

# A Short History of Interoperability

Michael Robkin

Independent Consultant

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# A Short History of Interoperability

- Lessons Learned from the history of Interoperability.
- Not a tutorial.
  
- We have a rich options available to us.
- Interoperability not a technical problem.

Interoperability is a people problem.

# 1<sup>st</sup> Interoperability Reference

- Homer, *The Iliad*
- Chimera has
  - the head of a Lion in front
  - the head of a Goat in the middle
  - the head of Snake for a tail.
- Breathes fire (not a capability found in the components!)
- Omen of Shipwrecks and Volcanoes

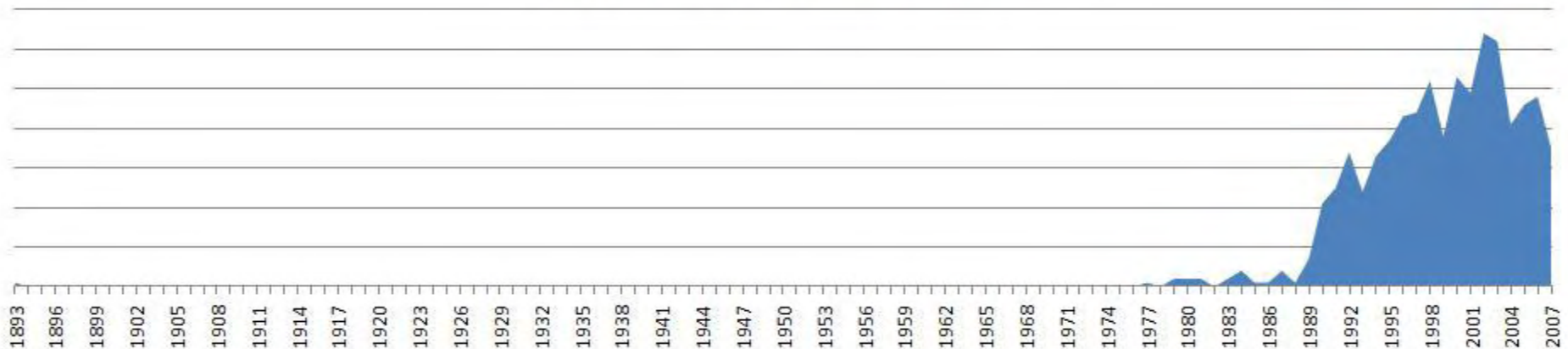


Credit: Mike Bainbridge, NHS

# Trends in Interoperability

- Interoperability. Webster's Timeline History 1893-2007
- Data: Prof. Philip Parker, INSEAD, Chaired Professor of Marketing
- Citation data of online use of "interoperability" and related concepts
  - patents, conferences, books, and papers
  - business, law, engineering, medicine, sciences, social sciences
  - filtered by references and relevance
  - Online sources bias totals towards the present.
- Performed keyword analysis of the references.
- Relative proportions assumed valid

**Interoperability References**





# Railcar Airbrakes: The First Mandated Interoperable System?



# 1893: Safe Appliances Act

- First US Government “Interoperability” Standard.
  - Defined compressed airbrakes as standard on railcars
  - One page long, a few updates since 1903
  - World-wide compatibility
- Section 1: Need safety checks on locomotive and a sufficient number of cars.
- Section 2: Need automatic couplers that can be uncoupled without manual intervention.
- Section 3: Can't receive cars not equipped.
- Section 4: Must have Secure grab irons.
- Section 5: Outsourced to standards bodies: The American Railway Association is authorized to set standard height of drawbars for freight cars.
- Section 6: \$100 fine per violation.
- Section 7: Can extend time for compliance
- Section 8: If someone working for a non-compliant train is injured, the railway still liable.

**TITLE 49 - TRANSPORTATION**  
**SUBTITLE V - RAIL PROGRAMS**  
**PART A - SAFETY**  
**CHAPTER 203 - SAFETY APPLIANCES**

**§ 20302. General requirements**

(a) **General.**— Except as provided in subsection (c) of this section and section 20303 of this title, a railroad carrier may use or allow to be used on any of its railroad lines—

- (1) a vehicle only if it is equipped with—
  - (A) couplers coupling automatically by impact, and capable of being uncoupled, without the necessity of individuals going between the ends of the vehicles;
  - (B) secure sill steps and efficient hand brakes; and
  - (C) secure ladders and running boards when required by the Secretary of Transportation, and, if ladders are required, secure handholds or grab irons on its roof at the top of each ladder;
- (2) except as otherwise ordered by the Secretary, a vehicle only if it is equipped with secure grab irons or handholds on its ends and sides for greater security to individuals in coupling and uncoupling vehicles;
- (3) a vehicle only if it complies with the standard height of drawbars required by regulations prescribed by the Secretary;
- (4) a locomotive only if it is equipped with a power-driving wheel brake and appliances for operating the train-brake system; and
- (5) a train only if—
  - (A) enough of the vehicles in the train are equipped with power or train brakes so that the engineer on the locomotive hauling the train can control the train's speed without the necessity of brake operators using the common hand brakes for that purpose; and
  - (B) at least 50 percent of the vehicles in the train are equipped with power or train brakes and the engineer is using the power or train brakes on those vehicles and on all other vehicles equipped with them that are associated with those vehicles in the train.

(b) **Refusal To Receive Vehicles Not Properly Equipped.**— A railroad carrier complying with subsection (a)(5)(A) of this section may refuse to receive from a railroad line of a connecting railroad carrier or a shipper a vehicle that is not equipped with power or train brakes that will work and readily interchange with the power or train brakes in use on the vehicles of the complying railroad carrier.

(c) **Combined Vehicles Loading and Hauling Long Commodities.**— Notwithstanding subsection (a)(1)(B) of this section, when vehicles are combined to load and haul long commodities, only one of the vehicles must have hand brakes during the loading and hauling.

(d) **Authority To Change Requirements.**— The Secretary may—

- (1) change the number, dimensions, locations, and manner of application prescribed by the Secretary for safety appliances required by subsection (a)(1)(B) and (C) and (2) of this section only for good cause and after providing an opportunity for a full hearing;
- (2) amend regulations for installing, inspecting, maintaining, and repairing power and train brakes only for the purpose of achieving safety; and
- (3) increase, after an opportunity for a full hearing, the minimum percentage of vehicles in a train that are required by subsection (a)(5)(B) of this section to be equipped and used with power or train brakes.

(e) **Services of Association of American Railroads.**— In carrying out subsection (d)(2) and (3) of this section, the Secretary may use the services of the Association of American Railroads.

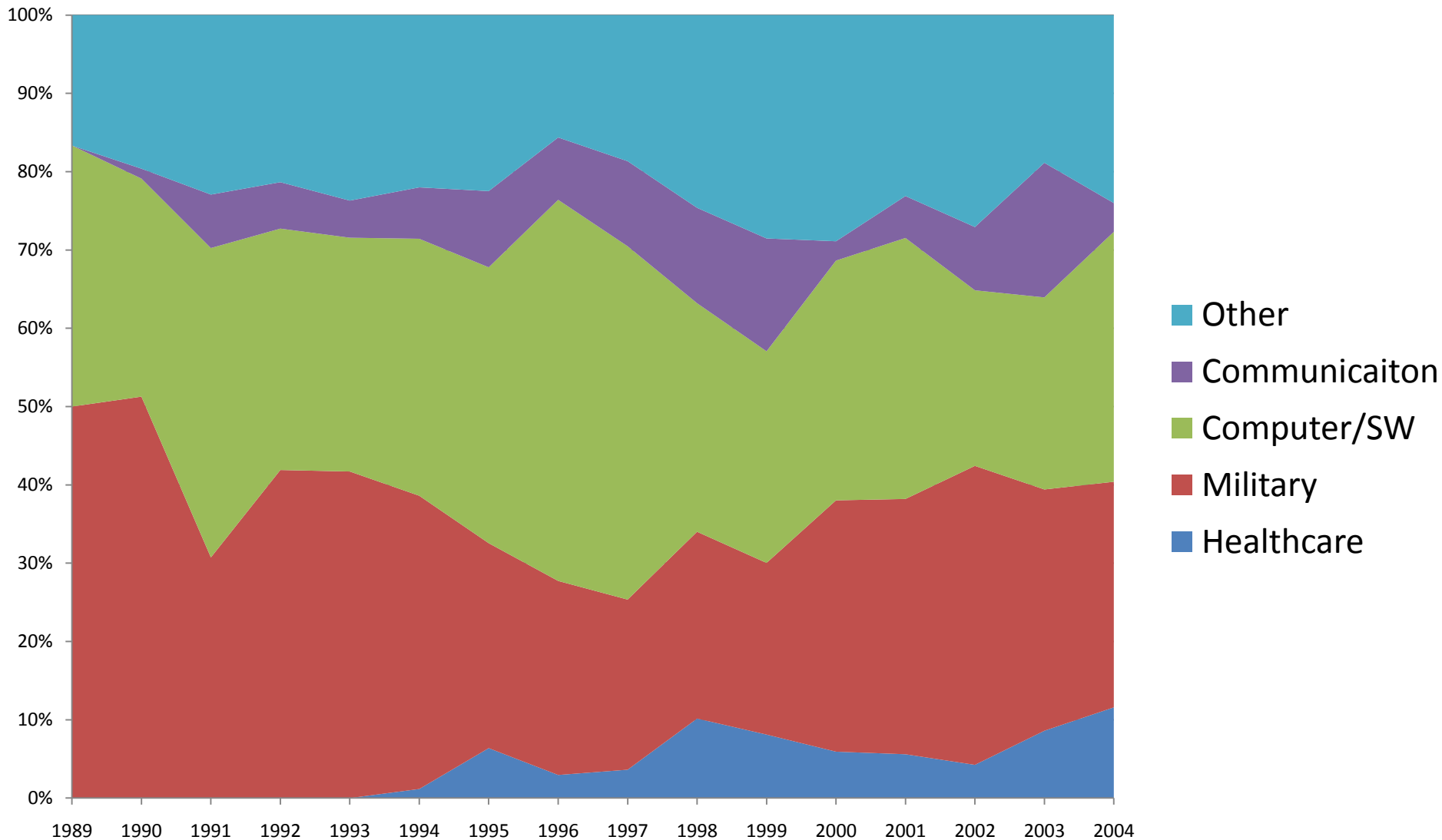


# History Lesson #1

- Safe Appliance Act has everything in its place:
  - The minimum amount of law defined only what was necessary for interoperability
    - And only for the critical safety aspects
  - An industry association set actual standards
  - Liability clearly defined
  - Compliance not confusing
  - Value added to the industry and consumers
  - Other responsible agencies, companies, and associations defined the myriad other safety details which evolve, but are not required for interoperability
    - Work rules
    - Procedures
    - Training & Education
    - Organization



# Interoperability References By Domain



# History Lesson #2

- Lots of work that can be re-used

# Military Interoperability Keywords

20%	C4I, C3, Command & Control
18%	Simulation, Modeling

# Pearl Harbor Attack, 7 December 1941

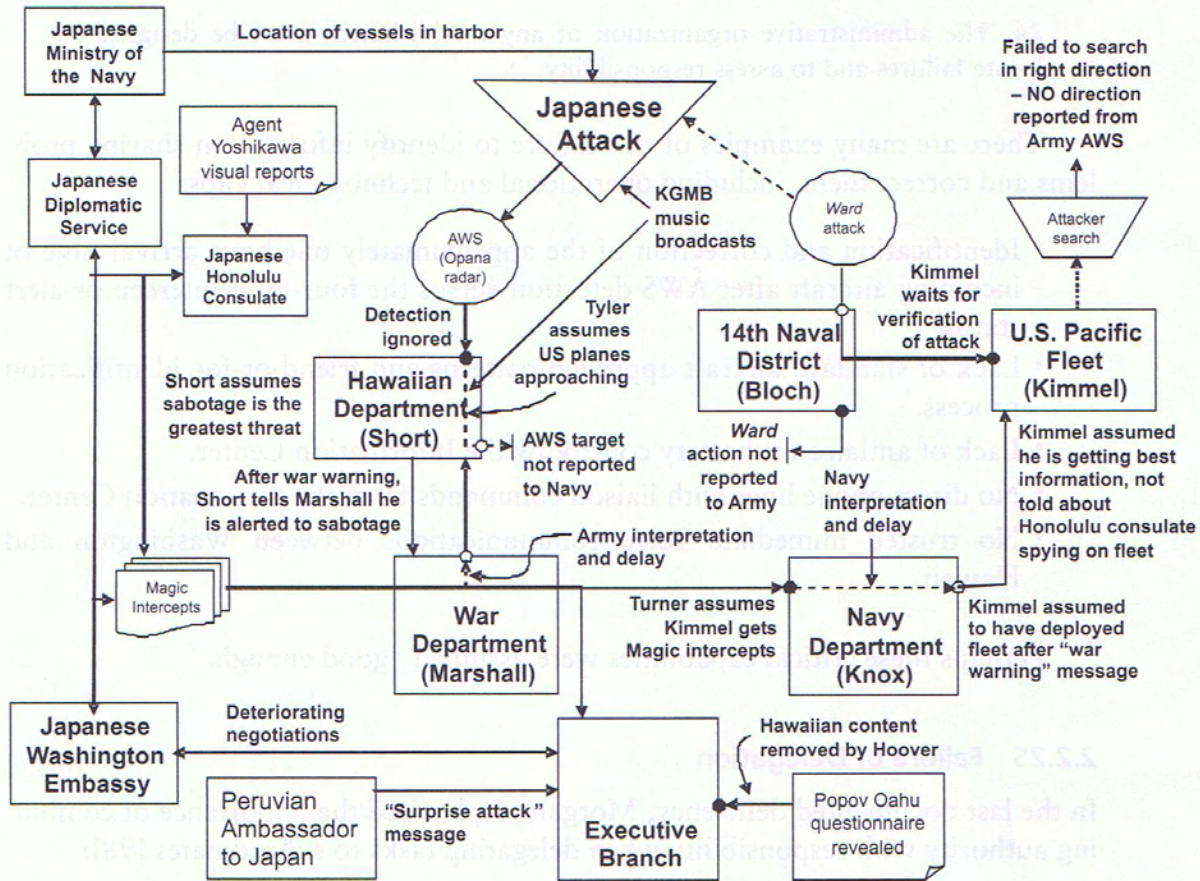
Photo # 80-G-19949 USS Maryland and capsized USS Oklahoma, 7 December 1941



USS Maryland (BB-46) alongside the capsized USS Oklahoma (BB-37).  
USS West Virginia (BB-48) is burning in the background.  
Official U.S. Navy Photograph, National Archives collection.



# Root Cause Interoperability Failures of Pearl Harbor



All organizational failures. No technology issues.

# 25 Organizational Deficiencies that Lead to Interoperability Failures

- Organization
- Assumption
- Omission
- Verification
- Supervision
- Alertness
- Complacency
- Intelligence
- Attitude
- Imagination
- Communications
- Paraphrase
- Adaptability
- Disclosure
- Insight
- Dissemination
- Inspection
- Preparedness
- Consistency
- Jealousy
- Relationship
- Priority
- Reporting
- Improvement
- Delegation

# History Lesson #3

- These are not 1941 technology issues.
- These are:
  - Organizational Failures
  - Poor Processes
  - Incorrect Policies
  - Bad Assumptions
  - Attitude Issues
  - Individual Deficiencies

Interoperability is an organizational problem.  
It is not a technical problem

# So What ?

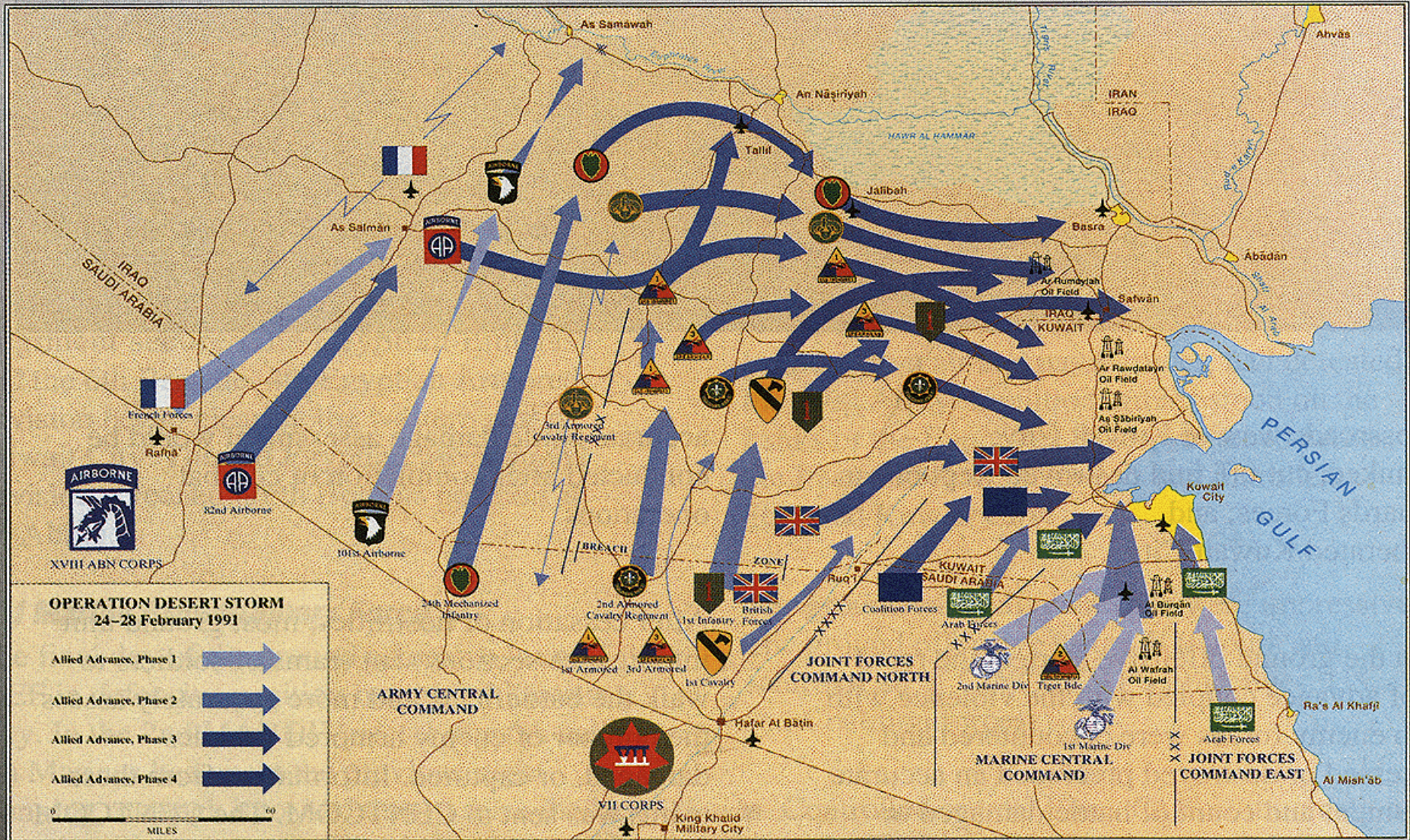
- Weapon Acquisition is complex.
- Logistics is complex
- Battlefields are complex.
- War is complex

⇒Complex Organizationally

⇒not just technologically



# Formal Methods Do Not Apply



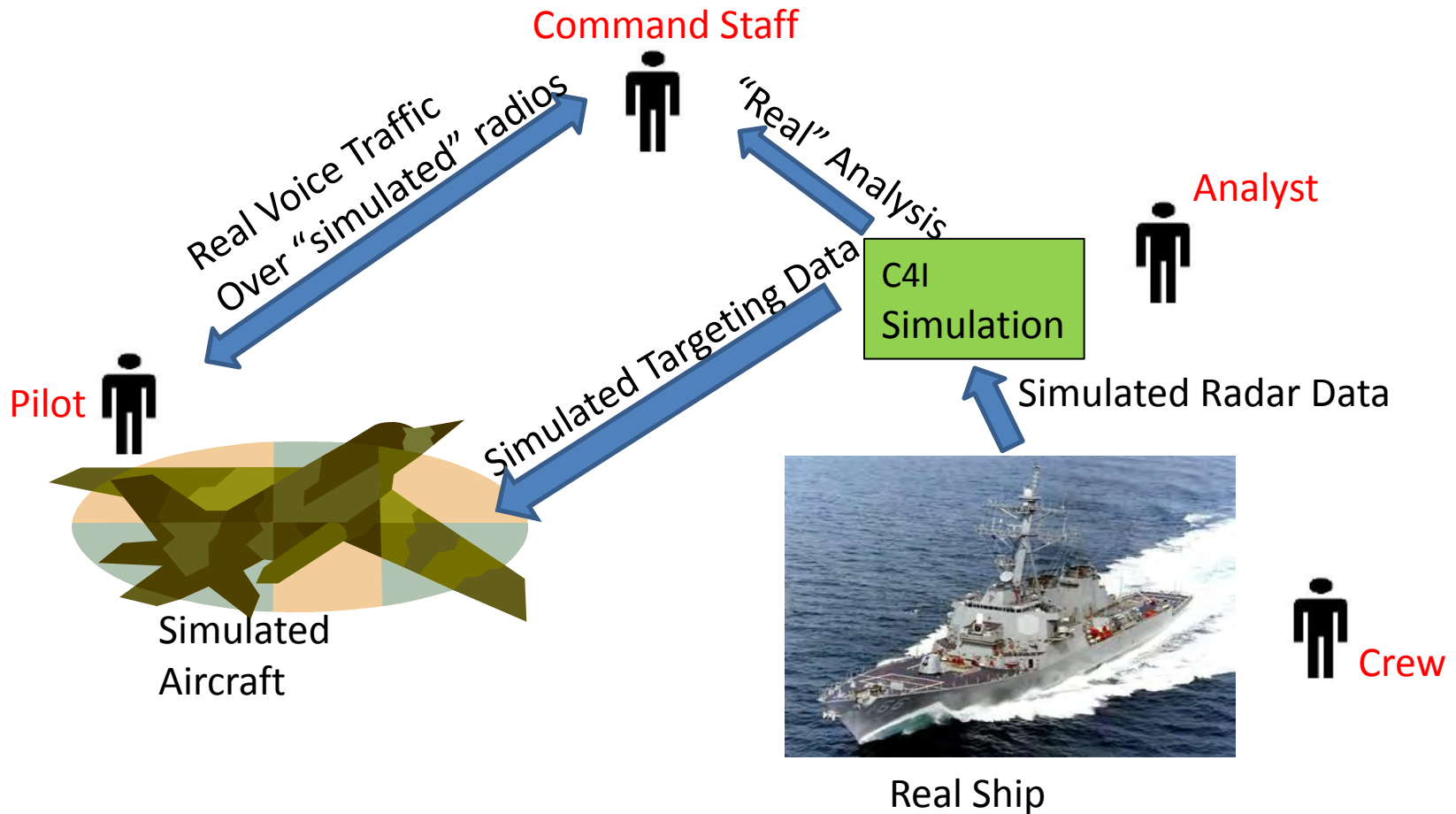


# The Problem:

## Organizational and Operational Interoperability

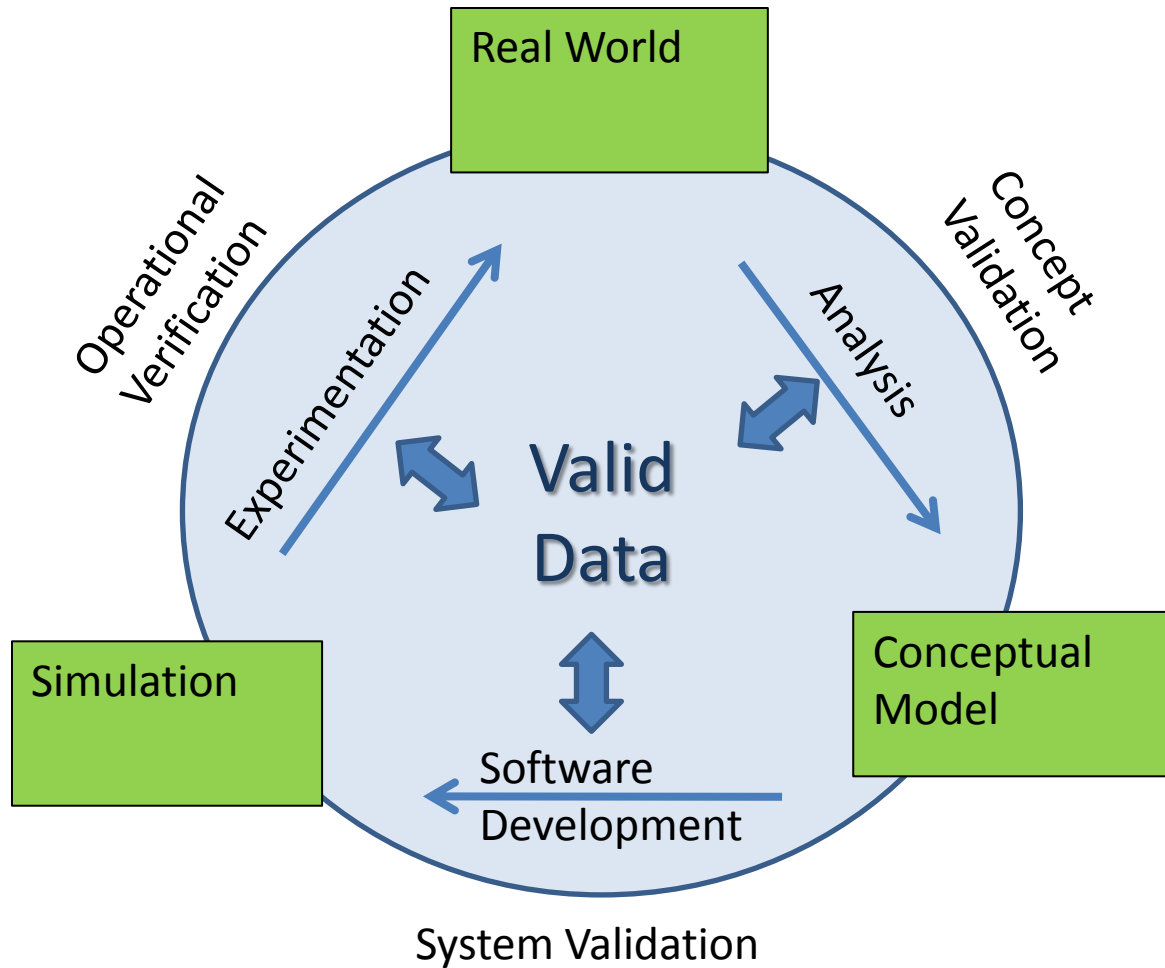
- Enormous Complexity
- Unpredictable Environments, Requirements, Usage
- C4I: Command, Control, Communications, & Intelligence
  - Human interactions
  - Organizational Design
- *Simulation to the Rescue*

# Organizational/C4I Simulation



“Mix and Match” real and simulated components as required

# Simulation, Validation, & Verification





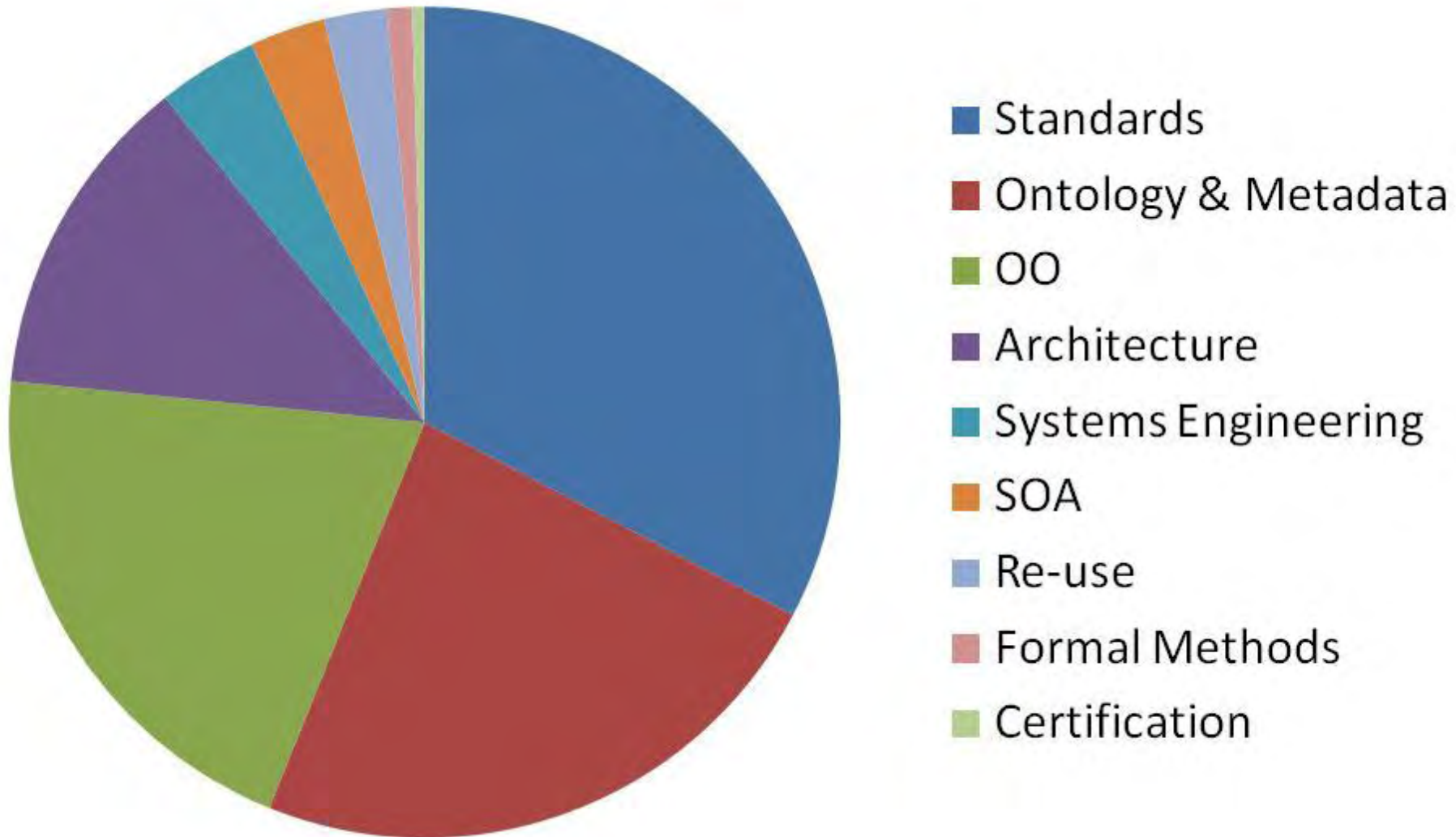
# History Lesson #4

- Other people have solved harder problems.

# History Lesson #5

- Other people have solved different problems.
  - Defense Contractors have ONE customer, ONE client, and ONE user.
  - The DOD:
    - Defines goals, purpose, requirements, & scope
    - Pays for everything and write acquisition policies
    - Trains all personnel
    - Handles Logistics
    - Operates all equipment
  - Airlines have TWO vendors: Boeing and Airbus
    - And they all hate unplanned events

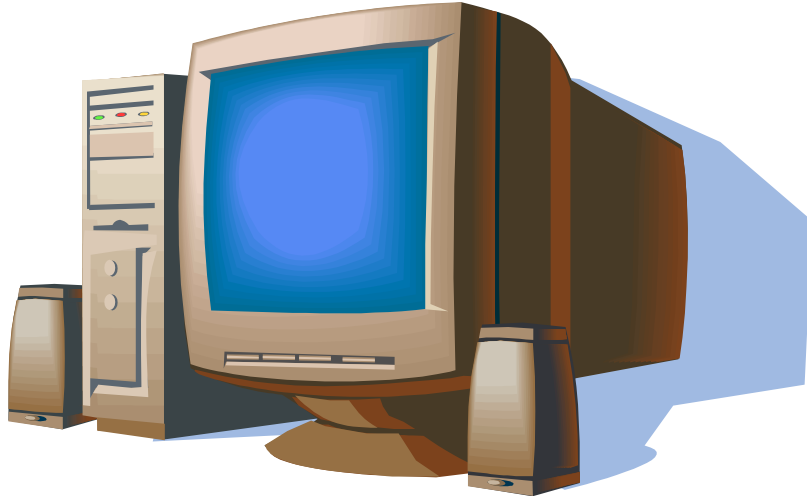
# Computer/SW Interoperability: Keywords Frequency



# History Lesson #6

- Standards
- Semantic Interoperability
- Object-Oriented
- Architecture

# Semantic Interoperability: Same Data, Different Meaning



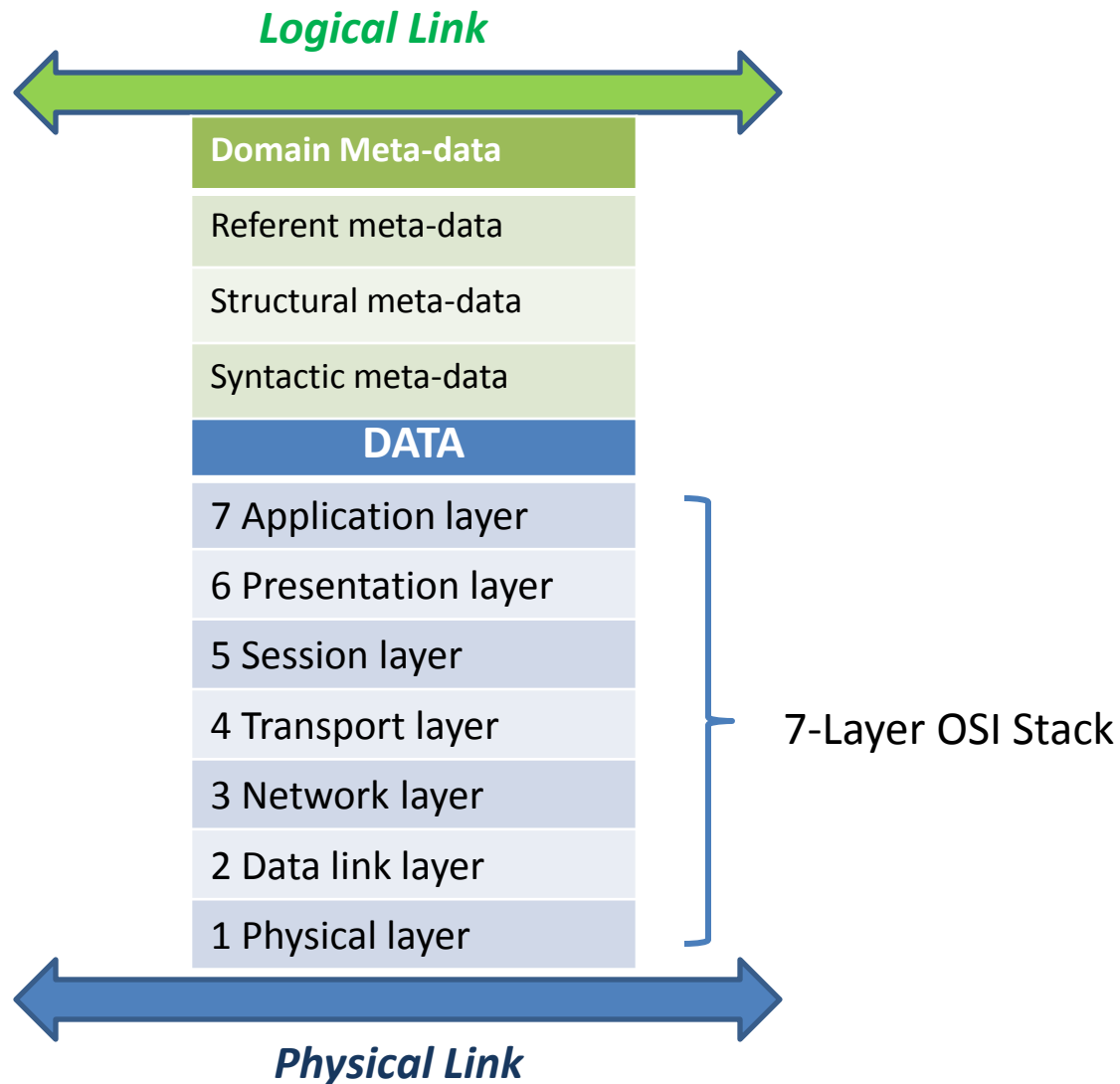
“My client isn’t working”



“My client isn’t working”

- Each instance of each word uses a different definition (10X!)
- Full understanding of each message requires knowing:
  - context
  - sender
  - intended recipient

# Semantic Interoperability



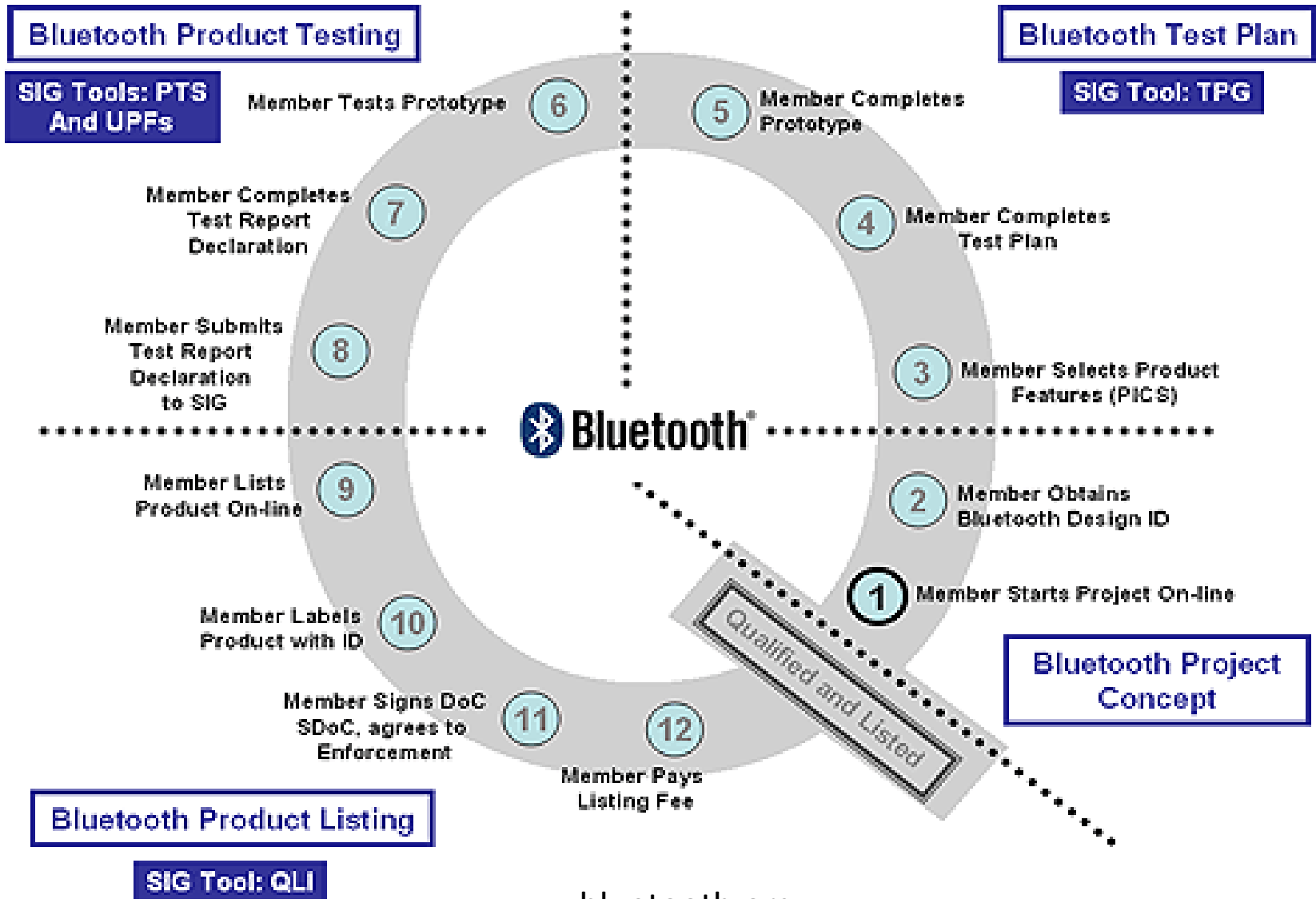
# Object Oriented

- Systems Approach
- Black Box
  - Internal Functions not visible. Don't care anyway.
  - Interface Only





# Bluetooth Certification





# Continua: Scope of Certification Program

## In Scope

**Compliance/Conformance Testing** -  
Verifying that a device meets a  
requirement in a  
standard/specification.

**Interoperability Testing** - Verifying that  
two devices work together in the  
intended way.

## Out of Scope

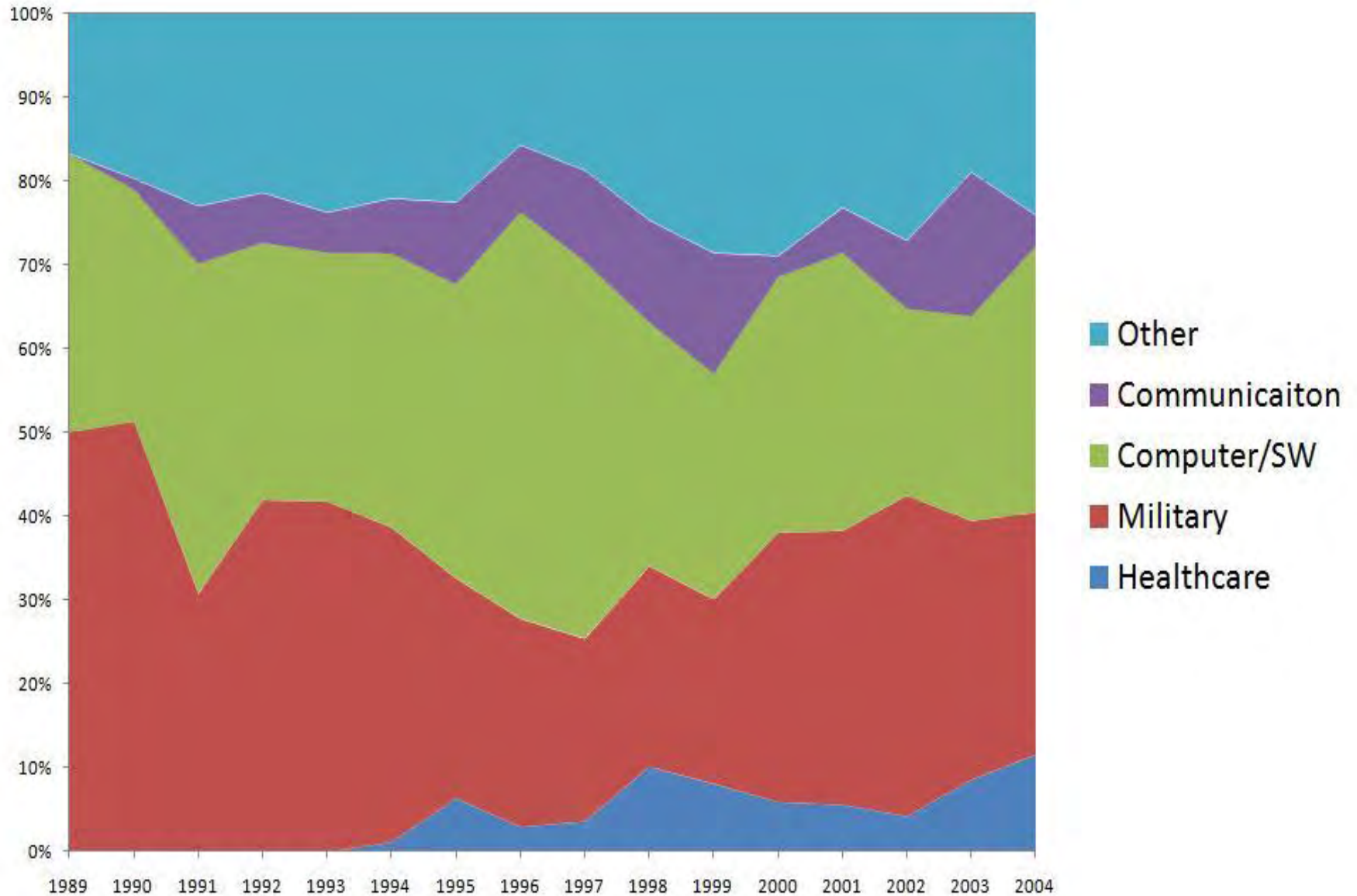
**Non-functional testing** -  
Testing not associated with  
a specification (i.e.,  
performance, stress,  
scalability, availability,  
reliability, usability, etc.)

**User Interface testing** -  
Verifying the user  
interface is well designed  
and reliable.

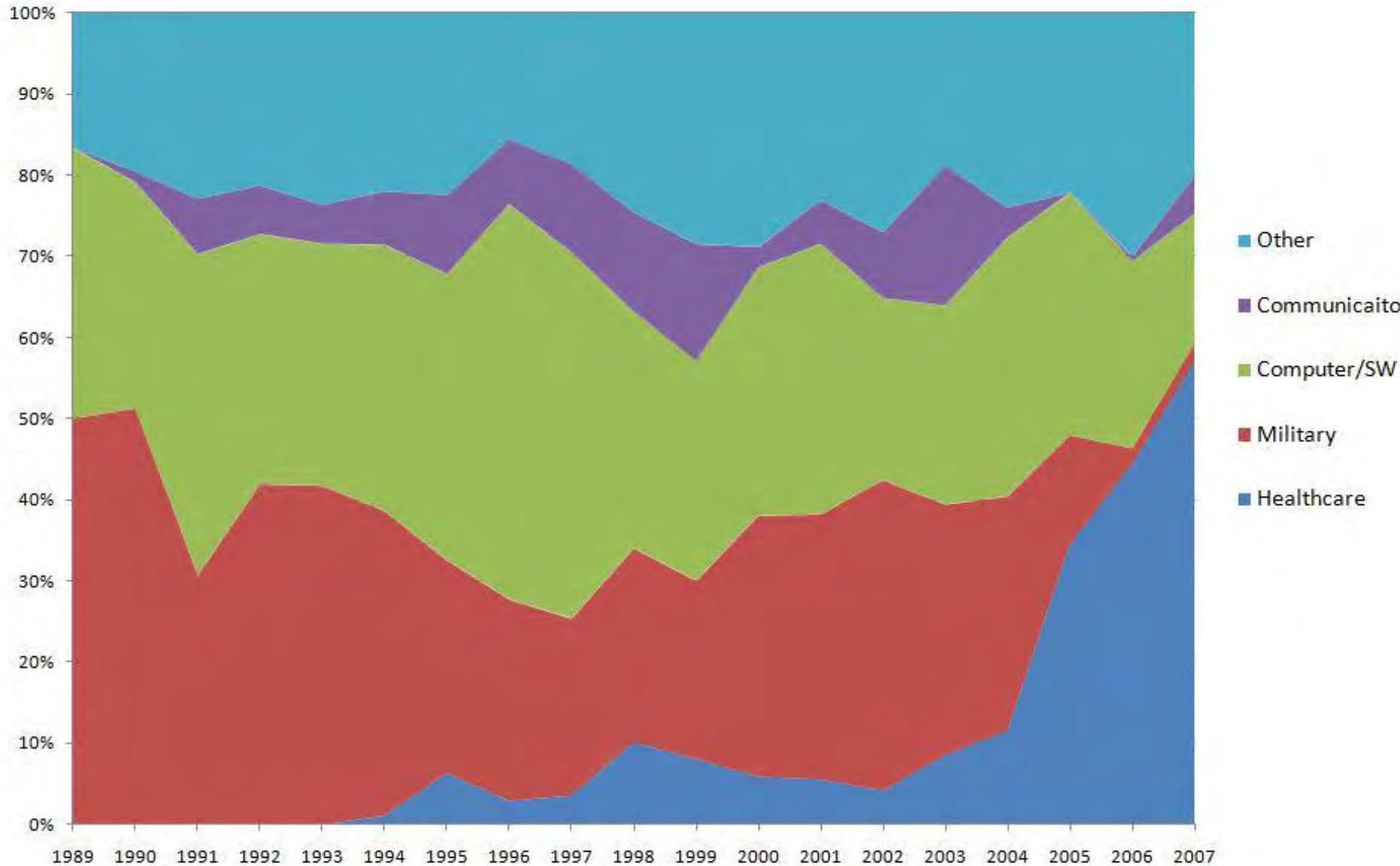
**Regulatory testing** - Tests  
to assist vendors with  
regulatory compliance.

***NOTE: Black Box/ Object Oriented/Systems Thinking***

# Interoperability References By Domain



# Interoperability References By Domain



# History Lesson #7

“Healthcare”

# Thank You

Michael Robkin

[www.MikeRobkin.info](http://www.MikeRobkin.info)