A Reference Architecture for Network-Centric Information Systems

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What problem does C2ERA try to solve?

What are the key aspects of the solution?
What The Users Want

- C2 users would like to have a single perfect C2 system
  - It does exactly what they need today
  - It’s easy to change into what they need tomorrow
  - All users and all parts working together as a seamless whole
  - Affordable, on schedule, etc...

- We couldn’t build that perfect system yesterday
  - And still can’t today
The Past Compromise

- Instead, we organized the world into program offices that built separate C2 systems
- A program built a system for its users
The Past Compromise

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- A program built a system for its users
  - All the mission functionality they wanted
  - All the infrastructure they needed
The Past Compromise

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- A program built a system for its users
  - All the mission functionality they wanted
  - All the infrastructure they needed
  - Delivered as a single amalgamation
The Past Compromise

- Instead, we organized the world into program offices that built separate C2 systems
- A program built a system for its users
  - All the mission functionality they wanted
  - All the infrastructure they needed
  - Delivered as a single amalgamation
- And other programs built other systems for other users...

*Hundreds of C2 systems...*
A Forest Of Stovepipe Systems
The C2 Enterprise Integration Problem

It’s difficult for these people to work together

Because it’s hard to make the systems they use interact with each other
Symptoms

- Hard to connect separate C2 systems
  - Different infrastructures

- Hard to make systems exchange C2 information
  - Shared semantics are difficult to arrange

- Hard to administer groups of C2 systems
  - Each system needs its own sysadmin staff

- Hard to manage change in C2 systems and functions
  - Inflexible interfaces
  - Rigid infrastructure
The Result

- Unhappy users
- Important C2 capabilities that we can’t afford, or build at any price
- Inflexible, stovepipe systems
- Co-evolution is impractical
- Delay in achieving NCW
The C2 ERA Solution

- Change how we organize C2 enterprise acquisition
  - Manage programs and systems as components of C2 Nodes

- Change how we build the individual C2 applications
  - Don’t build separate infrastructure for each system
  - Deliver applications that share a C2 Node Platform and a Common Integrated Infrastructure

Two different changes…
both built around the same C2 Node concept
First Change: How We Organize Acquisition

Begin with users that must cooperate closely

Program offices build the applications that those users need

C2 Node Manager ensures that those applications are seamlessly integrated
First Change: How We Organize Acquisition

Begin with users that must cooperate closely

Program offices build the applications that those users need

C2 Node Manager ensures that those applications are seamlessly integrated

And delivers integrated applications as a cohesive C2 weapon system
First Change: How We Organize Acquisition

Repeat for each distinct C2 Node User Community and each C2 Node Capability

Operational concerns dominate the selection of C2 Node boundaries...

But technical concerns can’t be ignored – because you must be able to build the “weapon system” you want

Result: Many fewer C2 Nodes… better, but still not good enough
Today’s Enterprise Integration Problem

Operational/Domain Focused

Capability 1

Capability 2

Capability 3

Capability n

System 1

System 2

System m

10s of Capabilities (n)

1000s of Systems (m)

10,000s (n*m) of Integration Points

Systems/Technology Focused
C2 Node Impact on Enterprise Integration

Enterprise Integration Problem
10s of Capabilities (n)
10s of Nodes (k)
100s (n*k) of Integration Points

Per Node Integration Problem
10s of Capabilities (n)
10s of Systems (k)
100s (n*k) of Integration Points
C2 Nodes

- **C2 Node:** A set of materiel and non-materiel solutions that is managed as a weapon system and provides warfighting capability at a specific location or set of locations.

- C2 Nodes are defined as strategically selected integration points to implement cross-mission and cross-capability integration.

- Well chosen C2 Nodes will:
  - Display **operational cohesion:** Have users who need to collaborate closely to perform their missions.
  - Display **implementation cohesion:** Collect and integrate mission applications which must work together seamlessly to support the users.
  - Display **infrastructure cohesion:** Collect mission applications which can be implemented using the same "C2 Node Platform" infrastructure.
Users and Systems Collected Into C2 Nodes

COI: Community of Interest
Second Change: How We Build

Most program offices build mission applications

Applications and infrastructure are CLEARLY SEPARATED…
– Apps use infrastructure
– Ideally nobody builds both

A few program offices build infrastructure
Second Change: How We Build

- Programs build mission applications to satisfy user requirements
- Those applications must use the infrastructure specified, built, and operated by somebody else
- We can’t build a single infrastructure that does everything for everyone, so...

INFRASTRUCTURE
Second Change: How We Build

- We split the infrastructure into two parts
- One part is different for each node
  - The C2 Node Platform is chosen by each Node Manager
- One part is the same for the entire C2 Enterprise
  - The Common Integrated Infrastructure is managed “like a node”
- The C2 Enterprise Reference Architecture describes the services in each part
Information Technology Overview

- Global Grid – seamless, enterprise network
- Enterprise directory of people, services, etc.
- Component frameworks – a way to build applications
- XML Web Services – how C2 Nodes interact
- Enterprise info assurance services
- Info Assurance constraints across the architecture
Why Divide The Infrastructure?

- Why have Node Platforms? Why isn’t everything in the CII?
  - Dependencies between nodes
  - Hard to change and evolve

- Why have the CII? Why isn’t everything in Nodes?
  - Some things *must* be the same

- What makes a service belong in the enterprise-level CII?
  - Enterprise essential
  - Enterprise control
  - Enterprise scale
  - Enterprise content or connectivity
**CII Example: Domain Name Service (DNS)**

Q: What is the IP address of www.acc.af.mil?

A: 131.6.12.199

**DNS belongs in the CII because:**
- DNS is a service
- DNS is essential
- Nobody builds their own DNS
- DNS is available everywhere
- It is the same DNS everywhere
- The DNS content is created by many people
- All this works because the rules for connecting DNS servers and for creating DNS content are the same for the whole enterprise.
DNS Is More Than Software

Q: What is the IP address of www.acc.af.mil?

[no response]
DNS Is More Than Software + Hardware

Q: What is the IP address of www.acc.af.mil?

A: unknown

Common Integrated Infrastructure
DNS Is People, Process, and Technology

Q: What is the IP address of www.acc.af.mil?
A: 131.6.12.199

Let www.acc.af.mil = 131.6.12.199
Result of the Two Changes

- Gather together (within each C2 Node) applications, which formerly were separate and independent
- Separate each application from its infrastructure... things which formerly were combined together
- Improved cohesion between things that should work together
- Reduced coupling between things that should change independently
- Better functionality and flexibility

New technology supports these improvements
C2ERA and GES / NCES

Common Integrated Infrastructure

Node Platform

XML

Node Platform

Levels of Services above core level

Community-of-Interest (COI) Capabilities

Comms Backbone

Core Enterprise Services (CES)

Global Information Grid (GIG) Enterprise Services (GES)
Summary

- C2ERA makes two changes to C2 systems
  - Manage related applications as C2 Nodes
  - Separate mission functionality from infrastructure

- Infrastructure separated into
  - Common Integrated Infrastructure (CII)
    Same for the whole enterprise
  - Node platforms – can be different for each C2 Node

- Consistent with new DoD approach

- Result: better functionality and flexibility

- Made feasible by new technology