

# International Foundations for C2 Assessment

- *NATO Code of Best Practice*
- *TTCP GUIDEx*
- *N2C2M2*

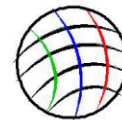
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**NCSOSE**

*National Centers for System of Systems Engineering*



**VMASC**

*Virginia Modeling Analysis and Simulation Center*

# Overview

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- **NATO Code of Best Practice for C2 Assessment**

- Written by NATO SAS-026 in support of Operations other than War
- General Operations Research Experimentation Blueprint

- **TTCP GUIDEx**

- Written by The Technical Cooperation Program (TTCP)
- Guide for Understanding and Implementing Defense Experimentation

- **N2C2M2**

- Written by NATO SAS-065
- NATO Net Enabled Capability (NEC) Command and Control (C2) Maturity Model

Foundation One

# **NATO CODE OF BEST PRACTICE FOR C2 ASSESSMENT**

# Research & Technology Organization Panels

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- **AVT** Applied Vehicle Technology
- **IST** Information Systems Technology
- **SET** Sensors & Electronics Technology
- **HFM** Human Factors and Medicine
- **SCI** Systems Concepts & Integration
- **SAS** Studies, Analysis & Systems
- **MSG** Modelling and Simulation Group

# Why has the COBP been written

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- First Version of the Code of Best Practice published in 1999
  - Focus on Article V operations
- Revised Version of the Code of Best Practice published in 2002
  - Broadening C2 Assessment to all Operations (including OOTW)

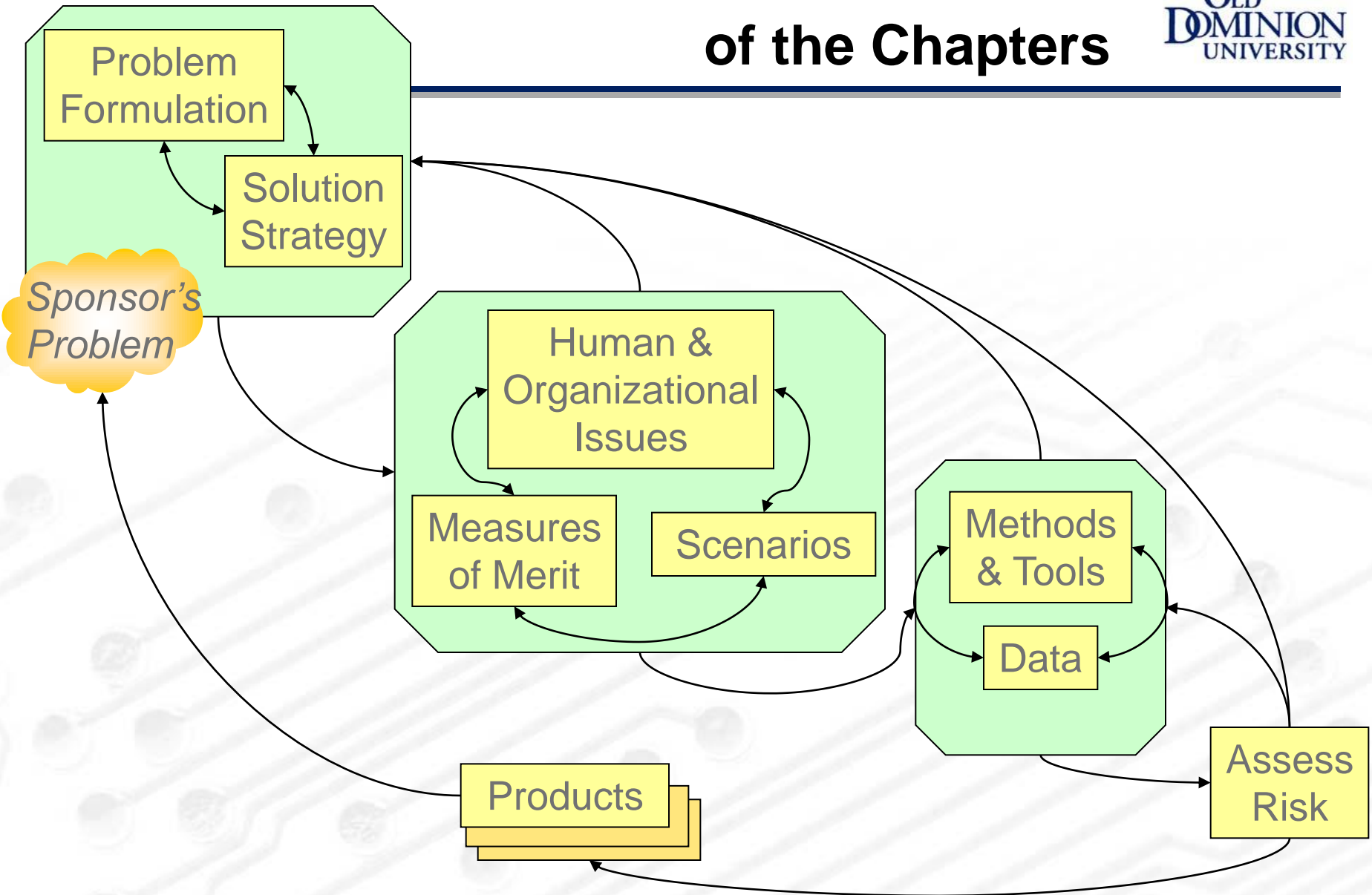
**To offer broad guidance on the assessment of C2 issues for the purpose of supporting a wide variety of decision makers and the conduct of C2 research**

# What is the COBP dealing with

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- *Multilateral dynamics* including interactions with
  - Non-Governmental Organizations (NGO),
  - Private Volunteer Organizations (PVO),
  - International Organizations (IO),
  - International corporations, transnational, sub-national, criminal, and other organizations
- Involve action-reaction dynamics characterized by the impact of interacting *soft elements* such as culture, morale, doctrine, training, and experience

# Overview of the Chapters



# A Roadmap for the Solution

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- Problem Formulation
  - **What** needs to be solved?
  - Addresses the Sponsor's problem
- Solution Strategy
  - **How** the problem will be solved, including
    - Measures of Merit
    - Human and Organizational Issues
    - Scenarios
    - Methods and Tools
    - Data (Sources, Availability)
    - Risk and Uncertainty

# Study Management Plan

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- Inputs from Problem Strategy (**What**) and Solution Strategy (**How**)
- Detailed guidance of the project (examples)
  - Time phased execution plan
  - Work Breakdown Structure
  - Sources for Methods, Tools, and Data
  - Configuration and Quality Management
  - Execution Plan
  - Delivery Milestones
  - Deliverables (Product list)

# Preparation Phase

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- Within the initialization phase, all sections and phases of the study has been dealt with initially to get “The Big Picture”
- The preparation phase deals explicitly with
  - Scenarios and Vignettes
  - Measures of Merit
  - Human and Organizational Issuesin detail to set up the experiments for the evaluation and assessment phase

# How to measure the results

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- Scenarios define
  - Elements
  - Relations
  - Dynamicsto be evaluated within the study related to the questions of the customer
- Measures of Merit enable to evaluate
  - Interim states
  - Final state
  - Particular eventsto deliver the data needed to answer the questions of the customer

**Scenarios capture operational context,  
Measures evaluate various levels of contribution:  
Measures for Performance of Systems  
and Measures for Effectiveness within an Operation**

# Hierarchy of Measures

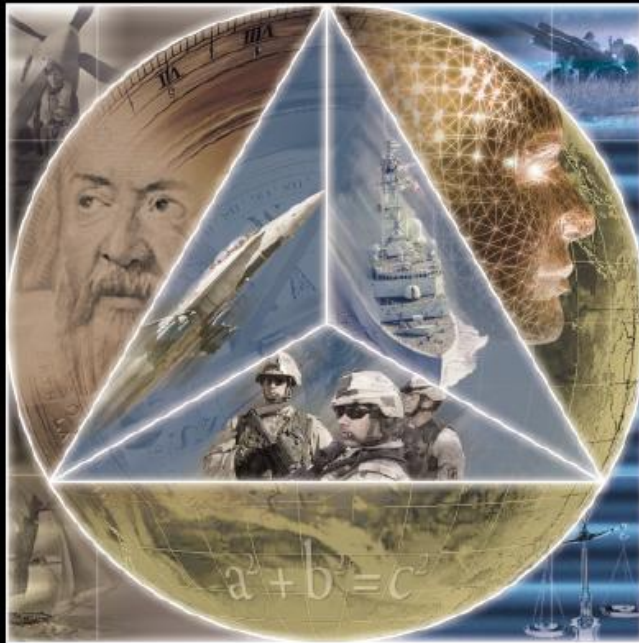
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- **Dimensional Parameters (DP)**
  - Properties or characteristics in physical entities
- **Measures of Performance (MoP)**
  - How do attributes of internal system behavior impact the results
- **Measures of C2 Effectiveness (MoCE)**
  - How C2 systems impact the results
- **Measures of Force Effectiveness (MoFE)**
  - How a force meets mission objectives
- **Measures of Policy Effectiveness (MoPE)**
  - How the political objectives are met

Foundation Two

# **TTCP GUIDE FOR UNDERSTANDING AND IMPLEMENTING DEFENSE EXPERIMENTATION (GUIDEX)**

**Guide for Understanding and Implementing  
Defense Experimentation  
GUIDEx**



The Technical Cooperation Program

- The Technical Coordination Program
  - Australia
  - Canada
  - New Zealand
  - UK
  - USA

# 14 Principles for Effective Experimentation

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## ■ Designing Valid Experiments

1. Defense experiments are uniquely suited to investigate the cause-and-effect relationships underlying capability development.
2. Designing effective experiments requires an understanding of the logic of experimentation.
3. Defense experiments should be designed to meet the four validity requirements.

## ■ Integrated Analysis and Experimentation Campaigns

4. Defense experiments should be integrated into a coherent campaign of activities to maximize their utility.
5. An iterative process of problem formulation, analysis and experimentation is critical to accumulate knowledge and validity within a campaign.
6. Campaigns should be designed to integrate all three scientific methods of knowledge generation (studies, observations and experiments).
7. Multiple methods are necessary within a campaign in order to accumulate validity across the four requirements.

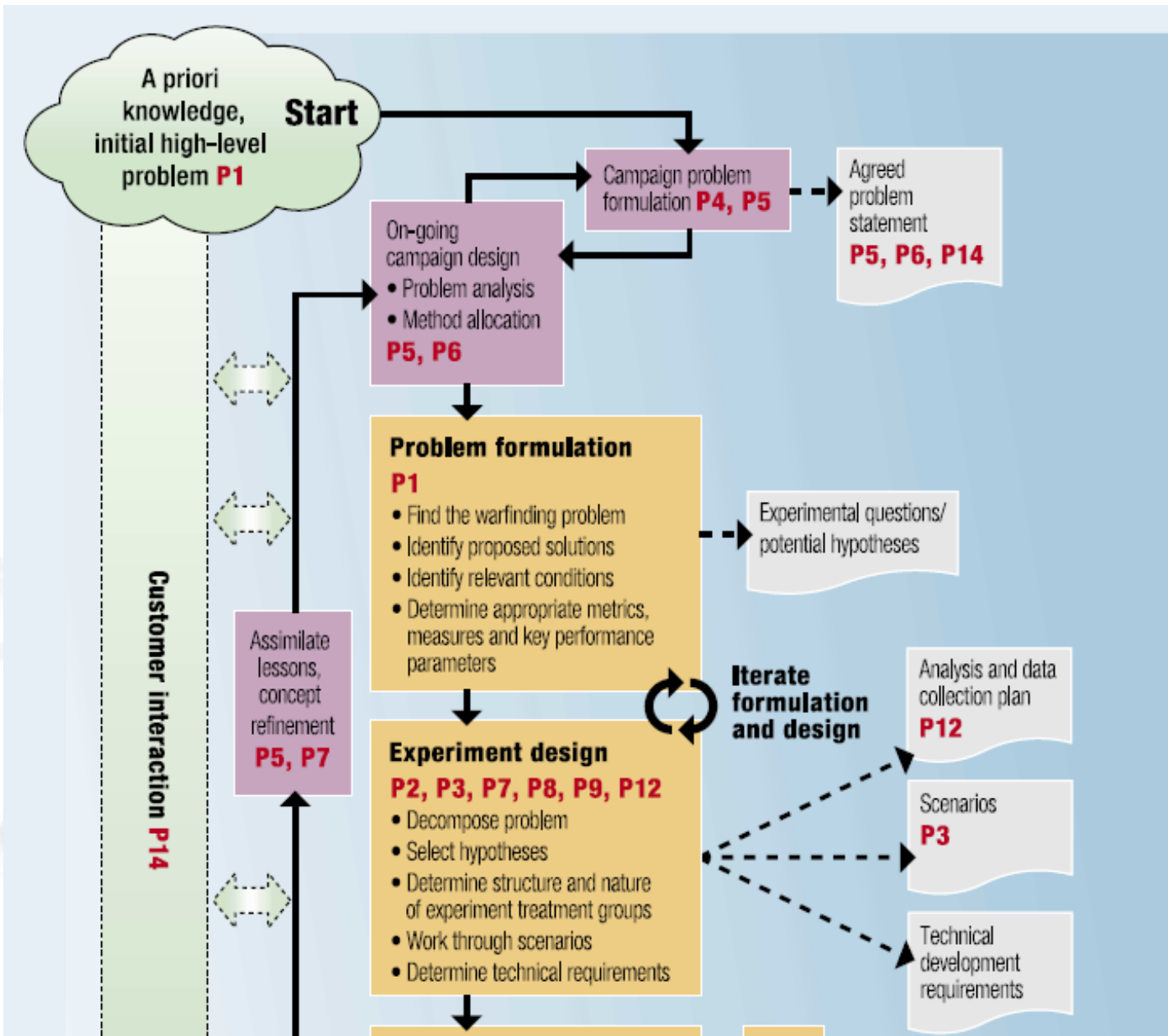
## ■ Considerations for Successful Experimentation

8. Human variability in defense experimentation requires additional experiment design considerations.
9. Defense experiments conducted during collective training and operational test and evaluation require additional experiment design considerations.
10. Appropriate exploitation of modeling and simulation is critical to successful experimentation.
11. An effective experimentation control regime is essential to successful experimentation.
12. A successful experiment depends upon a comprehensive data analysis and collection plan.
13. Defense experiment design must consider relevant ethical, environmental, political, multinational, and security issues.
14. Frequent communication with stakeholders is critical to successful experimentation.

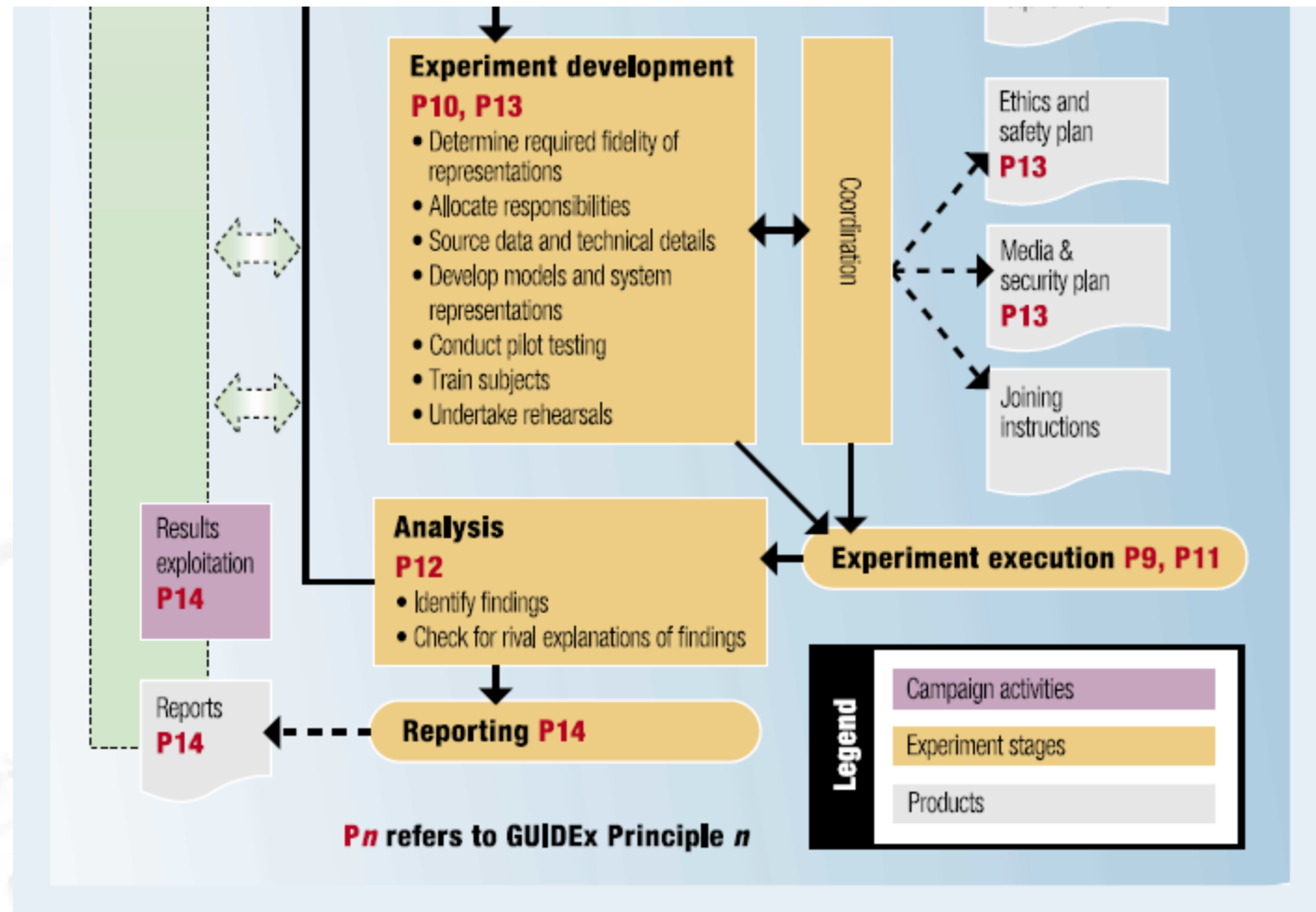
# Logic of Experimentation

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- **If** in an experiment a new solution A is applied
- **Then** the effect B can be observed in the experiment results
- **Showing** in reality that an operational objective can be reached
- Four **Validity** Requirements
  - Ability to employ the new capability (A)
  - Ability to detect change (B)
  - Ability to isolate the reason for change (A→B)
  - Ability to relate results to actual operations



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Foundation Three

## **NATO NEC C2 Maturity Model (N2C2M2)**

# NATO NEC C2 Maturity Model (N2C2M2)

C2 Approach	Allocation of Decision Rights to the Collective	Patterns of Interaction Among Participating Entities	Distribution of Information (Entity Information Positions)
<b>Edge C2</b>	Not Explicit, Self-Allocated (Emergent, Tailored, and Dynamic)	Unlimited As Required	All Available and Relevant Information Accessible
<b>Collaborative C2</b>  <b>Coordinated C2</b>  <b>De-Conflicted C2</b>	Collaborative Process and Shared Plan <hr style="border-top: 1px dashed black;"/> Coordination Process and Linked Plans <hr style="border-top: 1px dashed black;"/> Establish Constraints	Significant Broad <hr style="border-top: 1px dashed black;"/> Limited and Focused <hr style="border-top: 1px dashed black;"/> Very Limited Sharply Focused	Additional Information Across Collaborative Areas/Functions <hr style="border-top: 1px dashed black;"/> Additional Information About Coordinated Areas/Functions <hr style="border-top: 1px dashed black;"/> Additional Information About Constraints and Seams
<b>Conflicted C2</b>	None	None	Organic Information



# SUMMARY

# Summary

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- We do not have to start from the scratch
  - Powerful documentation is available
  - Methods have been successfully applied
  - Lessons learned are published
  
- Maxim of the Operational Context
  - Technical parameters are necessary and valuable, but not a value *per se*
  - Technical parameters define the Measure of Performance
  - Operational context defines the Measures of Effectiveness
  - Technical optimality does not ensure operational optimality
  - Experiment design and metrics are as important as technical specifications

**C2 Assessment must be rooted in Operational Concepts  
and based on Technical Specifications**

# Additional Material

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- **NATO Code of Best Practice for C2 Assessment** (Revised 2002); NATO RTO SAS-026; Command and Control Research Program, Washington, DC  
[http://www.dodccrp.org/files/NATO\\_COBP.pdf](http://www.dodccrp.org/files/NATO_COBP.pdf)
- **TTCP Guide for Understanding and Implementing Defense Experimentation (GUIDEx)**; The Technical Cooperation Program (TTCP), Joint Systems Analysis (JSA) Group, Action Group (AG) 12 on Methods and Approaches for Warfighting Experiments.  
<http://www.acq.osd.mil/ttcp/guidance/guidex.html>
- **NATO NEC C2 Maturity Model**; NATO RTO SAS-065; Command and Control Research Program, Washington, DC  
[http://www.dodccrp.org/files/N2C2M2\\_web\\_optimized.pdf](http://www.dodccrp.org/files/N2C2M2_web_optimized.pdf)
- Tolk, A., Bair, L.J., Diallo, S.Y. (2011): **Extending the Levels of Conceptual Interoperability Models towards an Interoperability Maturity Model**. Journal for Defense Modeling and Simulation (JDMS), DOI: 10.1177/1548512911428457. <http://dms.sagepub.com/content/early/recent>