The 21st Annual National Test & Evaluation Forum

Sponsored by the National Defense Industrial Association Test & Evaluation Division

March 9, 2005

Prosecuting T&E Using the Missions & Means Framework

Held at The Westin Charlotte, Charlotte, NC, 7-10 March, 2005.

Agenda

Introduction by Dr. Paul H. Deitz§:

- **Dr. Paul J. Tanenbaum‡ & LTC(R) Britt E. Bray†:**
  The Missions and Means Framework: Linking MDMP with DOTMLPF Solutions

- **Max Lorenzo#, Richard Cozby#:**
  The Missions and Means Framework in Support of Test and Evaluation

- **Ron Smits† & John Kearley†:**
  Testing in a Joint Environment, a Case Study

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‡ US Army Research Laboratory, Survivability/Lethality Analysis Directorate
† Dynamics Research Corporation # US Army Developmental Test Command

The Missions and Means Framework: Linking MDMP with DOTMLPF Solutions

Presentation at 21st Annual National Test & Evaluation Forum

9 March 2005

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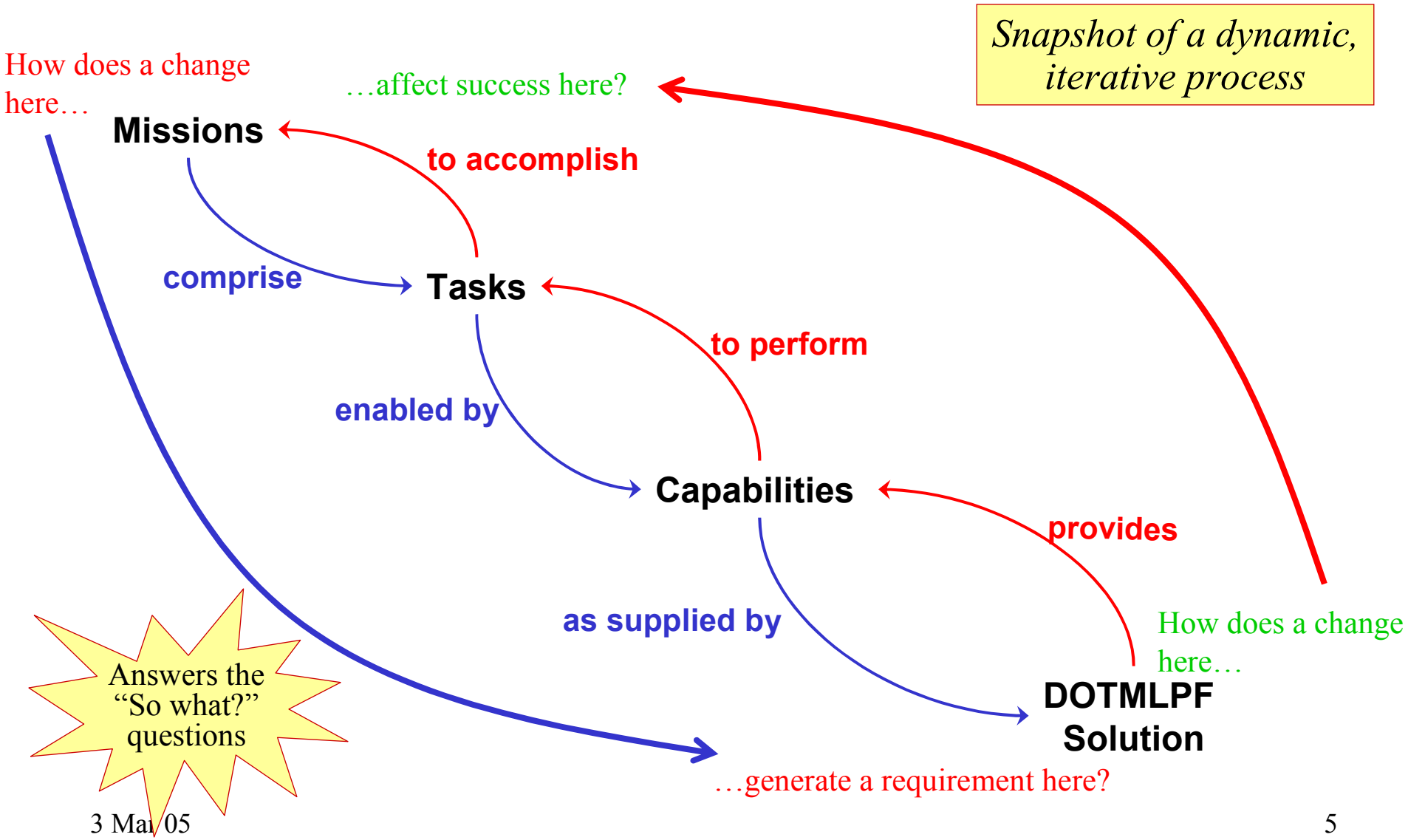
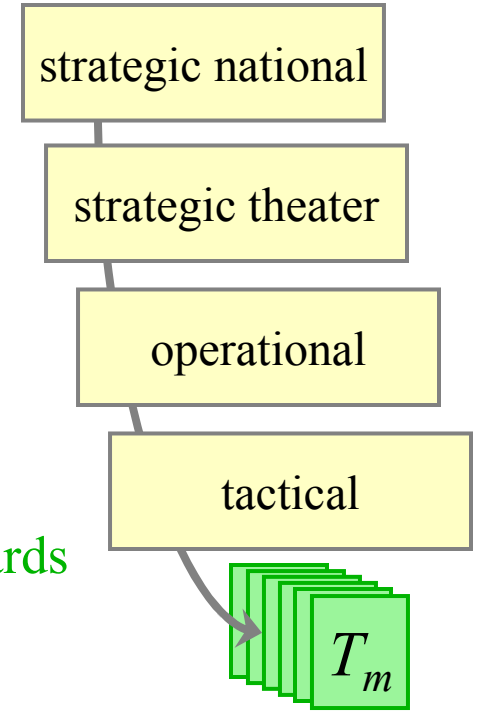
Problem statement

- Current reality is that DOTMLPF requirements are…
  - — based on, but not explicitly traceable to mission;
  - — not described in context of contribution to JFC mission;
  - — originated in human-readable form and then translated into machine-readable form at great cost in time, money, and accuracy;
  - — hard for the non-warfighter to follow because it leaves implicit much knowledge and procedure.
- Developing a complex system of systems requires tackling…
  - — effectiveness, suitability, and survivability in terms of the contributions of individual parts to the whole; and
  - — effectiveness of the whole in accomplishing assigned operational missions in the context of joint operating concepts.

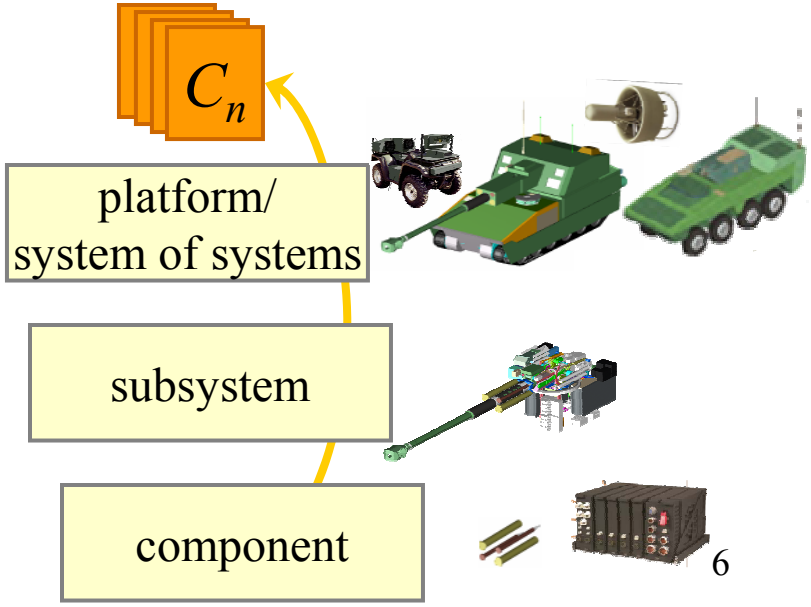
The MMF-Based Solution



Missions and Means Framework

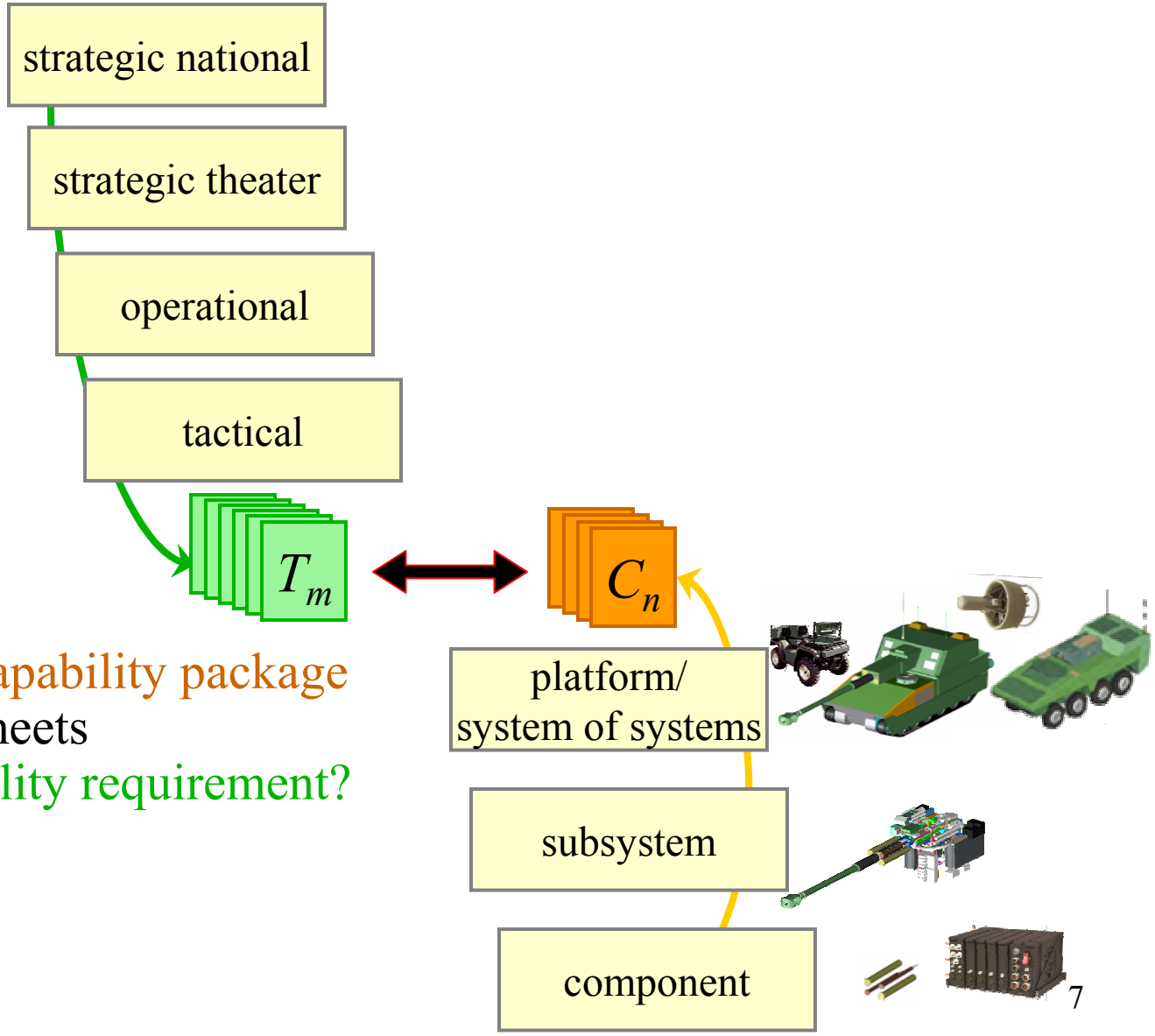


Mission hierarchy
induces
tasks, conditions, standards



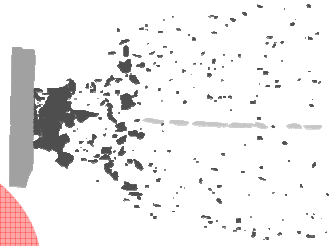
Hardware hierarchy
induces
capabilities

Missions and Means Framework



Is this a mission capability package
that meets
the mission capability requirement?

The venerable vulnerability/lethality "taxonomy"



Interactions

physics,
penetration models, ...

Component status

engineering,
criticality analysis, ...

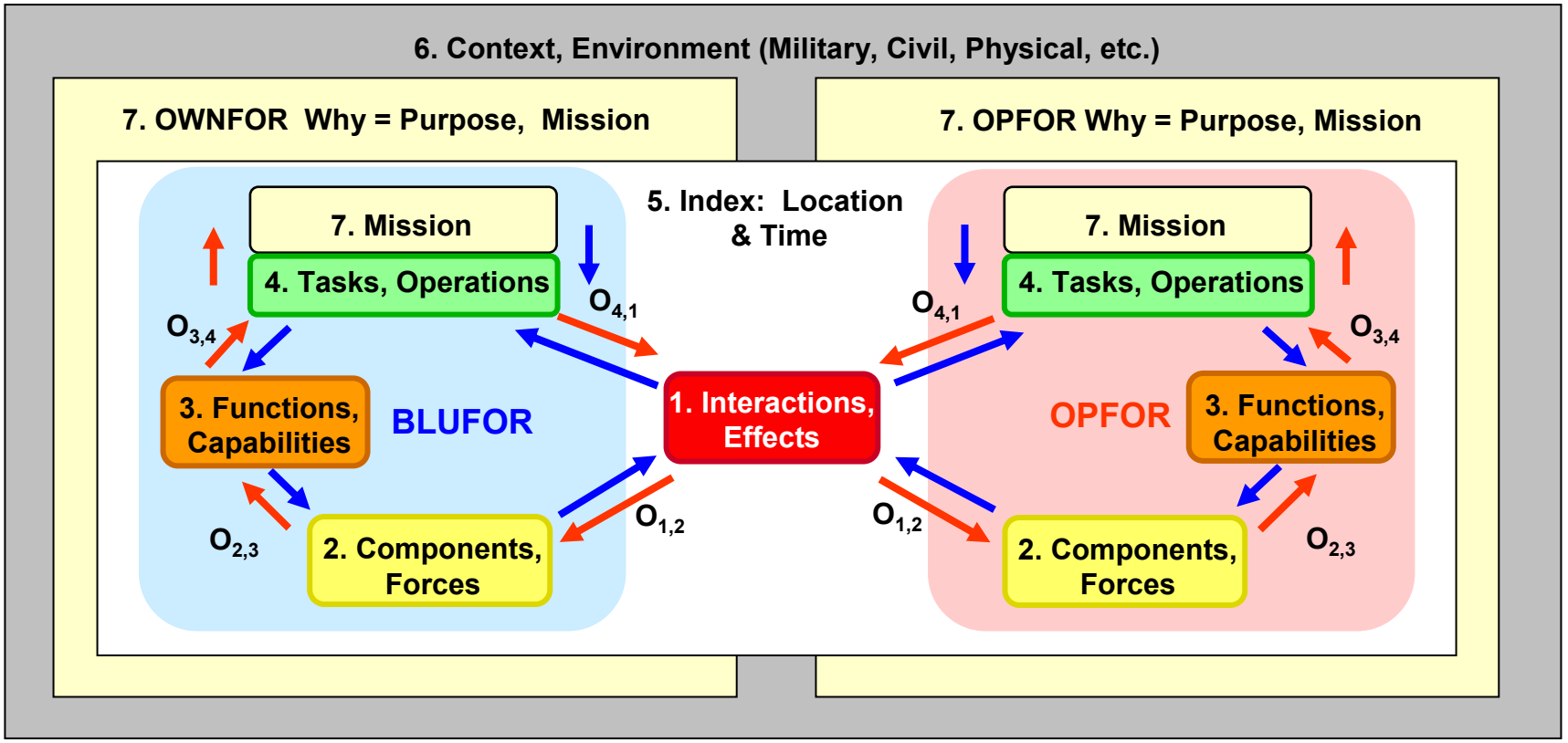
Capability status

operations research,
missions, scenarios, ...

Task-success status

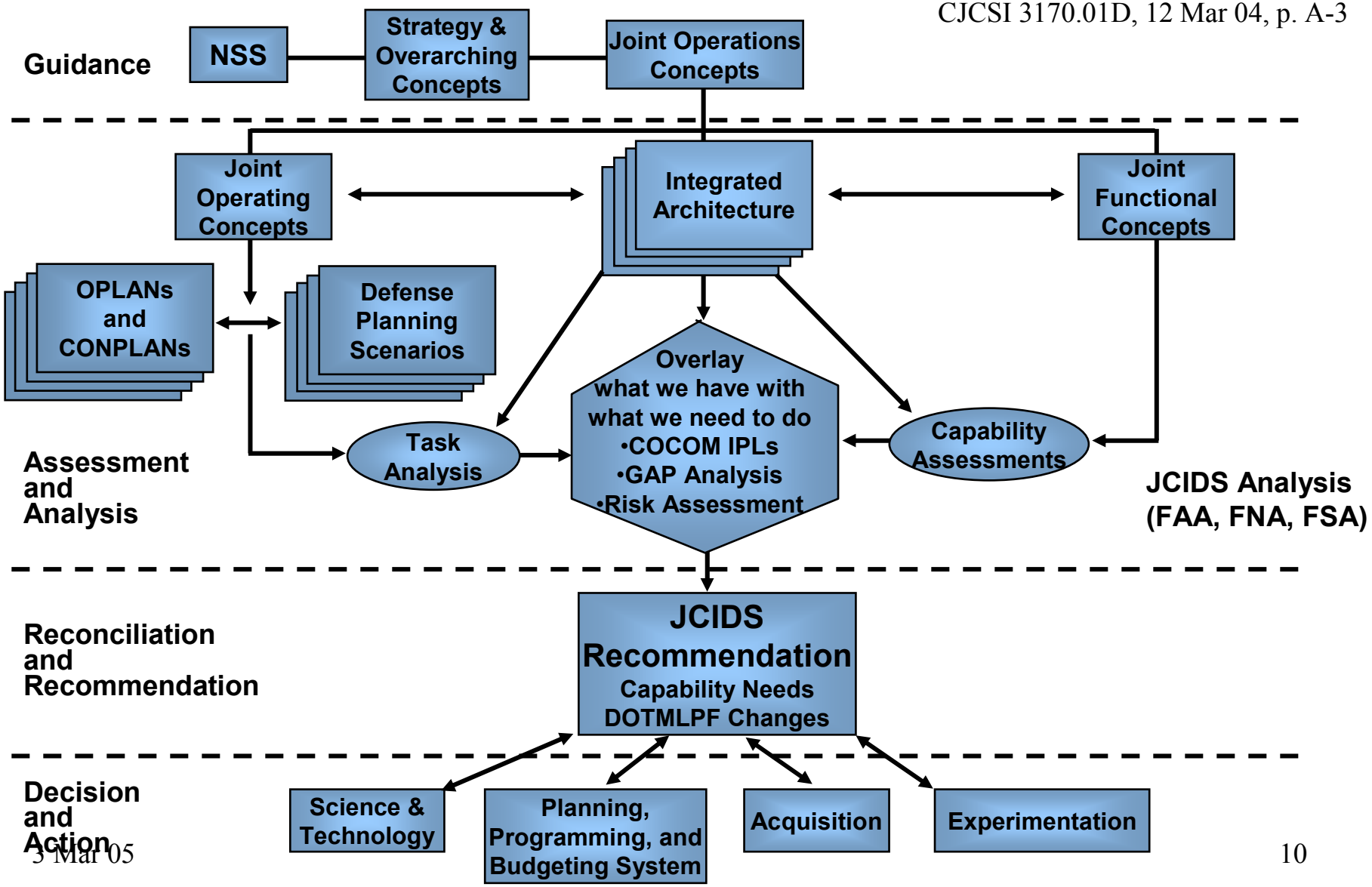
Missions and Means Framework

11 Fundamental Elements: 7 levels, 4 operators

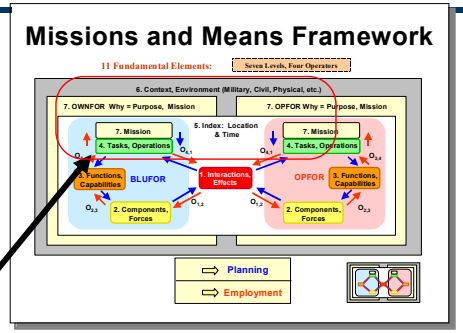


Joint Capabilities Integration and Development System (JCIDS)

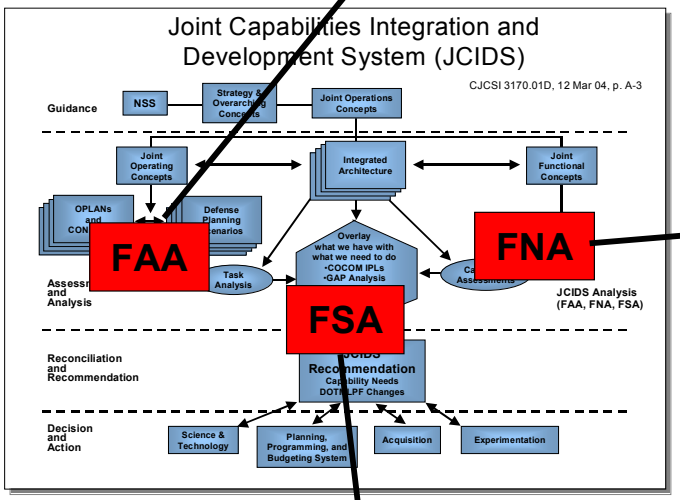
CJCSI 3170.01D, 12 Mar 04, p. A-3

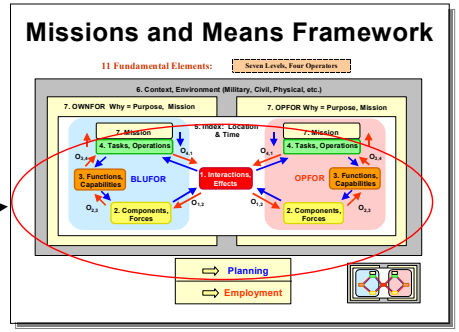


MMF Provides a Way to Implement JCIDS

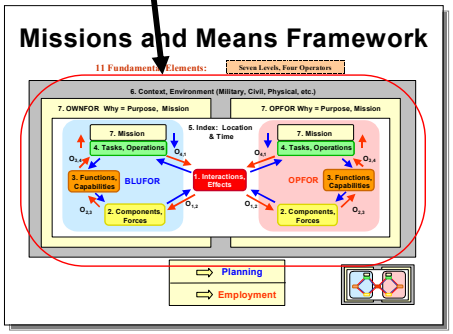


Functional Area Analysis = MMF Levels 7-4 documents operational tasks, conditions and standards needed to achieve military objectives contained in OPLANs/CONLANs and Defense Planning Scenarios. (Planning)





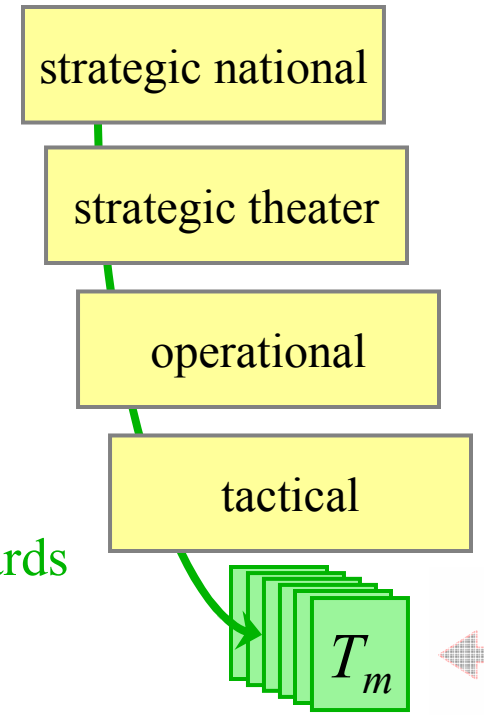
Functional Needs Analysis = MMF Levels 4-1 Compares current capabilities provided by Joint Functional Concepts to FAA derived required capabilities to identify gaps. (Planning)

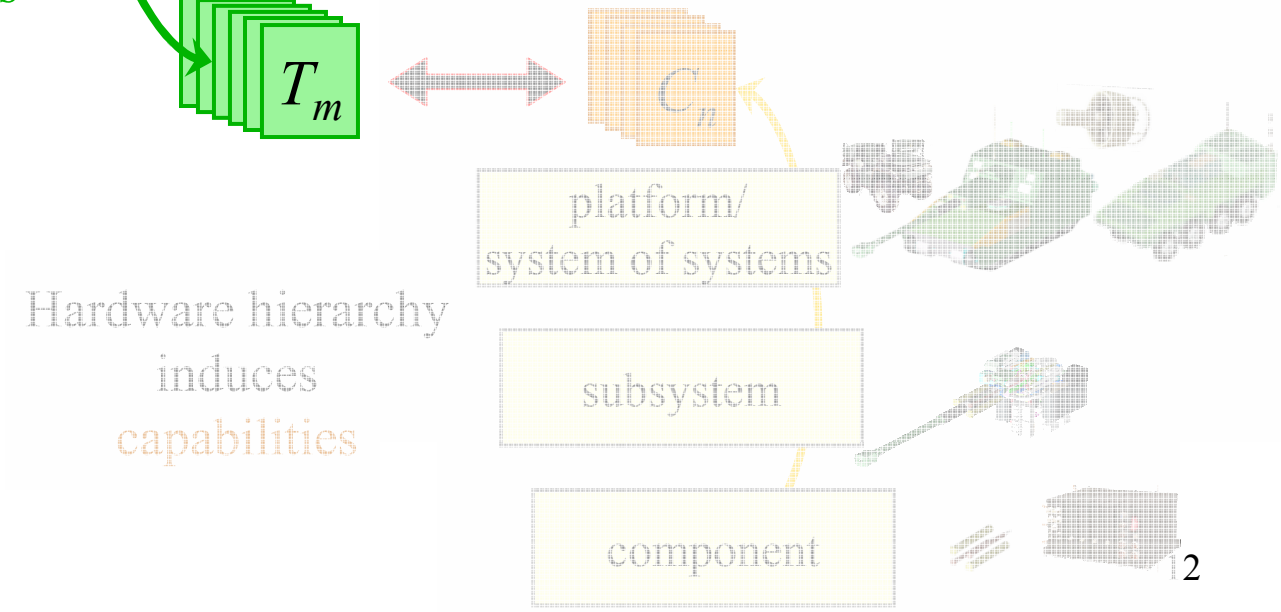


Functional Solutions Analysis = MMF Levels 7-1 Operationally based analysis of alternative DOTMLPF solutions via Live, Virtual, Constructive execution and adjudication of scenario vignettes. (Employment)

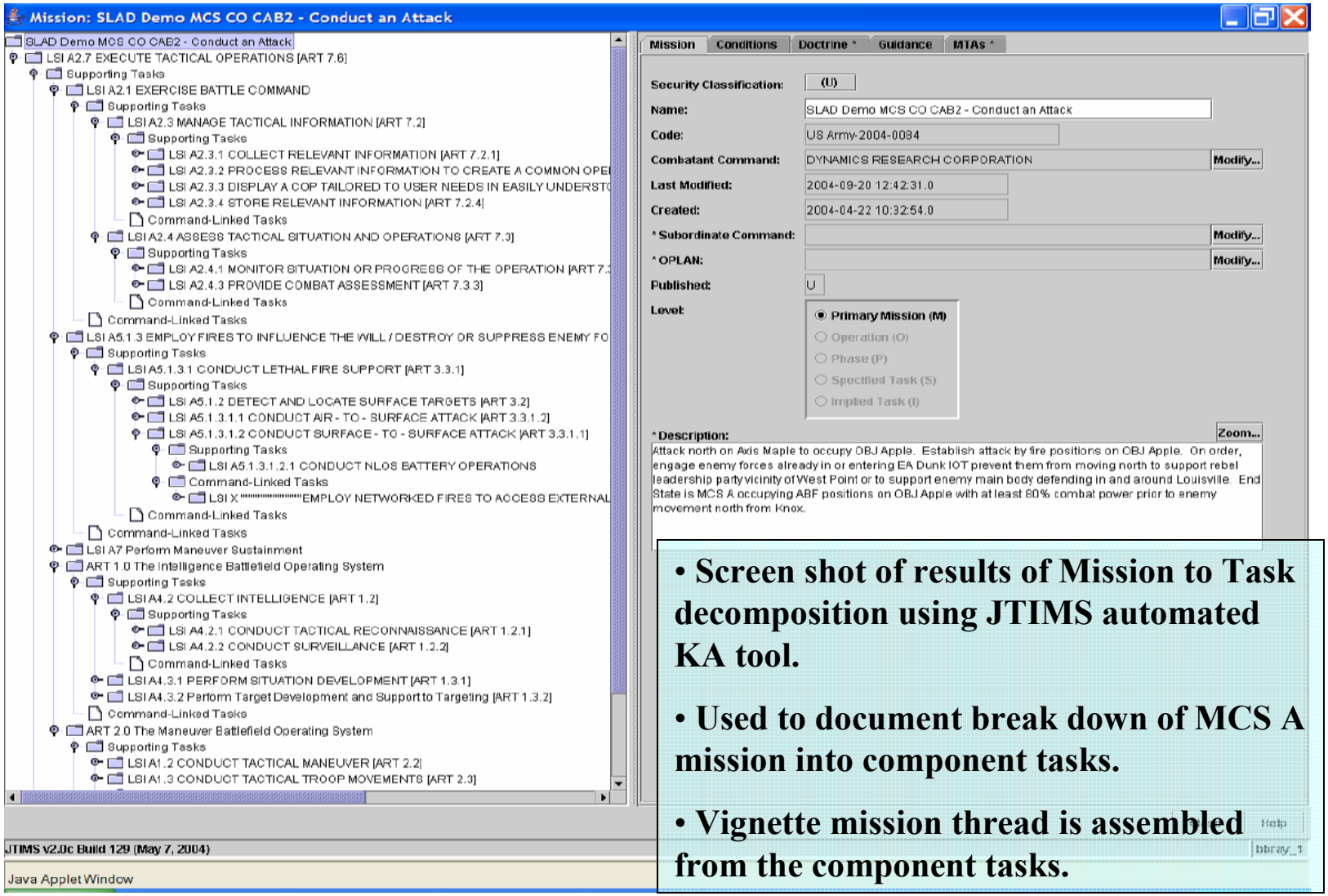
Addressing the Mission Hierarchy

Mission hierarchy
induces
tasks, conditions, standards





MMF Incorporates the Warfighter's Mission-to-Task Decomposition Process



- **Screen shot of results of Mission to Task decomposition using JTIMS automated KA tool.**
- **Used to document break down of MCS A mission into component tasks.**
- **Vignette mission thread is assembled from the component tasks.**

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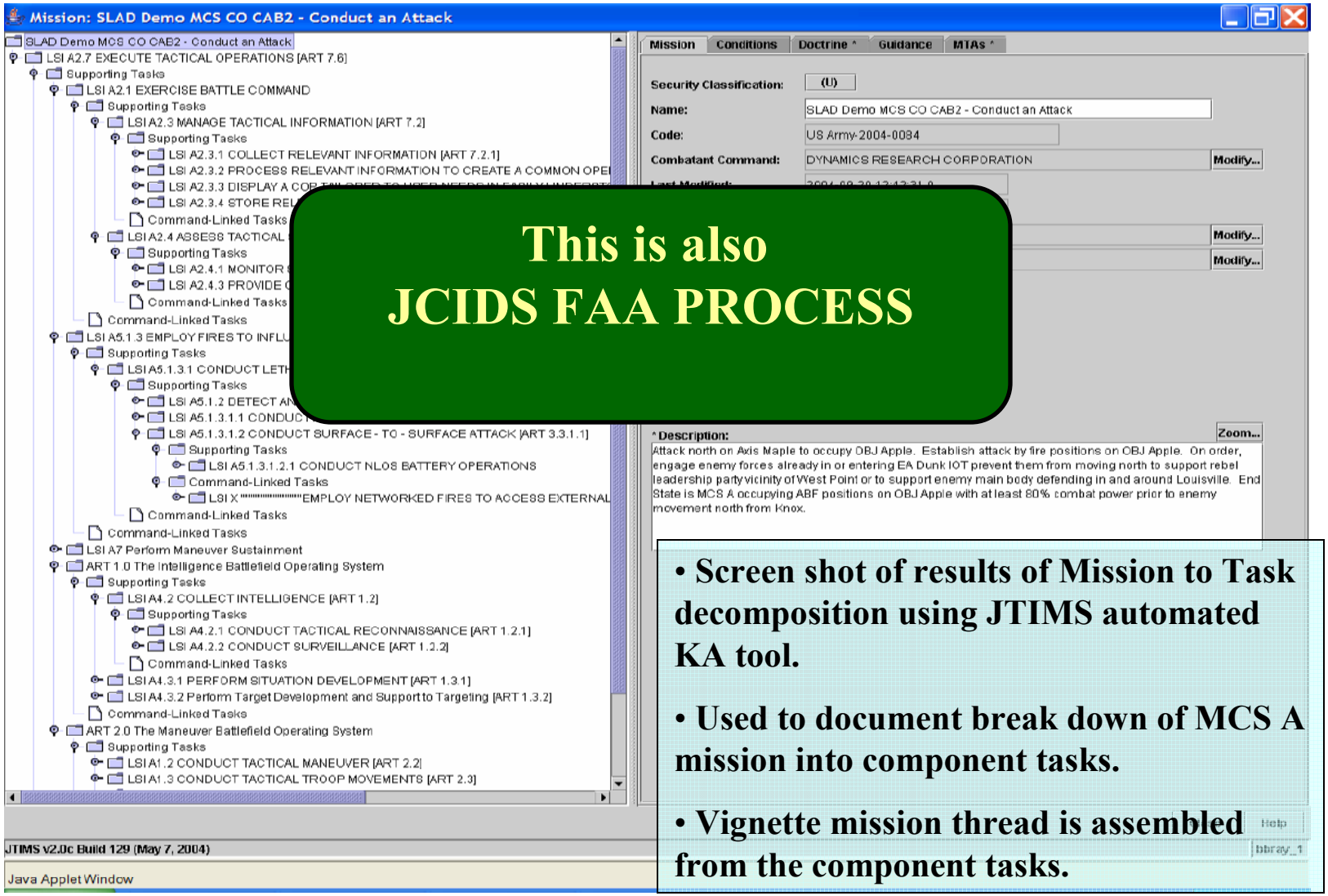

This is also
JCIDS FAA PROCESS

- **Screen shot of results of Mission to Task decomposition using JTIMS automated KA tool.**
- **Used to document break down of MCS A mission into component tasks.**
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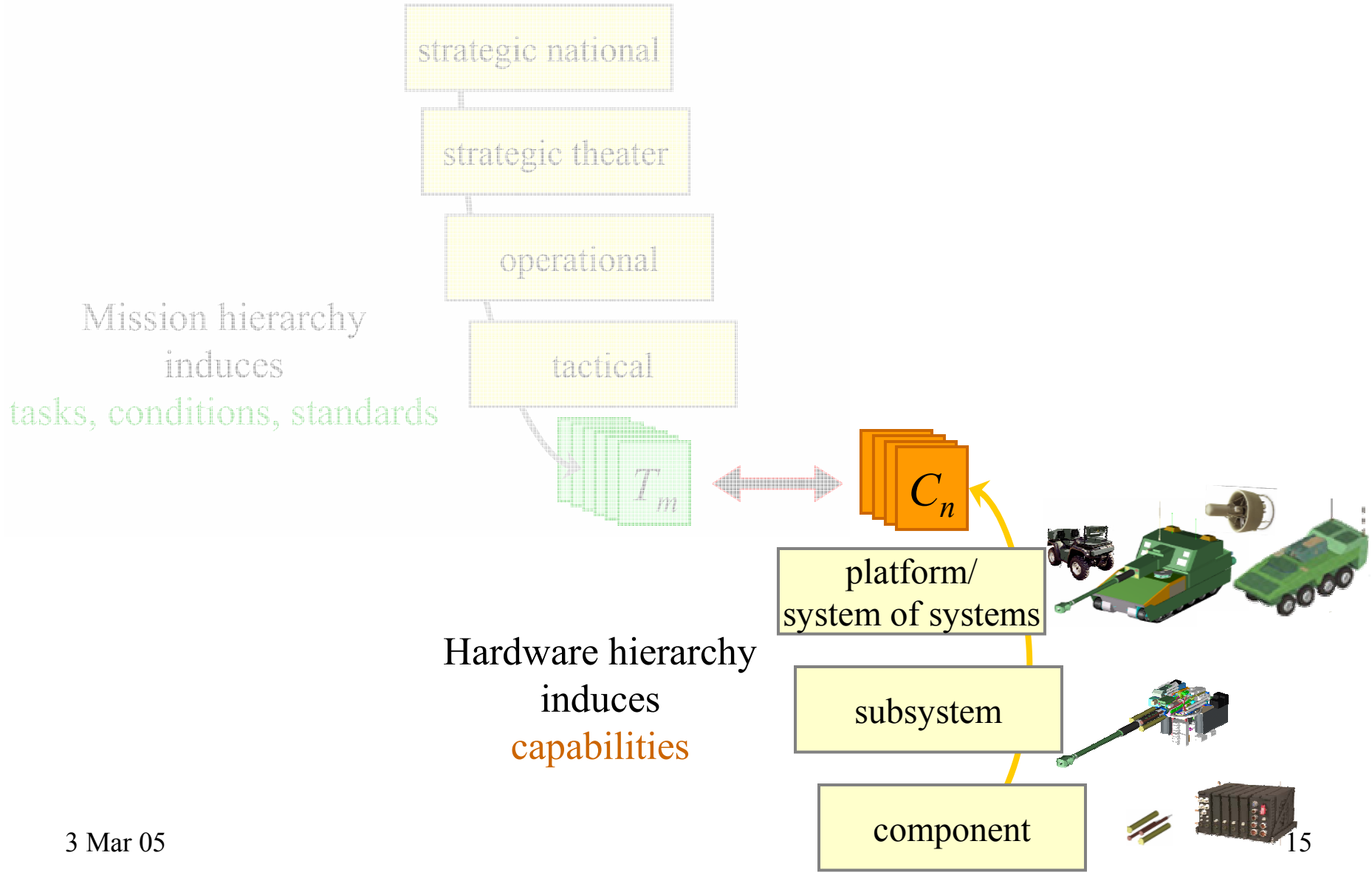
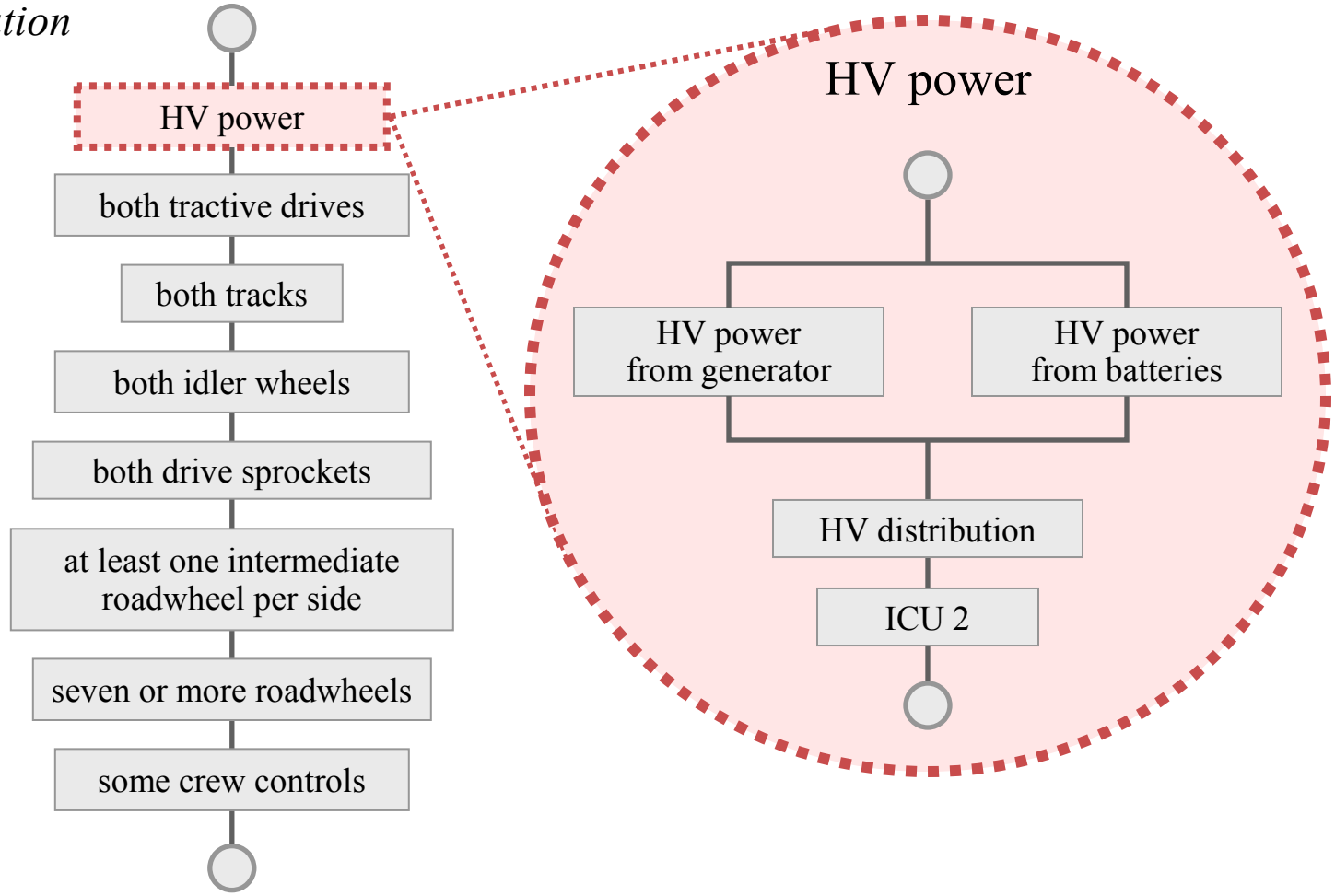
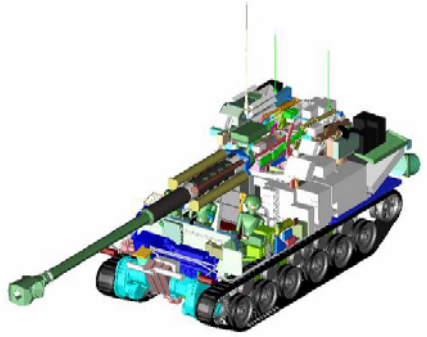
Component-to-Capability Construction



System capabilities aggregate from subsystems and components

Cutting this fault tree results in a total immobilization

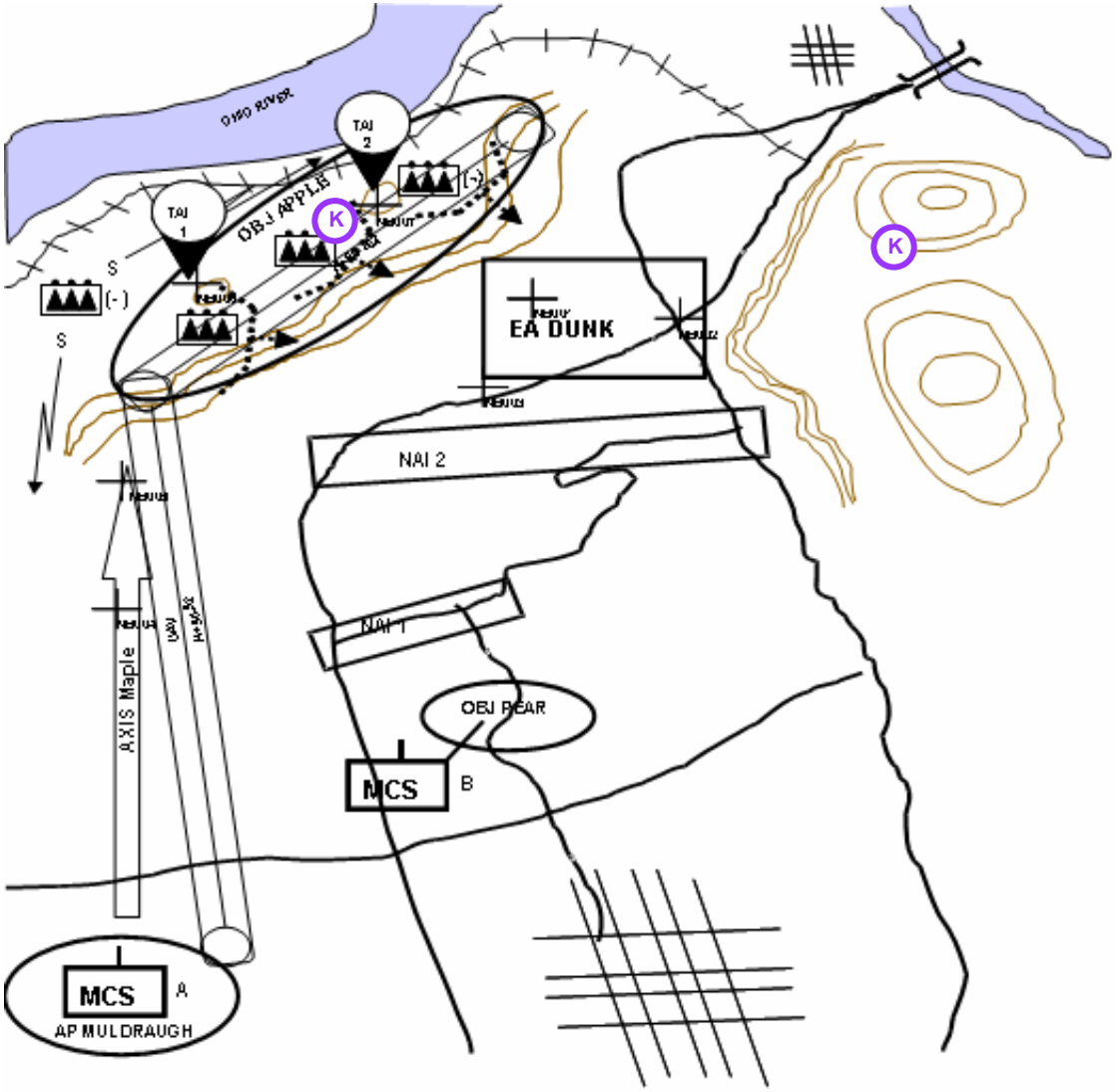




Demonstration: Applying MMF in a System of Systems Evaluation

Warfighter's View of the Battle Plan

MCS Co A phase 3 urban assault

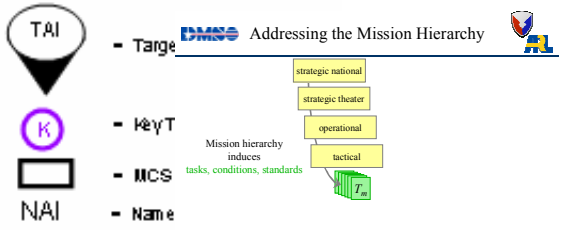


MISSION:

Attack north on AXIS Maple and seize OBJ APPLE NLT 0600 hrs. Establish attack by fire positions on OBJ APPLE and engage enemy forces already in or entering EA DUNK IOT block enemy forces from moving north to support rebel leadership vic Westpoint or support enemy forces defending in and around Louisville.

ENDSTATE:

Enemy forces vicinity of Knox remain south of EA DUNK until friendly operations vicinity of Westpoint are completed.



3 Mar 05

Basic elements of platform degraded-capability state

C2V

NLOS (6)

ARV-RISTA (3)

Class-II UAV (3)

Mobility

m_1 Reduced maximum speed

m_2 Reduced maneuverability

m_3 Stop after t min (leaks)

m_4 Total immobilization

Firepower

f_1 Lost ability to fire buttoned-up

f_2 Degraded delivery accuracy: main

f_3 Degraded initial rate of fire: main

f_4 Degraded subsequent rate of fire: main

f_5 Total loss of firepower: main

Target Acquisition

a_1 Lost daylight sights

a_2 Lost night sights

Surveillance & Reconnaissance

z_1 Lost primary sensor

z_2 Lost secondary sensor

z_3 Lost tertiary sensor

z_4 Lost vision blocks

Communication

x_1 Lost external data

x_2 Lost external voice

x_3 Lost internal comms

x_4 Lost LAN

x_5 Lost all comms

Survivability

s_1 Lost NBC protection

s_2 Lost ability to deploy obscurants

s_3 Lost silent-watch capability

s_4 Lost APS

s_5 Lost secondary armament

Crew

c_1 Commander incapacitated

c_2 Squad leader incapacitated

c_3 Driver incapacitated

c_4 Operator 1 incapacitated

c_5 Operator 2 incapacitated

c_6 Gunner incapacitated

c_7 Loader incapacitated

Other Mission Functions

o_1 Lost situational awareness

Catastrophic Loss

k_1 Lost every capability (fuel fire, ammo detonation, …)

Fault trees?

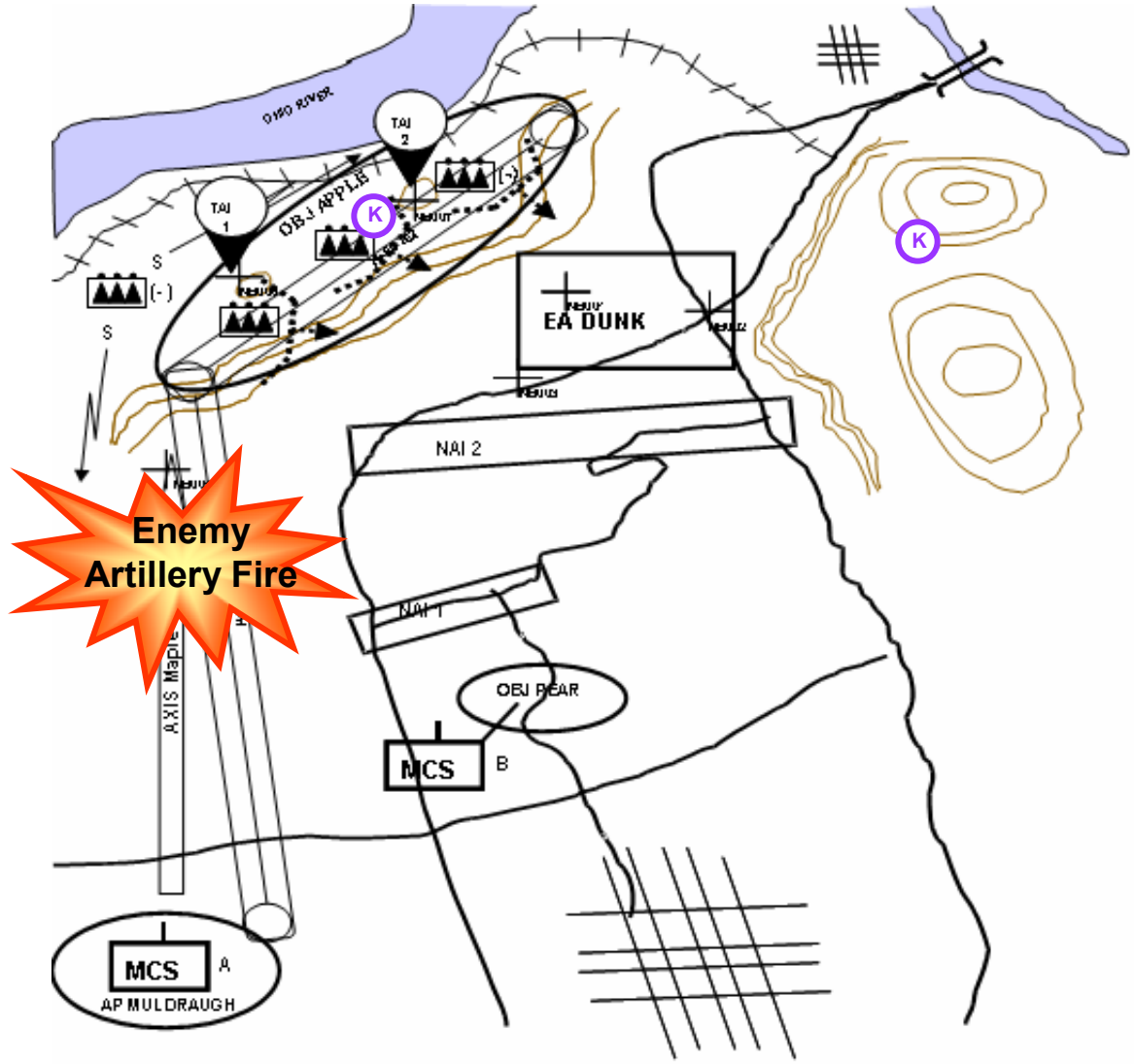
Tasks ⇄ Capabilities: Linking it all Together

	Lines from the TOEL											
2			TASKS	PLATFORM			Comms					
51	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 2			x0		x2	x3	x4	
52	0412-0417	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 2			x0		x2	x3	x4	
53	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 3			x0		x2	x3	x4	
54	0757-0802	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	ARV 3			x0		x2	x3	x4	
55	0200-1000	ART 7.2	*MTP 07-1-1COP.07-C332 Establish the Common Operational Picture	C2V			x0	x1	x2	x3	x4	x5
56	0200-0205, 0253-0258, 0308-0313, 0341-0346, 0437-0442, 0525-0530, 0633-0638, 0707-0712, 0800-0805, 0849-0854	ART 7.2	*ART 7.2.5 Disseminate Common Operational Picture and Execution Information	C2V			x0	x1	x2	x3	x4	x5
57	0200-1000	ART 7.2	LSI A2.3.1 Collect Relevant Information ART 7.2.1	C2V			x0	x1	x2	x3	x4	x5
58	0200-1000	ART 7.2	MTP 07-1-WT06.07-C332 Conduct Battle Tracking	C2V			x0	x1	x2	x3	x4	x5
59	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	C2V			x0	x1	x2	x3	x4	x5
60	0255-0300, 0313-0318, 0339-0344, 0410-0415, 0523-0528, 0612-0617, 0706-0711, 0750-0755, 0844-0849	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	C2V			x0	x1	x2	x3	x4	x5
61	0210-0542	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 1			x0	x1				
62	0250-0255, 0305-0310, 030-0335	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	UAV 1			x0	x1				
63	0340-0835	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 2			x0	x1				
64	0431-0436, 0715-0720	ART 7.2	*LSI A1.6.2.1.1.4.3 Report Enemy Information	UAV 2			x0	x1				
65	0543-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 3			x0	x1				

TIMELINES / P-Lines / Sheet3

Executing the Battle

MCS Co A phase 3 urban assault



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ENDSTATE:

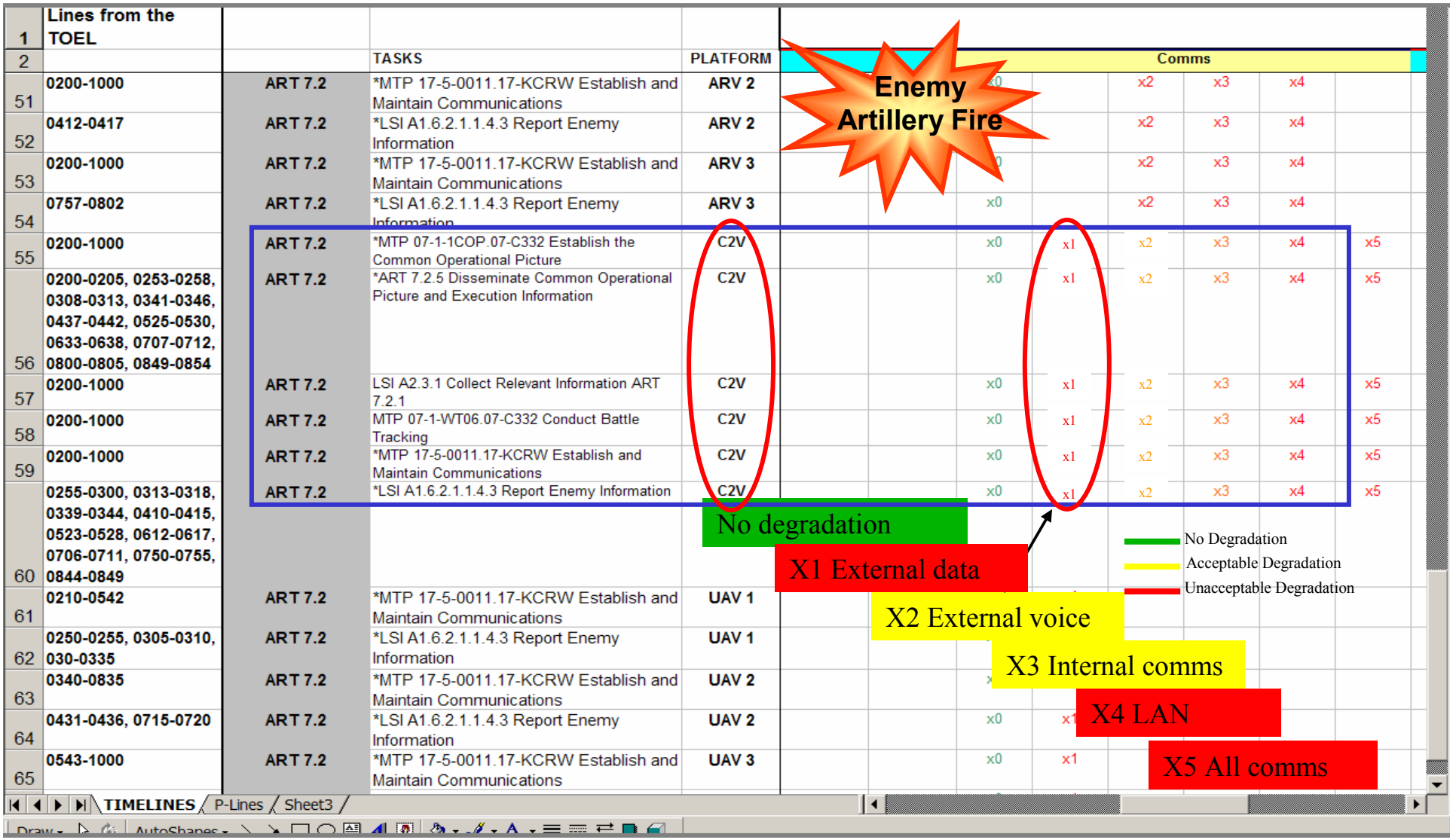
Enemy forces vicinity of Knox remain south of EA DUNK until friendly operations vicinity of Westpoint are completed.

TAI - Targeted Area of Interest

K - Key Terrain

NAI - Named Area of Interest

The *So what?* of Battle Damage



51	0200-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	ARV 2
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56	0200-0205, 0253-0258, 0308-0313, 0341-0346, 0437-0442, 0525-0530, 0633-0638, 0707-0712, 0800-0805, 0849-0854	ART 7.2	*ART 7.2.5 Disseminate Common Operational Picture and Execution Information	C2V
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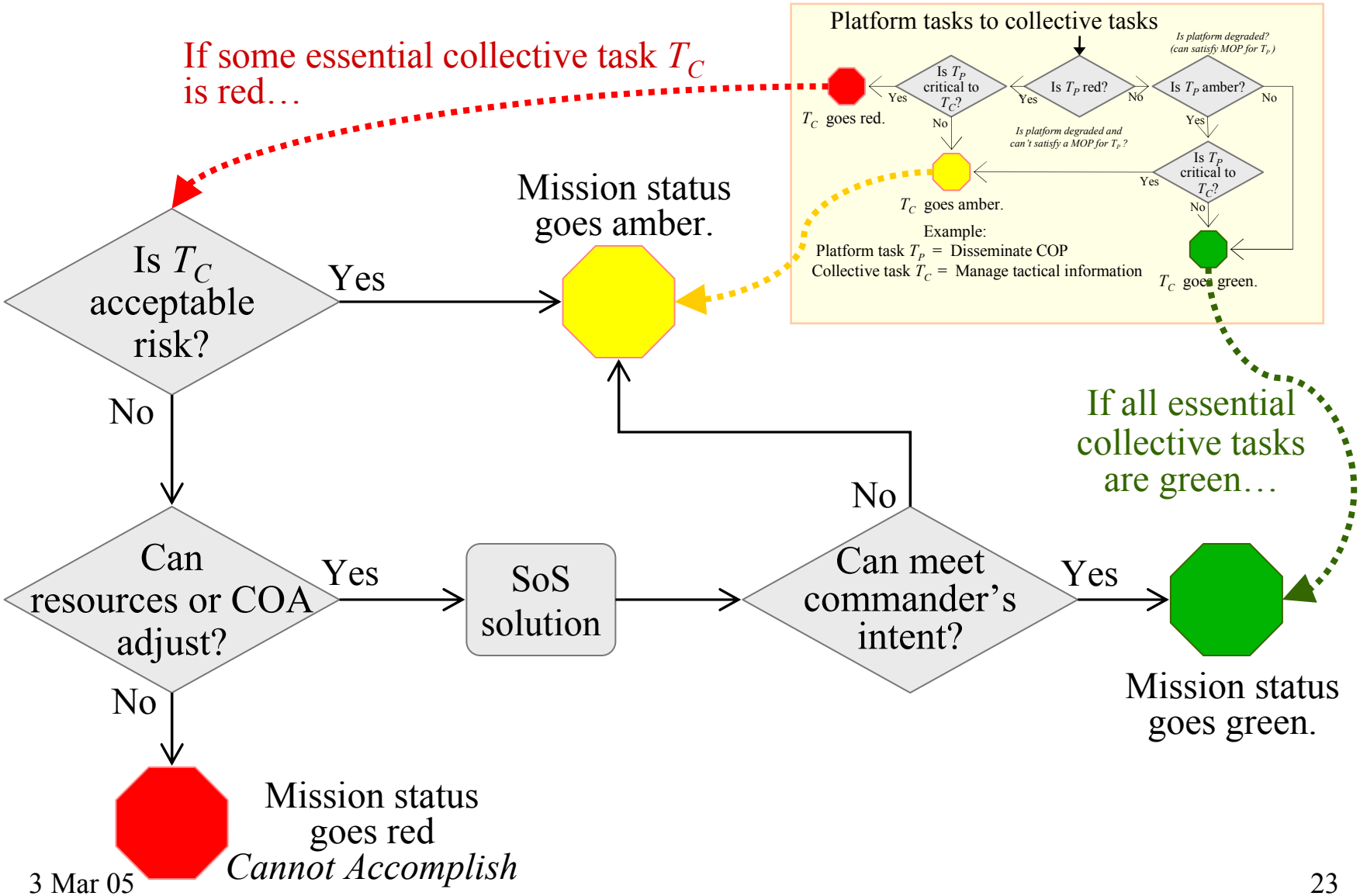
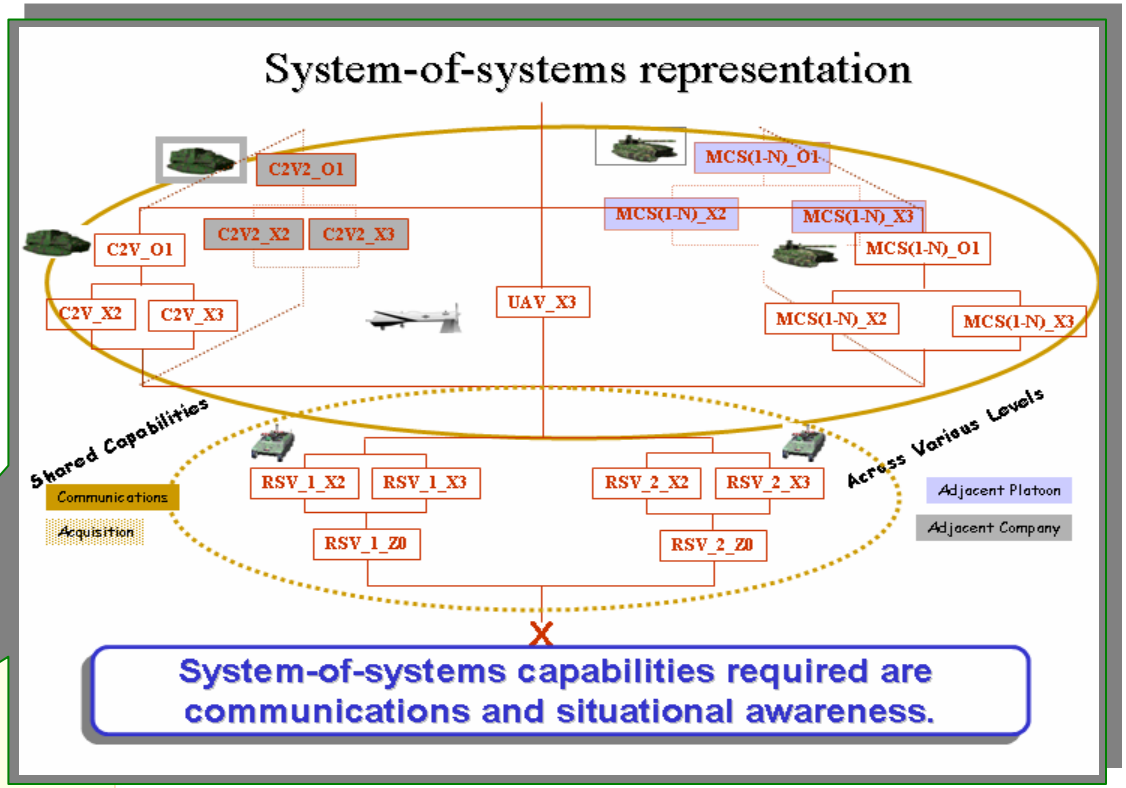
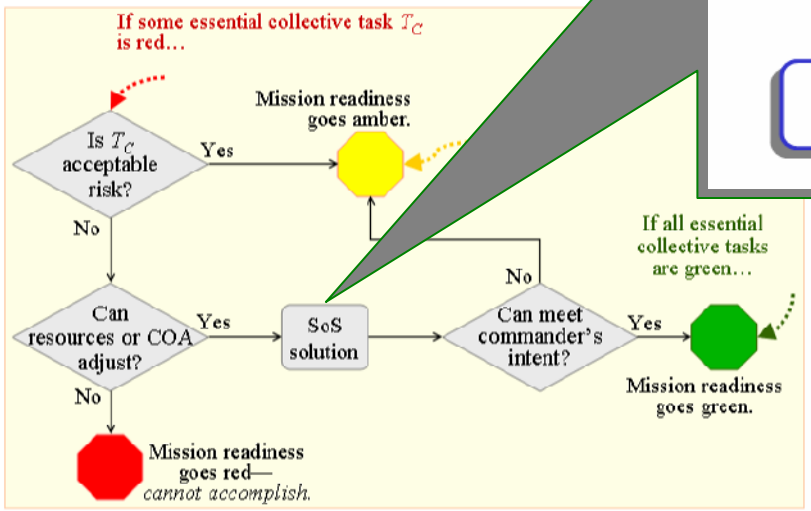
65	0543-1000	ART 7.2	*MTP 17-5-0011.17-KCRW Establish and Maintain Communications	UAV 3

Rolling up from platform tasks to SoS Mission Status



The system-of-systems solution



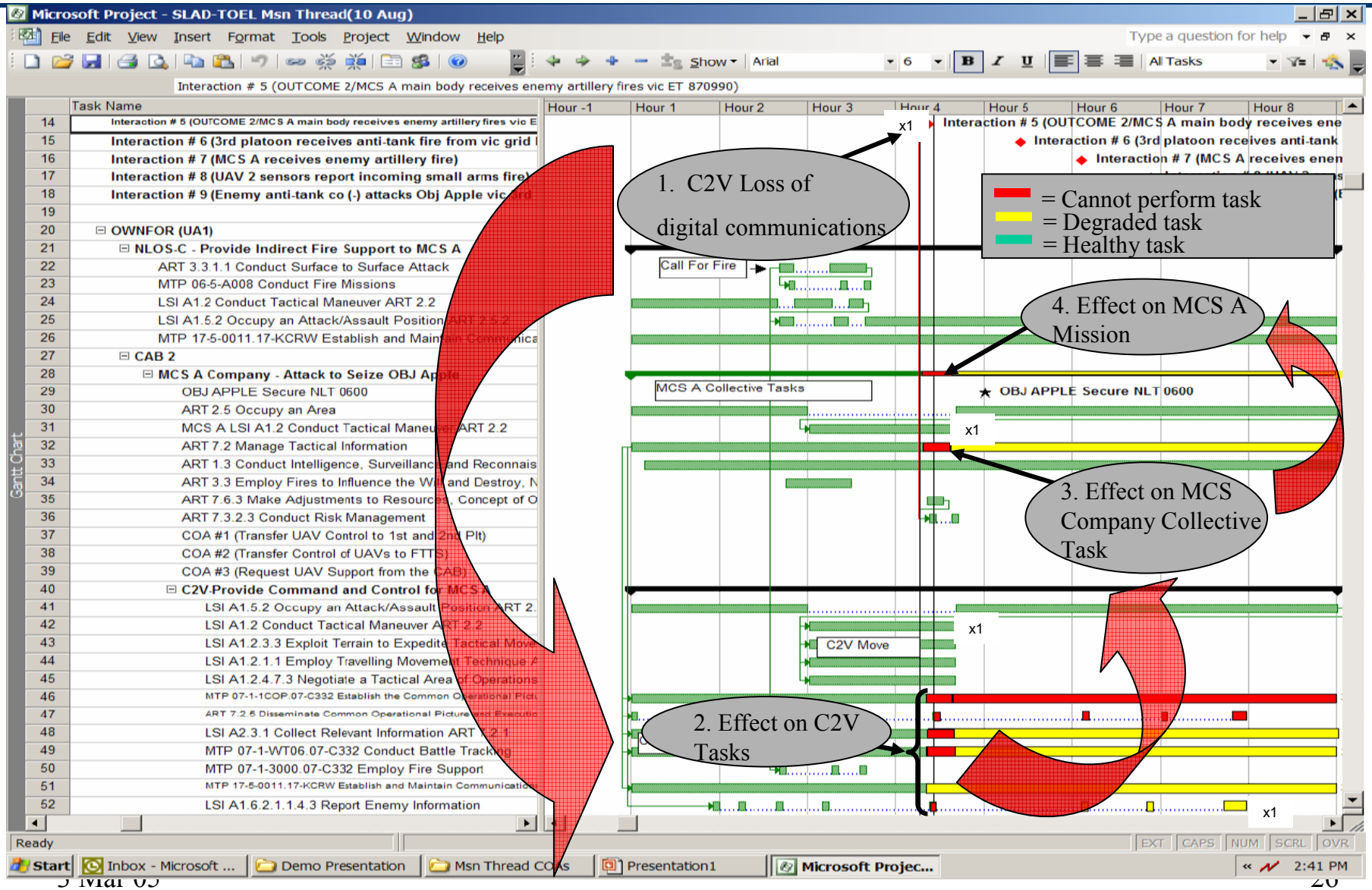


What options are available from the system of systems?

Replanning On the Fly: Alternative Tactical Responses

	Alternative Actions	Outcome
COA 1	**Transfer control of UAVs to 1st and 2nd platoons** Orders C2V to transfer control of UAVs to 1st and 2nd platoons. Takes control of SA/fires. Orders company to continue advance to Objective Apple (5 km/h).	**30-min delay** to transfer operational control of UAVs and to assume SA/fires control.
COA 2	**Transfer control of UAVs to FTTS** Takes control of fires. FDNCO transfers to Cdr's vehicle to control fires. Situational awareness (SA) transferred to FTTS. XO transfers to FTTS. Orders C2V to transfer control of UAVs 1 and 2 to FTTS. Robotics NCO transfers to FTTS. Orders launch and recovery equipment transferred to 2nd Plt. 1SG transfers to 3rd platoon security force. Requests contact maintenance team from Bn trains meet the company on Objective Apple to repair C2V digital comms. Orders company to resume advance towards Objective Apple at increased speed (10 km/h).	**15-min delay** to transfer operational control of UAVs to FTTS and to assume SA/fires control. Delay offset by increased speed.
COA 3	**Request support from CAB to pick up feed from UAVs 1 and 2** Requests CAB to pick up the feeds from UAVs 1 and 2 and to send updated feeds to the MCS CDR about enemy locations and activities as they are acquired. Takes control of SA/fires. Orders company to halt in place until receipt of new UAV feeds. Orders company to resume advance towards Objective Apple (5 km/h).	**15-min delay** while CAB assumes control of UAVs 1 and 2 and MCS CDR assumes SA/fires control.

Illustrating the roll up to system/mission health



Demonstration output—platform capabilities

Mean percentage of vignette time during which platforms of each type endure each element of capability degradation

	Mobility				Firepower loss					Acquisition loss		Surv./recon. loss			
	m_1 Reduced max speed	m_2 Reduced maneuv.	m_3 Stop after t min	m_4 Immobilized	f_1 Buttoned-up ability	f_2 Deliv. accuracy	f_3 Init. rate of fire	f_4 Subs. rate of fire	f_5 Total	a_1 Daylight sights	a_2 Night sights	z_1 Primary sensor	z_2 Secndry. sensor	z_3 Tertiary sensor	z_4 Vision blocks
C2V	13	12	2	12	0				0	0	0	0	0		0
NLOS-C	12	16	4	8		6	12	12	6						2
ARV	12	15	4	10					5	4	3	5	3	3	
UAV	25	27	25	25								26	25	25	

Demonstration output—platform capabilities, cont.

Mean percentage of vignette time during which platforms of each type endure each element of capability degradation

	Communication loss					Survivability loss					Personnel incapacitated								
	x_1 External data	x_2 External voice	x_3 Internal	x_4 LAN	x_5 All	s_1 NBC protec.	s_2 Obscurants	s_3 Silent watch	s_4 APS	s_5 Secondary wpn.	c_1 Commander	c_2 Squad leader	c_3 Driver	c_4 Operator 1	c_5 Operator 2	c_6 Gunner	c_7 Loader	o_1 Lost SA	k_1 Catastrophic loss
C2V	0	1	1	0	0	2	0	2	0		2	3	2	1	3				
NLOS-C	2	2	2		2	3			3	3	2		2			2	2	2	2
ARV	4				4			5											3
UAV	25																	25	

Demonstration output—success rate for (platform) critical tasks

Success rate*	Time succeeding (min) / time required (min)	Platform type	Task
1.000	1,280 / 1,280	C2V	Report enemy information
1.000	9,600 / 9,600	C2V	Establish and maintain comms
1.000	480 / 480	C2V	Employ fire support
0.999	9,588 / 9,600	C2V	Establish COP
0.999	9,588 / 9,600	C2V	Collect relevant information
0.999	9,588 / 9,600	C2V	Conduct battle tracking
0.990	1,584 / 1,600	C2V	Disseminate COP
0.969	7,501 / 7,740	NLOS-C	Conduct tactical maneuver
⋮	⋮	⋮	⋮
0.665	5,012 / 7,540	UAV	Fly UAV mission
0.648	2,312 / 3,570	UAV	Conduct tactical reconnaissance
0.595	773 / 1,300	UAV	Detect and locate surface targets

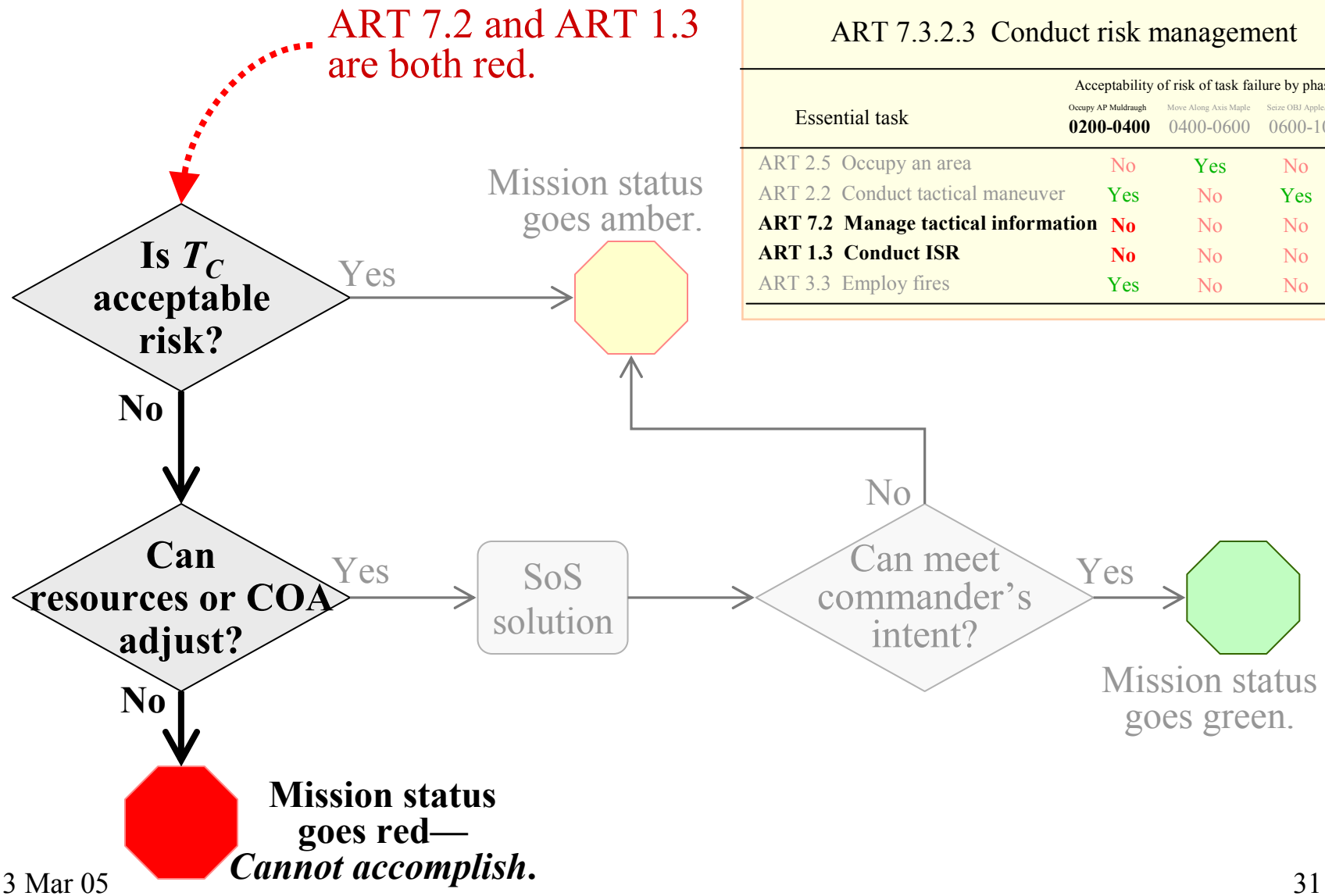
*Of the cumulative time the platform needed ability to perform the task, the portion during which it could actually do so.

Demonstration output— Tracing the causes of a mission failure

- Mission: Attack to seize Objective Apple
  - ART 2.5 Occupy an area
  - ART 2.2 Conduct tactical maneuver
  - ART 7.2 Manage tactical information
  - ART 1.3 Conduct ISR
    - ART 7.6.3 Make adjustments to resources

Time = 02:40:51.312

Demonstration output—
What caused the mission failure?

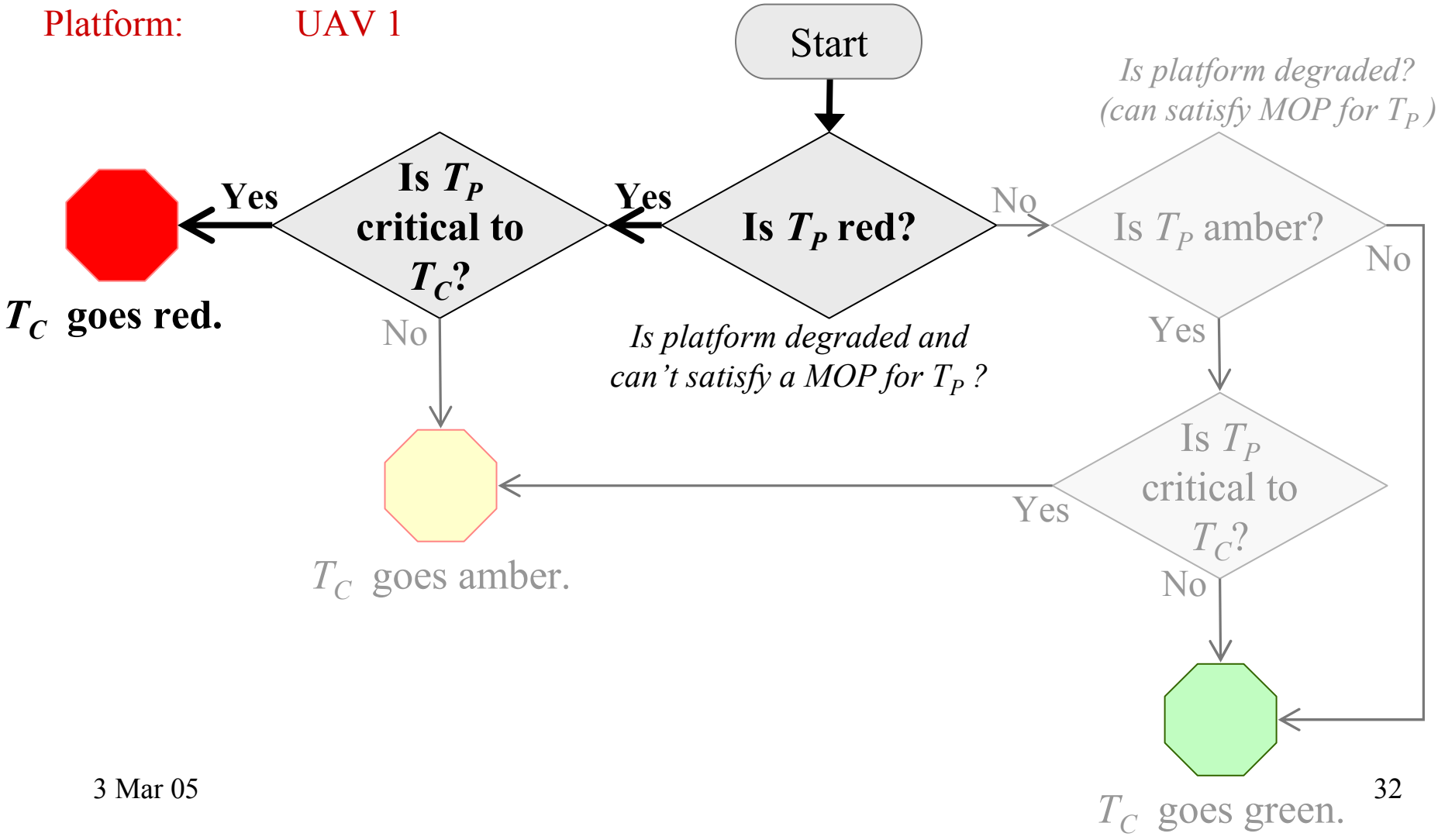


ART 7.3.2.3 Conduct risk management

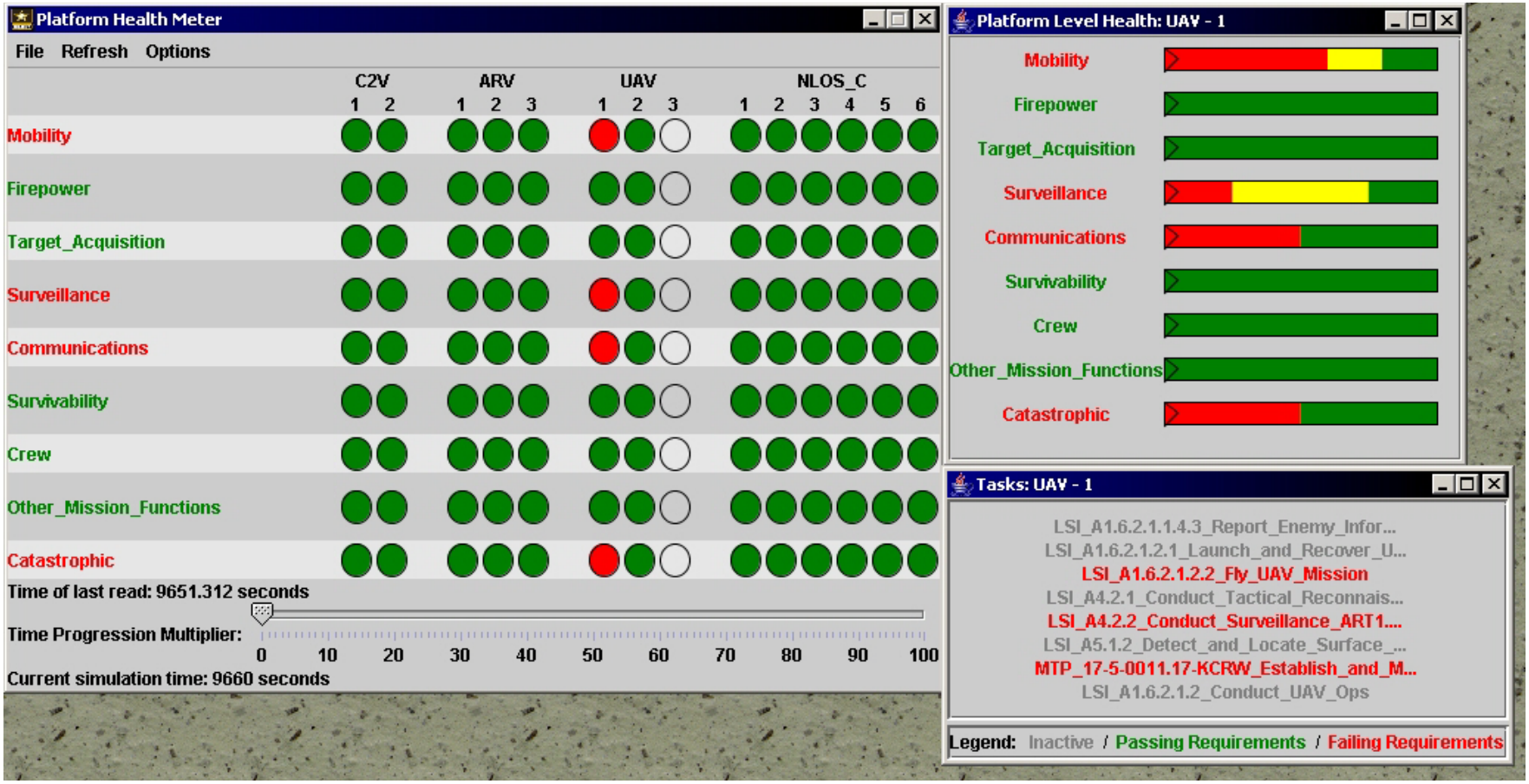
Essential task	Acceptability of risk of task failure by phase		
	Occupy AP Muldraugh **0200-0400**	Move Along Axis Maple 0400-0600	Seize OBJ Apple/Occupy 0600-1000
ART 2.5 Occupy an area	No	Yes	No
ART 2.2 Conduct tactical maneuver	Yes	No	Yes
ART 7.2 Manage tactical information	**No**	No	No
ART 1.3 Conduct ISR	**No**	No	No
ART 3.3 Employ fires	Yes	No	No

Demonstration output—
Why did a collective task fail?

Collective task: ART 7.2 Manage tactical information.
Platform task: MTP 17-5-0011.17 KCRW establish and maintain communications
Platform: UAV 1

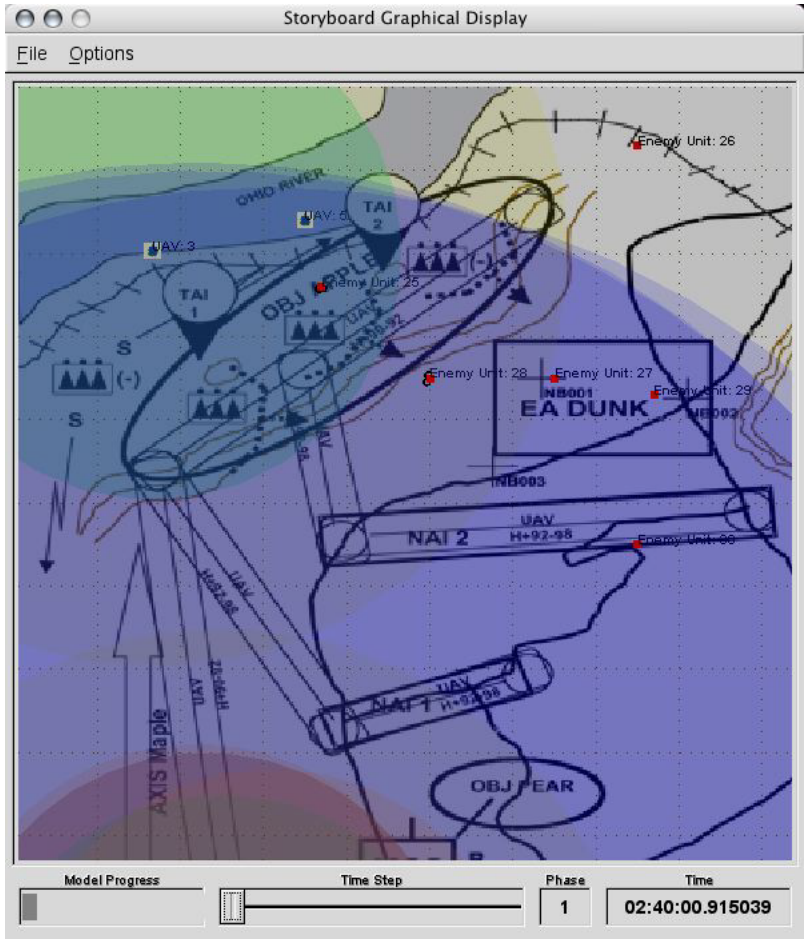


Demonstration output—
Why did the platform task fail?

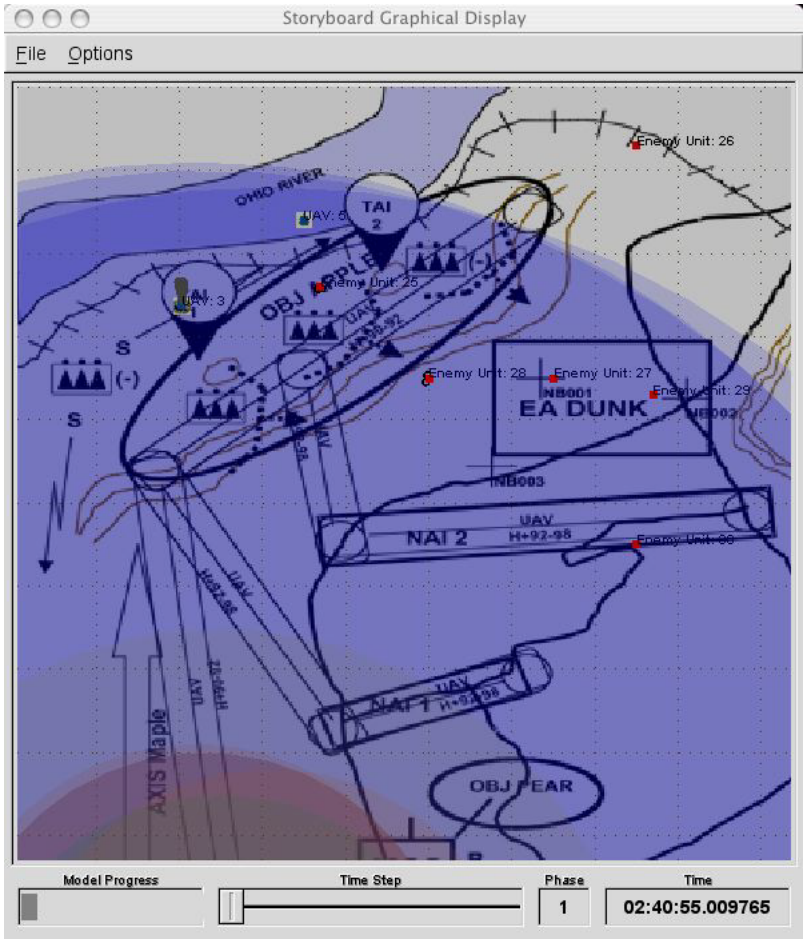


Demonstration output—
What was happening when the platform's capability changed?

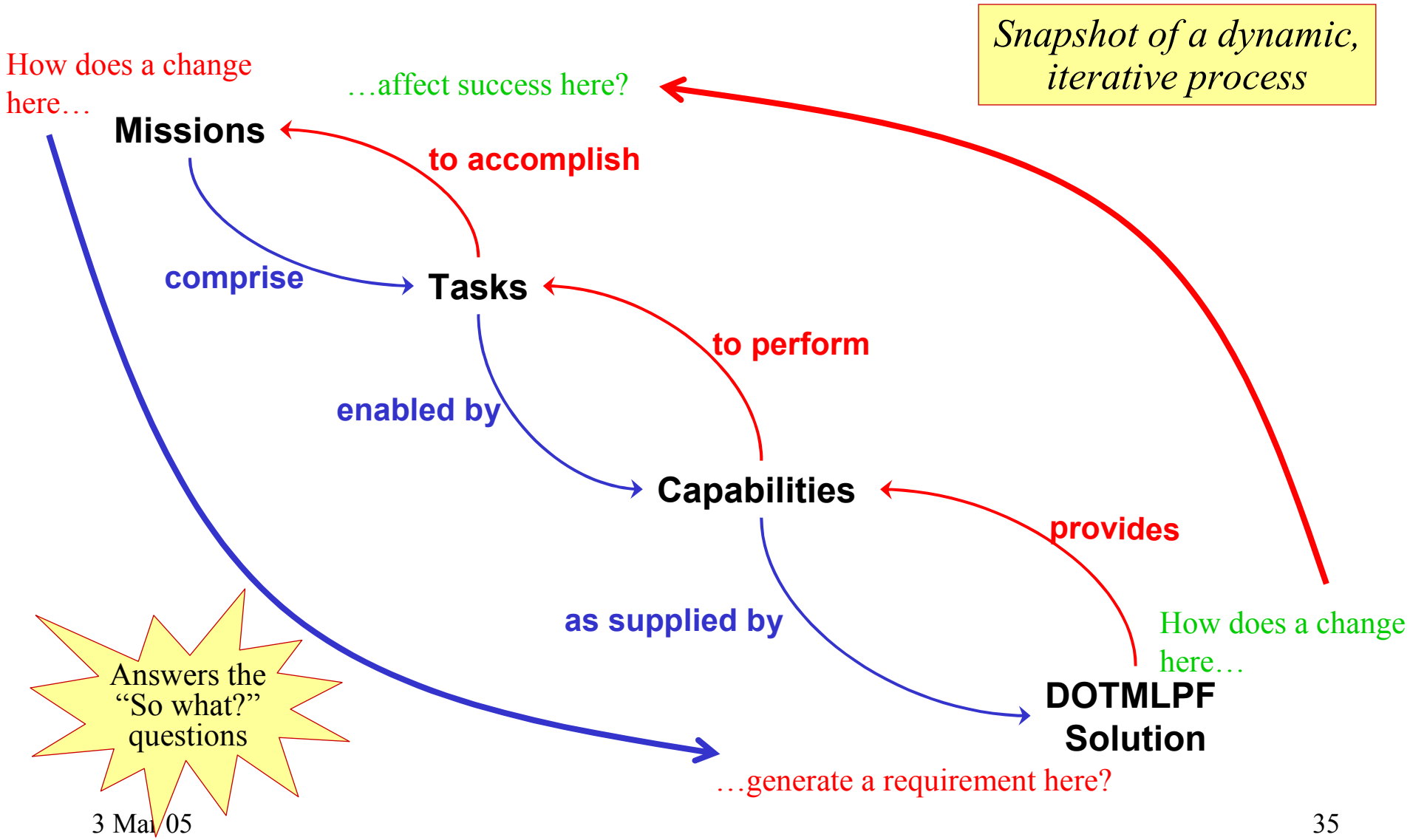
Before UAV 1 lost mobility



After



MMF linking MDMP with DOTMLPF solutions

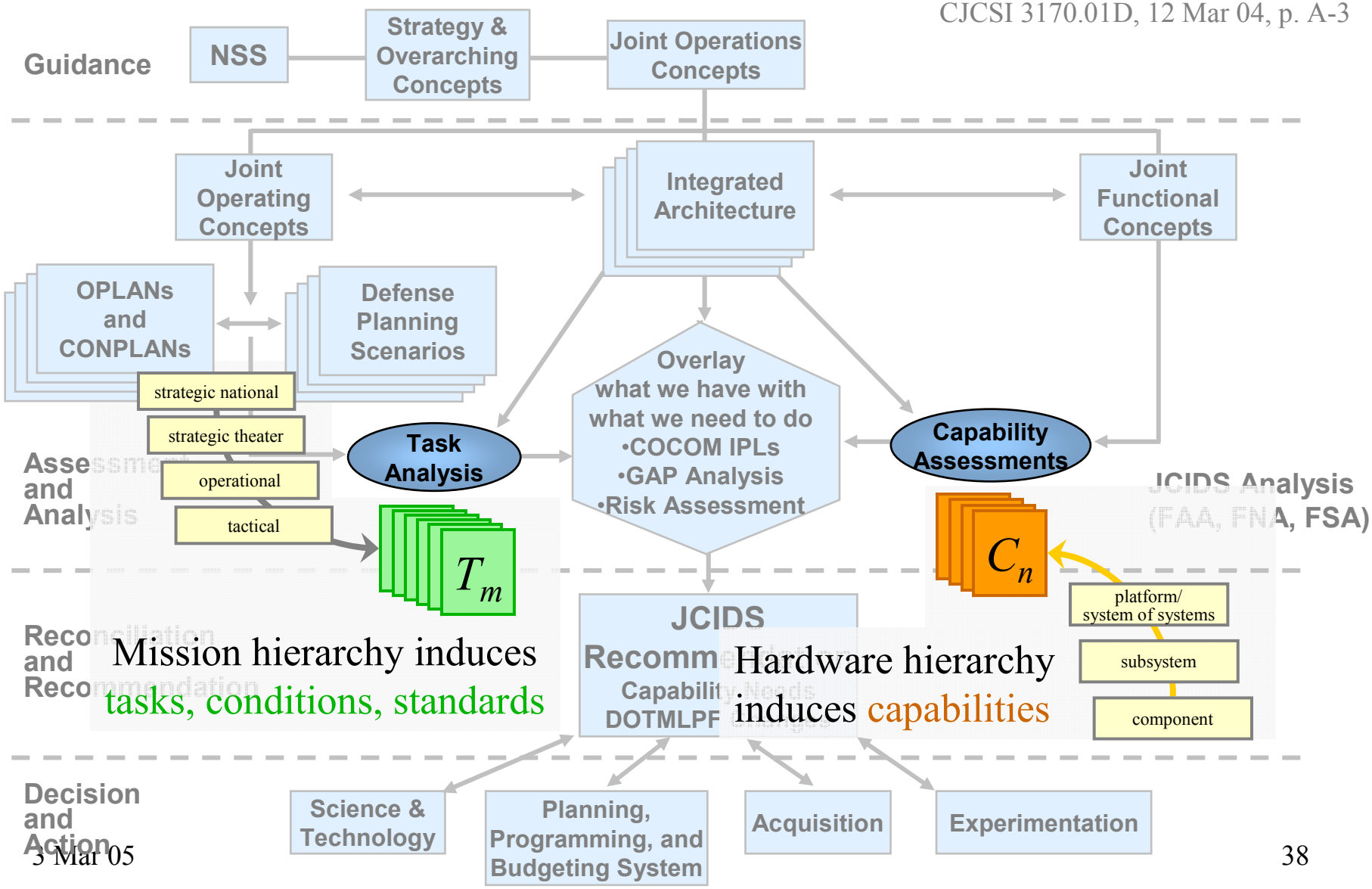


Conclusions

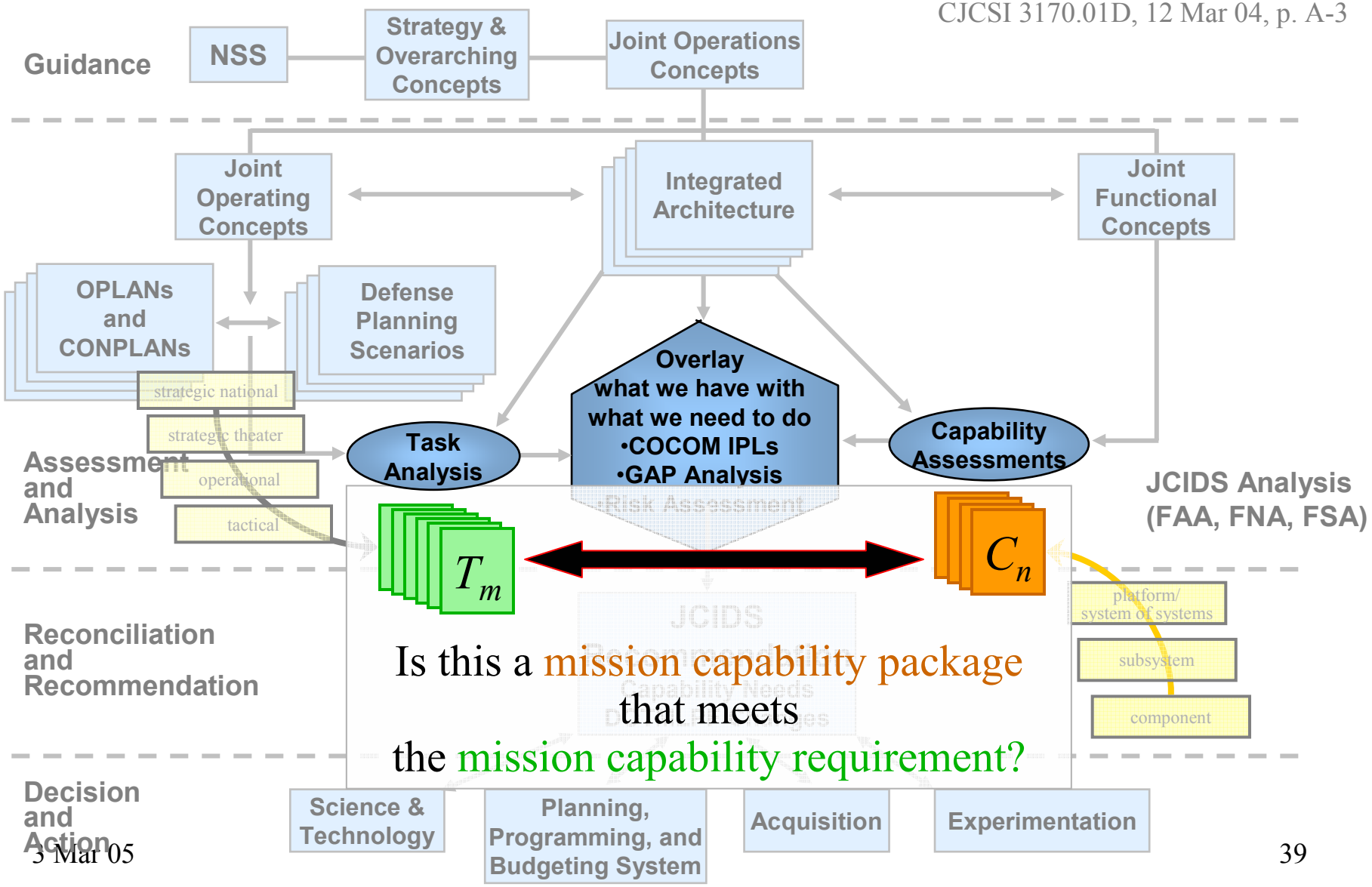
- We have demonstrated a rigorous approach for tracing the causal links between task/mission success and the detailed dynamic state of materiel.
- Applying this approach in a large-scale project requires further development – several application initiatives are underway.
- The Missions and Means Framework is:
  - The **LINK** between the Military Decision Making Process and the domain of DOTMLPF solutions
  - A **WARFIGHTER-FOCUSED STRUCTURE** for rigorous, complete, and detailed analysis in crucial evaluation programs
  - An **ORGANIZING PRINCIPLE** for requirements, test planning, and evaluation

BACKUP SLIDES

How MMF supports JCIDS



How MMF supports JCIDS



How MMF links state of materiel to mission success