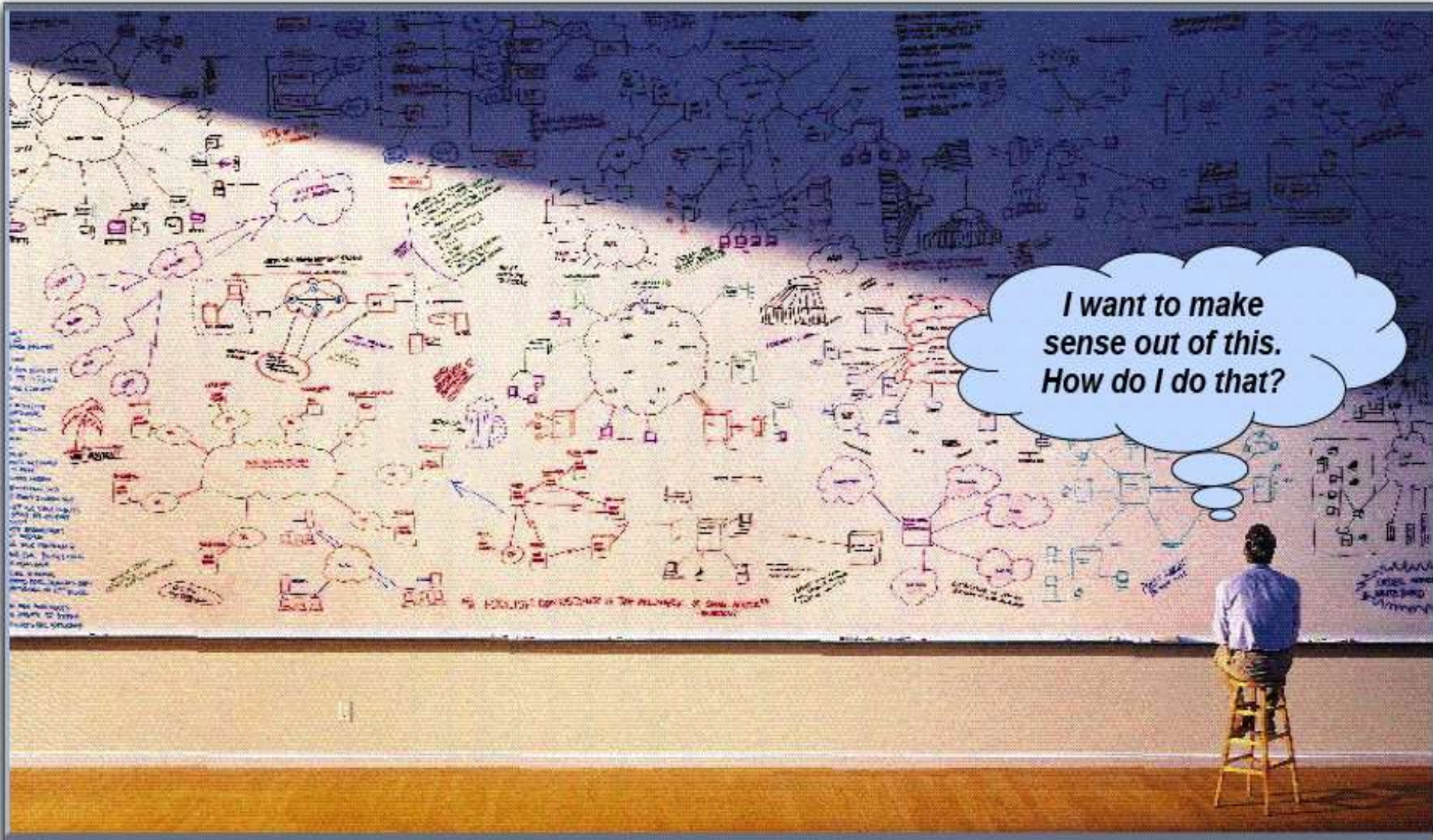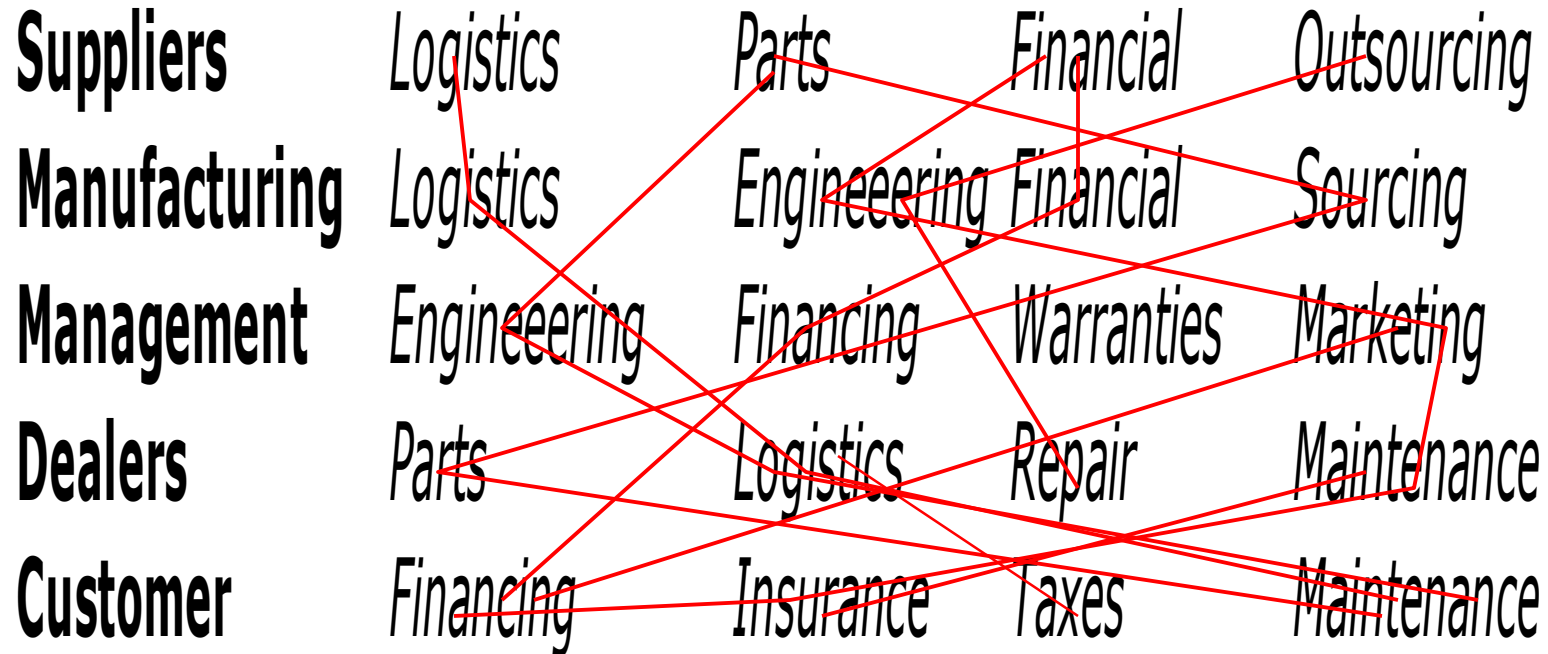# What is a Service Oriented Architecture?

Prof. Paul A. Strassmann
George Mason University, November 19, 2007

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Problems Addressed by a Service Oriented Architecture
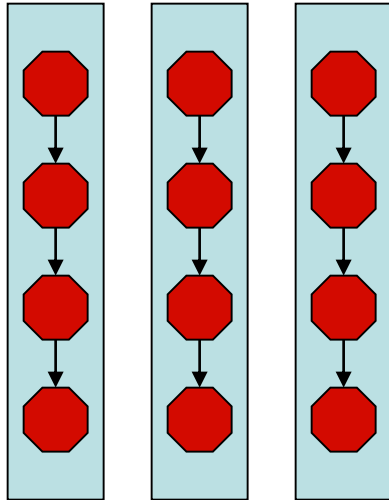
Purpose of Architecture: To Manage Interdependencies

Suppliers *Logistics* *Parts* *Financial* *Outsourcing*

Manufacturing *Logistics* *Engineeering* *Financial* *Sourcing*

Management *Engineering* *Financing* *Warranties* *Marketing*

Dealers *Parts* *Logistics* *Repair* *Maintenance*

Customer *Financing* *Insurance* *Taxes* *Maintenance*

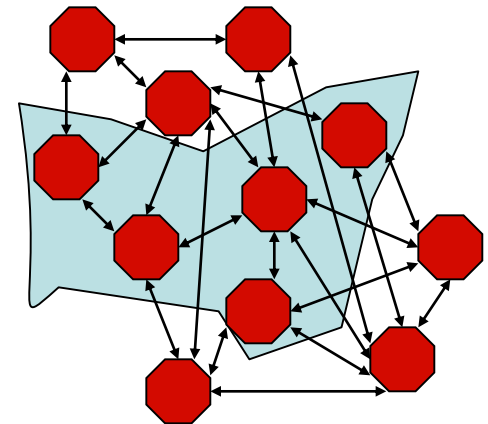# *Directions of System Architecture*

1960 - 1980

1990 - 2000

2010 - 2050

•Organization Focus
•Mainframe Centric
•Internal Use
•Unique Data
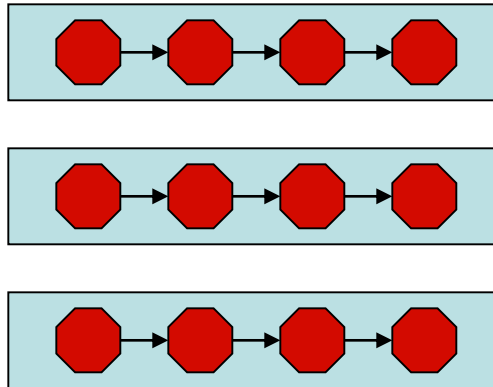
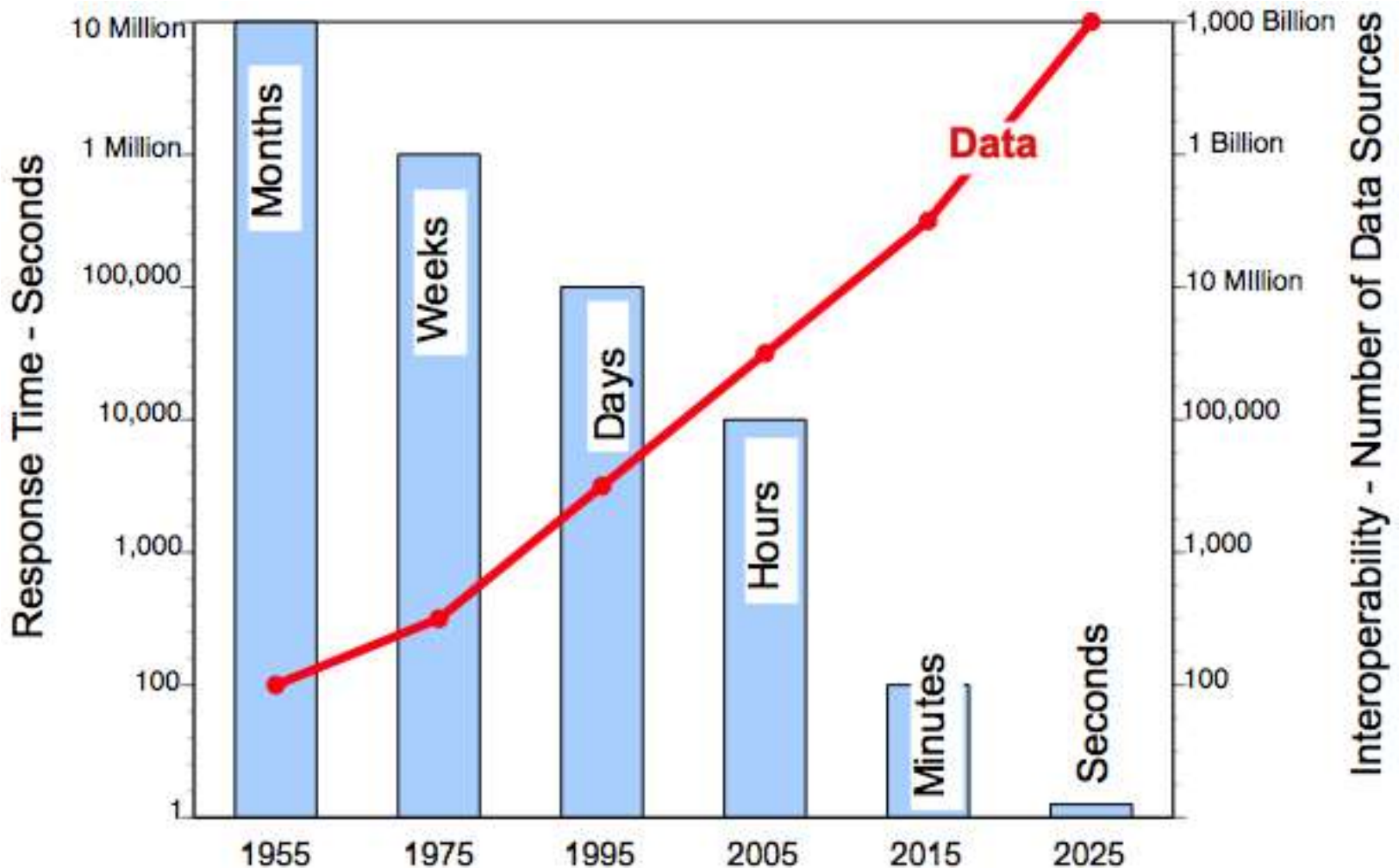•Process Focus
•Client Server
•Partial Connectivity
•EDI File Transfer

•Distributed Functions
•Data Centric
•Universal Interoperability
•Real-time Connectivity

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Data Interoperability Expands as Response Time Shrinks

Interoperability Does not Scale

Generation	Period	Missions for National Security Systems	Interoperability: Number of Data Sources
1	1955 - 1975	Automate Separate Applications	100
2	1975 - 1995	Automate Separate Processes	1,000
3	1995 - 2005	Integrate Processes within a Function	100,000
4	2005 - 2015	Integrate Functions within an Organization	10 Million
5	2015 - 2020	Innovate Processes As Needed	1 Billion
6	2025 -	Sense and Respond	1,000 Billion

What is a Service Oriented Architecture (SOA)?

- A method of design, deployment, and management of both applications and the software infrastructure where:

  - All software is organized into business services that are network accessible and executable.
  - Service interfaces are based on public standards for interoperability.

Key Characteristics of SOA

- Quality of service, security and performance are specified.

- Software infrastructure is responsible for managing.

- Services are cataloged and discoverable.

- Data are cataloged and discoverable.

- Protocols use only industry standards.

What is a "Service"?

- A Service is a reusable component.

- A Service changes business data from one state to another.

- A Service is the only way how data is accessed.

- If you can describe a component in WSDL, it is a Service.

Information Technology is Not SOA

Business Mission

Information Management

SOA

Information Systems

Systems Design

Computing & Communications

Information Technology

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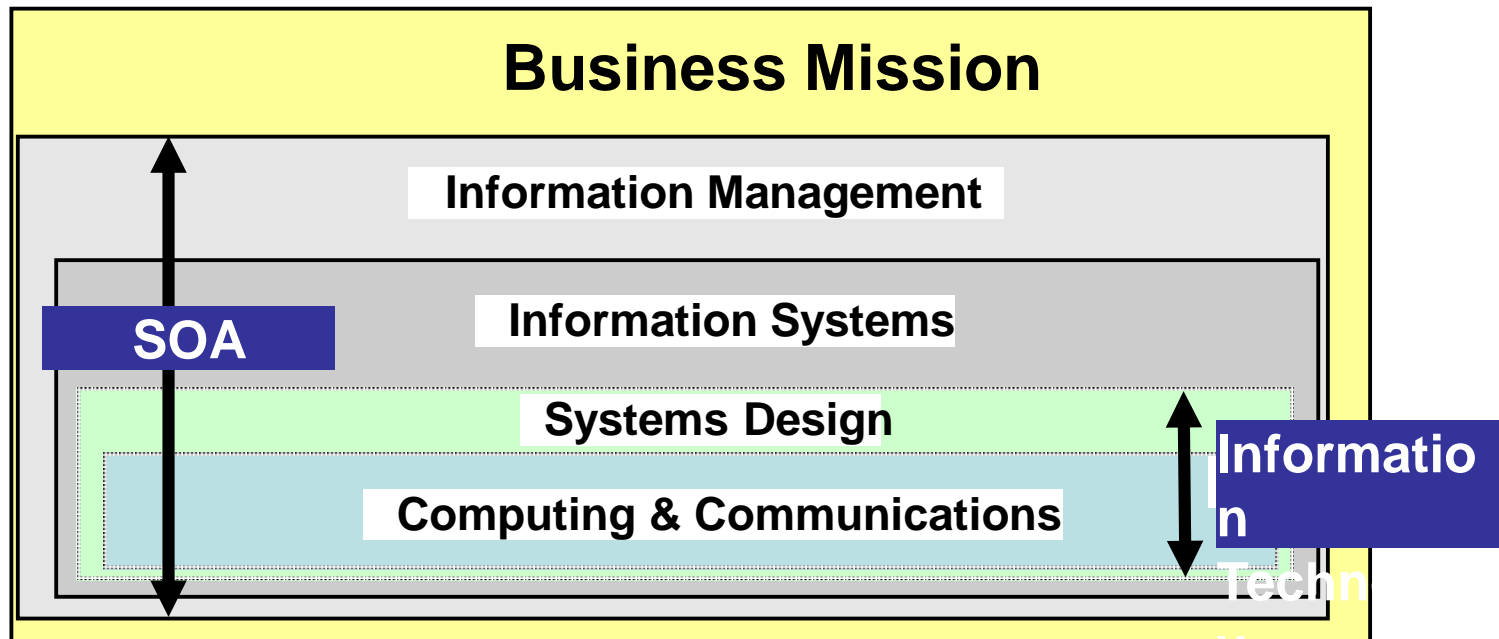
Current Infrastructure Costs are Excessive *($ Millions, I.T. Costs)*

Function	Total 07 Spending	% of Total Spending
Warfighter Missions	$10,876	36%
IT Infrastructure	$14,185	47%
Logistics	$2,377	8%
HR Management	$1,834	6%
Finance & Administration	$1,036	3%
Other	$185	1%
Total DoD FY 07	$30,492	100%

SOA →

Contractors Will Build Separate Infrastructures without SOA

$ Billions	FY05	FY06	FY07
Overall DOD IT Spend	$28.7	$29.9	$30.7
Contracted DoD IT Spend	$21.1	$22.6	$24.1
% Contracted	73.5%	75.6%	78.5%

Why Getting SOA Will be Difficult
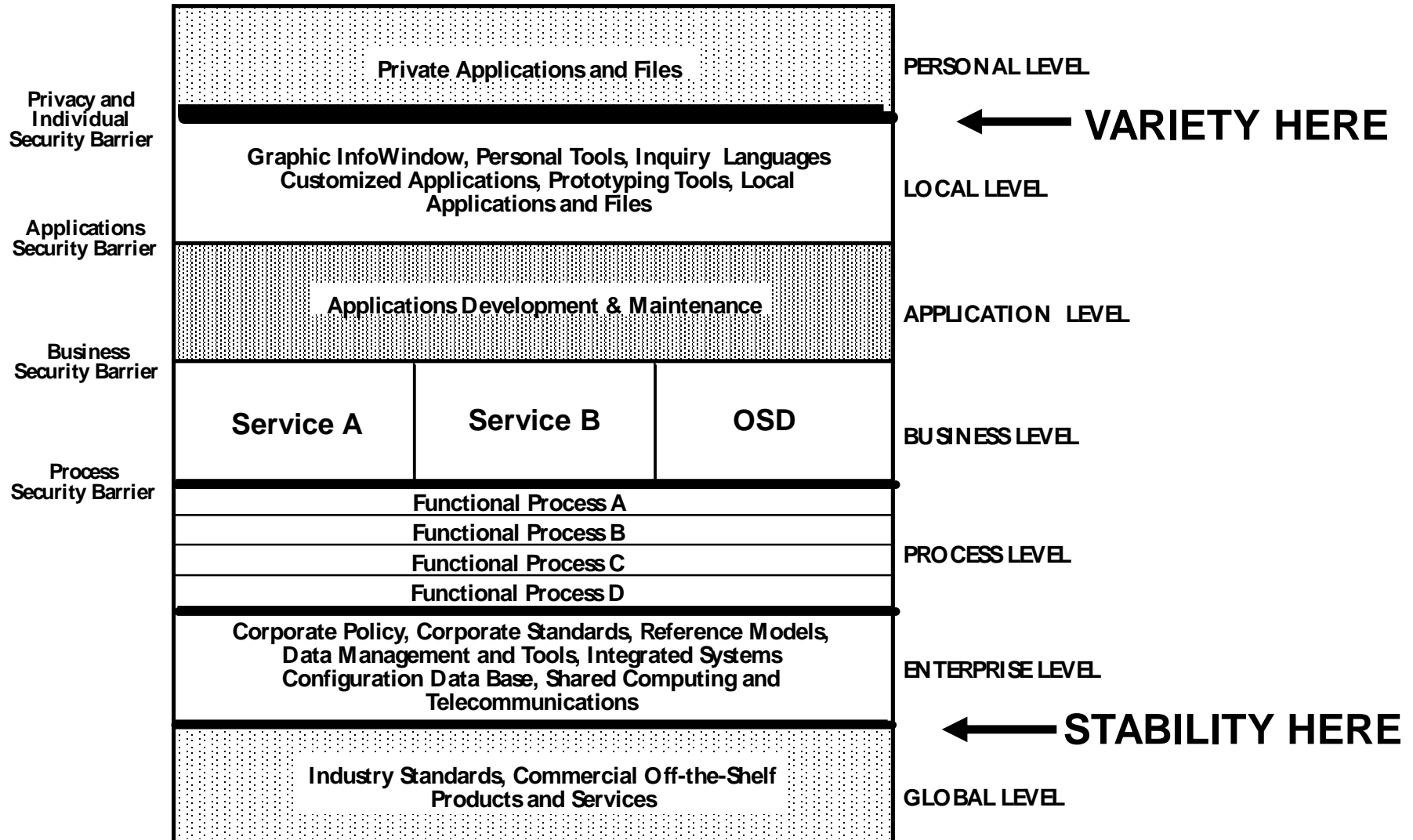
- Managing for Projects:
  - Software: 1 - 4 years
  - Hardware: 3 - 5 years;
  - Communications: 1 - 3 years;
  - Project Managers: 2 - 4 years;
  - Reliable funding: 1 - 4 years;
  - User turnover: 30%/year;
  - Security risks: 1 minute or less.
- Managing for SOA:
  - Data: forever.
  - Infrastructure: 10+ years.
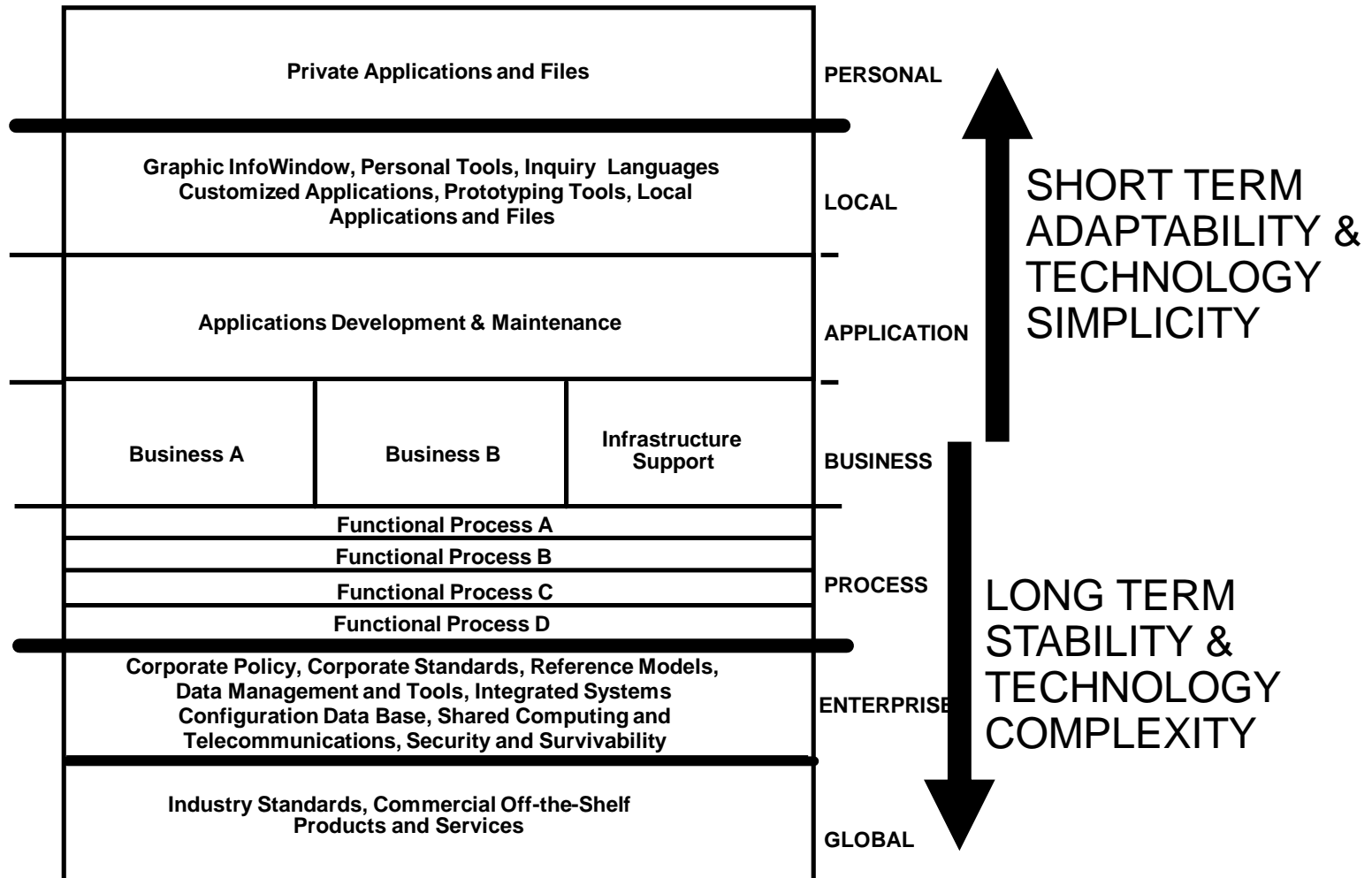
Why Managing Business Systems is Difficult?

- 40 Million lines of code in Windows XP is unknowable.
- Testing application (3 Million lines) requires $>10^{15}$ tests.
- Probability correct data entry for a supply item is <65%.
- There are >100 formats that identify a person in DoD.
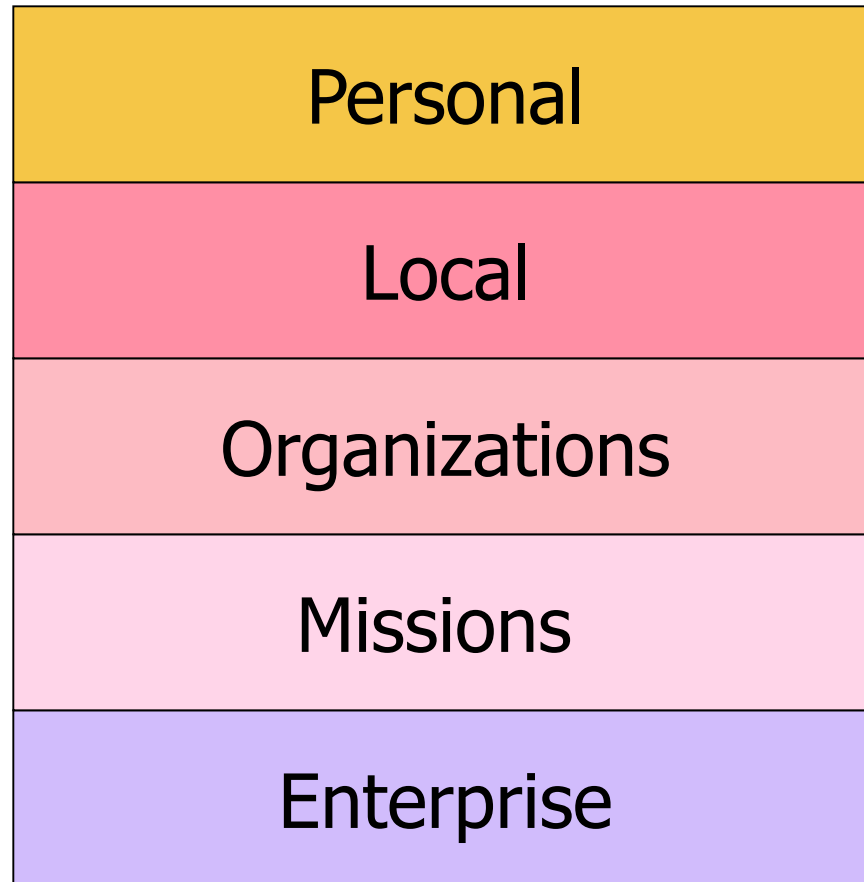- Output / Office Worker: >30 e-messages /day.

How to View Organizing for SOA

Private Applications and Files	PERSONAL LEVEL

Privacy and Individual Security Barrier

← VARIETY HERE

Graphic InfoWindow, Personal Tools, Inquiry Languages
Customized Applications, Prototyping Tools, Local Applications and Files

LOCAL LEVEL

Applications Security Barrier

Applications Development & Maintenance

APPLICATION LEVEL

Business Security Barrier

Service A	Service B	OSD

BUSINESS LEVEL

Process Security Barrier

Functional Process A
Functional Process B
Functional Process C
Functional Process D

PROCESS LEVEL

Corporate Policy, Corporate Standards, Reference Models, Data Management and Tools, Integrated Systems Configuration Data Base, Shared Computing and Telecommunications

ENTERPRISE LEVEL

← STABILITY HERE

Industry Standards, Commercial Off-the-Shelf Products and Services

GLOBAL LEVEL

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SOA Must Reflect Timing

Private Applications and Files	**PERSONAL**
Graphic InfoWindow, Personal Tools, Inquiry Languages Customized Applications, Prototyping Tools, Local Applications and Files	**LOCAL**
Applications Development & Maintenance	**APPLICATION**
Business A / **Business B** / **Infrastructure Support**	**BUSINESS**
Functional Process A / **Functional Process B** / **Functional Process C** / **Functional Process D**	**PROCESS**
Corporate Policy, Corporate Standards, Reference Models, Data Management and Tools, Integrated Systems Configuration Data Base, Shared Computing and Telecommunications, Security and Survivability	**ENTERPRISE**
Industry Standards, Commercial Off-the-Shelf Products and Services	**GLOBAL**

↑ SHORT TERM ADAPTABILITY & TECHNOLOGY SIMPLICITY

↓ LONG TERM STABILITY & TECHNOLOGY COMPLEXITY

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SOA Must Reflect Conflicting Interests

DoD Concept How to Organize for SOA

Programs

Army, Navy Air Force

Agencies

Combatant Commands

Business Mission

WarFighting Mission

Intelligence Mission

Focus of this Presentation →

Enterprise Information Environment

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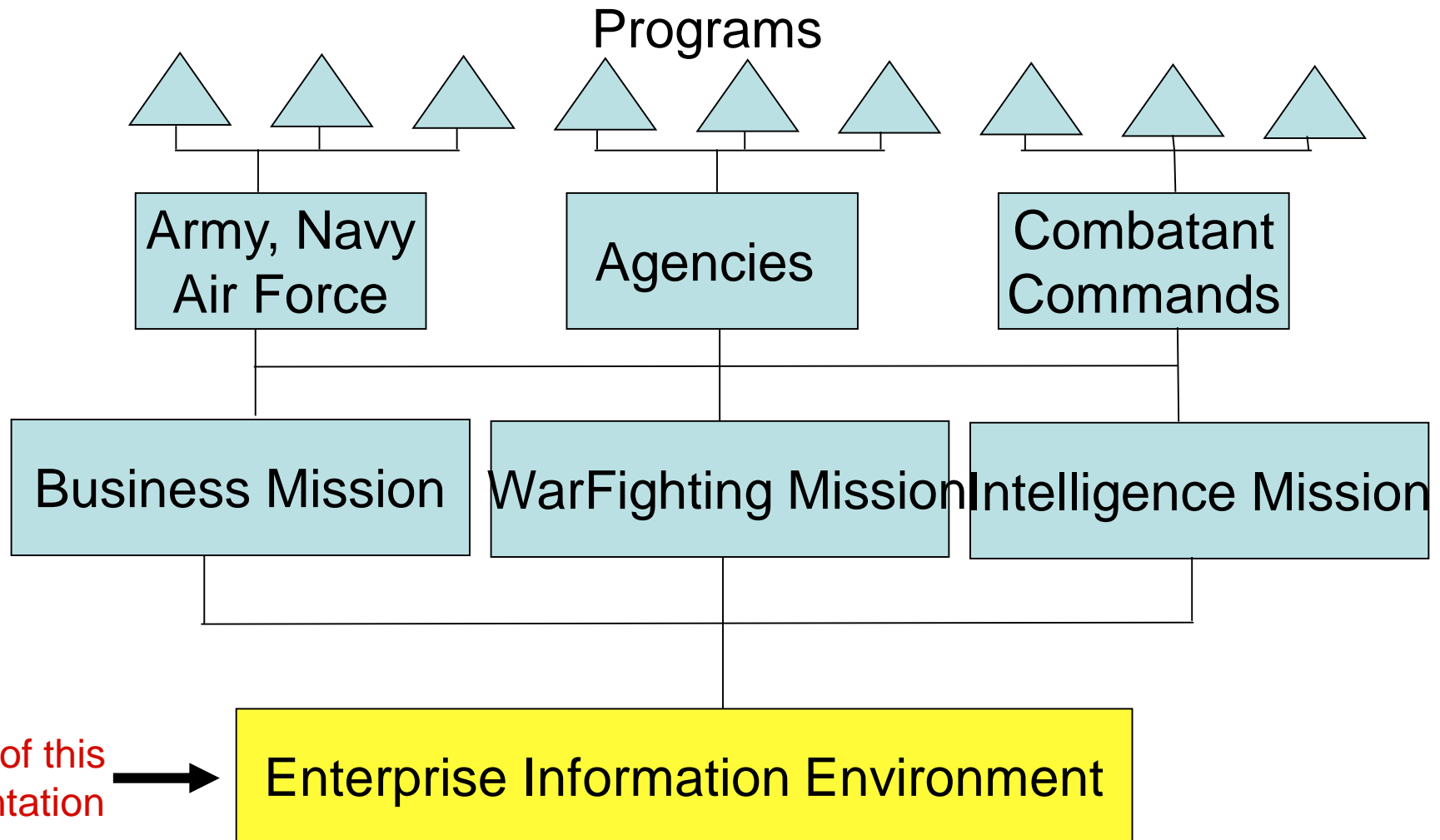
Organization of Infrastructure Services
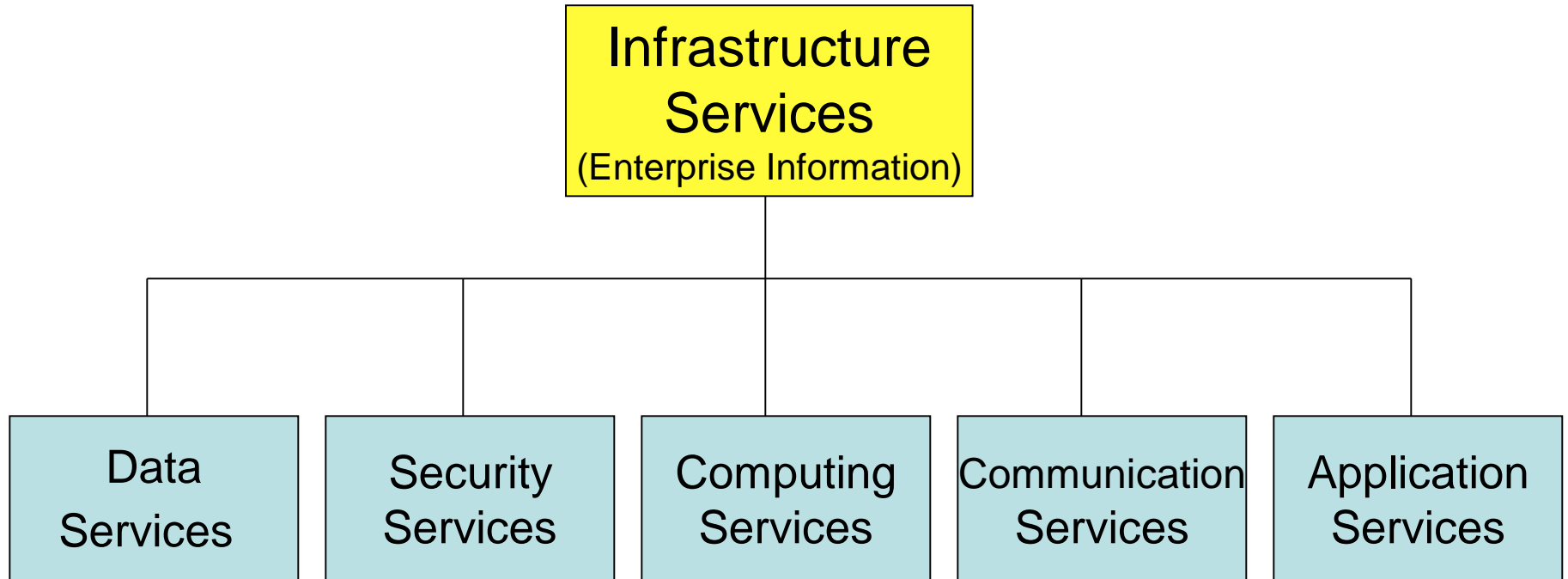
Organization of Data Services

```
                         ┌──────────────┐
                         │     Data     │
                         │   Services   │
                         └──────────────┘
        ┌──────────┬──────────┼──────────┬──────────┐
┌───────────┐┌───────────┐┌───────────┐┌───────────┐┌───────────┐
│ Discovery ││Management ││Collaboration││Interoperability││ Semantic │
│ Services  ││ Services  ││ Services  ││ Services  ││ Services  │
└───────────┘└───────────┘└───────────┘└───────────┘└───────────┘
```
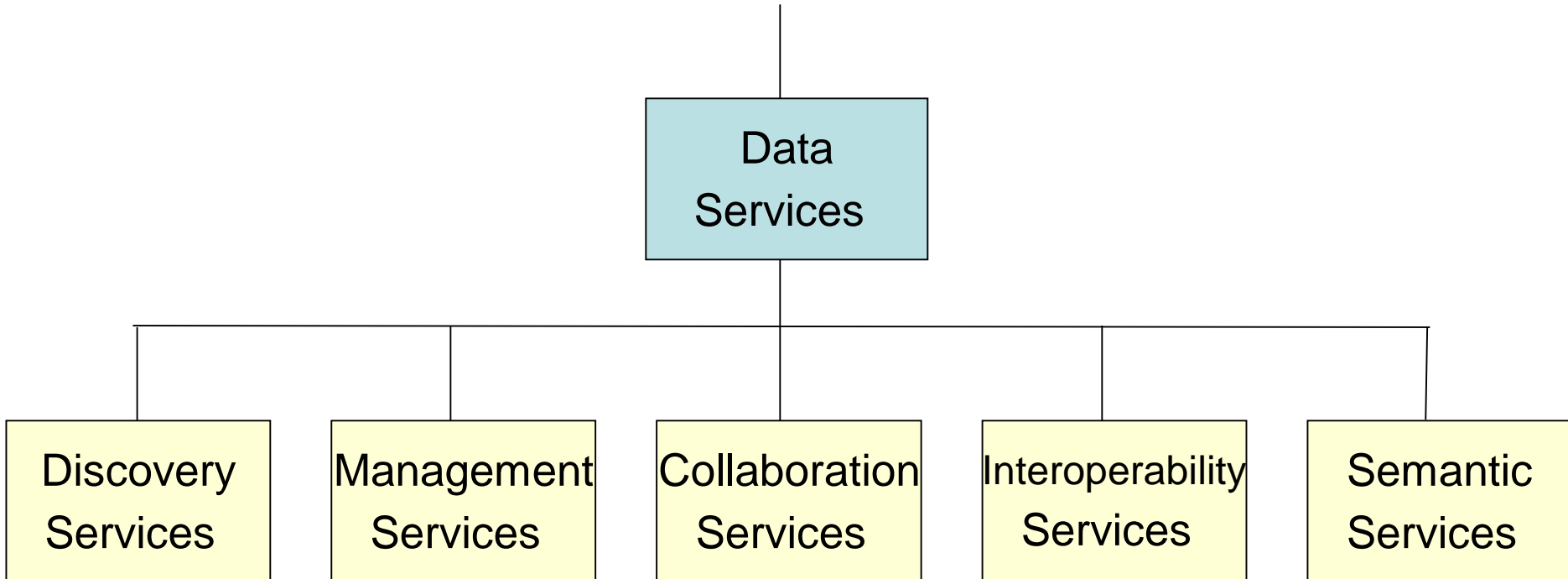
Data Interoperability Policies

- Data are an enterprise resource.
- Single-point entry of unique data.
- Enterprise certification of all data definitions.
- Data stewardship defines data custodians.
- Zero defects at point of entry.
- De-conflict data at source, not at higher levels.
- Data aggregations from sources data, not from reports.

Example of Data Pollution

Citizen?	Frequency
US	9,451
Yes	228
USA	158
U.S.A.	128
U.S.	88
United States	20
(US)	5
Green Card	2
Naturalized	1
Applied	1
???	323

What Data?

UNSTRUCTURED	SEMI-STRUCTURED	XML
Microsoft Word	XML	LegalXML
Microsoft Excel	HL7	IFX
PowerPoint	HIPAA	cXML
PDF	ASTM	ebXML
Star Office	EDI–X12	HL7 V3.0
Word Perfect	EDI-Fact	ACORD (AL3,
ASCII reports	FIX	GJXDM
HTML	Cargo IMP	TWPDES
EBCDIC	MVR	
Undocumented	AFP	
Flat files	Post Script	
RPG	DJDE	
ANSI		

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Data Concepts

- Data Element Definition
  - Text associated with a unique data element within a data dictionary that describes the data element, give it a specific meaning and differentiates it from other data elements. Definition is precise, concise, non-circular, and unambiguous.   (ISO/IEC 11179 Metadata Registry specification)
- Data Element Registry
  - A label kept by a registration authority that describes a unique meaning and representation of data elements, including registration identifiers, definitions, names, value domains, syntax, ontology and metadata attributes. (ISO 11179-1).

Data and Services Deployment Principles

- Data, services and applications belong to the Enterprise.

- Information is a strategic asset.

- Data and applications cannot be coupled to each other.

- Interfaces must be independent of implementation.

- Data must be visible outside of the applications.

- Semantics and syntax is defined by a community of interest.

- Data must be understandable and trusted.
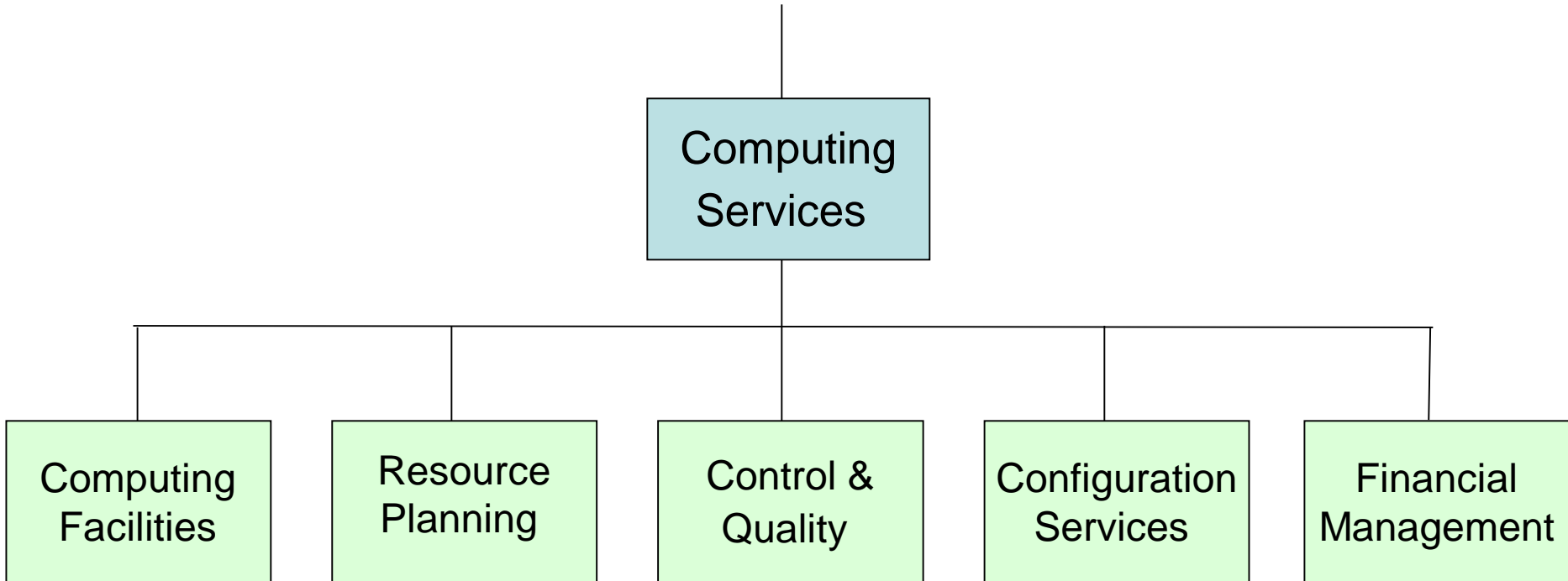
Organization of Security Services
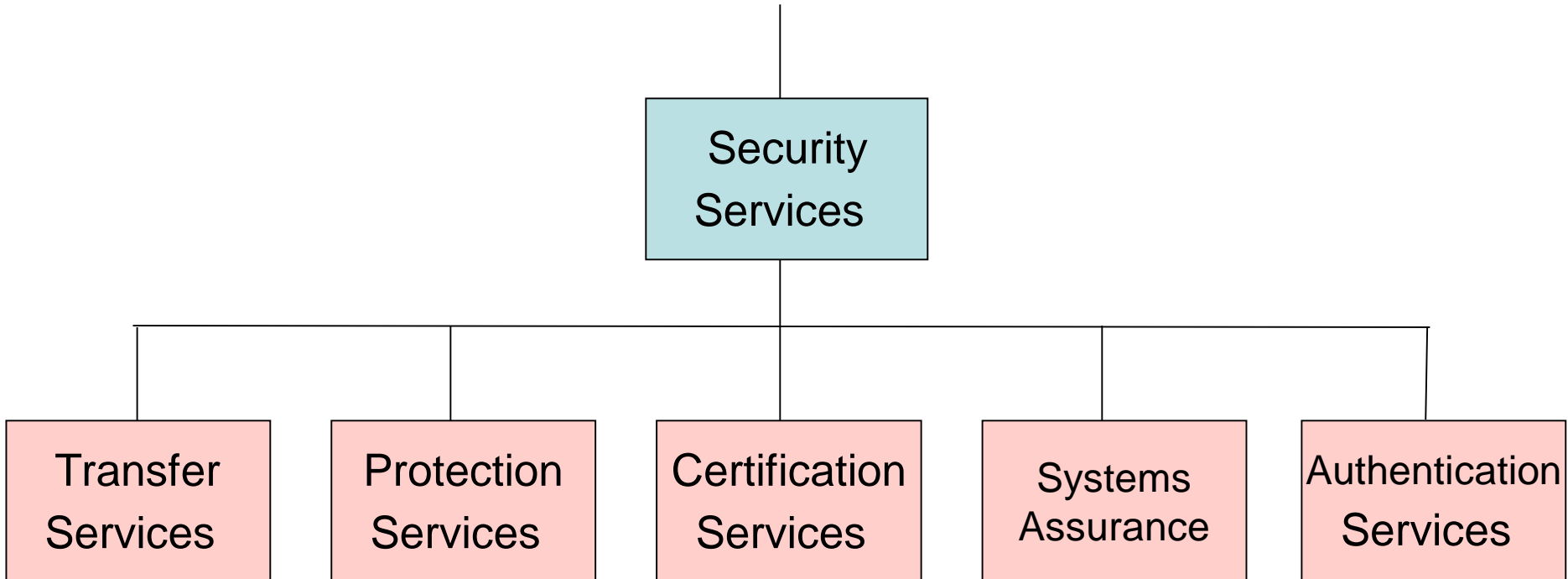
Security Services = Information Assurance

- Conduct Attack/Event Response
  - Ensure timely detection and appropriate response to attacks.
  - Manage measures required to minimize the network's vulnerability.

- Secure Information Exchanges
  - Secure information exchanges that occur on the network with a level of protection that is matched to the risk of compromise.

- Provide Authorization and Non-Repudiation Services
  - Identify and confirm a user's authorization to access the network.

Organization of Computing Services

```
                        ┌─────────────┐
                        │  Computing  │
                        │  Services   │
                        └──────┬──────┘
        ┌──────────┬───────────┼───────────┬──────────┐
┌───────────┐ ┌──────────┐ ┌──────────┐ ┌─────────────┐ ┌─────────────┐
│ Computing │ │ Resource │ │ Control &│ │Configuration│ │  Financial  │
│ Facilities│ │ Planning │ │  Quality │ │  Services   │ │ Management  │
└───────────┘ └──────────┘ └──────────┘ └─────────────┘ └─────────────┘
```

Computing Services

- Provide Adaptable Hosting Environments
  - Global facilities for hosting to the "edge".
  - Virtual environments for data centers.
- Distributed Computing Infrastructure
  - Data storage, and shared spaces for information sharing.
- Shared Computing Infrastructure Resources
  - Access shared resources regardless of access device.

Organization of Communication Services

```
                        ┌─────────────────┐
                        │  Communication  │
                        │    Services     │
                        └─────────────────┘
```

Interoperability Services	Spectrum Management	Connectivity Arrangements	Continuity of Services	Resource Management
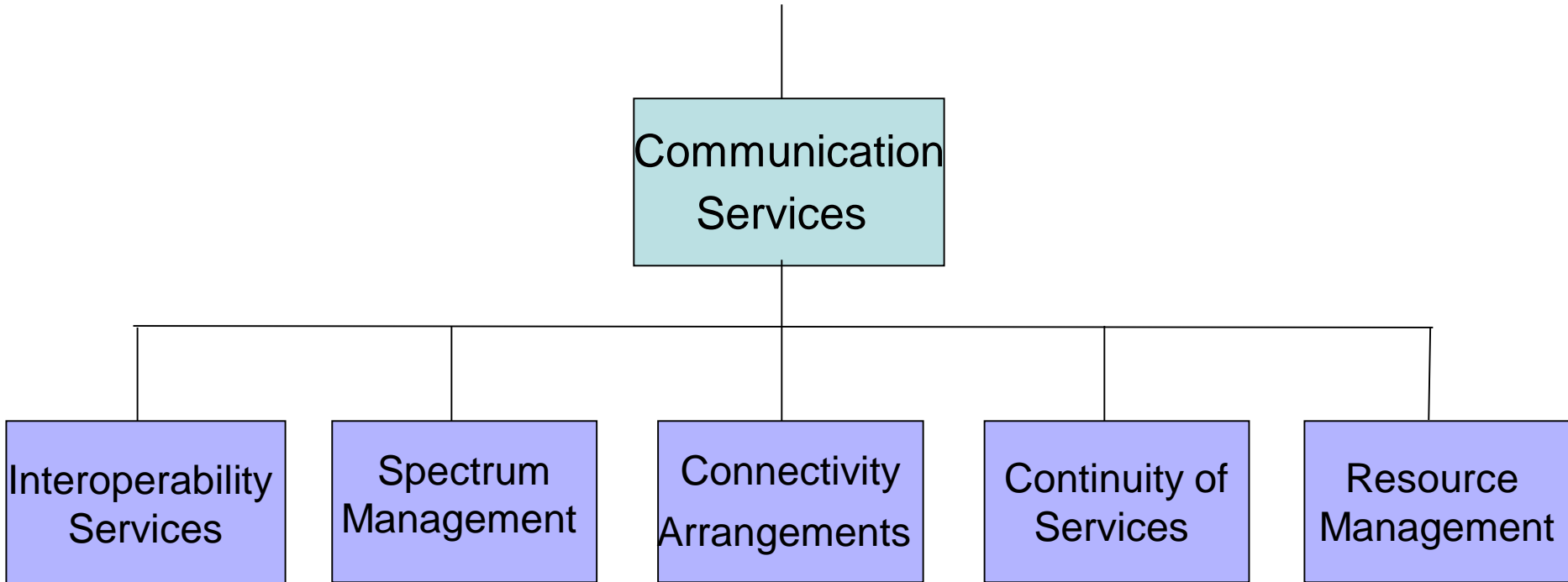
Network Services Implementation

- From point-to-point communications (push communications) to network-centric processes (pull communications).

- Data posted to shared space for retrieval.

- Network controls assure data synchronization and access security.

Network Control is the Key

Communication Services

- Provide Information Transport
  - Transport information, data and services anywhere.
  - Ensures transport between end-user devices and servers.
  - Expand the infrastructure for on-demand capacity.

Organization of Application Services

```
                    Application
                    Services
                         |
  ┌──────────┬──────────┼──────────┬──────────┐
```

| Component Repository | Code Binding Services | Maintenance Management | Portals | Experimental Services |

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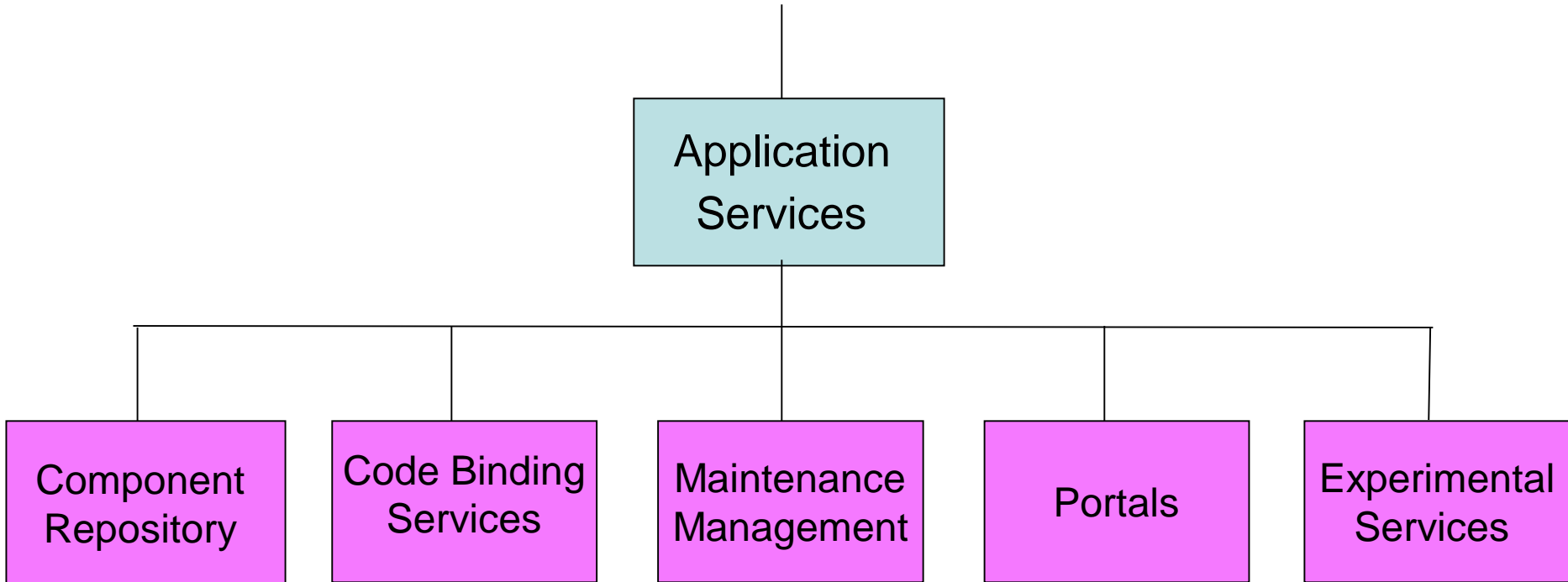
Application Services and Tools

- Provide Common End User Interface Tools
  - Application generators, test suites, error identification, application components and standard utilities.
- Common end-user Interface Tools.
  - E-mail, collaboration tools, information dashboards, Intranet portals, etc.

Example of Development Tools

• Business Process Execution Language, **BPEL**, is an executable modeling language. Through XML it enables code generation.

Traditional Approach   BPEL Approach

- Hard-coded decision logic   - Externalized decision logic

- Developed by IT   - Modeled by business analysts

- Maintained by IT   - Maintained by policy managers

- Managed by IT   - Managed by IT

- Dependent upon custom logs   - Automatic logs and process
capture

- Hard to modify and reuse   - Easy to modify and reuse

A Few Key SOA Protocols

- Universal Description, Discovery, and Integration, **UDDI**. Defines the publication and discovery of web service implementations.

- The Web Services Description Language, **WSDL**, is an XML-based language that defines Web Services.

- **SOAP** is the Service Oriented Architecture Protocol. It is a key SOA in which a network node (the client) sends a request to another node (the server).

- The Lightweight Directory Access Protocol, or **LDAP** is protocol for querying and modifying directory services.

- Extract, Transform, and Load, **ETL**, is a process of moving data from a legacy system and loading it into a SOA application.

SOA Interoperability Goals for the Department of Defense

- Interoperability of solutions across the DoD strategic goal.

- Rules for sharing of data and services across the enterprise.

- Enforcement of standards.

- All data, services, and applications shall be accessible, understandable, and trusted.

- Global Information Grid for sharing of information with Federal Departments, Department of Homeland Security, the Intelligence Community, state and local governments, allied, coalition, non-governmental organizations (NGOs), academic, research and business partners.

Example of Customizable Web Services (www.salesforce.com)

Why SOA Saves Code

- Provides a standard way of interacting with shared software.

- Enables software to become building blocks for reuse.

- Shifts focus to application assembly rather than design.

- Creates new applications out of existing components.

- Integrates with applications in other enterprises.

Preservation of Assets is the Purpose of SOA

What the Customer Trains to Apply; Applications Usage

↔

Open Systems, Equipment, Software, Communications

↔

Data & Systems Integration; Communications Infrastructure Architecture

Short-term Asset (An Enterprise Function) >70% of Cost

Obsolescent Commodity Asset (Outsource According to Architecture) <20% of Cost

Long - term Asset (An Enterprise Function) <10% of Cost
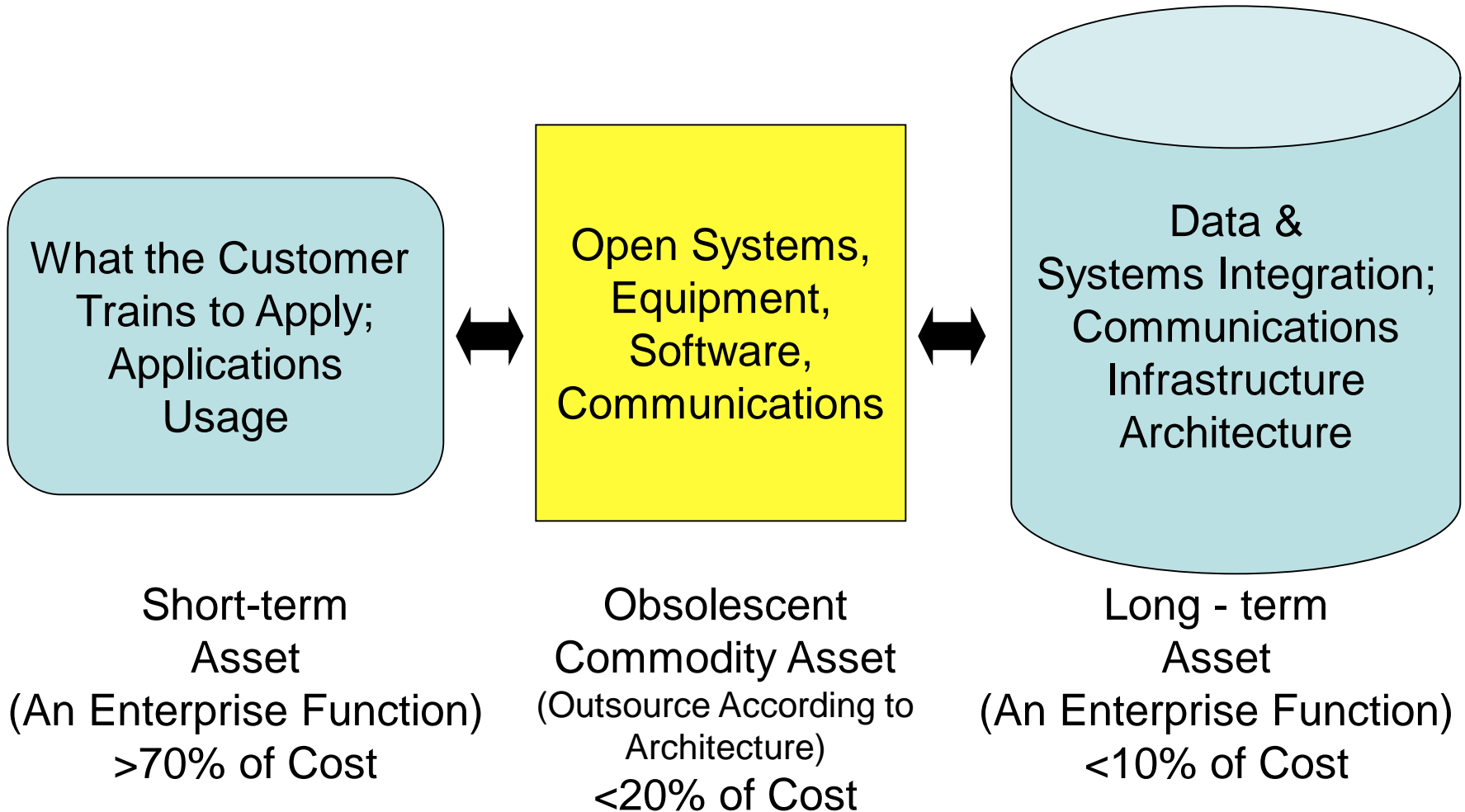
Impacts of Information Technologies

- Information drives economic "arms race".
- Obsolete assets will be discarded.
- Collaboration favors global consolidation.
- I.T. becomes an economic weapon.

A Historical Perspective