Applying CMMI-AM to a C4ISR Project from the Buyer's View

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Vita

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- Retired from the Defense Information School, National Defense Management College, National Defense University
- C4ISR research center in Taipei
- Graduated in Computer Science Department, U.S. Naval Postgraduate School, in 1999
- Interested research field
  - Automatic software engineering
  - Computer-aided prototyping system
  - C4ISR system development and implementation

Outlines

- Introduction
- C4ISR systems
- C4ISR systems with CMMI-AM
- Lessons learned

Introduction

- Purpose
- What and how?
- Battlefield objects
- Acquirer and supplier
- Maturity grid of technical and management skill
- Chinese Tai Chi theory

Purpose

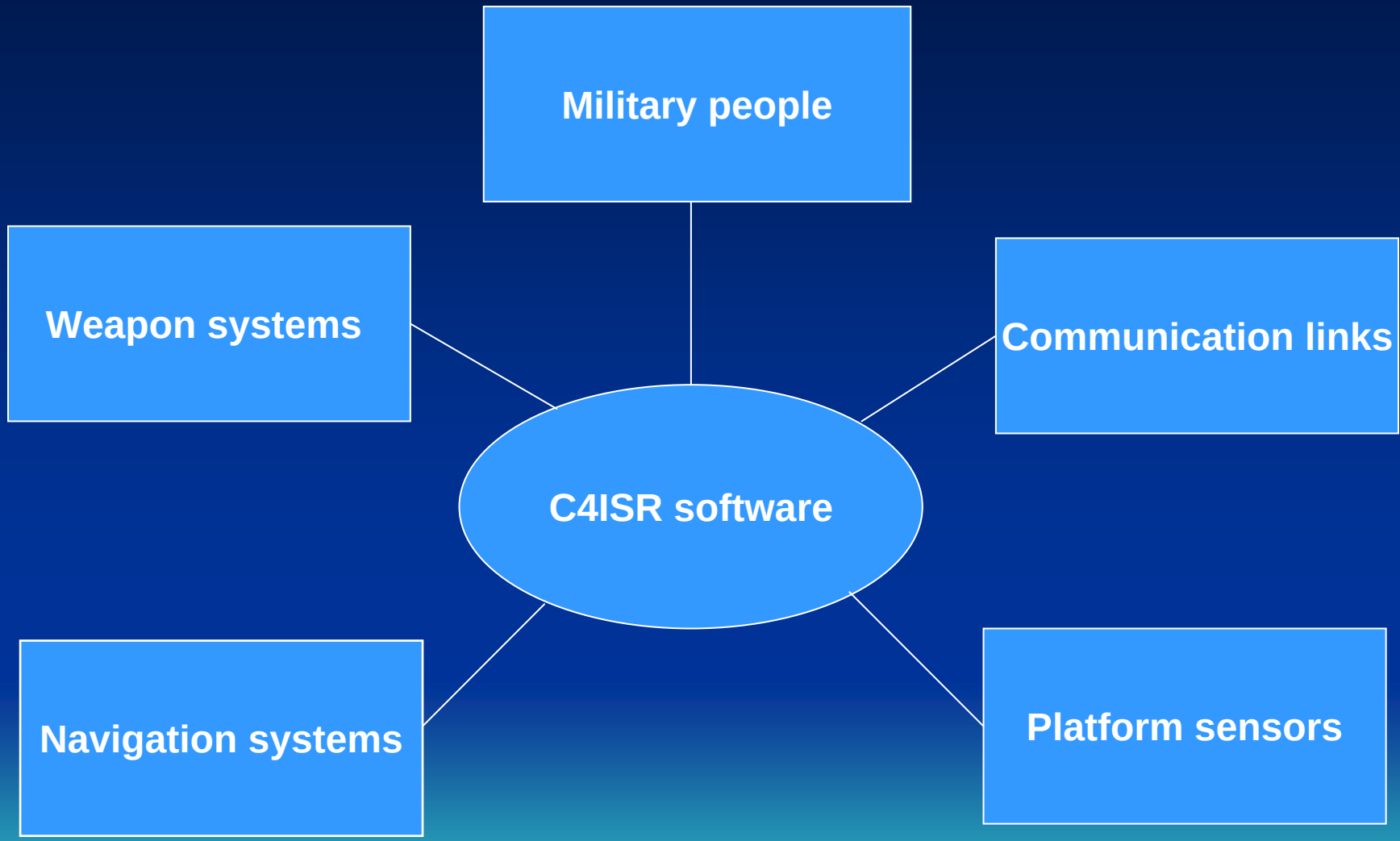
- To find a better approach
  - Rapid prototyping method
  - Object-oriented method
  - CMMI
- To find a better tool
  - CAPS – Computer-Aided Prototyping System
  - CASES – Computer-Aided Software Evolution System
  - SA and DoD AF

What and How

- What is the C4ISR system?
  - C2 systems
  - Real-time embedded systems
  - System of system (SoS)
  - Software intensive systems
  - Object integrated systems
  - Man-machine, Man-battlefield, and Machine-battlefield Systems
  - Tailored systems
- How to develop a suitable C4ISR system?
  - DIY
  - Outsourcing
  - Turn key system

Battlefield Objects

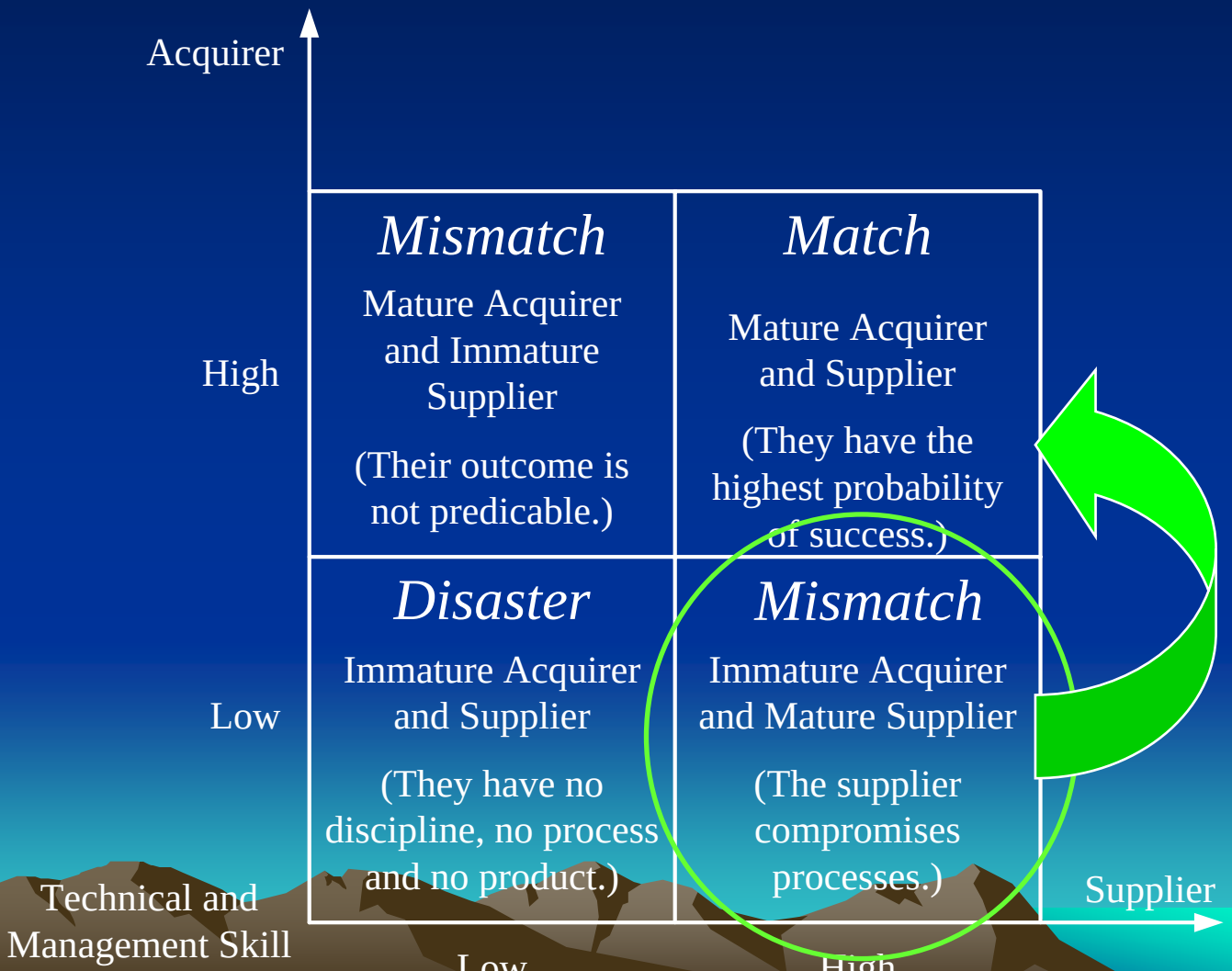
- Military people
- Weapon systems
- Navigation systems
- Platform sensors
- Communication links


Military people
Weapon systems
Communication links
C4ISR software
Navigation systems
Platform sensors

Acquirer and Supplier

- Acquirer
  - Customer or buyer
  - Can the supplier's maturity guarantee the success of a C4ISR project?
  - What can the acquirer do to contribute the success of a C4ISR project?
- Supplier
  - Developer

Maturity Grid of Technical and Management Skill (by Blanchette)



Chinese Tai Chi theory

C4ISR Systems

- Importance of the C4ISR system
- C4ISR system features
- Developmental experiences of a C4ISR system

Importance of the C4ISR System

- *Effective C4ISR is a critical ingredient for the success of any military operation.*

From Wentz's report: NATO-led Implementation Force (IFOR)

C4ISR System Features

- C3I features [Luqi, 1992]
  - Correctness and reliability
  - Requirements are complex and difficult to determine
  - Large distributed systems connected by long-haul networks
  - Complex, dynamic interfaces
  - Low productivity of software development
- Extensive features
  - Integration
  - Interoperability
  - Surveillance
  - reconnaissance

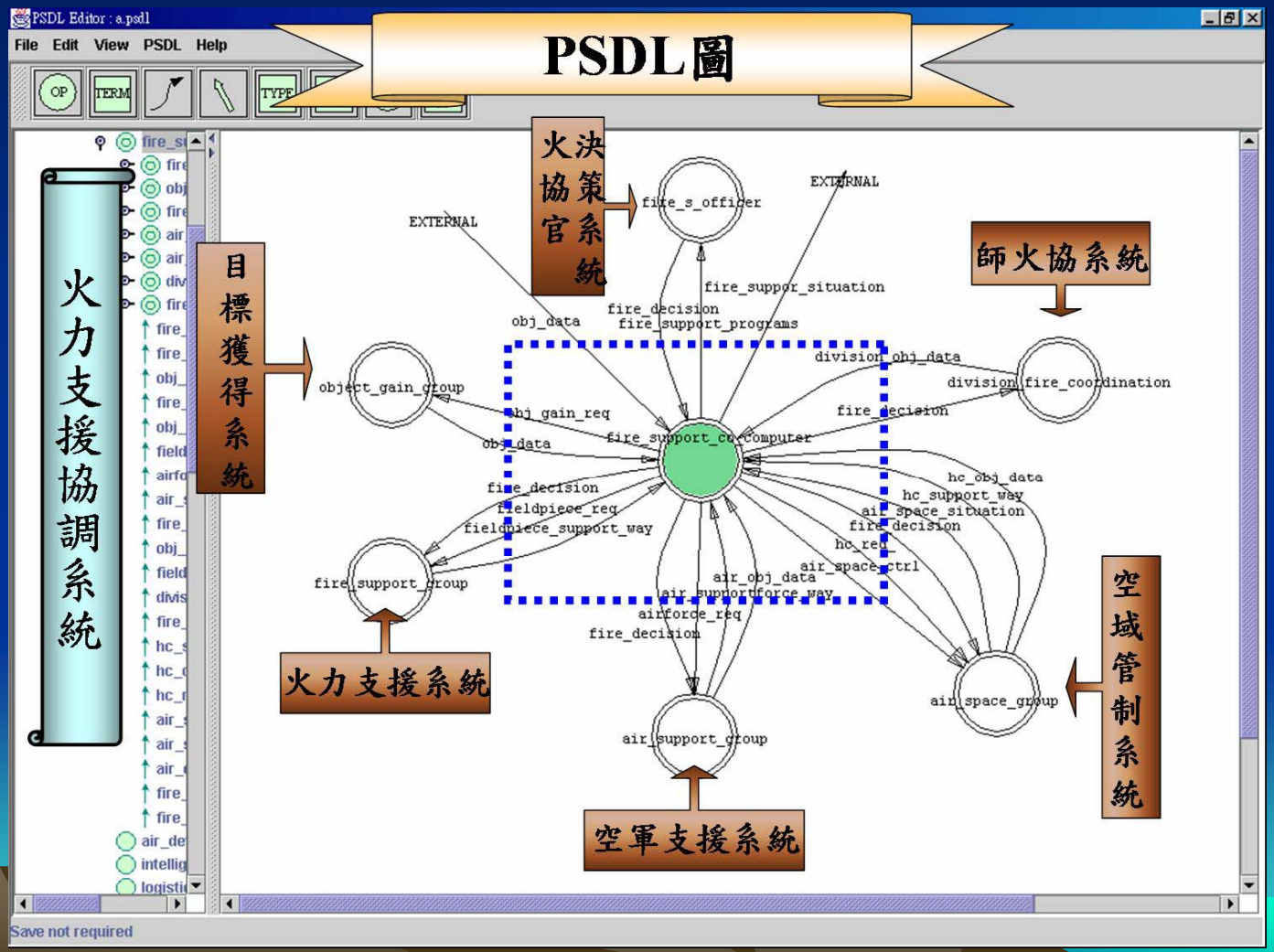
Developmental Experiences of a C4ISR System

- National Defense University of Taiwan, R. O. C
- Over 200 military officers
- Project team
  - 9 groups
  - One leader and 24 members per group in charge of 25 large-grain programs
- 230 large-grain prototypes of C4ISR subsystems [Harn *et al.*, 2004]

An Army C4ISR Prototype System

- Joint Operational Command and Control System (JOCCS)
- Decision Support System of Operation Area Commander (DSSOAC)
- Fire Support and Coordination System (FSCS)
- Battle Command System (BCS)
- Intelligence Surveillance and Reconnaissance System (ISRS)
- Air Defense System (ADS)
- Disaster Control System (DCS)
- Operational Service System (OSS)
- Personnel Information Integration System (PIIS)

Fire Support and Coordination System (FSCS)



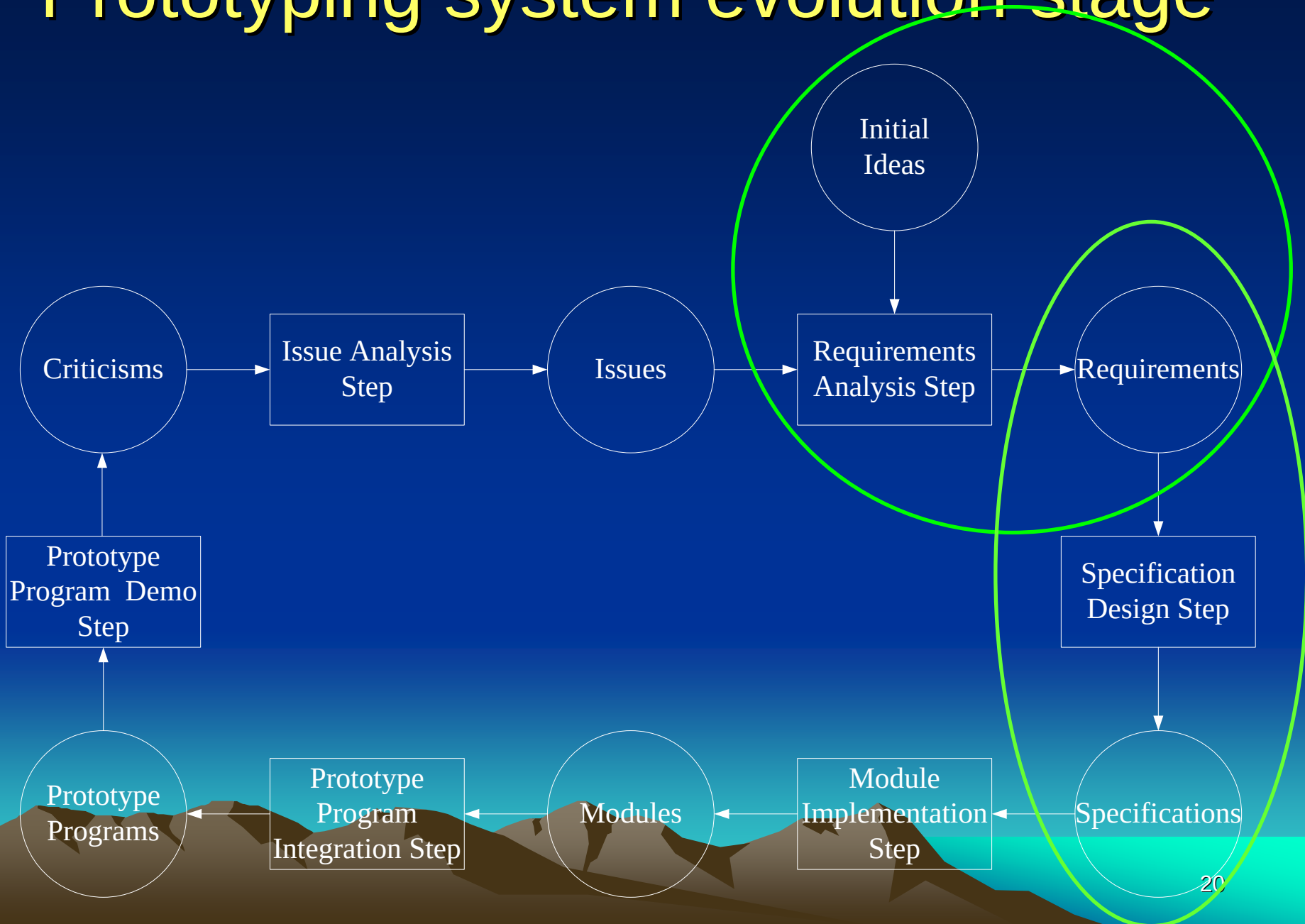
Fire Support and Coordination System (FSCS)

- Object-obtaining subsystems
- Fire-supporting subsystems
- Fire-coordinating subsystems
- Air-supporting subsystems
- Air-controlling subsystems
- Fire-coordinating command and control subsystems

C4ISR System Acquisition

- Prototyping system evolution stage
- Production system generation stage

Prototyping system evolution stage



Formalization of C4ISR systems

- Definition 1 (Requirements Analysis Step) Let *H (N, E, I, O)* be a *relational hypergraph*. Let i_i be an *initial idea* or an *issue* component with version *i* and r_i be a *requirement* component with version *i*, for *i = 1*,…, *n*. We say that the hyperedge e_i € *E* is called a *requirements analysis step* with version *i* if and only if there exists a *secondary input node* i_{i-1} € *N* to the hyperedge e_i, a *primary input node* r_{i-1} € *N* to the hyperedge e_i, and an output node r_i € *N* to the hyperedge e_i, where i_{i-1} in $I(e_i)$, r_{i-1} in $I(e_i)$ and r_i in $O(e_i)$.

Formalization of C4ISR systems

Operational Need

CMMI Acquisition Module

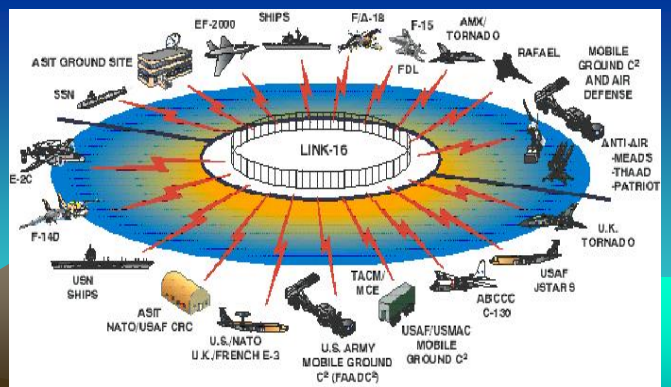
Acquirer

Acquisition Planning	RFP Prep.	Solicita-tion	Source Selection	Program Leadership Insight / Oversight	System Acceptance	Transition

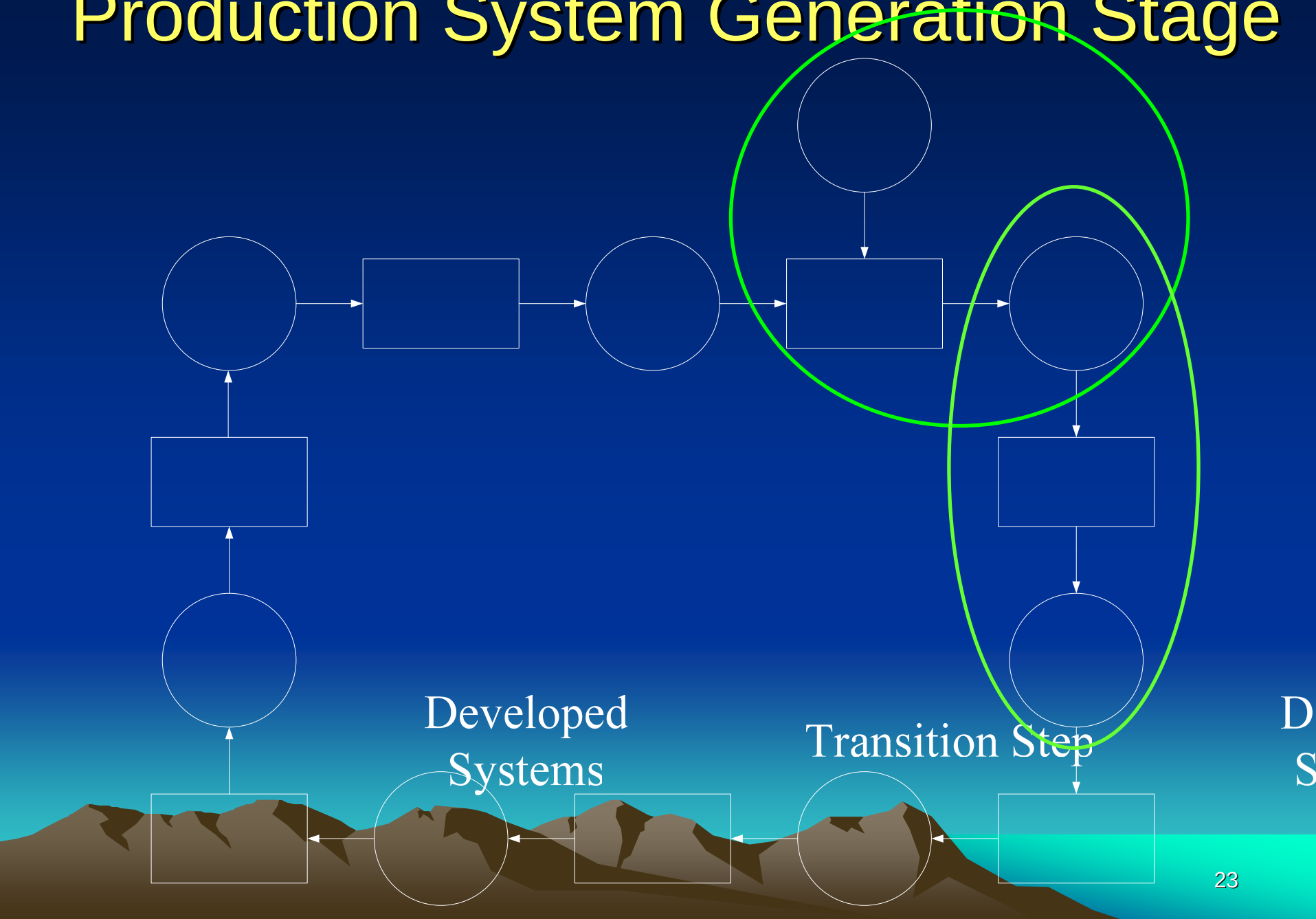
DEVELOPER

Plan	Design	Develop	Integrate & Test	Deliver

CMMI-SE/SW/IPPD/SS



Production System Generation Stage



Formalization of C4ISR systems

- Definition 7 (Acquisition Planning Step) Let *H (N, E, I, O)* be a *relational hypergraph*. Let y_i be an *operational need* or a *delivered system* component with version *i* and a_i be an *acquisition plan* component with version *i*, for $i = 1,\ldots, n$. We say that the hyperedge $e_i \in E$ is called an *acquisition planning step* with version *i* if and only if there exists a *secondary input node* $y_{i-1} \in N$ to the hyperedge e_i, a *primary input node* $a_{i-1} \in N$ to the hyperedge e_i, and an output node $a_i \in N$ to the hyperedge e_i, where y_{i-1} in $I(e_i)$, a_{i-1} in $I(e_i)$ and a_i in $O(e_i)$.

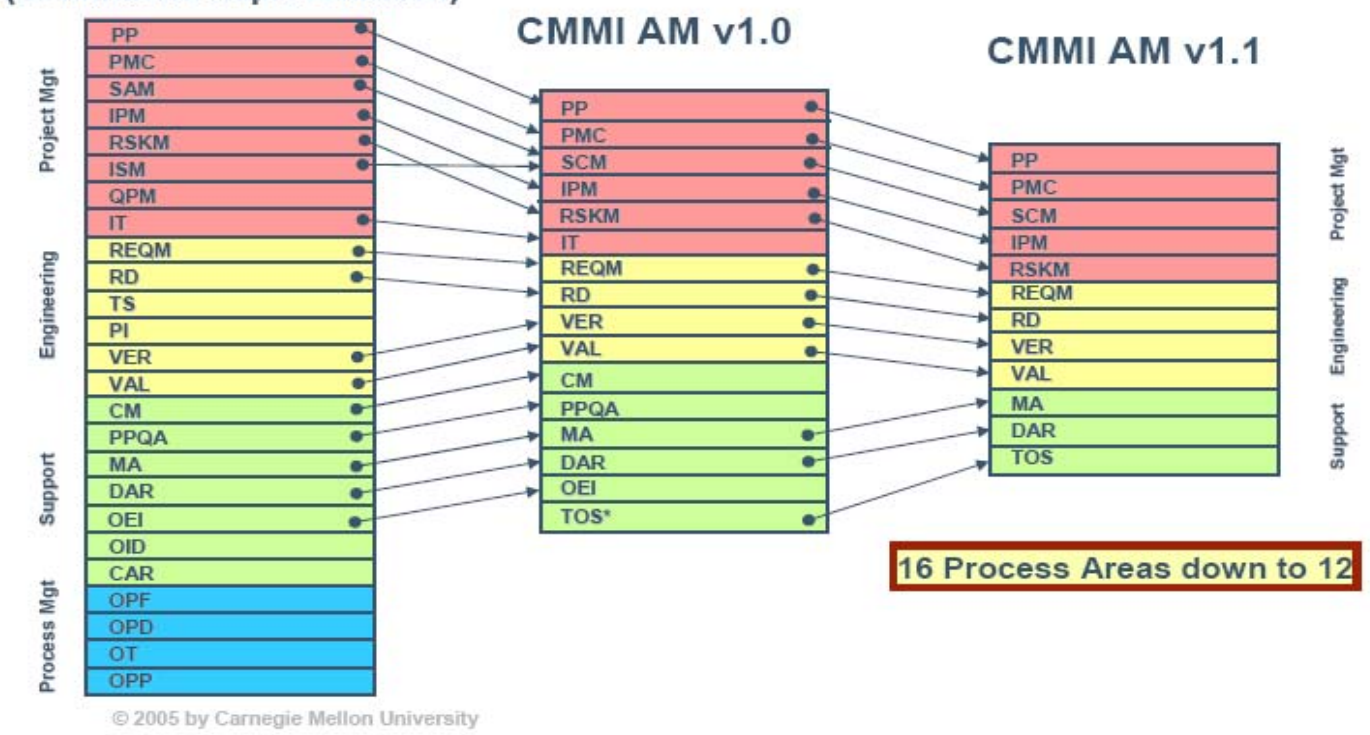
C4ISR Systems with CMMI-AM

- CMMI-AM
- CMMI-AM process areas
- Formalizing the C4ISR system development process
- Selecting CMMI-AM guidelines
- CMMI-AM and the project organization

CMMI-AM

Carnegie Mellon
Software Engineering Institute

Evolution of the CMMI-AM v1.1



CMMI-AM Process Areas

CMMI Acquisition Module Process Areas	
Category	Process Areas
Project Management	Project Planning (PP) Project Monitoring and Control (PMC) Solicitation and Contract Monitoring (SCM) Integrated Project Management (IPM) Risk Management (RSKM)
Engineering	Requirements Management (REQM) Requirements Development (RD) Verification (VER) Validation (VAL)
Support	Decision Analysis and Resolution (DAR) Measurement and Analysis (MA) Transition to Operations and Support (TOS)

Formalizing the C4ISR System Development Process

- The prototyping system evolution stage
  - CAPS
  - CASES
  - CMMI-AM
- The production system generation stage
  - SA with DoD AF
  - CMMI-AM

Selecting CMMI-AM Guidelines

- Selected guidelines
- Ignored guidelines

CMMI-AM and the Project Organization

- Kernel project team
  - Acquirer
  - Inner project team
  - Hierarchical Organization
    - Project leader
    - Project manager
    - Project specialist
- Virtue project team
  - Supplier
  - Outer project team

Lessons Learned

- Developing a project management platform of the CMMI-AM on the web
- Analyzing the guidelines of the process areas of the CMMI-AM
- Selecting the suitable guidelines of the CMMI-AM
- Designing a digital learning environment to train our project team members
- Enhancing the business organization maturity
- Modifying the CASES and the CAPS