Is a Bespoke Design for Multi-Domain C2 Necessary?

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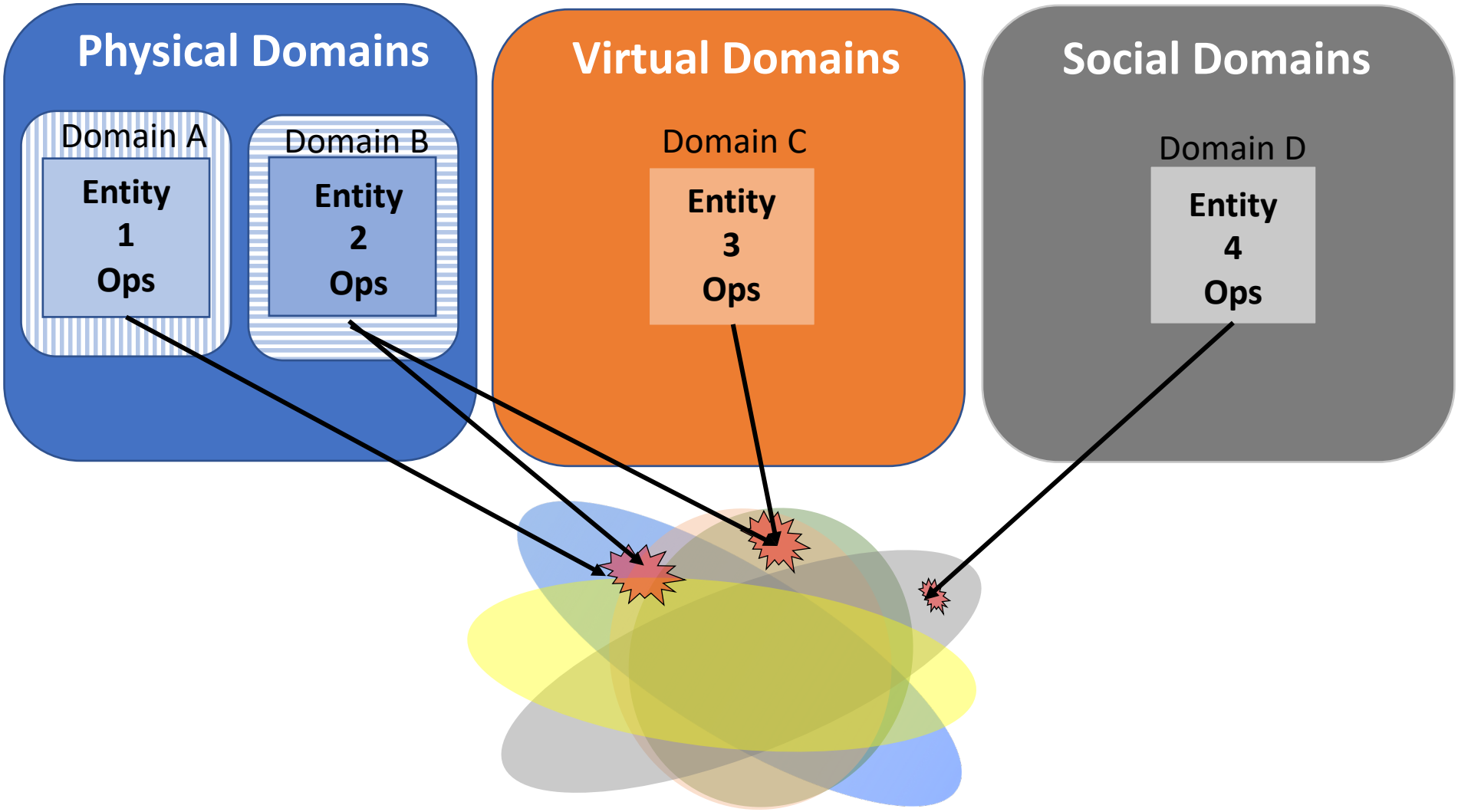
Agenda

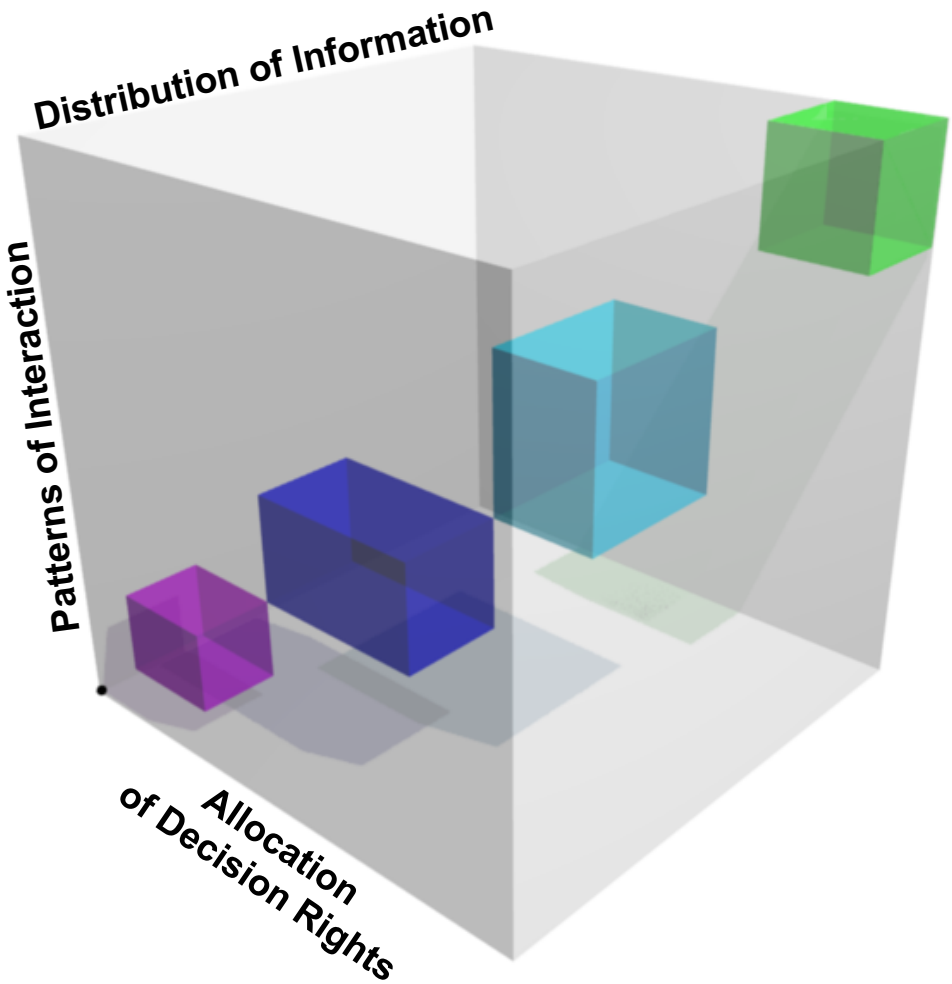
- Nature of Multi-Domain Operations
- C2 Approach Space
- Multi-Domain C2
- Multi-Domain C2-Harmonization Arrangements Space
- “Off the Shelf” v. “Bespoke”
- Methodology
- Research Findings
- Conclusions

Multi Domain Operations



Effects Space Dimensions

Entity C2 Approach Space



Multi-Domain C2 (MDC2)

Multi-Domain C2 seeks to
avoid conflicts and enable synergies
within, between, and among entities
conducting operations in multiple domains, and
the effects that these operations create

Multi-Domain C2 involves both

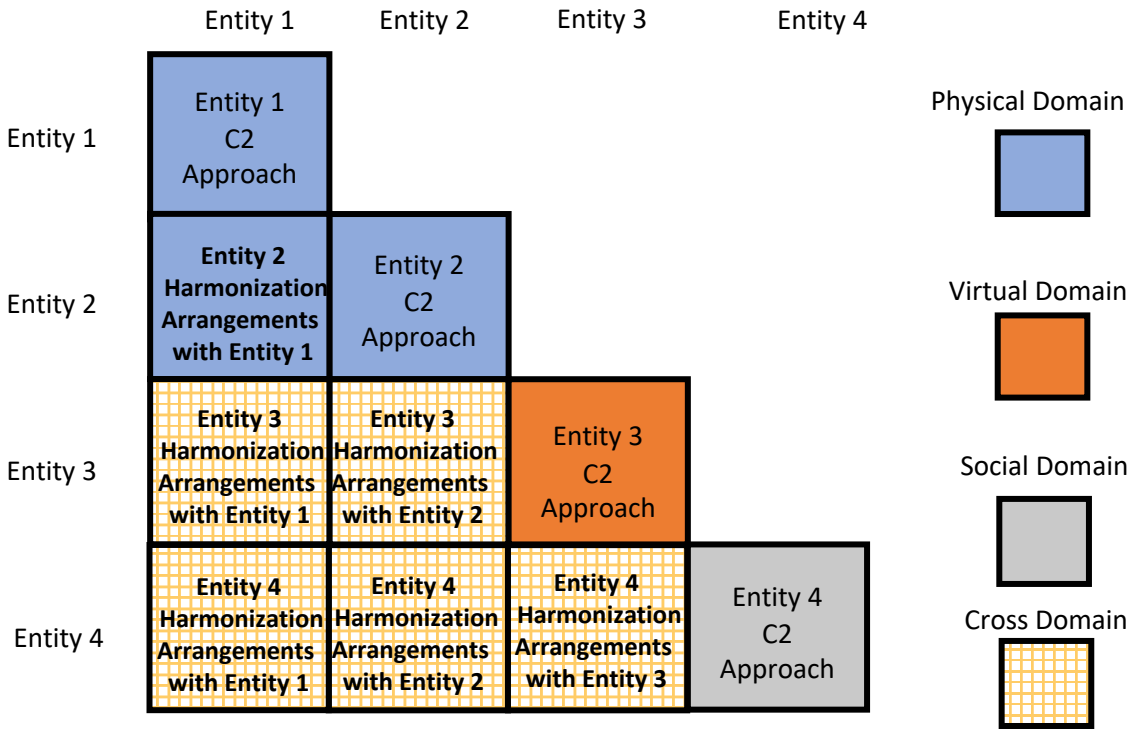
- C2 Approaches that are adopted by each of the entities in each of their operating domains

- the Harmonization Arrangements that govern behaviors between and among the set of entities participating in a MDO

Multi-Domain C2-Harmonization Arrangements Space

Multi-Domain C2-H Arrangement

- Entity Domain Operations C2 Approaches
- Within Domain Harmonization Arrangements
- Entity Cross-Domain Harmonization Arrangements

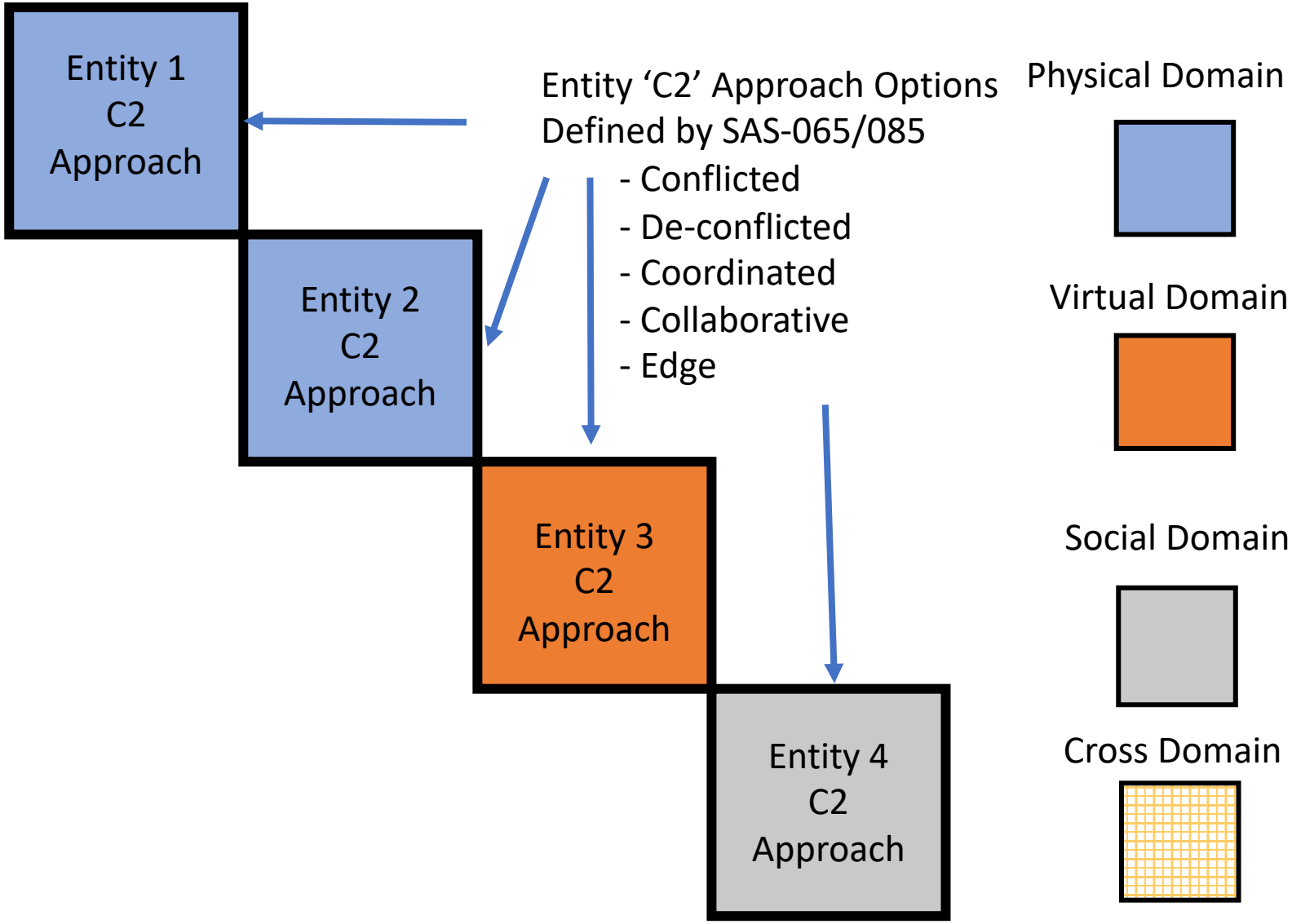


Multi-Domain C2 (MDC2)

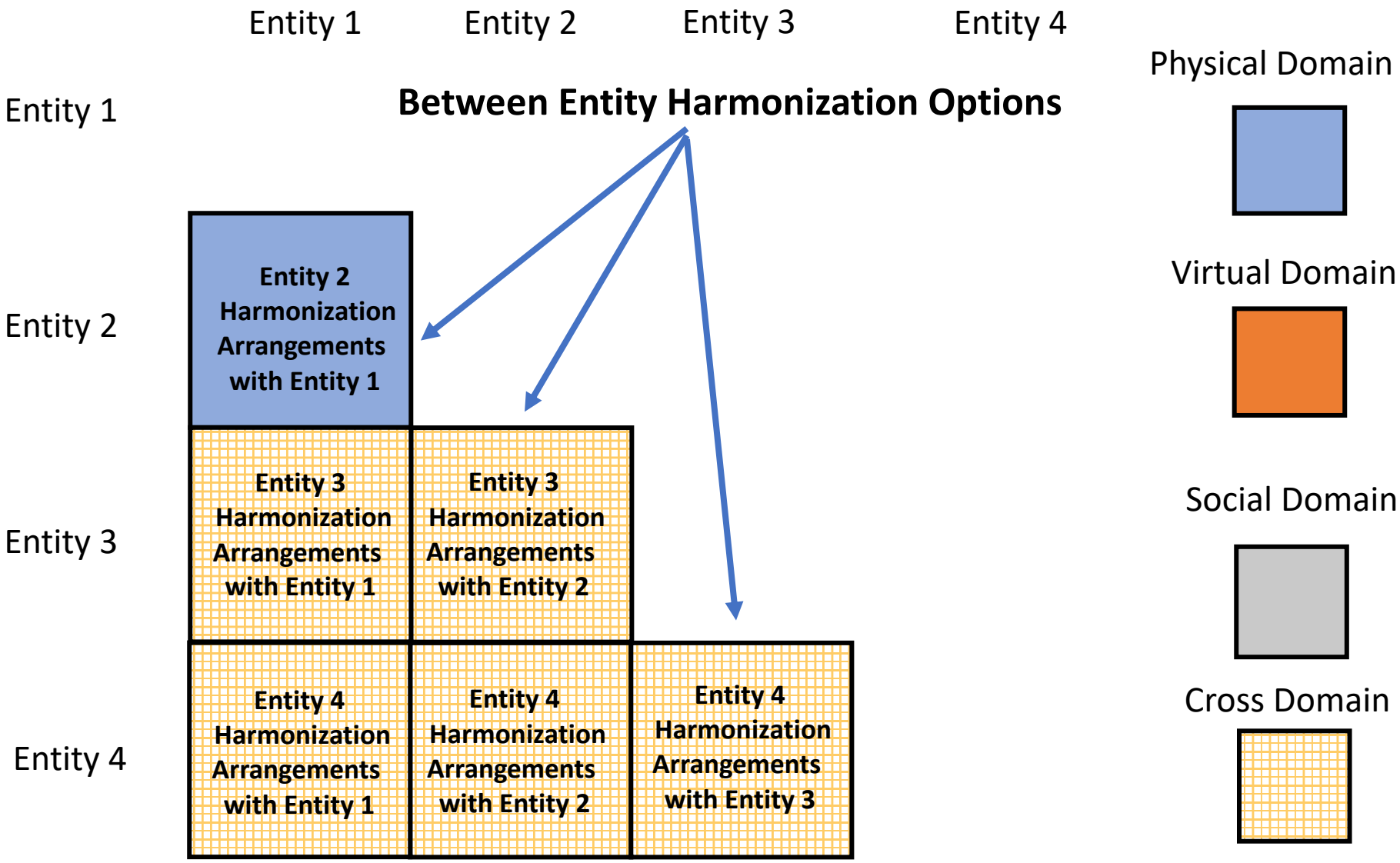
- Goal: find a MDC2 Approach such that operations conducted by different types of entities are collectively as effective, efficient, and agile as is appropriate given the MDO

- Hypotheses: The most appropriate entity-domain approaches to C2 cannot be determined without considering the nature of the MDO and the participating partners (requires a holistic design)

Entity C2 = Diagonal of the MDC2 Arrangements Space

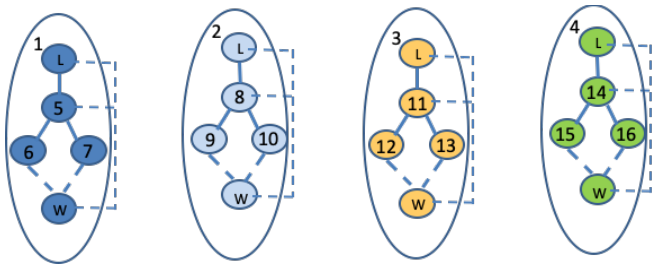


Off-Diagonal Options of the MDC2 Arrangements Space

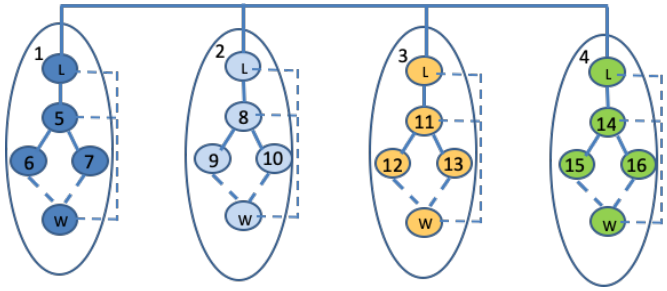


‘Off-the-Rack’ MDC2-H Arrangements

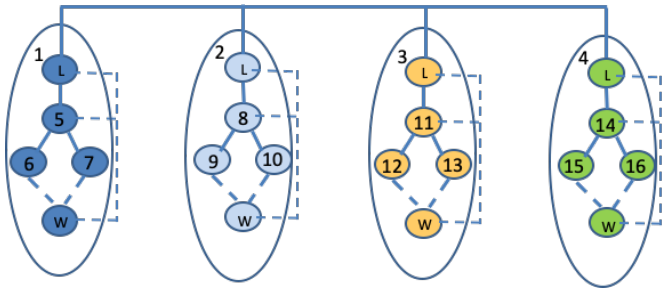
Hierarchy – Level 0



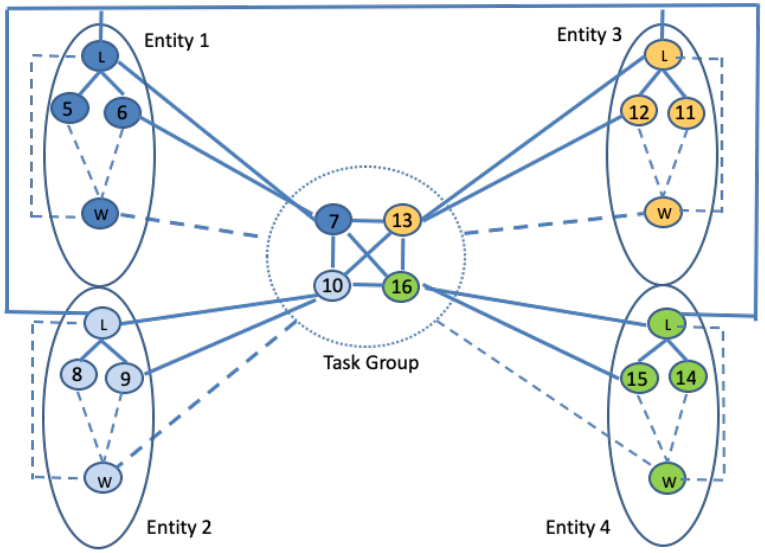
Hierarchy – Level 1



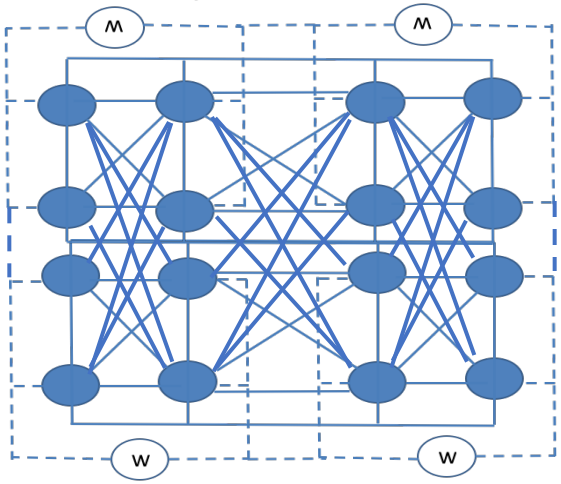
coordinated – Level 2



Collaborative – Level 3



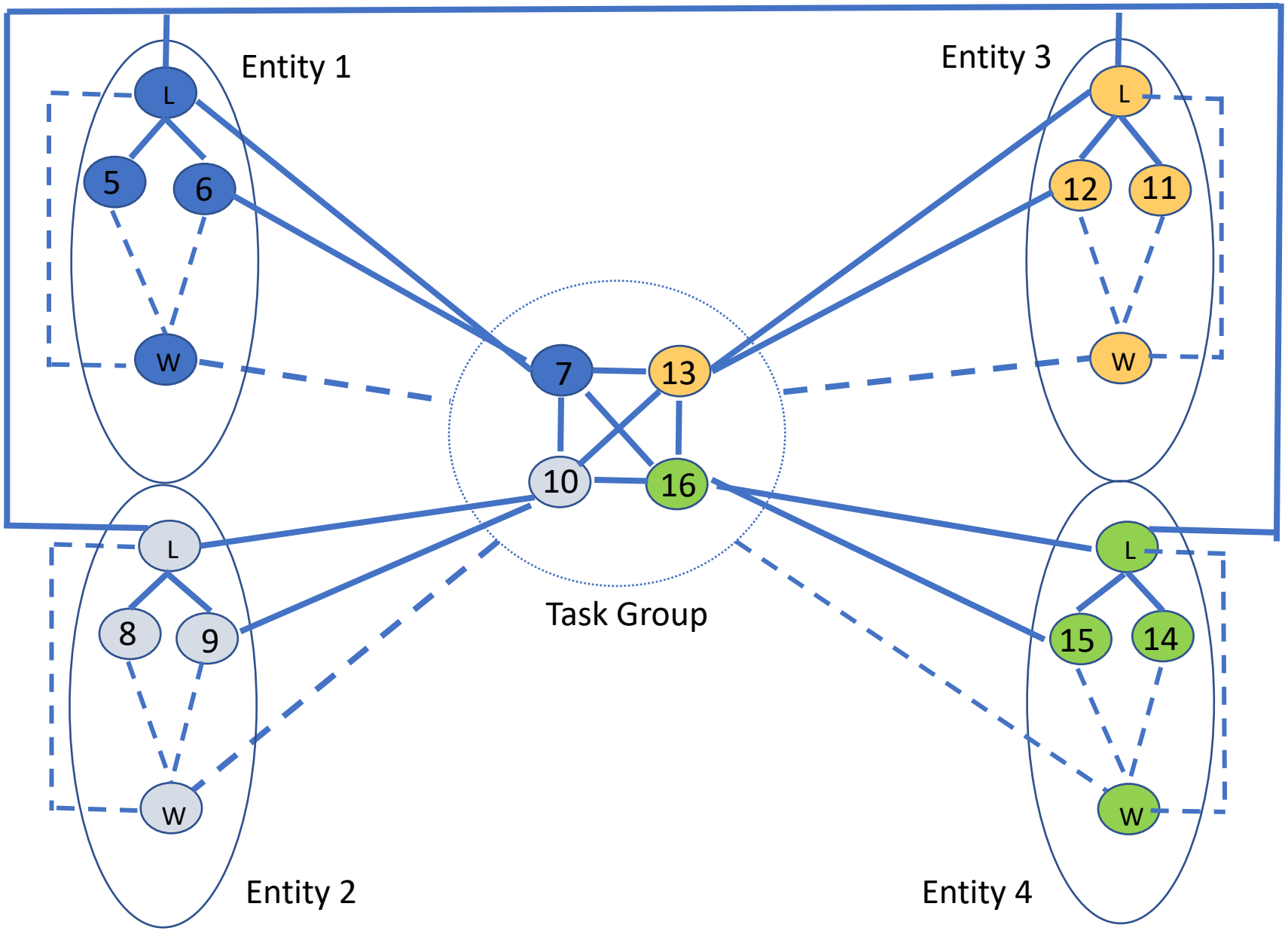
Edge – Level 4



MDC2/H Arrangement CCCC333333-1

	Entity 1	Entity 2	Entity 3	Entity 4
Entity 1	C			
Entity 2	3	C		
Entity 3	3	3	C	
Entity 4	3	3	3	C

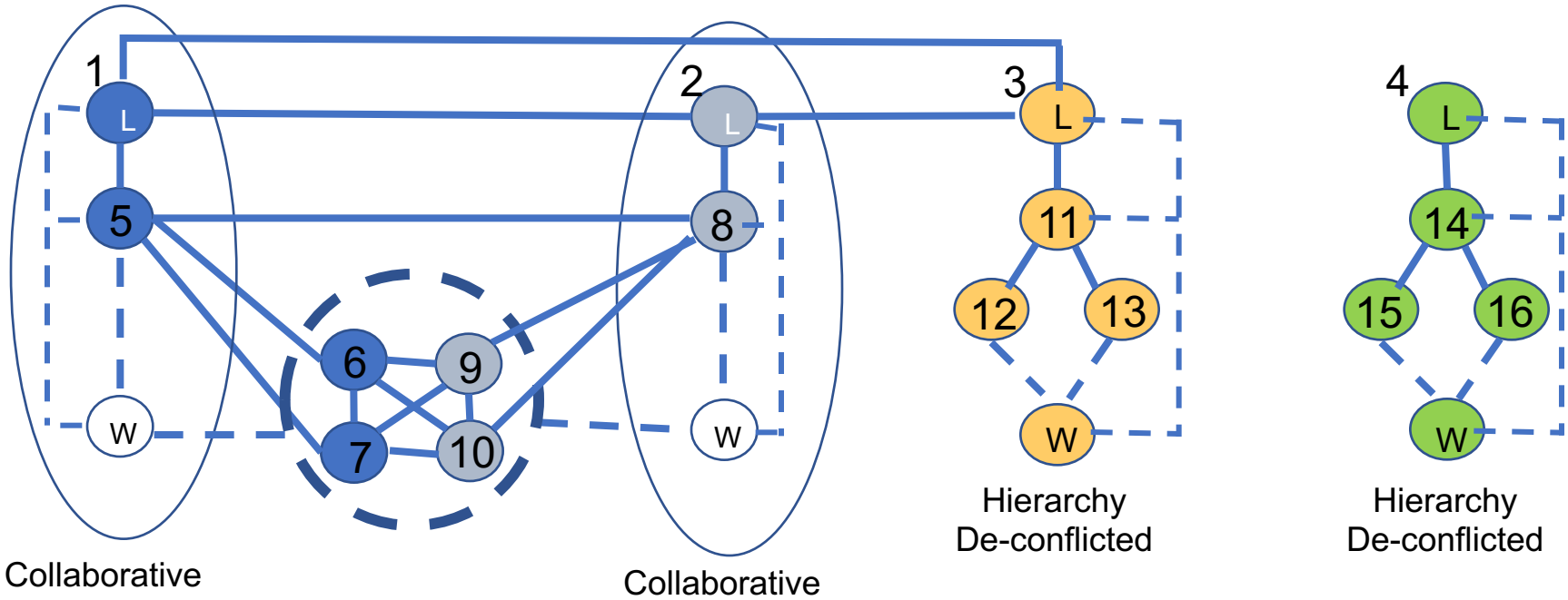
“Off-the-Shelf” CCCC333333-1



Bespoke CCHH313000

	Entity 1	Entity 2	Entity 3	Entity 4
Entity 1	C			
Entity 2	3	C		
Entity 3	1	3	C	
Entity 4	0	0	0	C

A Bespoke MDC2-H Arrangement



Scenario 8
most challenging scenario

Dependencies (High)
- Shared Situation Awareness required <u>across</u> dependent entities
- Significant amount of non-organic information required by entities
- Planning and/or Operations undertaken by different entities in the same or different domains are constrained or sequenced
- The effects created by an operation in one domain impacts the success of an operation in another domain one domain (success dependencies)

Dynamics (High)
- Less time available to complete plan – operation

Complexity (High)
- Extra time required to plan and execute
- More Situation Awareness <u>within</u> entities are required to plan and execute
- Extra time required for to 'think' – perform required cognitive tasks
- Small amount of non-organic information required
- Requires more effort to extract necessary information (a lot of noise)

Baseline Results (All Humans – No Cyber Damage)

Baseline Scenarios (Dynamics, Complexity, Dependencies)

MDC2/H Arrangement	1 (G) LLL	2 (H) HLL	3 (E) LLH	4 (F) HLH	5 (C) LHL	6 (D) HHL	7 (A) LHH	8 (B) HHH
Hierarchy Level 0	31.7	31.7	A	A	A	A	A	A
Hierarchy Level 1	31.7	31.7	A	A	A	A	A	A
coordinated Level 2	31.9	31.9	A	A	A	A	A	A
Collaborative 1 Level 3	39.2	39.2	A	A	121.5	T	A	A
Collaborative 2 Level 3	33.4	33.4	47.1	47.1	183.1	T	A	A
Edge Level 4	43.3	43.3	46.9	46.9	77.5	T	127.5	T

T Lacks timeliness

A Lacks sufficient shared awareness

Satisfies all constraints and exceeds all success criteria

Bespoke MDC2 Arrangement Results

(All Humans – No Cyber Damage)

Baseline Scenarios (Dynamics, Complexity, Dependencies)

MDC2/H Arrangement	1 (G) LLL	2 (H) HLL	3 (E) LLH	4 (F) HLH	5 (C) LHL	6 (D) HHL	7 (A) LHH	8 (B) HHH
Bespoke	49.1	49.1	A	A	A	A	A	A

T Lacks timeliness

A Lacks sufficient shared awareness

Satisfies all constraints and exceeds all success criteria

“Real World #1” Results

(All Humans – No Cyber Damage)

“Real World” Scenario (Dynamics, Complexity, Dependencies)

MDC2/H Arrangement	3 (E) LLH	4 (F) HLH	5 (C) LHL	6 (D) HHL	7 (A) LHH	8 (B) HHH
Bespoke #1	52.7	52.7	101.3	T	A	A
coordinated Level 2	A	A	A	A	A	A
Collaborative 1 Level 3	A	A	218.6	T	A	A
Collaborative 2 Level 3	A	A	206.4	T	A	A
Edge Level 4	55.0	55.0	180.3	T	114.4	T

T Lacks timeliness

A Lacks sufficient shared awareness

Satisfies all constraints and exceeds all success criteria

Conclusions

- It is possible to design a “Bespoke” MDC2-H Arrangement that is both more effective and efficient than any “off-the-shelf” arrangement for almost all of the scenarios
- Entities should consider developing a capability to operate at different harmonization levels with different partners
- These levels should reflect how dependent their domain operations are upon each partner’s information or operations.