



# **Final Report**

## ***Roadmap to the Single Integrated Picture (SIP) Study***

**25 September 2001**

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**National Defense Industrial Association (NDIA),  
Strike, Land Attack and Air Defense (SLAAD) Committee**

# The Benefits of Collaboration

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**“When you assemble a number of men to have the advantage of their joint wisdom, you inevitably assemble with those men all their prejudices, their passions, their errors of opinion, their local interests and their selfish views.”**

**Benjamin Franklin**

- I** • **Section I --- Introduction**
  - *Terminology and Context --- Vocabulary and Analytical Framework*
- II** • **Section II --- Recommendations**
- III** • **Section III --- Insights and Issues**
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# Section I

# Introduction

**National Defense Industrial Association (NDIA),  
Strike, Land Attack and Air Defense (SLAAD) Committee**

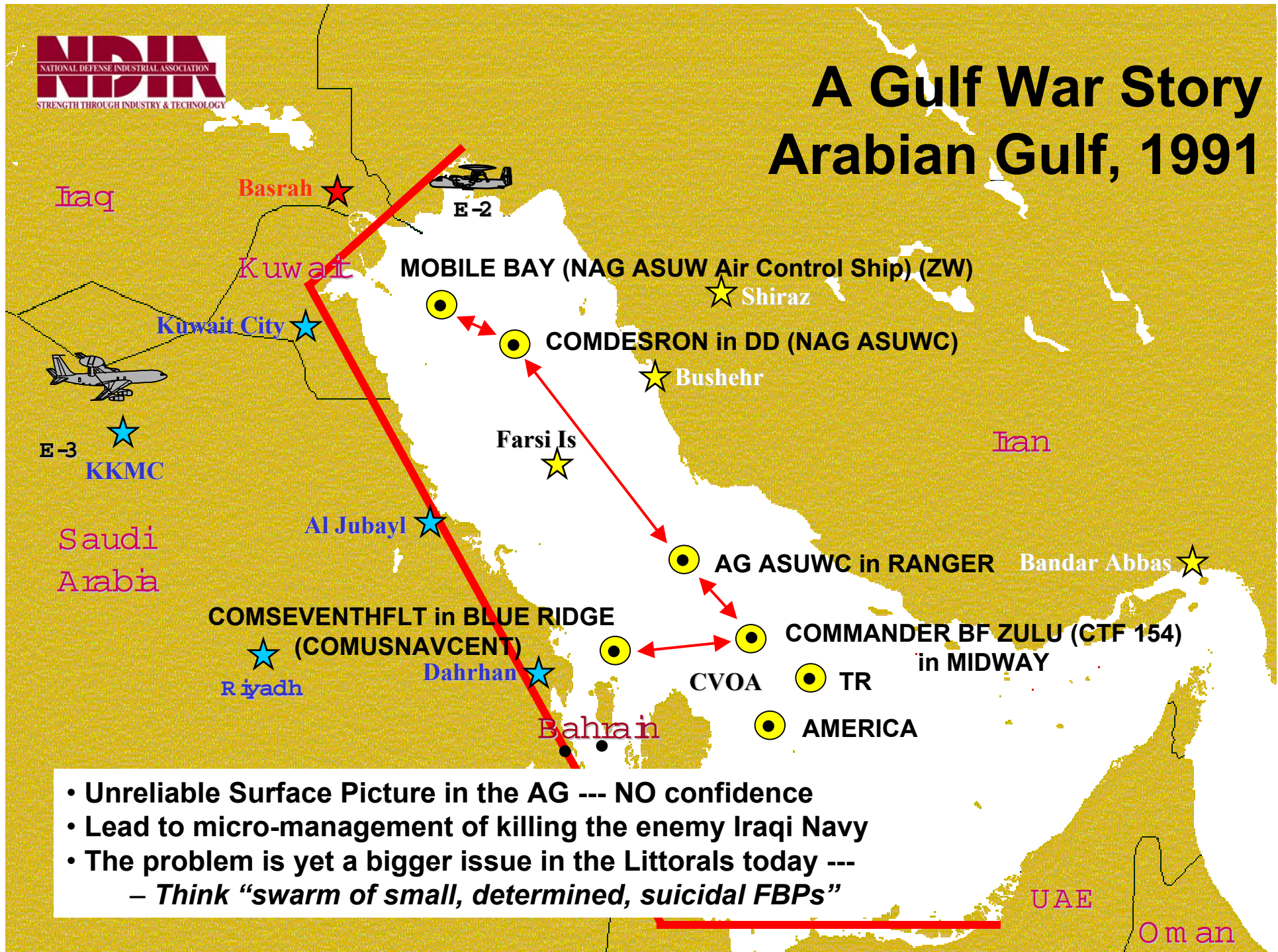
# Why We Need A SIP Statement of the Requirement

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- **In the context of Joint warfighting, the Joint Force Commander, all Subordinate Commanders, and other users need a Single Integrated Picture (SIP) for command and control, battlespace situational awareness, and for the coordination, control, integration, and deconfliction of all force movements and fires, within realistic, combat-driven timelines**
- **The SIP is directly scalable to overall Joint, Allied & Coalition levels**

- **The timing is right for transformational thought**
- **The Navy is in the ideal position to take the lead in building the foundation for creating a SIP for the warfighters, beginning with integrated Surface and Undersea Pictures**
- **The effort will require proactive collaboration with the other Services and Agencies**
- **The effort will also provide a vehicle for transcending PPBS with respect to Joint Interoperability, in all its aspects**

# A Gulf War Story Arabian Gulf, 1991



- Unreliable Surface Picture in the AG --- NO confidence
- Lead to micro-management of killing the enemy Iraqi Navy
- The problem is yet a bigger issue in the Littorals today ---  
– Think “swarm of small, determined, suicidal FBP’s”

# A Story from the Future

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- **What if CONUS were to be attacked by cruise missiles from a ship or submarine offshore?**
  - *How would we know who did it, without a Surface, Undersea, or Air Picture?*
  - 1 – *A similar scenario was recently exercised in a June 2001 FTX AMALGUM VIRGO 01, a NORAD homeland defense exercise in the Gulf of Mexico*
- **What if Taiwan were to be similarly attacked?**
  - *Again, how would we know who did it?*
- **Our ability to track down the instigator of such attack would require several elements of a SIP**
  - *Including especially an historic and near-real-time Surface, Undersea, and Air Pictures*

## “Cleaning the Augean Stables ...”

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- **Beyond the networks themselves, the foundation for Network Centric Warfare is the Single Integrated Picture**
- **A satisfactory SIP as we define it does not exist today**
  - *Elements are in various stages of development, from fielded to conceptualized*
  - *Integration of these elements is required to get a SIP --- it is a non-trivial and continuing systems engineering task*
- **The SIP challenge mirrors the complexity of modern warfare**
  - *Multi-Service, multi-Agency, NGO, Multi-National, ....*
  - *The value of SIP and related interoperability issues reaches well beyond the Services and Intelligence Agencies*

***This is real hard !***

# SIP Study Leadership

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- **Study Sponsor: VADM Dennis V. McGinn, USN, OPNAV (N7)**
    - *Co-Sponsors include Dr. Susan Marquis, Acting OPNAV (N8) and VADM Richard A. Mayo, USN, OPNAV (N6), as well as POCs RADM Daniel R. Bowler, USN (N70), RADM Lewis W. Crenshaw Jr., USN (N81), and RADM Thomas J. Wilson III, USN (N76B)*
    - *Also included: VADM Al Harms, USN (former N81), RADM John Kelly, USN (former N76B)*
  - **Study leadership:**
    - ***Dr. Stephen R. Woodall***
      - *Study Director; representing NDIA Strike, Land Attack and Air Defense (SLAAD) Committee, Theater Air Defense (TAD) Sub-Committee*
        - *Consultant to CSC & President and CEO, Strategic Synthesis, Ltd.*
    - ***The SIP Study Group Team !***

# SIP Study Participation

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- 2** • **Participating Organizations**
  - *More than 95 people from 35 Corporations and Companies*
  - *More than 80 people from 27 Department of Defense Organizations, including DoD, the Joint Staff, the Services and other Service and Joint Organizations*
  
- 3** • **More than 70 subject matter experts have provided briefings**

## 4 SIP Study Analytical Approach

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- **SIP Concept Definition Team**
  - *Leader: Jim Aitkenhead (SPAWAR Systems Center)*
- **Interoperability and Architecture Team**
  - *Leader: Paul Work (CSC WIDAN)*
- **Technologies Team**
  - *Leader: Dan Bogdewic (SAIC)*
- **Analysis Team**
  - *Oleg Jankovic (J&A)*
- **Linkage Coordinator across Teams**
  - *Chris MacNulty (Applied Futures)*

# SIP Definition

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- **The Single Integrated Picture (SIP) is timely, fused, accurate, scalable and reliable information from the entire battlespace / area of operations --- undersea, surface, ground, air, space, and cyberspace --- maintained within realistic, combat-driven timelines, that can be tailored to meet the mission planning, execution, and assessment needs of each user.**

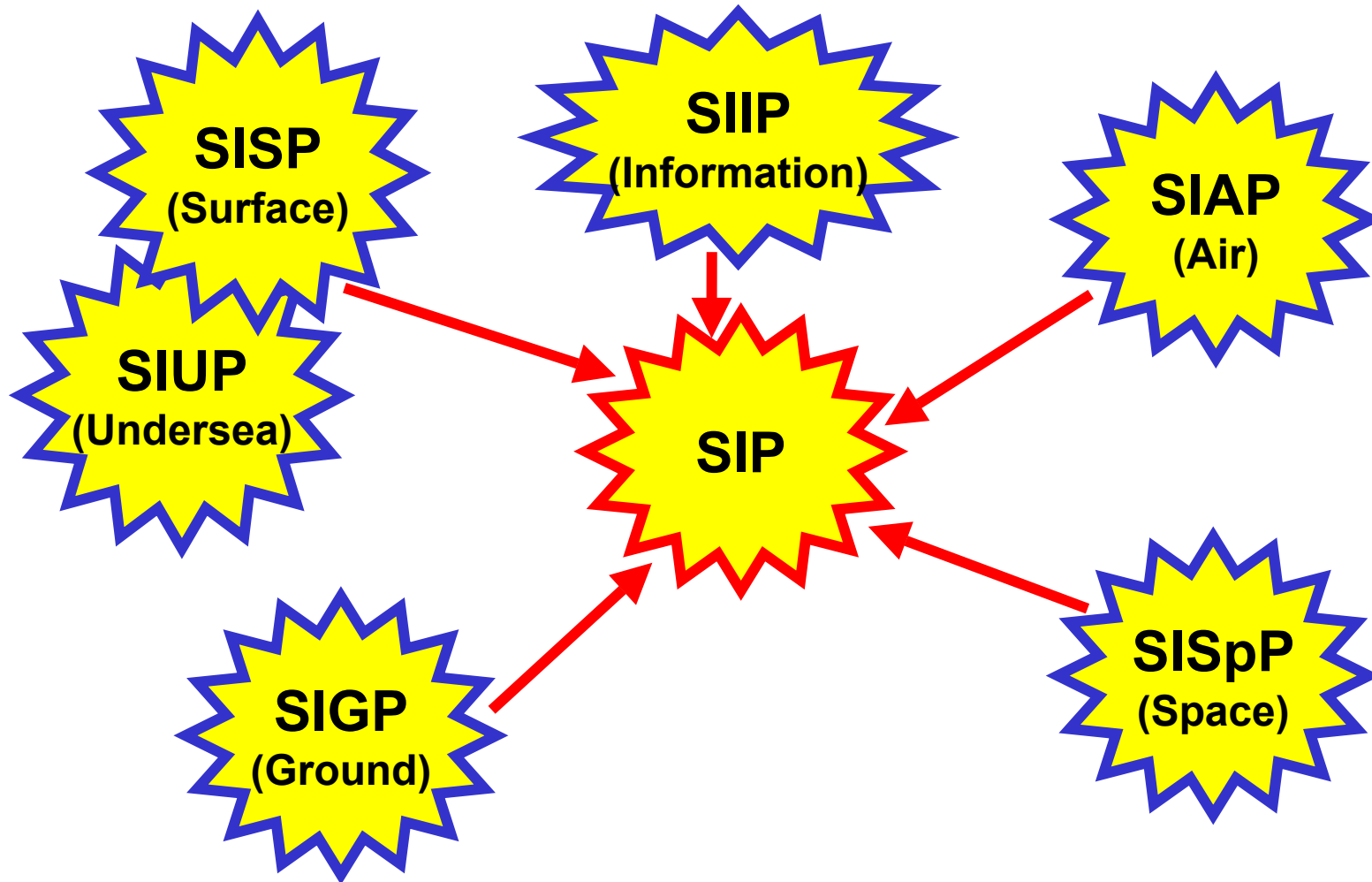
***Coherent, Consistent, Credible***

# Decomposition of the Term “SIP”

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- **SIP is the enabler that allows the Commander to “Tell the Story”**
  - *Not just “Paint the Picture” --- **the SIP puts the data in context***
- **S is for “Single”**
  - *All members of the network have access to the same data.*
- **I is for “Integrated”**
  - *The data base consists of all the data available from sensors, links, networks and other sources--- fused, correlated, and deconflicted --- so that there is one file per object*
- **P is for “Picture”**
  - *The Picture is NOT just symbols displayed on a screen, a visualization*
  - ***The “Picture” is a Data Base***
  - *Symbols on a screen are an interpretation of the data base, tailored to the user, mission, and command level*

# SIP (SixP) Elements



# SixP Elements

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- The diagram features a central yellow starburst with the text 'SIP' inside. Six orange arrows point from this central starburst to six surrounding blue starbursts, each containing one of the SixP elements: SIUP, SISP, SIGP, SIAP, SISpP, and SIIP. The list of elements is positioned to the left of the diagram.
- **SIUP** --- Mines, submarines, other undersea vehicles and systems
  - **SISP** --- Surface vehicles and platforms, raised periscopes
  - **SIGP** --- Ground vehicles and objects
  - **SIAP** --- Air vehicles, missiles, bullets
  - **SISpP** --- Satellites, space vehicles and objects, ballistic missiles, warheads, other reentry vehicles (including decoys)
  - **SIIP** --- Intelligence, surveillance, and reconnaissance data, network configurations, capacity and status, media feeds, plan elements, Blue Force readiness and logistics information, political indicators, economic indicators, cultural/social indicators, ...

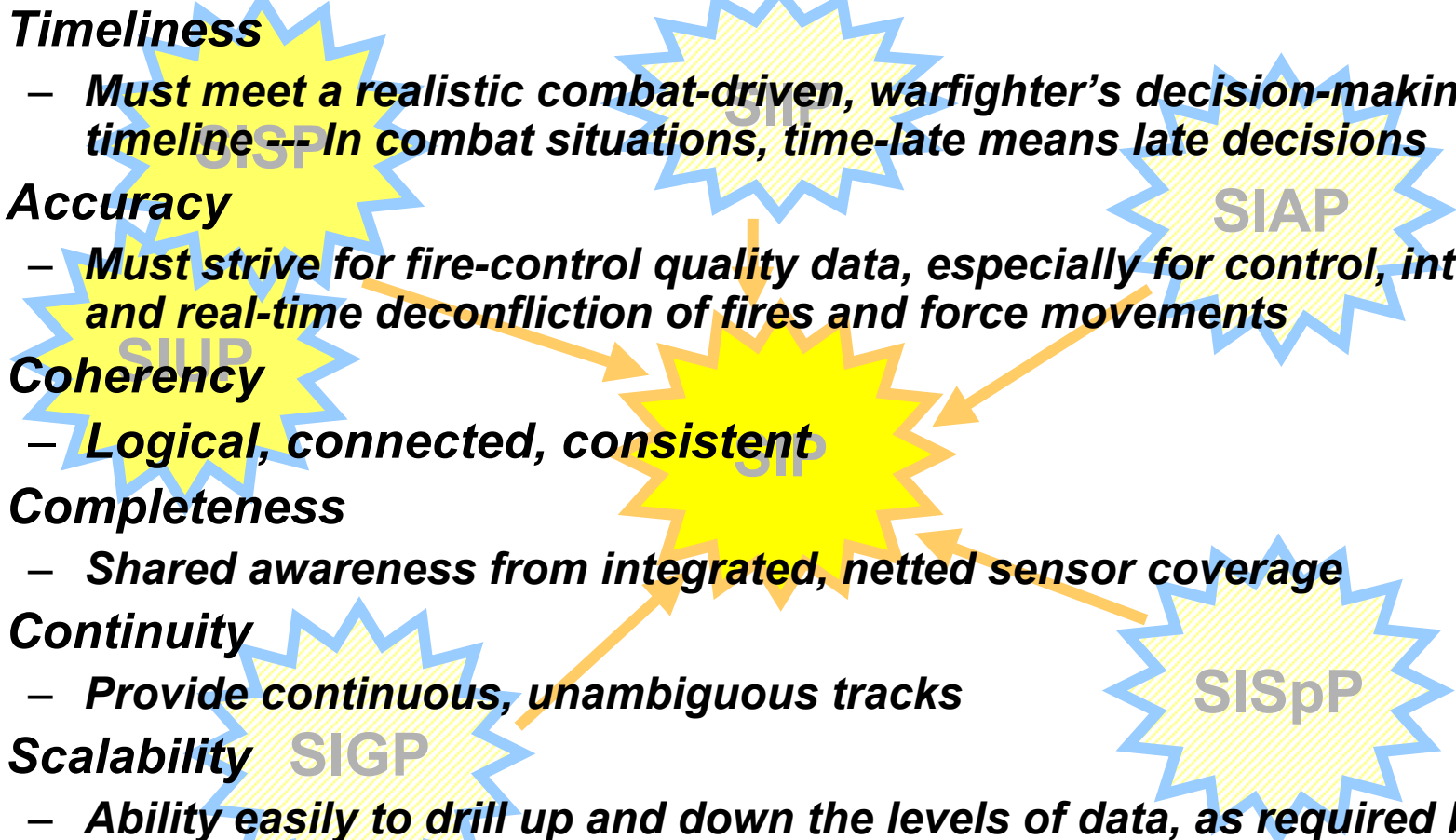
# SixP Common Elements

- Terrain and elevation data, both land and underwater  
Forests and swamps, mountains and desert, lakes and rivers, ...
- Infrastructure, including cultural features such as roads, buildings, power grid, ...
- Weather, atmospheric electromagnetic, underwater temperature and acoustic data, currents and eddies, etc., ...
- Plan elements, templates
- Blue Force readiness and logistics information
- Major lines of communication, including Maneuver corridors, air defense corridors, sea routes, Q-routes, orbits, ...
- Political, economic, socio-cultural features

# SixP Status Today

- **SIUP** --- ASTO/SEA 93 CUP effort, no POR
- **SISP** --- No POR; pieces exist in form of AWS, ACDS, GCCS-M, Link 11/16, ... but there is no Single Integrated Surface Picture Program
- **SIGP** --- USA ABCS CTP/JCDB; USMC working with Army
- **SIAP** --- Joint POR, working Link 16 interoperability
- **SISpP** --- SPACECOM / NORAD picture exists, but catalog limited and not widely sharable with current C<sup>2</sup> systems; TBMD picture is situation and sensor-availability specific
- **SIIP** --- GCCS I3 (Intel, Information & Imagery), JIVA/JEP, GBS/IDM, Multi-dimensional, no overall POR; recently, the Navy designated N2 as the ISR Manager for Acquisition

# SIP Attributes

- **Timeliness**
    - *Must meet a realistic combat-driven, warfighter's decision-making timeline --- In combat situations, time-late means late decisions*
  - **Accuracy**
    - *Must strive for fire-control quality data, especially for control, integration, and real-time deconfliction of fires and force movements*
  - **Coherency**
    - *Logical, connected, consistent*
  - **Completeness**
    - *Shared awareness from integrated, netted sensor coverage*
  - **Continuity**
    - *Provide continuous, unambiguous tracks*
  - **Scalability**
    - *Ability easily to drill up and down the levels of data, as required by users*
- 

**Confidence is a function of all of these.**



## **Section II**

# **Recommendations**

**National Defense Industrial Association (NDIA),  
Strike, Land Attack and Air Defense (SLAAD) Committee**

# Roadmap to the SIP 2001 Introductory Thoughts

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- Navy should build a foundation for creation of the SIP
- Start with the naval set of foundation elements --- the SISP and SIUP
- Apply the successful, multi-Service processes of evolving SIxP foundation elements, especially SIAP
- 5 – *Take into account what has been learned from other Common Picture efforts, such as FIOP, CROP, GFIIAP*
- Begin to create naval infrastructure changes necessary to create, manage, and disseminate the “SIP Data Base” (SIPDB) --- including the SISP and the SIUP

# Introductory Thoughts, Continued

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- **SIP is an ideal example of a system of systems, to which to apply the MCP Process**
- **A** • **Toward that end, we have begun draft:**
  - ***SIP CONOPS, MNS --- Requirements for the “Ideal SIP” described***
  - ***OV Diagrams, Operational Vignettes as Illustrations***
  - ***Capability Evolution Description (CED) --- Roadmap to the SIP***
  - ***SIP Technology Roadmap***

# Begin with What the Navy Can Do

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- **Start with both the SISP and SIUP**
- **Put someone in OPNAV in charge --- we recommend N7**
- **Consider running a Fleet exercise, to ...**
  - ***Determine (measure) the validity of the current Surface and Undersea pictures --- establish a Baseline***
  - ***Similar in approach to JSCIET for the Air Picture***
- **Establish the requirements for a SISP and SIUP**
- **Consider using the “JOTS to JMCIS to GCCS-M” acquisition and development approach (Operational Fleet-Laboratory development)**

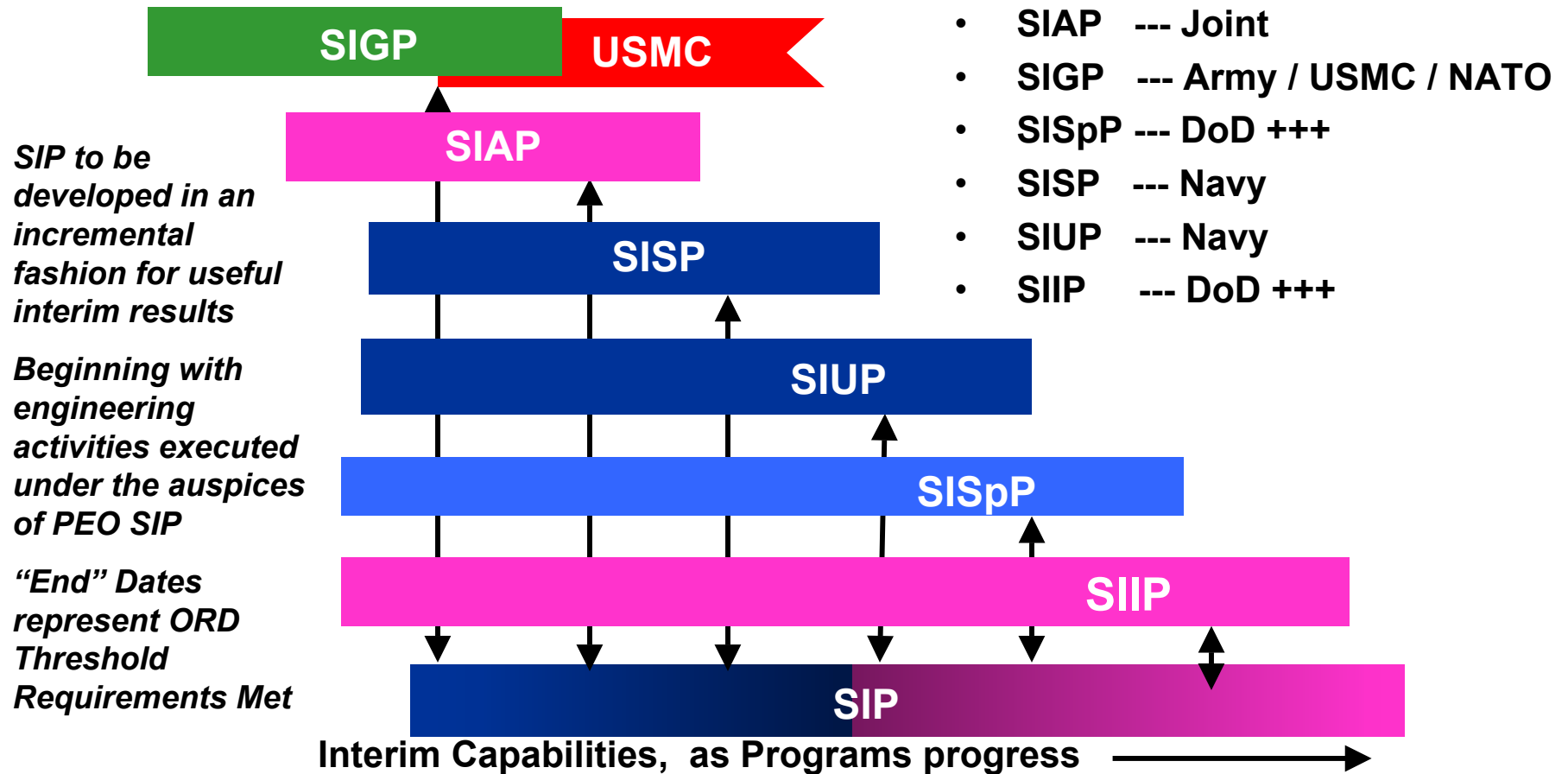
# Begin with What the Navy Can Do, Continued

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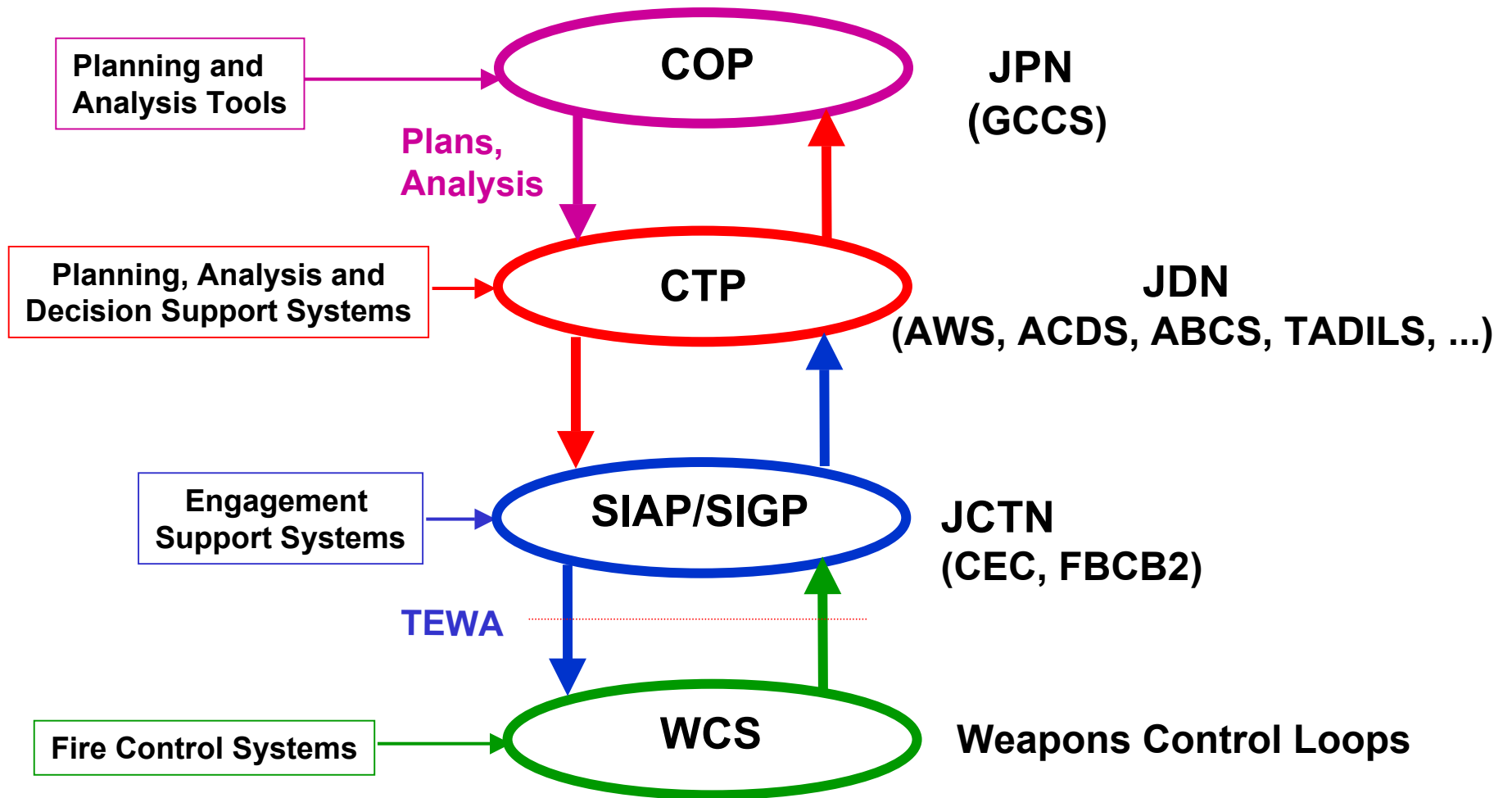
- **Start with low-hanging fruit**
- **Maximize integration of all existing, legacy systems and platforms --- glue together what you've got**
  - *E-2C, AWACS, JSTARS, JLENS, UAVs, U-2s, EP-3, RIVET JOINT, surface and undersea systems, ...*
  - *C4ISR Systems, including GCCS-M, CEC, TBMCS, ABCS, AWS, SSDS, ACDS, ...*
  - *GIG, ESG, ...*

# SISP and SIUP in the Context of The Roadmap to the SIP

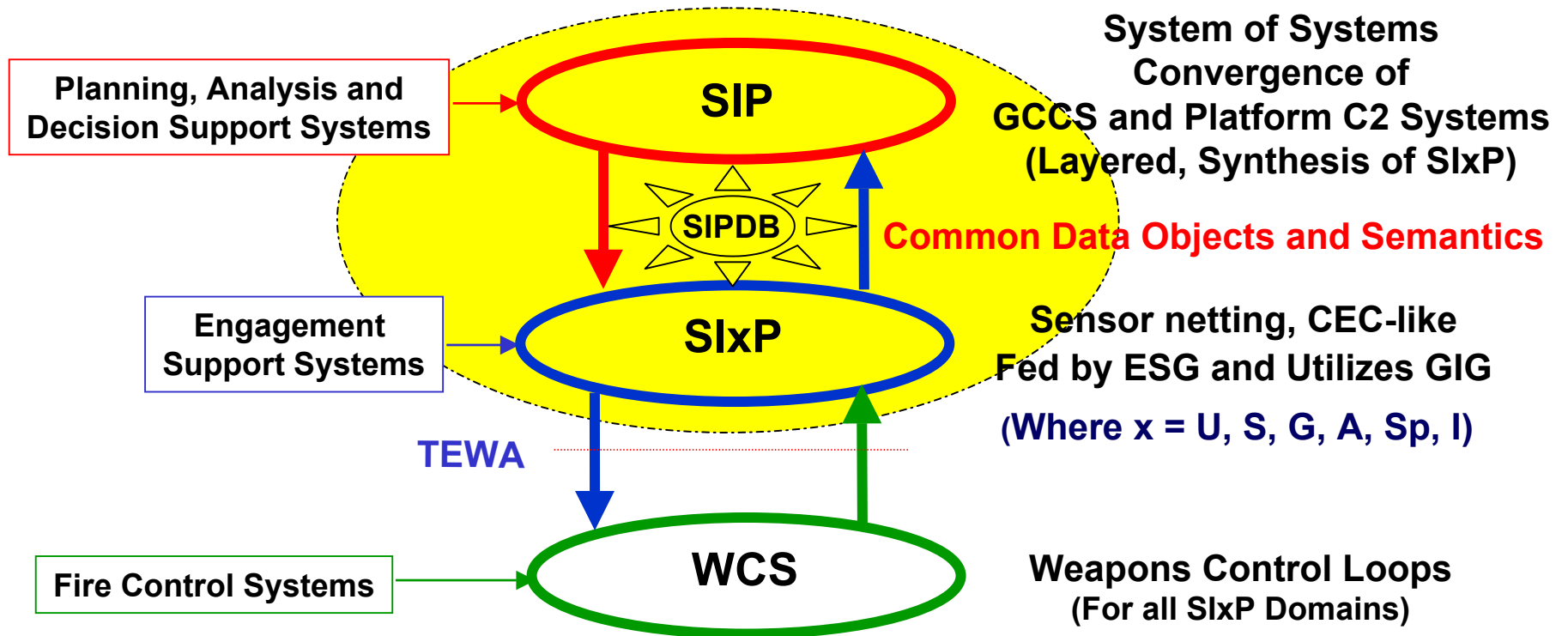
2002	2004	2006	2008	2010	2012	2014
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# Legacy “Picture” Hierarchy

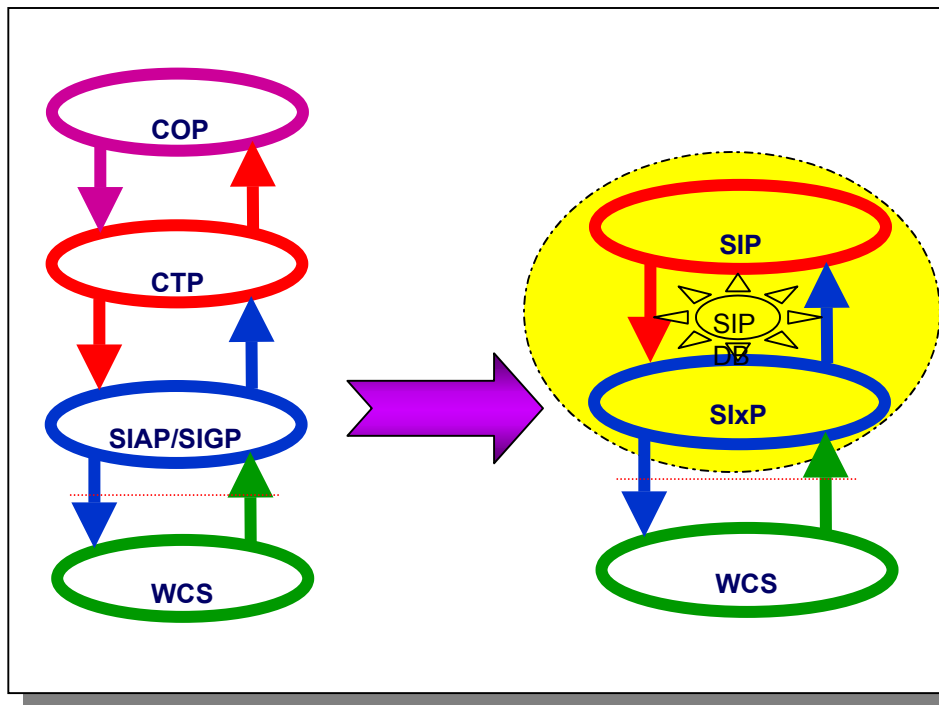


# Where SIP Needs to Go



**SIPDB = Single Integrated Picture Database (Distributed / Replicated)**

# Acquisition Migration Path for SIP



- There needs to be an OPNAV Requirements Sponsor for the SIP (including SISP, SIUP)
  - *We recommend N7*
- There needs to be an Acquisition counterpart
  - *Think about “Charter”*
- Every SYSCOM, PEO and Lab is a Stakeholder in SIP
  - *Plus everyone else in DoD, and beyond !*

***This Will Require Strong Leadership !***

- The timing is right for transformational thought
- The Navy is in the ideal position to take the lead in building the foundation for creating a SIP for the warfighters, beginning with SISP and SIUP
- The effort will require proactive collaboration with the other Services and Agencies
- The effort will also provide a vehicle for transcending PPBS with respect to Joint Interoperability, in all its aspects

***This isn't Magic! (But, ... it is hard!)***



# From a Man Who Understood Change

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**“Good ideas are not adopted automatically, they must be driven into practice with courageous impatience.”**

**ADM Hyman G. Rickover**



# **Section III**

## **Insights and Issues**

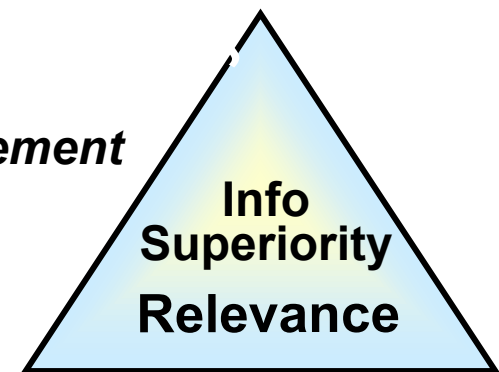
**National Defense Industrial Association (NDIA),  
Strike, Land Attack and Air Defense (SLAAD) Committee**



# SIP Symposium

## 6 Insights from N7

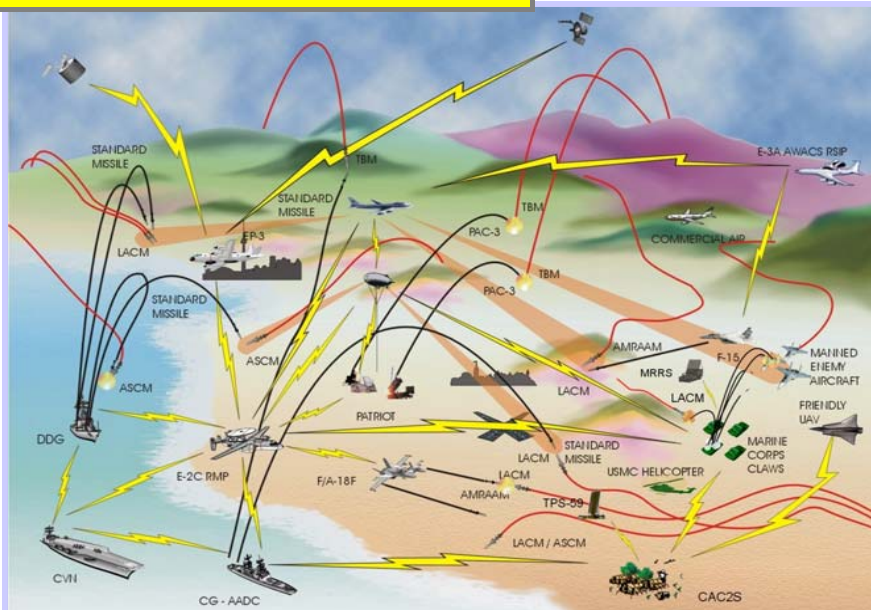
- **SIP will help to gain the information and knowledge advantage**
- **Information Advantage to Competitive Advantage**
  - *Equals historical regional knowledge + real-time battlespace awareness*
  - *Foundation for assured access and effects-based operations*
- **Power from Robust Networking by Warfighters.**
  - *Very high levels of shared battlespace awareness*
  - *Shared knowledge of commanders intent*
- **Navy Force Differentiation**
  - *Knowledge built through presence and engagement*
  - *First on scene, sensors deployed early*
  - *Surveillance conducted from the sea*
  - *Establishes early C2 architecture*



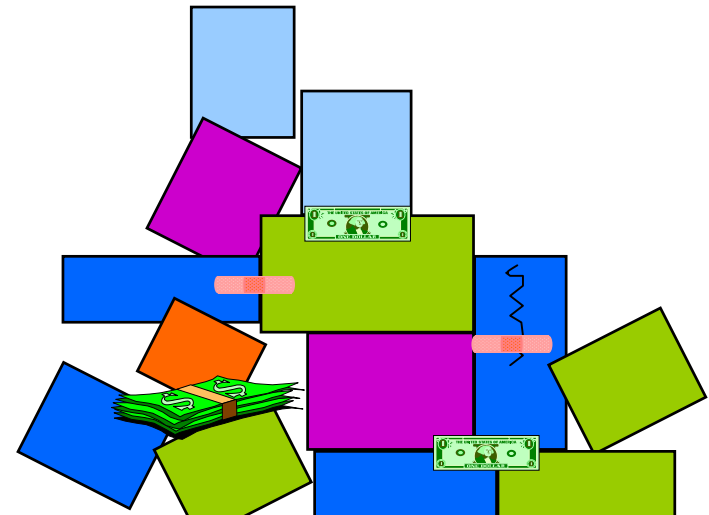
# SIP Symposium

## 7 Insights from N8

### What We Want ...



### ... And How We're Trying To Get There Today



- **The acquisition Challenge for a SIP**
  - We're not treating the whole capability as a "system"
  - No top-level design or plan
  - Patchwork of stove-piped processes

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# SIP Creation --- Issues

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- **Interoperability, Process, and Standards --- the DII COE dilemma**
- **Bandwidth Management**
- **Multi-Level Security (MLS)**
  - *Internal dissemination of high-level materials related to SIP*
  - *Exchange of high-level materials to Allies and Coalition partners*
- **Mapping and the SIP**
- **Human Implications of the SIP and NCW**
  - *Knowledge Warriors --- identification and training*

***SIP requires addressing ALL of these !***

# Where is DII COE today?

## US Navy

- Command and Control (GCCS-M/TACMOBILE)
- Weapons Control Systems (ATWCS)
- Combat Systems Integration
- Cryptologic Systems (TCS, COBLU)
- Environmental Systems (TESS)

## US Coast Guard

- Shipboard C2 System (SCCS)
- Vessel Traffic Service (VTS)
- Command Centers
- Airborne C2

## Joint C4I / DoD

- Global Command & Control System (GCCS)
- Global Combat Support System (GCSS)
- Electronic Commerce (EC/EDI)

## US Air Force / US Army

- Theater Battle Management Core System (TBMCS)
- AWACS COP I/F
- Army GCCS
- Mission Planning & Decision Aids

## US Marine Corps

- MAGTF C4I
- Combat Operations Systems (TCO, DACT)
- Intelligence Systems (IAS)

## International

- United Kingdom
- Australia
- Canada
- France
- GCC
- Italy
- Japan
- NATO
- Denmark
- Germany

**100,000 COE-based warfighter “seats” are fielded today ----**

**DISA expects growth to @ 400,000 in the next 4 years.**

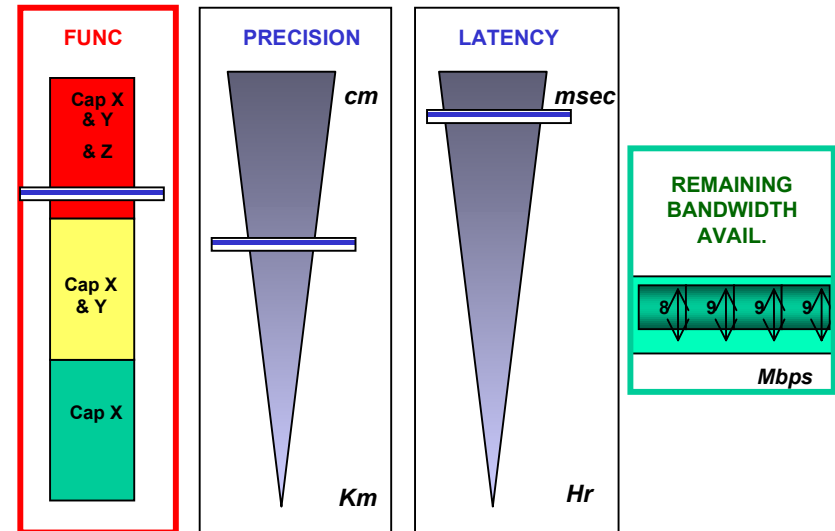
**Worldwide today, 125+ COE-based Systems are fielded or in development.**

## What should we do with DII COE? Recognize down side; keep it, but ...

- Review the current DISA DII COE management process
  - Add more Service operational, warfighter, technical, and industry representation
  - Review DISA resourcing to *MEET* the Services' needs
- Leverage DII COE where you can, to save money and improve interoperability
  - Accelerate XML, Realtime, component-based architecture, and web-enabled approaches
- Consider having Navy, together with DISA, focus on the military-specific areas, and let the commercial world do the rest
- Recommend that the minimum DII COE compliance level should be level 6/7 to maximize interoperability, software reuse, and cost reduction

# Bandwidth Management Recommendations

- A key factor for progress in achieving a SIP is sufficient communications and network bandwidth in the Theater warfighting environment
  - *Bandwidth for moving around data and information will continue to be the major constraint in building a flexible, robust, operational SIP*



- Applications will always be able to overwhelm our communications capacity, so we recommend:
  - *System components and new tools that optimally aggregate and allocate available bandwidth to competing applications based on priorities, in an operational context (ADNS today)*
  - *A consistent approach to development of scalable applications that can operate under various bandwidth environments*

# Multi-Level Security (MLS) Recommendations

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- **Short term**

- *CINCs continue individual efforts for their Theaters*
- *Look into focusing collaboration efforts on having warriors operate on Multinational Network, vice SIPRNET (US only) to reduce risk during coalition ops*
- *Begin laying groundwork for more universal approach*
  - *An approach is to establish JFCOM J6 as in charge of MLS in general, and Coalition Interoperability in particular, with CJSC J6 in support*

- **Long term**

- *Continue the research to develop Government solutions*
- *Continue to bring solutions to the appropriate Fleet Battle Experiments, Millenium Challenge 2002, and Olympic Challenge 2004 Experiments*
- *Monitor commercial activities (e.g., Trusted Computing Platform Association (TCPA)) and encourage them to evolve to MLS (access to data elements based on labels)*

# 11 Mapping and the SIP Recommendations

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- **Concern: Reliance on mapping products digitized from paper charts introduces errors into targeting as well as creating positional problems (e.g., navigation, deconfliction)**
- **No comprehensive, authoritative Littoral Warfare Data Environment exists today**
- **Recommendation: Expedite development of an integrated Geospatial Feature Foundation (GFF)**
  - *Comprehensive seamless, worldwide multi-source, scalable geospatial feature database, attributed in concert with intelligence products*
  - *Includes littoral environmental information as envisioned in defunct Defense Hydrographic Initiative (DHI)*
  - *Positional accuracy's commensurate with GPS*

## Human Implications of the SIP and NCW

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- **Effective operation in NCW and in utilization of a SIP requires people with the same type of capabilities:**
  - *Multi-plex (multi-tasking)*
  - *Synthesize, and from the synthesis, communicate the story:*
    - *What is happening, how, to whom*
    - *What is likely to happen next*
  - *Replicate the picture (in their heads) if the systems go down*
  - *Prioritize --- pick out what is important*
  - *“See” alternative scenarios developing, and analyze the implications at all three levels (tactical, operational, strategic)*
  - *Accomplish all the above faster and more effectively than most other people, especially adversaries*
- **Such people are Knowledge Warriors (KW)**
- **Knowledge Managers (KM) are effective at collecting, collating and disseminating information**



## **Section IV**

# **Summary and Recommendations**

**National Defense Industrial Association (NDIA),  
Strike, Land Attack and Air Defense (SLAAD) Committee**

# Summary

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- **The Requirement: a SIP is needed for command and control, battlespace situational awareness, and for the coordination, control, integration, and deconfliction of all force movements and fires, within realistic, combat-driven timelines**
- **SIP is a distributed, synchronized Data Base**
- **SIP is directly scalable to overall Joint, Allied & Coalition levels, and users at all levels**
- **“Single” Picture, multiple views**

# Summary, Continued

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- **To create a SIP, all these key issues are inherent in the total solution, and must be taken into account:**
    - *The DII COE (recently, the COE, since the GIG has superceded the DII)*
    - *Bandwidth Management*
    - *Multi-Level Security*
    - *Mapping*
    - *Human element of SIP and NCW*
  - **Roadmap to the SIP**
    - 13 – *SIP as a systems of systems is an ideal example for the new MCP process --- beginning with the SISP and the SIUP*
    - *There are important organizational and process implications*
      - *At all levels --- Joint, DoD, Services, Secretariat, OPNAV, Systems Commands, and beyond*

# Recommendations

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- **Work toward a SIP, taking into account all of the key issues we have reviewed**
- **Begin by building the SISP and the SIUP, integrated**
  - *Will resolve many of the Blue Force picture problems of today's COP*
- **Get on with SIP Study, Phase II !**

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14.1



# From a Fortune Cookie August 2001

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**“Every truly great accomplishment  
is at first impossible.”**

**Fortune Cookie**

# Our SIP "SixP" Logo !

**"The SIP  
SixP"**



**.... What the real Warfighter reaches for**

# **T** SIP Study Report Tabs Summary

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- 1 • FTX AMALGUM VIRGO 01 FTX Report**
- 2 • Listing of Contributors and Participants**
- 3 • Briefings received as the SIP Study Group**
- 4 • SIP Study Analytical Approach**
- 5 • Other “Common Operational Picture” Efforts**
- 6 • N7 Presentation to SIP Symposium**
- 7 • N8 Presentation to SIP Symposium**
- 8 • DII COE Information and Recommendations**
- 8.1 • New COE Community Process 7 Sept 2001 from AOG**

# SIP Study Report Tabs Summary (2)

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- 9 • Bandwidth Management Information**
- 9.1 • Frame of Reference for SIP Operational Bandwidth Requirements**
- 10 • Multi-Level Security Information**
- 10.1 • NSA Support to Coalition Interoperability Through MLS**
- 11 • Mapping Issues and Recommendations**
- 12 • NCW and SIP Regarding Knowledge Warriors**
- 13 • SIP-Related MCP Process OV Diagrams and Relevant Process Information**
- 14 • Draft SOW for SIP Study Phase II**
- 14.1 • Ideas for SIP Study Phase II**

## **A** Appendices

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- A1** • Draft SIP CONOPS
- A2** • Draft SIP MNS
- A3** • Draft SIP Capability Evolution Document (CED)
  - A3.1** • Draft CED Matrix
  - A3.2** • Draft CED Framework Matrix
- A4** • Draft SIP Technology Roadmap and Diagrams
  - A4.1** • Draft SIP Technology Roadmap Matrix
- A5** • Thoughts on SIP-Related Metrics
- A6** • SIP Contributors and Participants
- A7** • SIP Study Roster as of 6 September 2001
- A8** • SIP Study Milestones

## Appendices (2)

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- A9** • **Common Picture-Related Terms Glossary**
- A10** • **Insights from the Fleets**
- A11** • **US Army Experience with SIGP and Blue Force Picture**
- A12** • **Developing the SIP and SISP White Paper by VADM JD Williams, USN(ret)**
- A13** • **Targeting by MapQuest from the WWW (Pentagon)**
- A13.1** • **Targeting by MapQuest from the WWW (CSC)**
- A14** • **SIP *Mind Map* from SIP Study Group Meeting #1**
- A15** • **Original SIP Study SOW Document**
- A16** • **Original SIP Study SOW Briefing**
- A17** • **SIP Study Charter Letter from Original Sponsor, N8**

## Appendices (3)

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- A18 • Briefings from the Roadmap to the SIP Symposium held at the JHU/APL on 24 April 2001:**
- – *Dr. Woodall (NDIA SLAAD) SIP SYMPOSIUM INTRODUCTION*
  - – *VADM McGinn (N7) SIP WARRIOR VISION*
  - – *VADM Giambastiani (N8) ACQUISITION OF THE SIP*
  - – *RADM Bowler (N70) SIP AND THE WARRIOR*
  - – *MG Boutelle (USA C3S) SIP AND THE LAND WARRIOR*
  - – *COL Callicutt (USAF C4ISR Center) FIOP AND THE SIP*
  - – *CAPT Wilson (SIAP Program Office) SIAP UPDATE*
  - – *RADM Balisle (CCDG THREE) FLEET PERSPECTIVE ON SIP*
  - – *Mr. Johnson (SPAWAR) HORIZONTAL INTEGRATION*
  - – *Dr. Barnett (NWC) INFORMATION SUPERIORITY*
  - – *Mr. Aaron Fuller (CSC WIDAN) CYBERSPACE AND THE SIP*
  - – *Ms. MacNulty (Applied Futures) KNOWLEDGE WARRIORS*

## Appendices (4)

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- A19** • Global 2001 Planning Overview for SIP Cell
- A20** • Global 2001 SIP Cell Summary Report
- A21** • Summary Insights Briefing for CNO from Global 2001
- A22** • Information Superiority Briefing from Global 2001
- A23** • Instructions to access SIP Web Site at SPAWAR Systems Center (SSC), San Diego, CA
- A24** • Spectrum Adaptive Radio (SAR) Briefing

## Appendices (5)

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- A25** • **Common Undersea Picture (CUP) Briefing**
- A26** • **Expeditionary Sensor Grid (ESG) Briefing**
- A27** • **Joint Continuous Strike Environment (JCSE) Briefing**
- A28** • **NATO Ground Picture Paper**
- A29** • **JAVA 2 Enterprise Edition and the Integrated C4I System Framework (ICSF) Briefing (DII COE Issues)**
- A30** • **Top Ten Joint Interoperability Issues from JFCOM J8**

## Appendices (6)

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- A31** • JCS MNS and ORD Instruction 3170.01A
- A32** • C4ISR Acronym List from the CUP Study
- A33** • DII COE Implementation by US Army C3S for ABCS, USA C3S White Paper
- A34** • Paper ---Knowledge Warriors, Born or Made?