

Toward a Rigorous Integration of Systems Engineering with Operational Art in Cyberspace

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Motivation

“A nation that makes a great distinction between its scholars and its warriors will have its thinking done by cowards and its fighting done by fools.”

Spartan King Archidamus

“The essence of operational art lies in being able to produce the right combination of effects in time, space, and purpose relative to a center of gravity to neutralize, weaken or destroy it . . .”

JP 3-0: Joint Operations

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Characteristics of past revolutions in military affairs¹

1. Technology alone has rarely driven them
2. Emerged from problem-solving directed at specific operational and tactical issues (*actual not hypothetical*)
3. Require coherent frameworks of doctrine and concepts
4. Rooted in and limited by strategic givens and by the nature of war
 - They are not a substitute for strategy

¹Knox and Murray, *The Dynamics of Military Revolution, 1300–2050* ▶

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Mission

- Develop the next generation of cyber warfare leaders

Means

- 10-week summer education program of classes, on-the-job mentoring, officer development, & weekly 8-mile runs
- Rigorous math; classified threat briefs; 2-day hackfest
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- 226 graduates since its inception in 2003 through 2010

Hackfest



2008 Graduating Class



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Purpose & Preview

Purpose

Describe our efforts to link military strategy and systems engineering within the ACE context

- Officer development
- Computer engineering

Preview

1. Strategic framework and doctrine
2. Operational context
3. Technical problem
4. Critical requirements
5. Conclusion

This is work in progress

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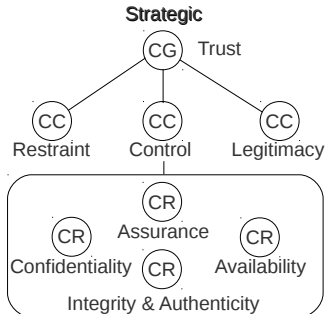
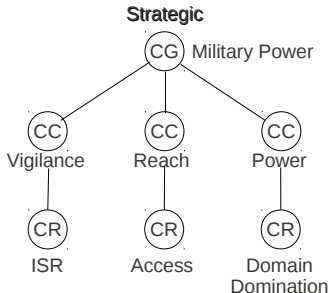
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Centers of Gravity: Primary sources of moral or physical strength, power and resistance

Critical Capabilities: Primary abilities which merits a Center of Gravity to be identified as such in the context of a given scenario, situation or mission

Critical Requirements: Essential conditions, resources and means for a critical capability to be fully operative

Dr. Joe Strange, *Perspectives on Warfighting, No. 4, 2nd Edition*



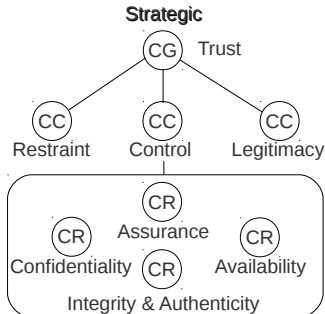
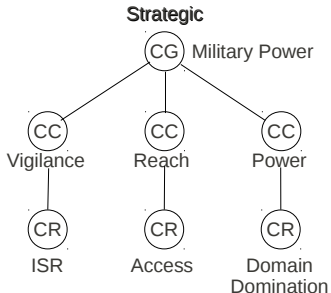
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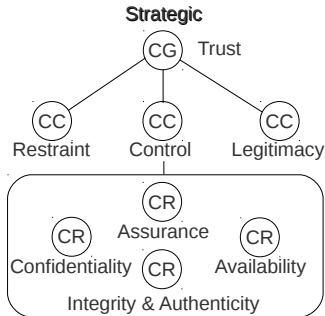
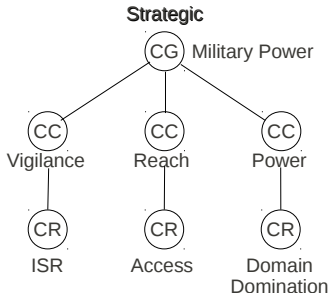
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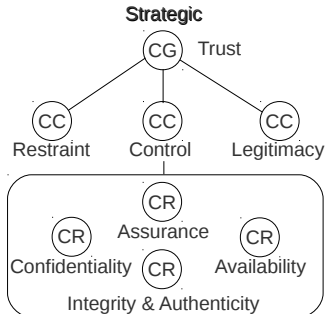
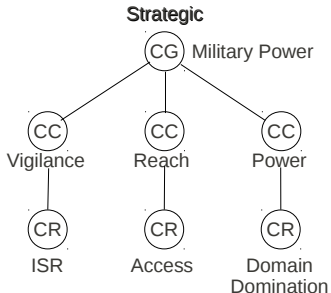
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Operational Context



Joint Terminal Air Controller



Remotely Piloted Vehicle



Airborne Early Warning & Control



Air Operations Center



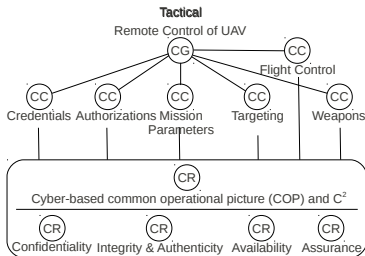
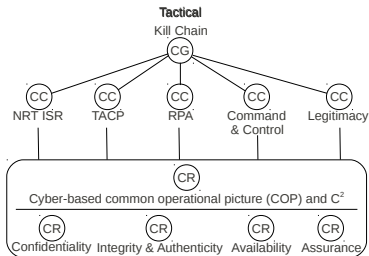
Technical Problem

"That is, the pilot can trust information that a target is the foe, not innocent inhabitants of a school building or hospital or embassy. ... This new way of war is data dependent. So we need to think in terms of trust and securing trust."

Michael Wynne, Former SECAF

"No operator should ever have to ask ... 'Will my weapon work?' ... Cyberspace warfare creates just this possibility."

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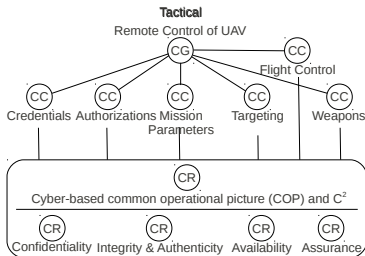
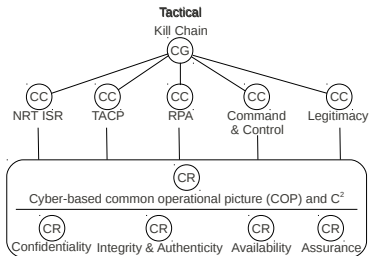


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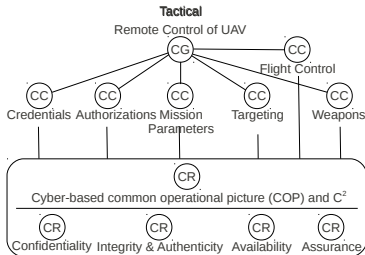
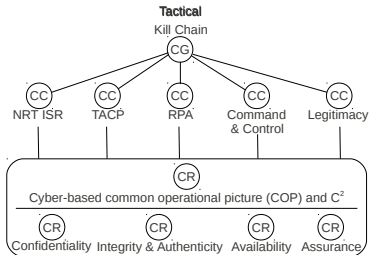


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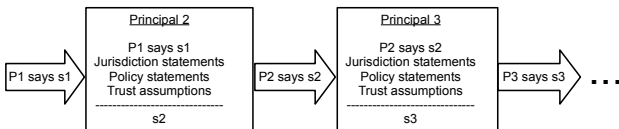
Critical Requirements Given to Cadets

Kill chain integrity

- Formulate MAC policy for integrity based on *mission validation appliances*
- CONOPS for authenticating targets, commands, and personnel
- CONOPS for trust management

UAV control integrity

- Formulate MAC policy for integrity based on *capability system*
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Formal description and verification of CONOPS for system integrity in access-control logic

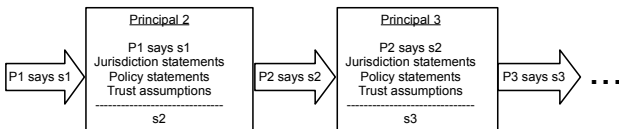
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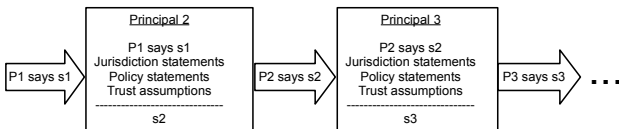
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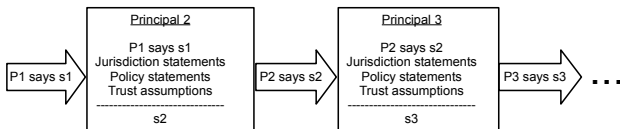
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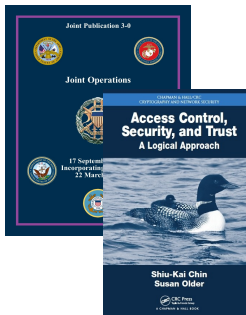


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- Quality of formal descriptions and proofs exceeded expectations
- More work is needed; this is just the beginning

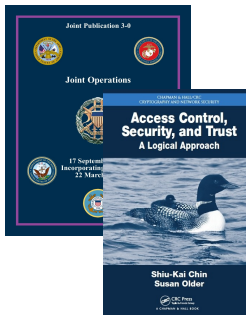


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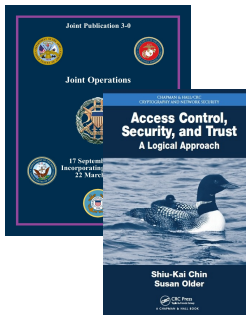


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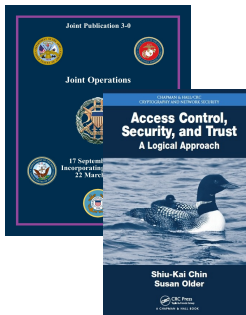


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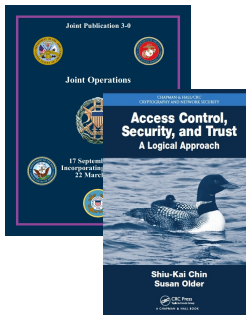


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