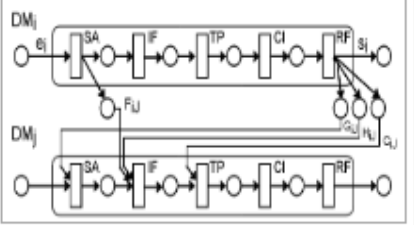
Adding Interconnections

Tool Box
Link Properties

Please select all required interactions

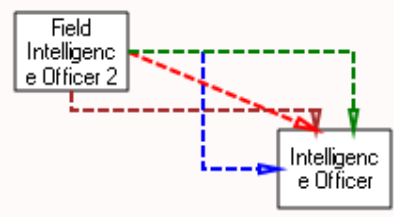
Interactions

- F: SA to IF**
 - Fixed Variable
- G: RS to SA**
 - Fixed Variable
- H: RS to IF**
 - Fixed Variable
- C: RS to CI**
 - Fixed Variable



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Matrices View Detailed View

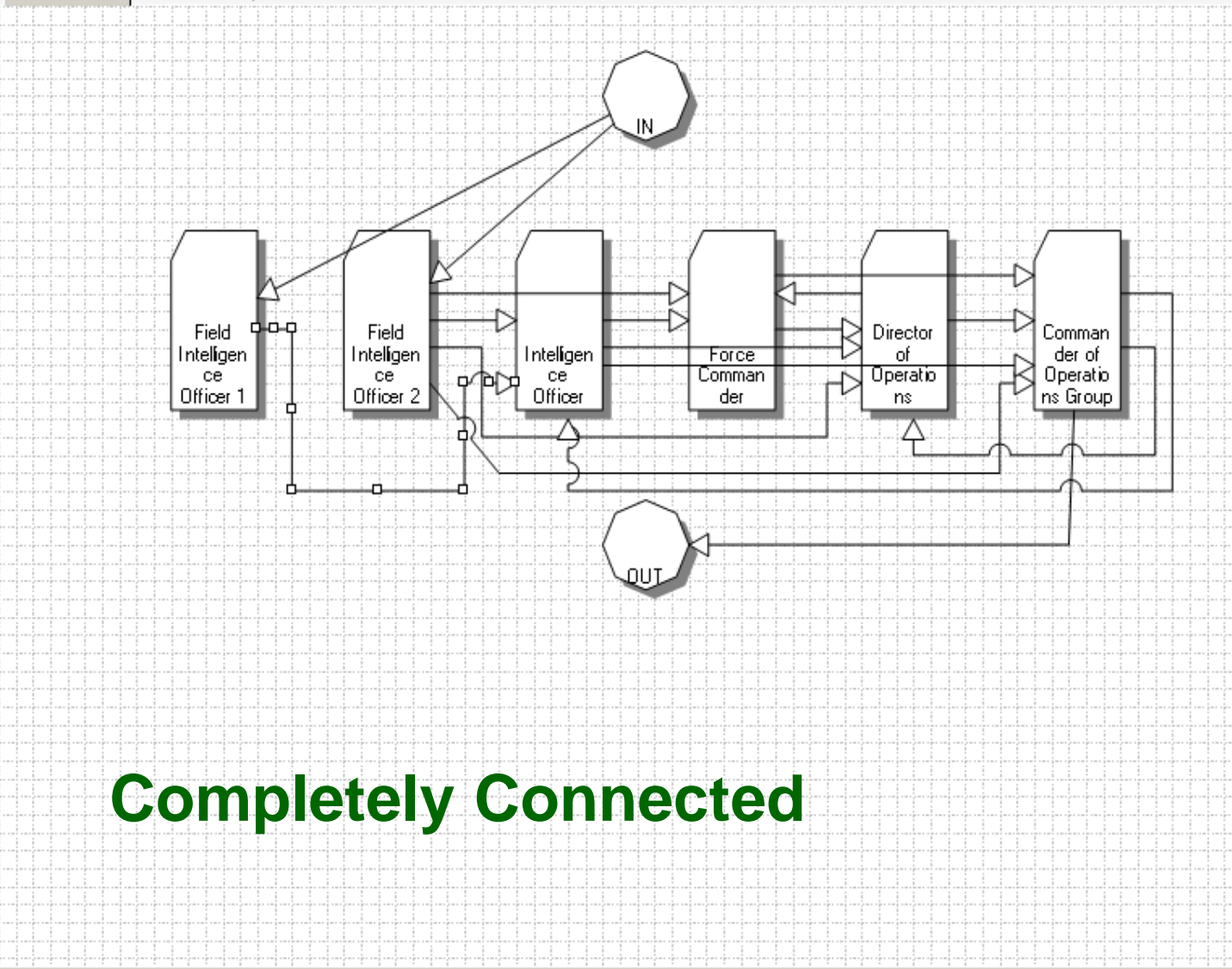




Please select all required interactions

Interactions

- F: SA to IF**
 - Fixed Variable
- G: RS to SA**
 - Fixed Variable
- H: RS to IF**
 - Fixed Variable
- C: RS to CI**
 - Fixed Variable



Completely Connected



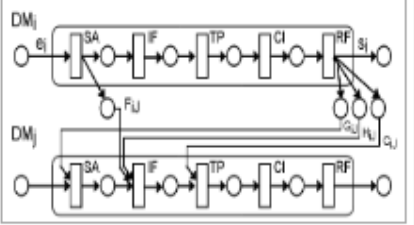
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ToolBox

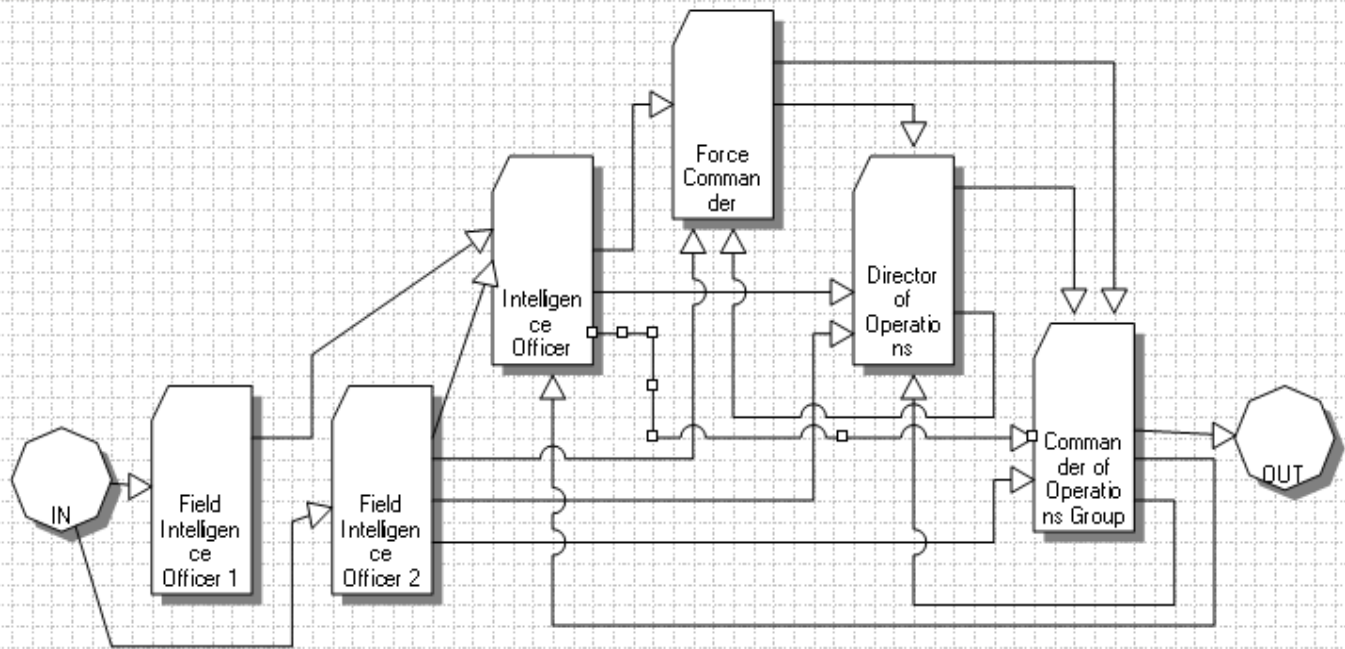
Link Properties

Please select all required interactions

- Interactions
- F: SA to IF**
 Fixed Variable
 - G: RS to SA**
 Fixed Variable
 - H: RS to IF**
 Fixed Variable
 - C: RS to CI**
 Fixed Variable



Design View Analysis View



Changed Layout



Start DMsLaid.cae

Solution Explorer

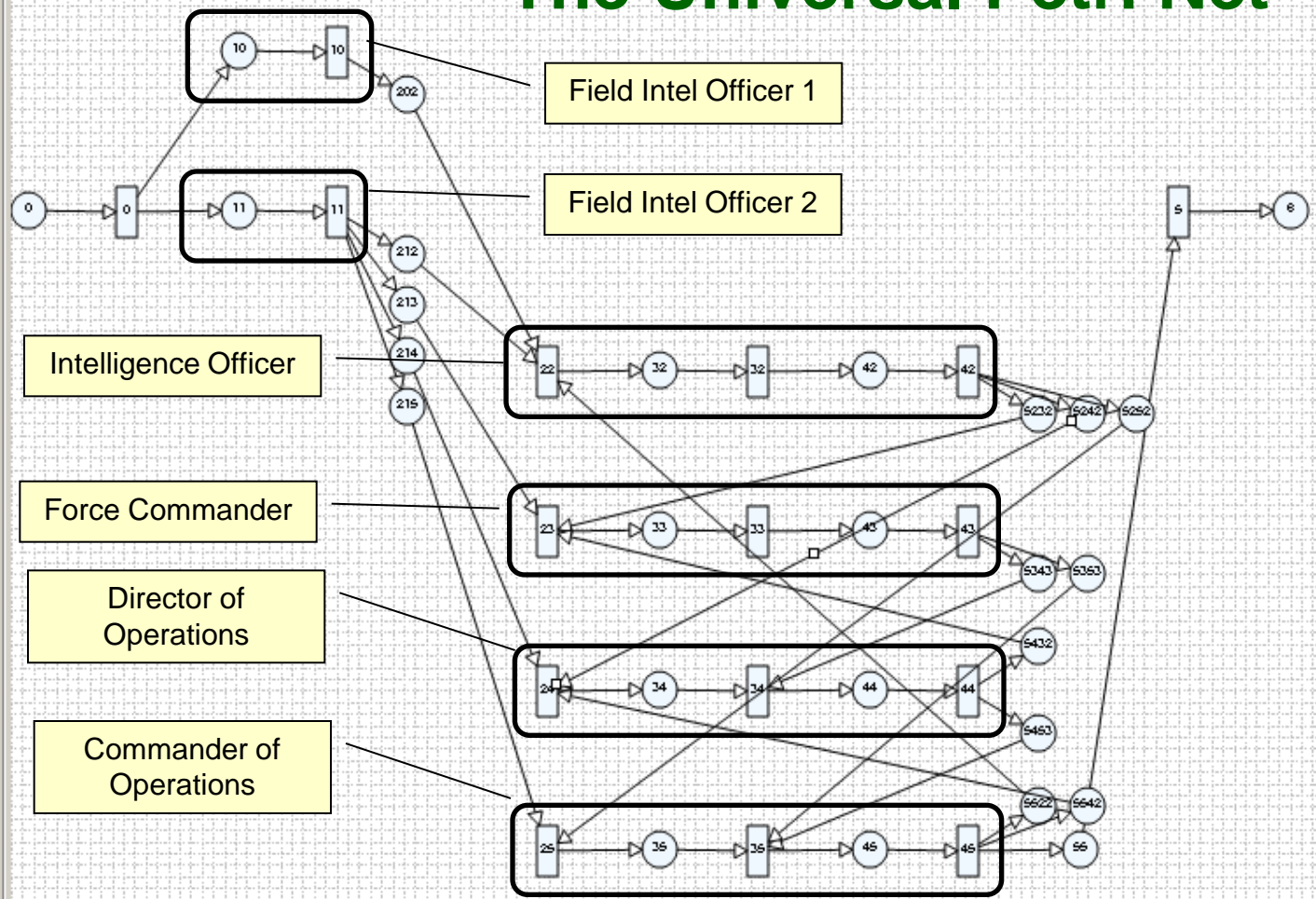
Build Universal Net and Kernel Net

Run Lattice

- Universal Net
- Simple Paths
- Circuits
- Kernel Net

Design View Analysis View

The Universal Petri Net



Universal Net Solution Space



Start DMSLaid.cae

Solution Explorer

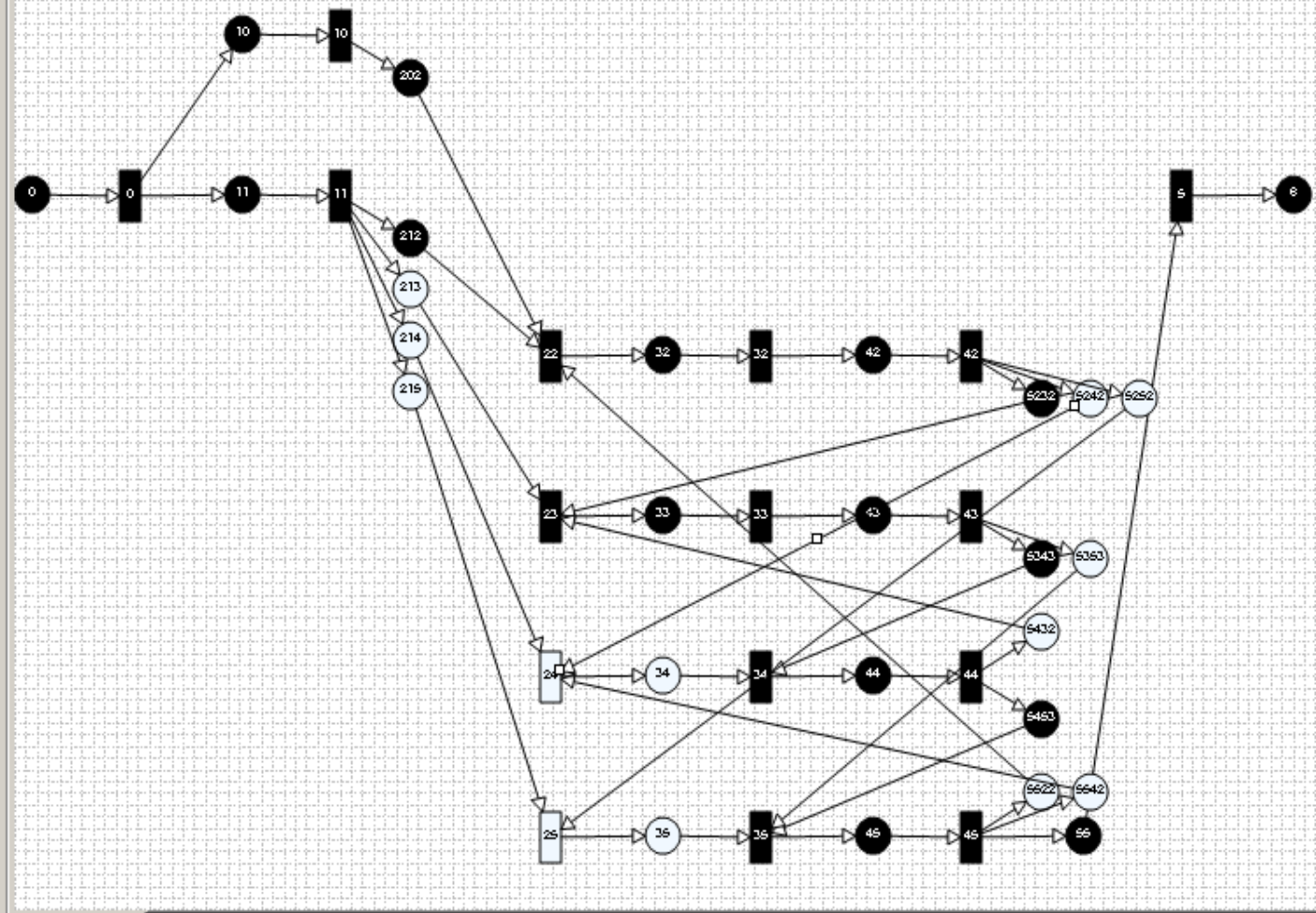
Build Universal Net and Kernel Net

Run Lattice

- Universal Net
- Simple Paths
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- Kernel Net

Design View Analysis View

The minimal Petri Net



Universal Net Solution Space



Start DMslaid.cae

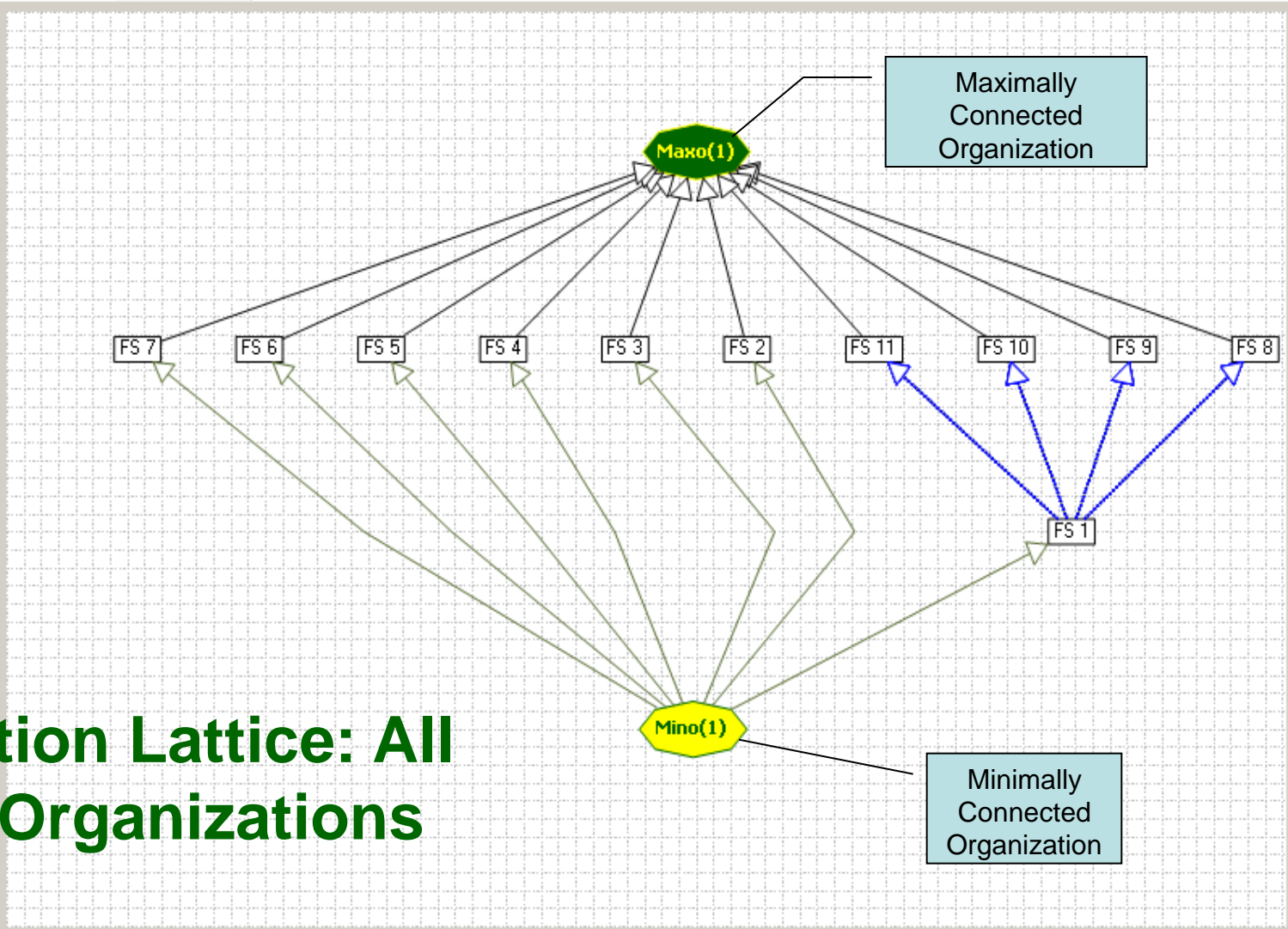
Solution Explorer

Build Universal Net and Kernel Net

Run Lattice

- [-] Universal Net
 - [+] Simple Paths
 - [+] Circuits
 - Kernel Net
 - Maxos
 - [+] (0,1,2,3,4,5,6,7,8,12,13,14)
 - Minos
 - [+] (4,5)
 - Lattice
 - [+] Lattice 1: Mino(1) » Maxo(1)
 - Solution Space

Design View Analysis View

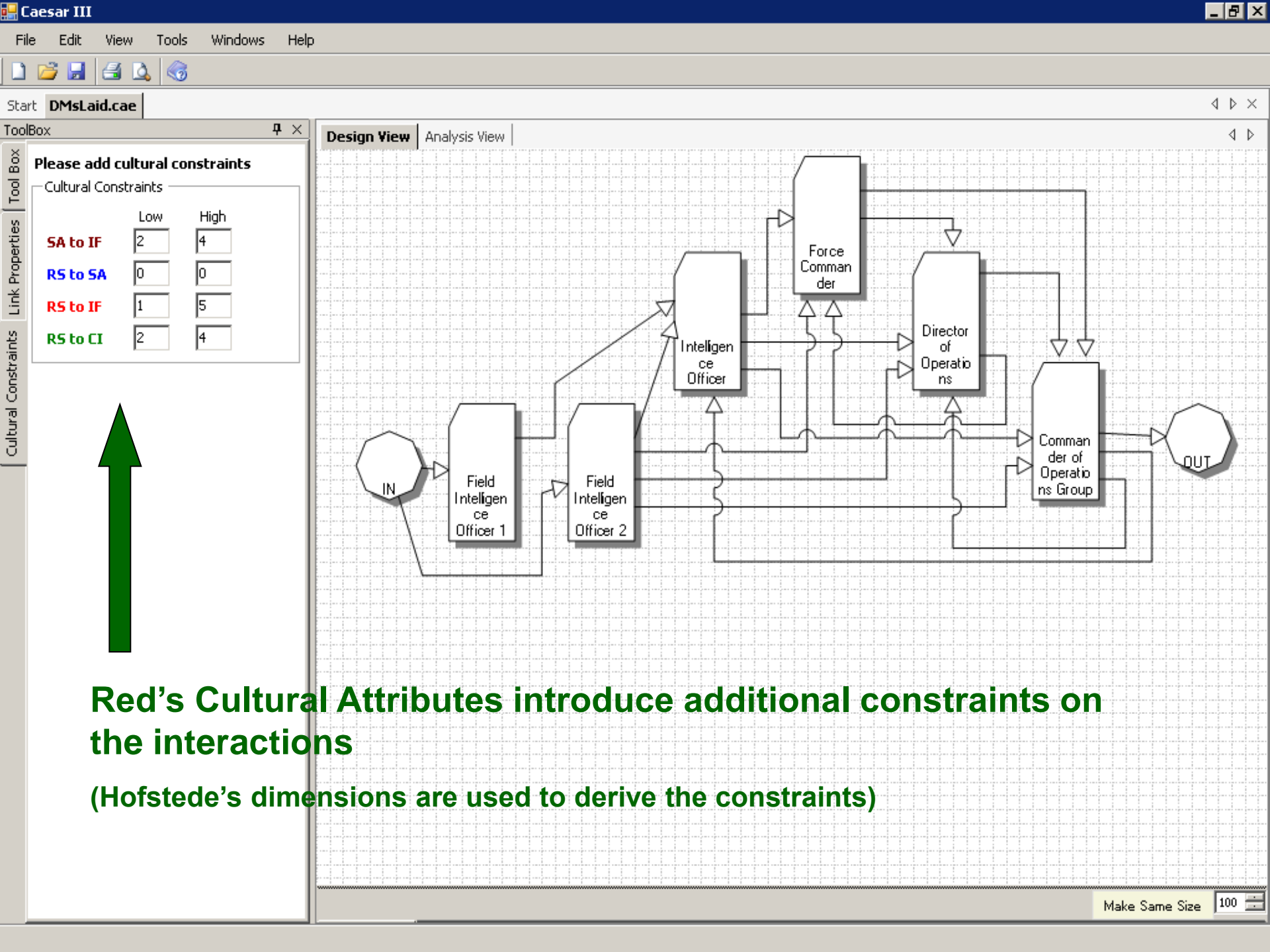


The Solution Lattice: All Feasible Organizations

Universal Net Solution Space

Apply CC Remove Expand

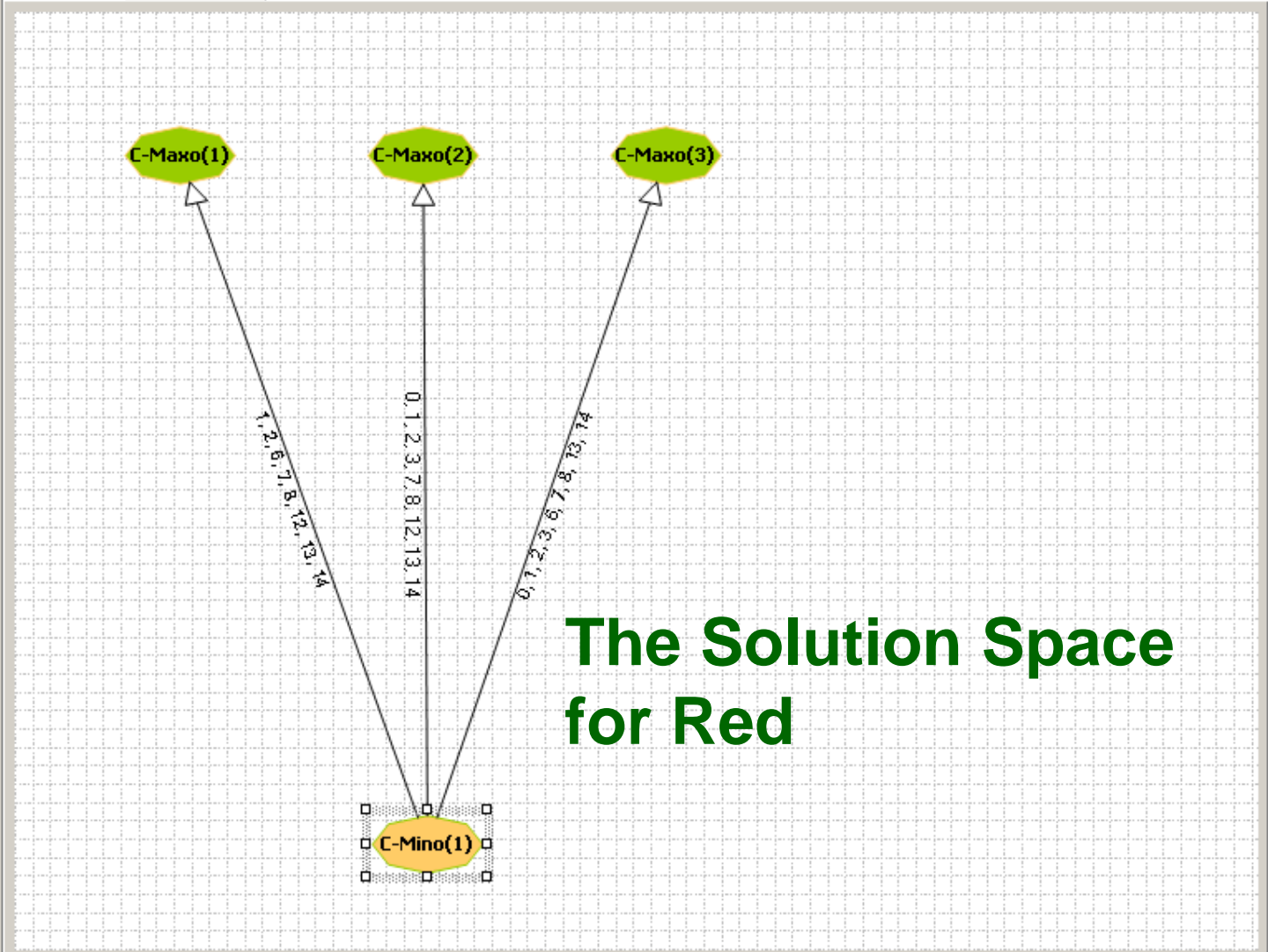
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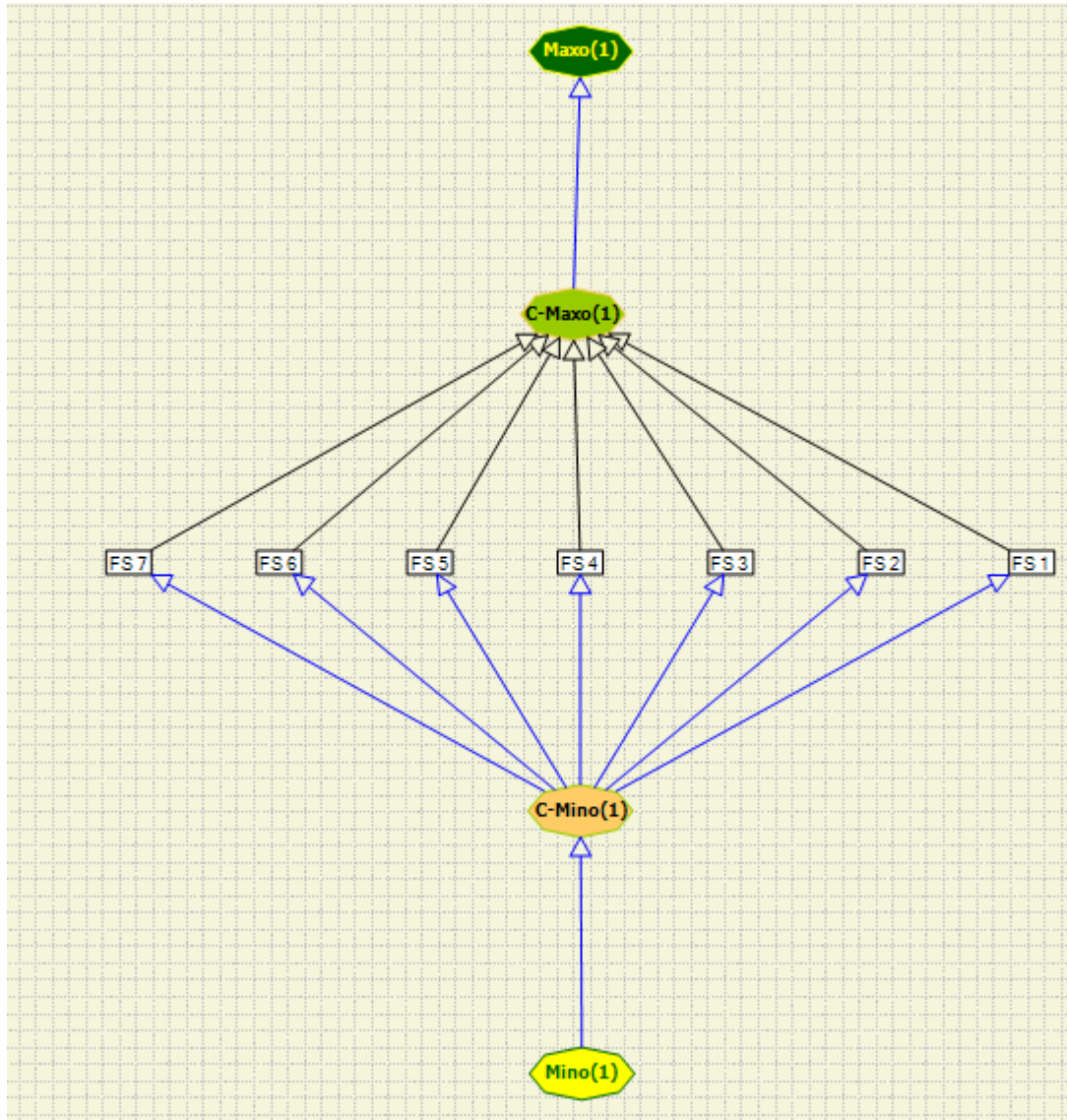
- Build Universal Net and Kernel Net**
- Run Lattice**
- Run C-Lattice**

- [-] Universal Net
 - [+] Simple Paths
 - [+] Circuits
- [-] Kernel Net
- [+] Maxos
- [+] Minos
- [+] Lattice
- [+] Solution Space
- [-] C-Maxos
 - [+] (1,2,4,5,6,7,8,12,13,14)
 - [+] (0,1,2,3,4,5,7,8,12,13,14)
 - [+] (0,1,2,3,4,5,6,7,8,13,14)
- [-] C-Minos
 - [+] (4,5)
- [+] C-Lattices
- [+] C-Solution Space

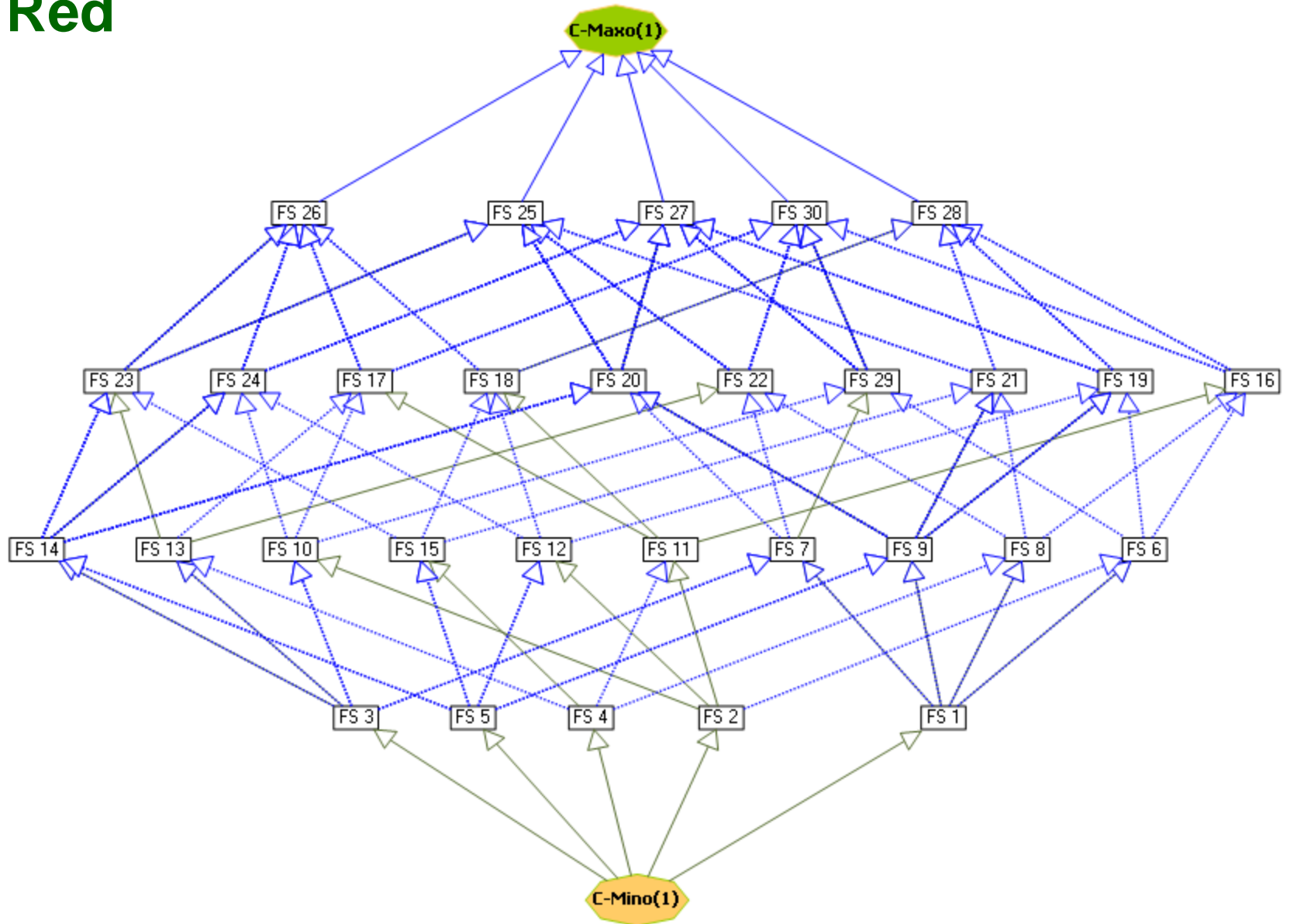


The Solution Space for Red

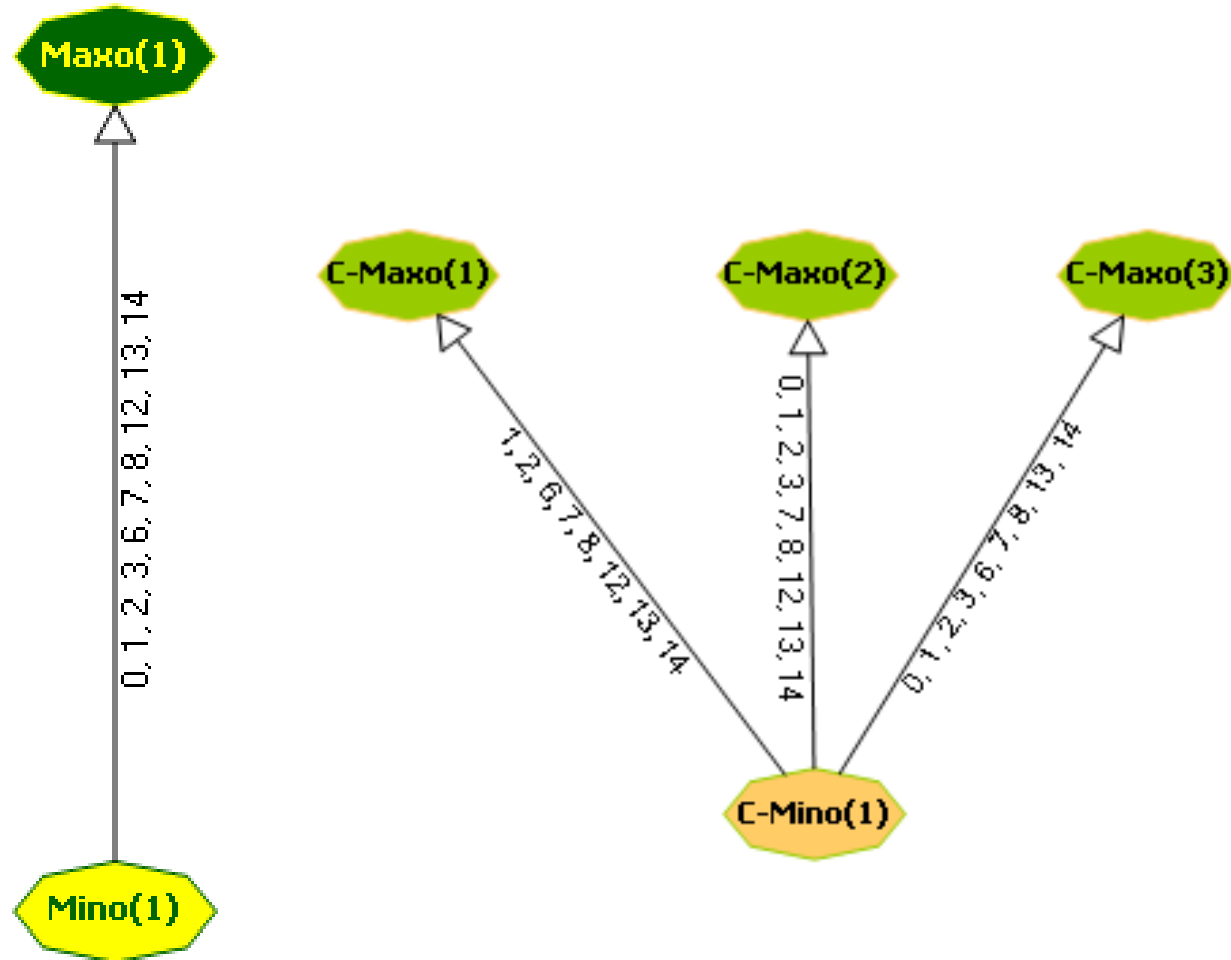
The Solution Lattice for Red

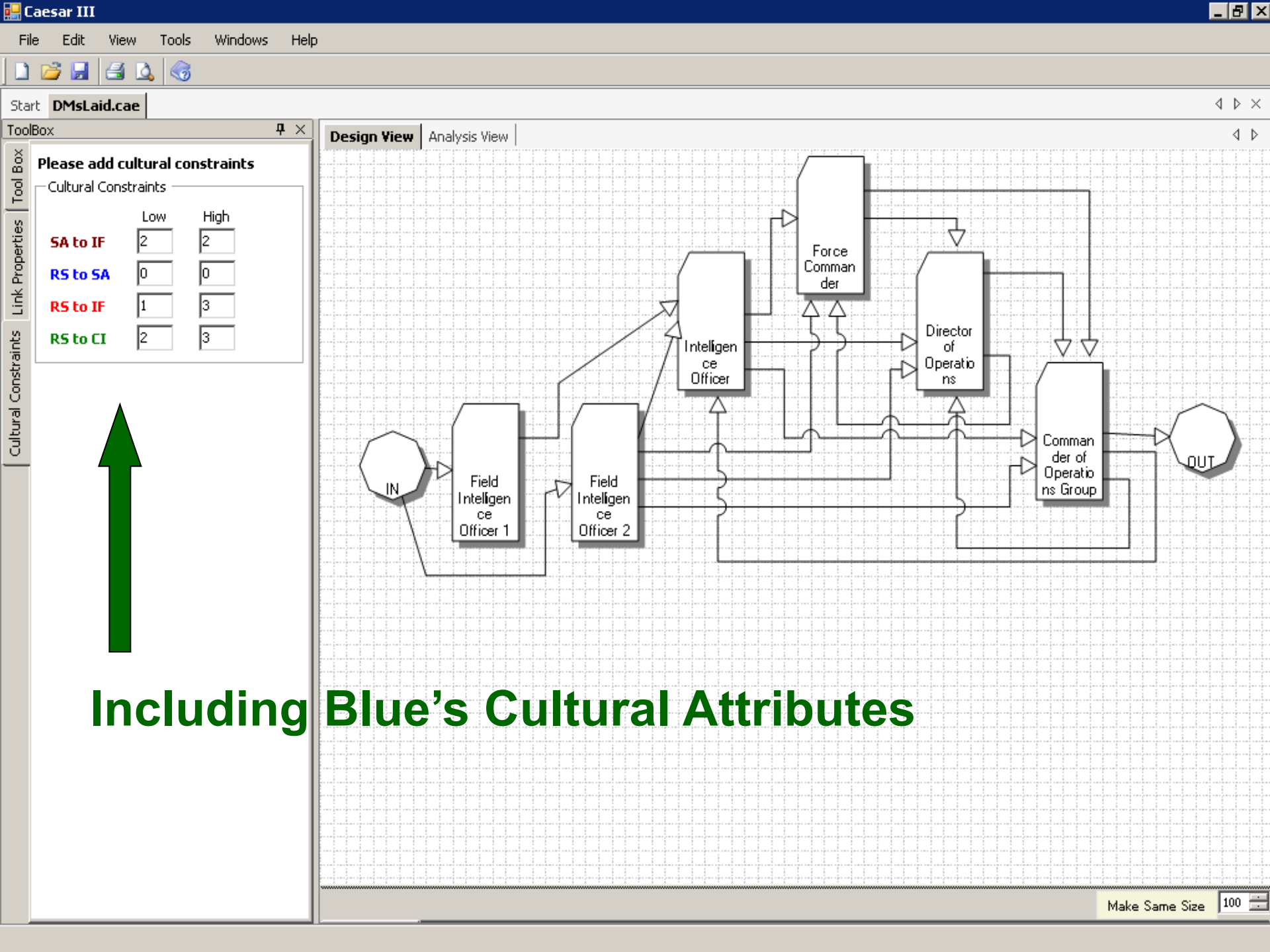


The Solution Lattice for Red



Comparison of Unconstrained and Red's Culturally Constrained solutions





Including Blue's Cultural Attributes



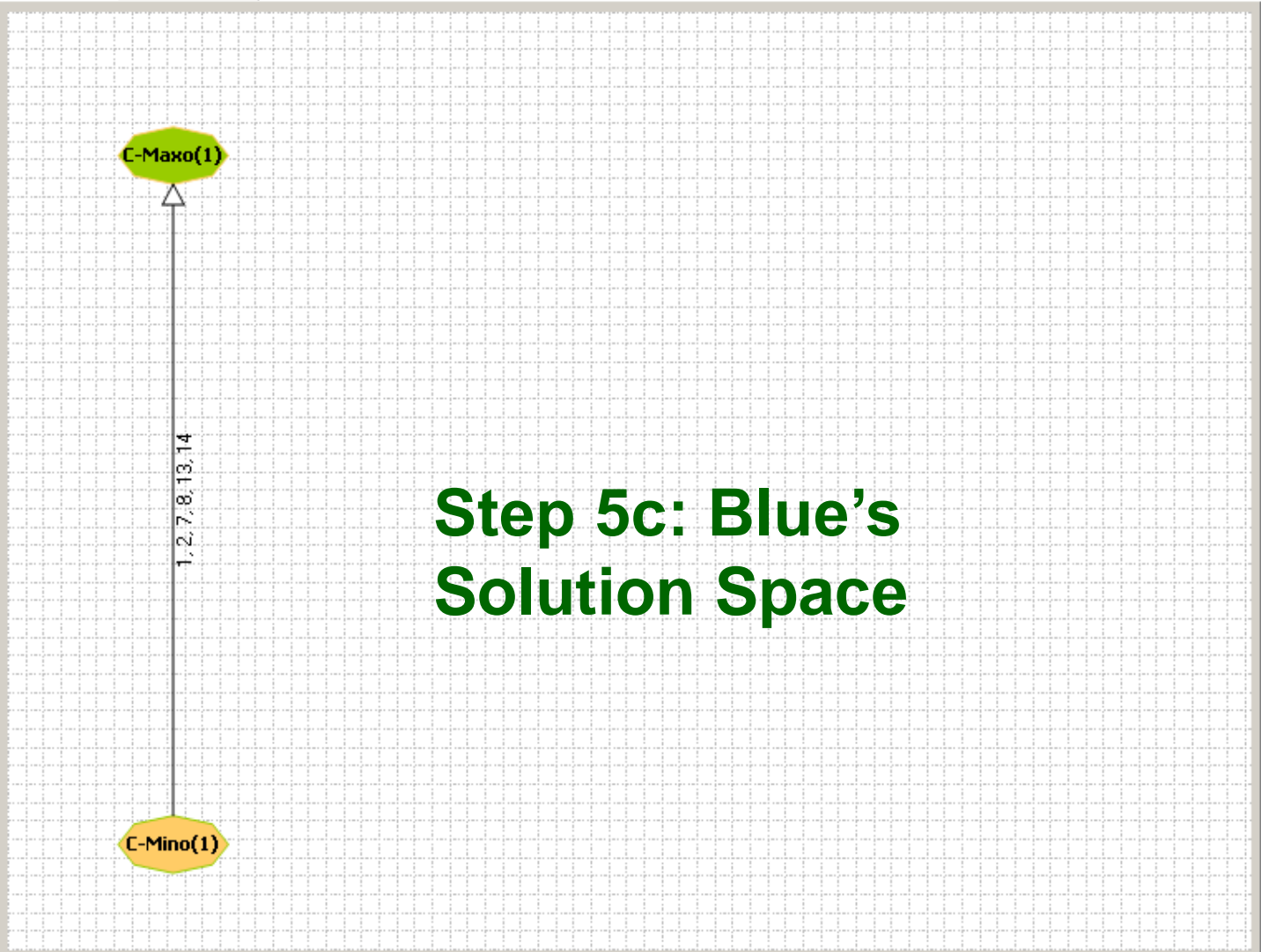
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Solution Explorer

- Build Universal Net and Kernel Net
- Run Lattice
- Run C-Lattice

- [-] Universal Net
 - [+] Simple Paths
 - [+] Circuits
- [-] Kernel Net
- [+] Maxos
- [+] Minos
- [+] Lattice
- [+] Solution Space
 - [+] C-Maxos
 - [+] (1,2,4,5,7,8,13,14)
 - [+] C-Minos
 - [+] (4,5)
 - [+] C-Lattices
 - [+] C-Solution Space

Design View Analysis View

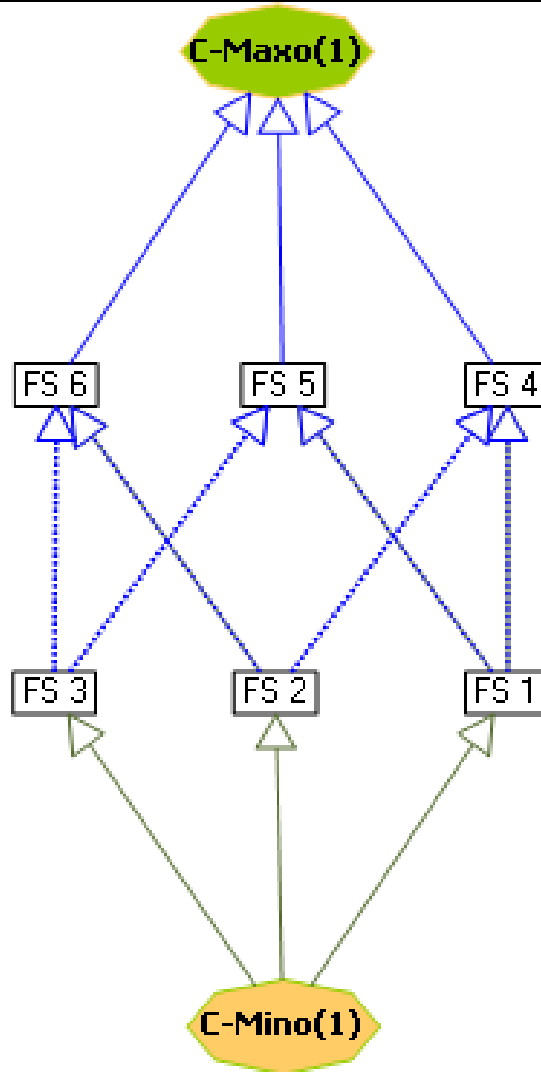


Step 5c: Blue's Solution Space

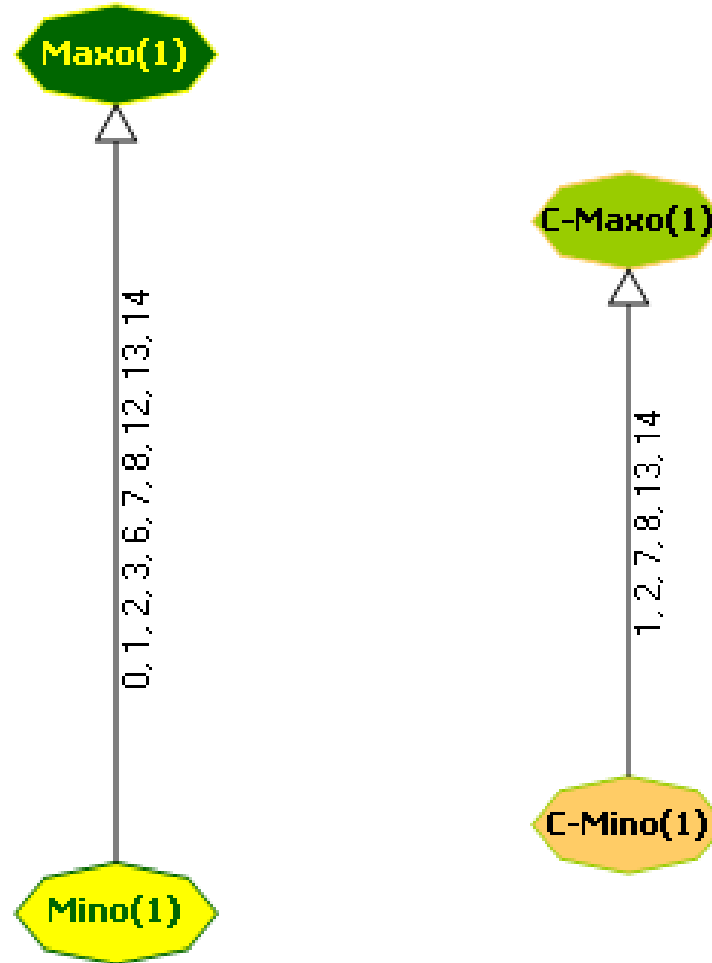
Universal Net Solution Space CC Solution Space

Apply CC Remove Expand

Make Same Size 100



Comparison of Unconstrained and Blue's Culturally Constrained solutions





- The different solution spaces for the two cases show that cultural attributes do affect the structure of the organization.
- They can provide valuable insight into possible structures that may be used by an adversary.
- The common interactions in the C-MINOs can be used to identify the high value ISR targets.
- Metrics from Social Network Analysis can indicate the strength of the relationships; the organizational structure can inform the Social Network of the types of interactions between network nodes.