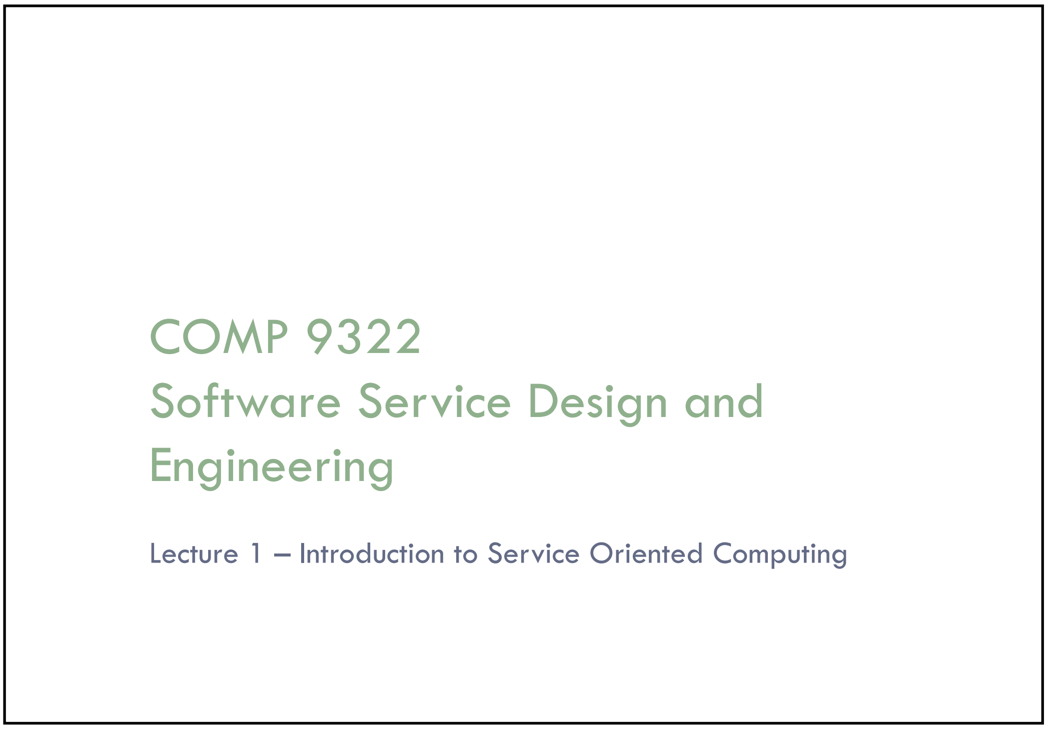
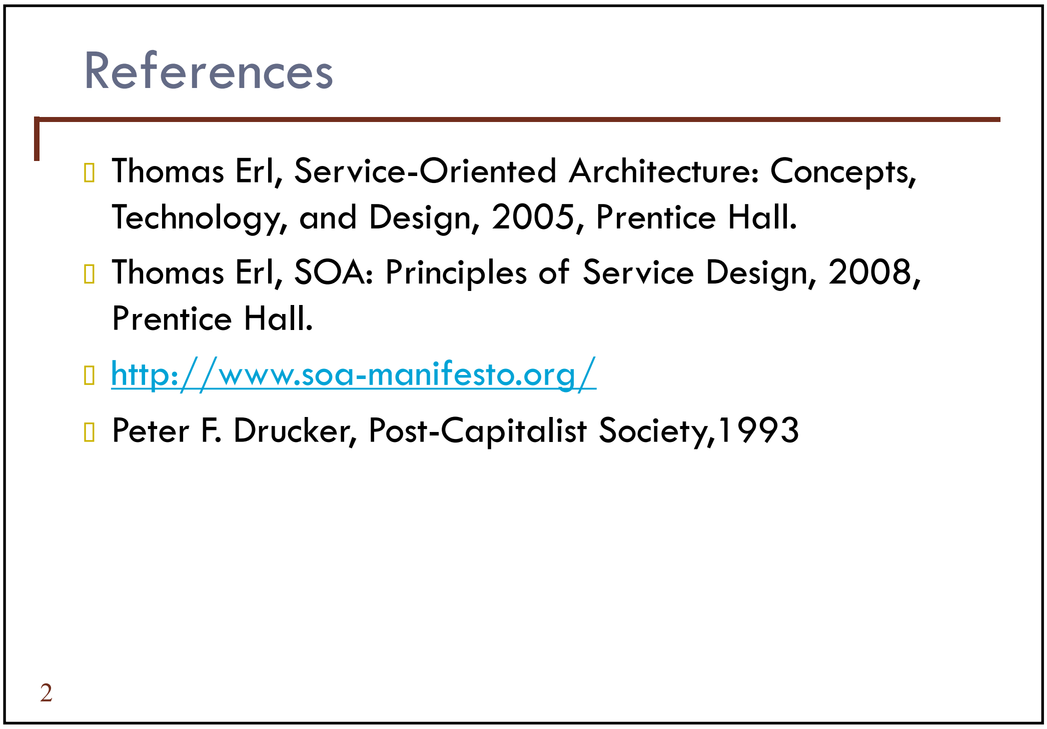


# COMP 9322 Software Service Design and Engineering

Lecture 1 – Introduction to Service Oriented Computing



## References

- Thomas Erl, Service-Oriented Architecture: Concepts, Technology, and Design, 2005, Prentice Hall.
- Thomas Erl, SOA: Principles of Service Design, 2008, Prentice Hall.
- http://www.soa-manifesto.org/
- Peter F. Drucker, Post-Capitalist Society,1993

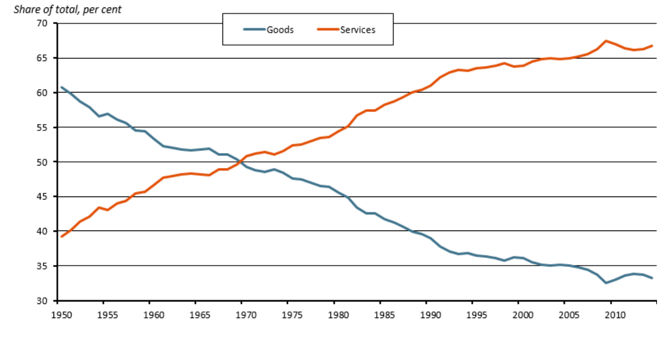
## Outline

- Service Orientation
  - The roots, Services
  - Service Oriented Architecture
  - Service Design Principles
  - State of the Art: Web Services
- Challenges of Service Orientation
- SOA Manifesto as a Summary

## Service in Business

- Service:
  - is the application of specialized competences (knowledge and skills), through deeds, processes, and performances for the benefit of another entity or the entity itself. LUSCH & VARGO, "The Service-Dominant Logic of Marketing". (Armonk, NY: ME Sharpe. 2006).

US Personal Consumer Spending, 1950 - 2014



Source: US Bureau of Economic Analysis.

*Goods* ⟷ *Services*

| **Pure Goods** | **Core Goods** | **Core Services** | **Pure Services** |
|---|---|---|---|
| Food | Appliances | Airlines | Teaching |
| Chemicals | Automobiles | Hotels | Medical advice |

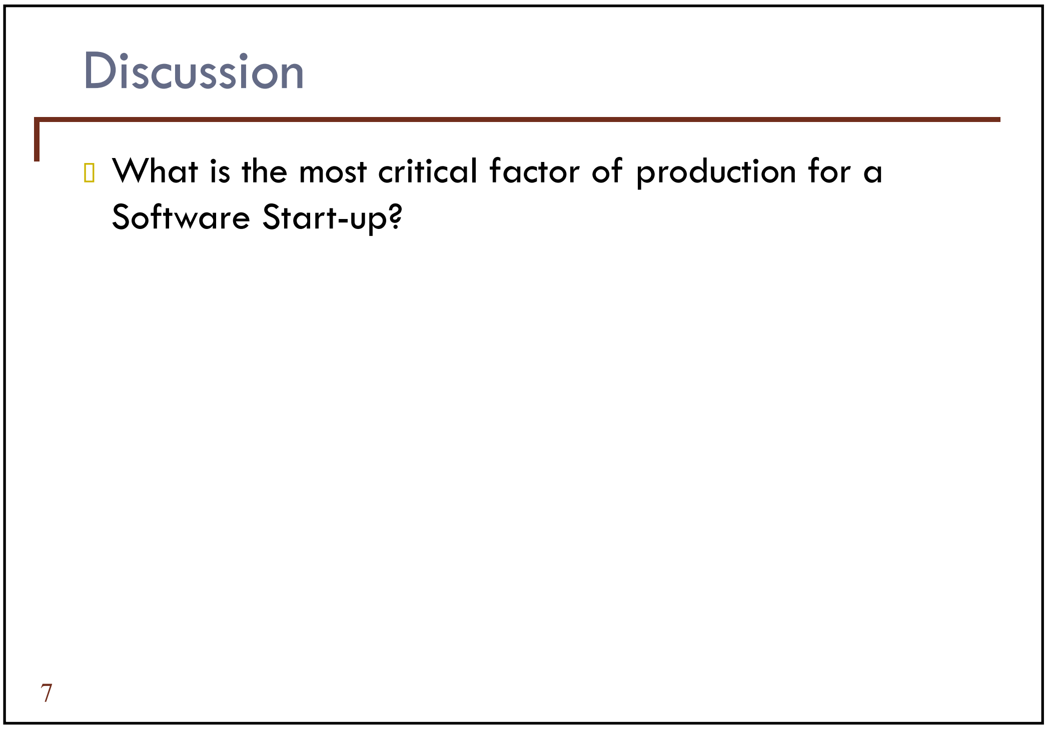
## What does software industry produce?

## Organization's of Yesterday

- Structured to produce goods
- Vertical Integration was the mode of operation:
  - The whole supply chain was owned by a single company.
  - Ford owned and produced everything in The Rouge
- Critical factors of production was:
  - Land, labor and capital

**The Ford River Rouge Complex:**
2.4 km x 1.6 km
93 buildings, 1.5 km2 floor space, 100,000 workers

https://en.wikipedia.org/wiki/Ford_River_Rouge_Complex



## Discussion

- What is the most critical factor of production for a Software Start-up?

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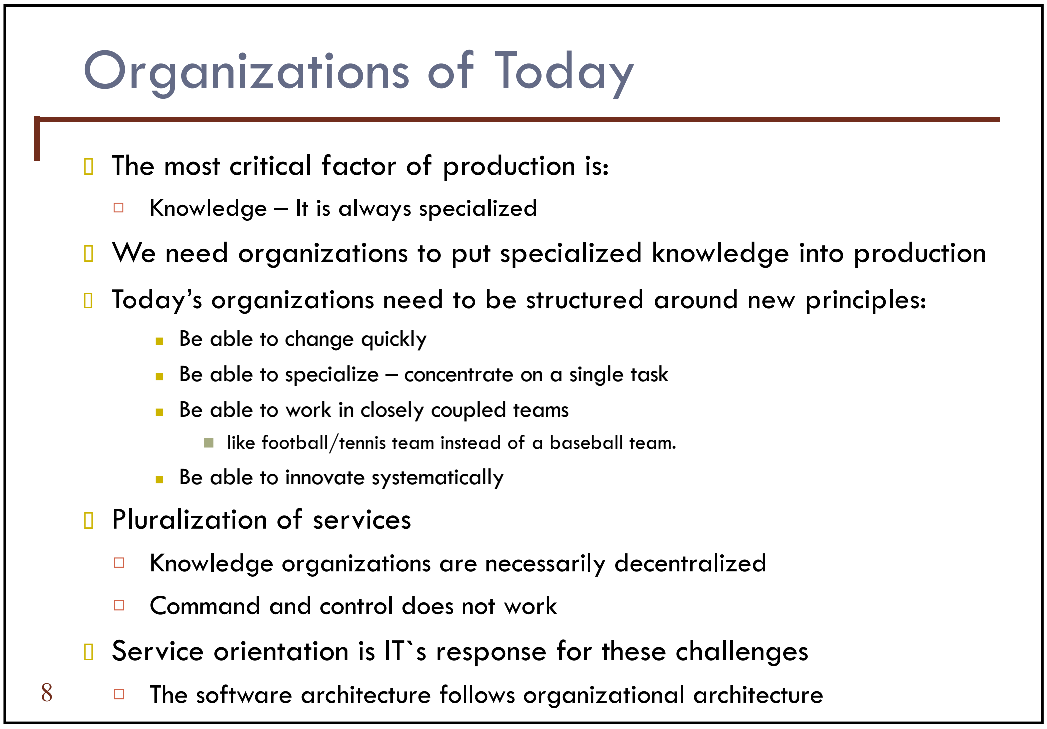

## Organizations of Today

- The most critical factor of production is:
  - Knowledge – It is always specialized
- We need organizations to put specialized knowledge into production
- Today’s organizations need to be structured around new principles:
    - Be able to change quickly
    - Be able to specialize – concentrate on a single task
    - Be able to work in closely coupled teams
      - like football/tennis team instead of a baseball team.
    - Be able to innovate systematically
- Pluralization of services
  - Knowledge organizations are necessarily decentralized
  - Command and control does not work
- Service orientation is IT`s response for these challenges
  - The software architecture follows organizational architecture

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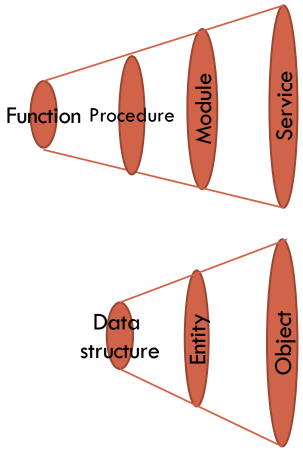
## ‘Service Orientation’

- Separation of concerns:
  - To solve a large problem decompose it into smaller related pieces.
  - Each of these pieces addresses a concern or a specific part of the problem.
- How SO achieves this separation?
  - It is like different companies producing specialized goods and services as oppose to a large vertically integrated company, like General Motors producing everything.

## Service is an Abstraction

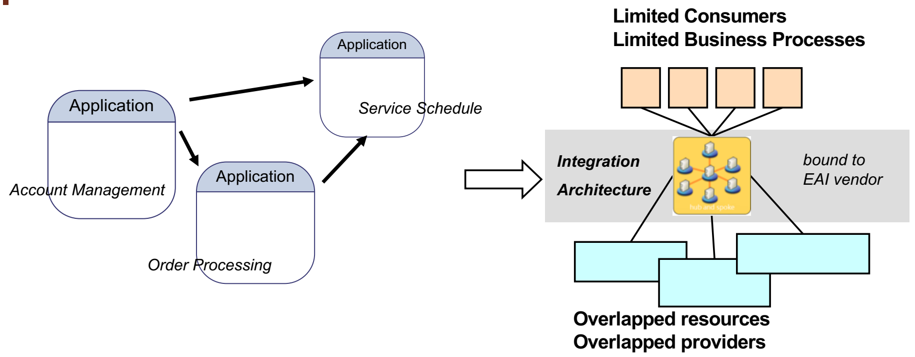


- Programming abstractions:
  - Procedures
  - Modules
  - Objects
  - Components
  - Services
- Hide the details
- Decompose systems into procedures, objects, or services

## SDLC Before Service Orientation

- The common popular approach:
  1. Identify the business tasks to be automated
     (Keeping inventory of items )
  2. Define the software requirements
     (The system shall …. Or For the user to be able to …)
  3. Build a corresponding solution logic
     (Decompose into classes including attributes and methods …)
- The benefits of the approach:
  - Solutions can be built efficiently -they are specialized
  - The business analysis effort is straightforward – well defined
  - The project management is relatively easy
  - Can take advantage of the latest technology – independent solutions

## Application Centric



Application
Account Management
Application
Service Schedule
Application
Order Processing

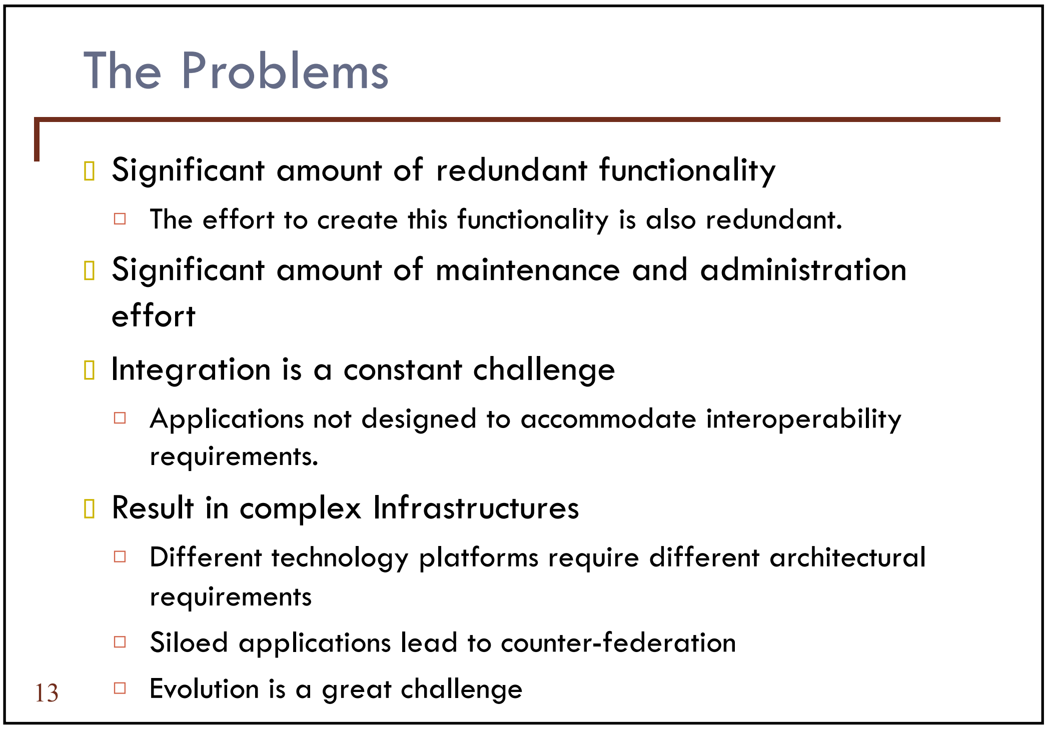
Limited Consumers
Limited Business Processes

Integration Architecture
bound to EAI vendor

Overlapped resources
Overlapped providers

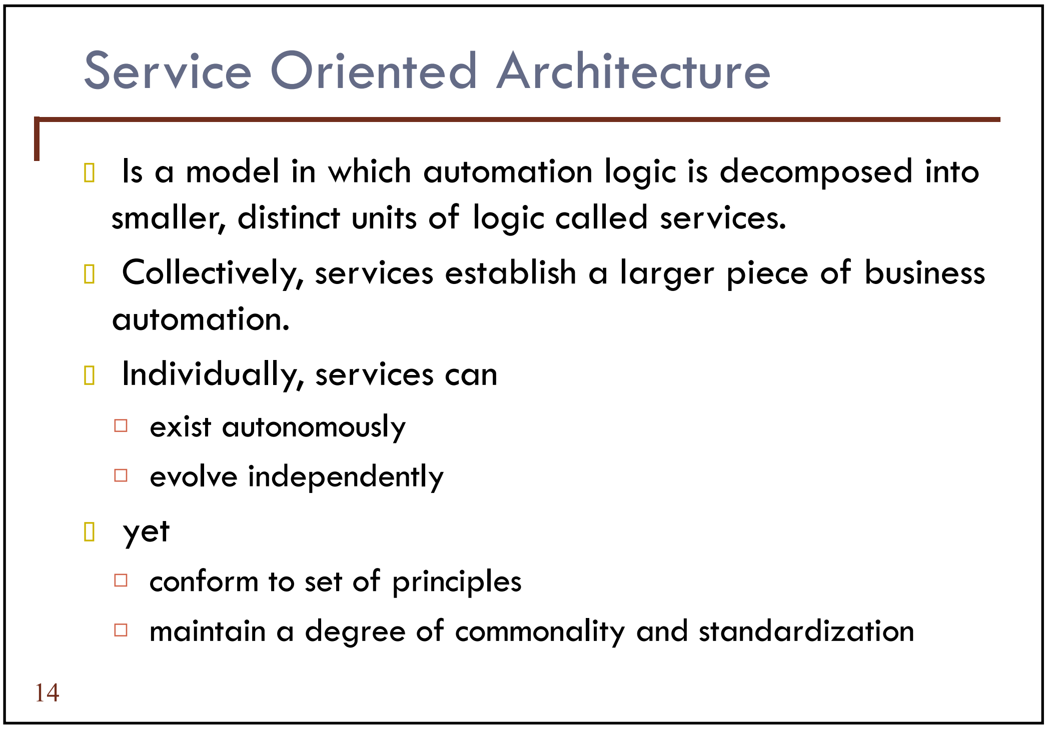
**Functionality is duplicated in each application – generating a report**

EAI ‘leverage’ application silos with the drawback of data and function redundancy.



## The Problems

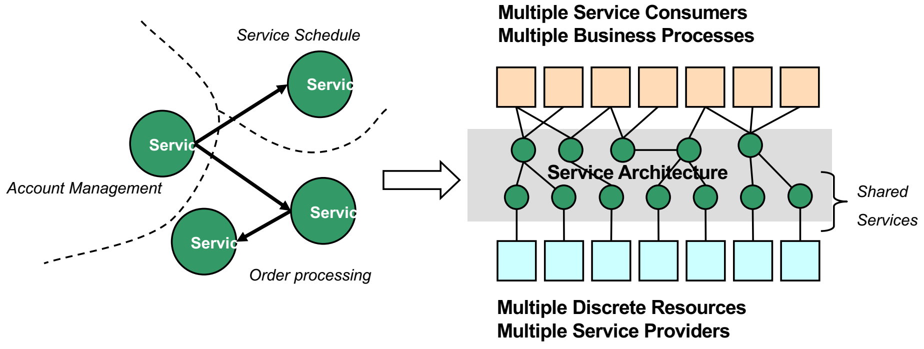
- Significant amount of redundant functionality
  - The effort to create this functionality is also redundant.
- Significant amount of maintenance and administration effort
- Integration is a constant challenge
  - Applications not designed to accommodate interoperability requirements.
- Result in complex Infrastructures
  - Different technology platforms require different architectural requirements
  - Siloed applications lead to counter-federation
  - Evolution is a great challenge



## Service Oriented Architecture

- Is a model in which automation logic is decomposed into smaller, distinct units of logic called services.
- Collectively, services establish a larger piece of business automation.
- Individually, services can
  - exist autonomously
  - evolve independently
- yet
  - conform to set of principles
  - maintain a degree of commonality and standardization

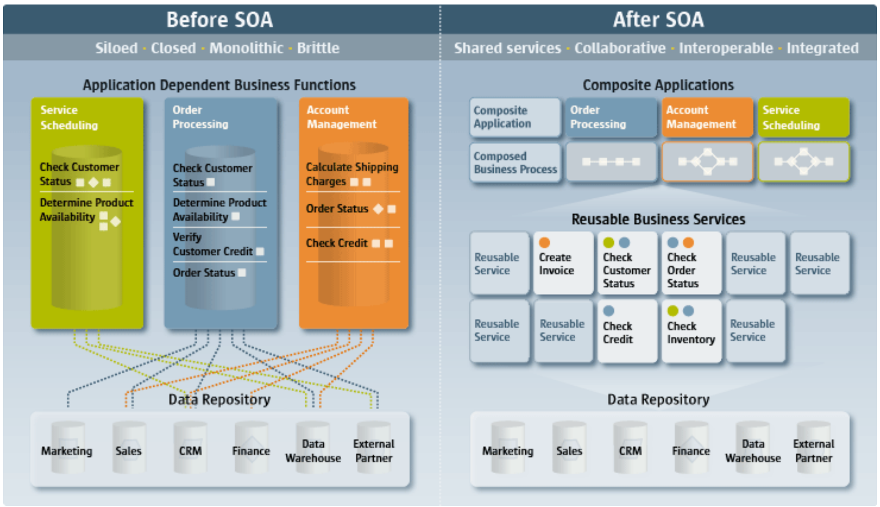
# Service Centric



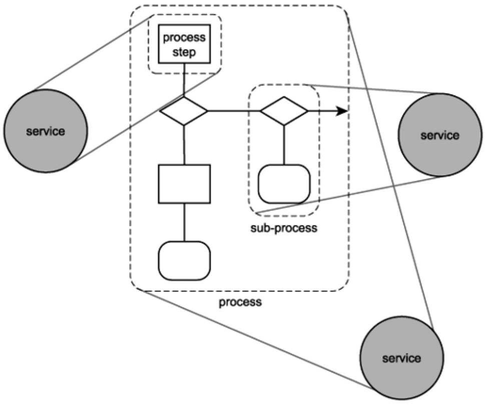
**SO structures the business and its systems as a set of capabilities that are offered as Services**

Service abstracts the details of how - Enables multiple providers and consumers to participate together in shared business activities.

# Before and After SOA

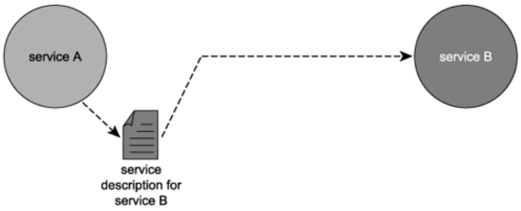


## Service Context



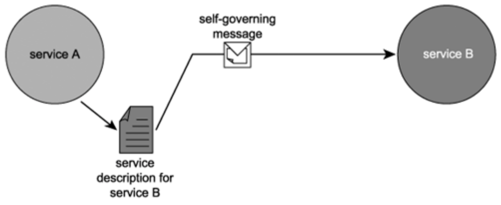
- Each service work in a distinct context:
  - Size might vary
  - Might require coordinated aggregation – service composition
  - To work together they should be related and communicate with each other

## Service Interface Description



- At the minimum:
  - the name,
  - the data expected and
  - The data returned
- If Service A knows the Service B's description Service A can communicate with Service B.

## Services Communicate



- Messages are independents units of communication
- Once the message is sent the service has no control over the message

## Service orientation is a design paradigm

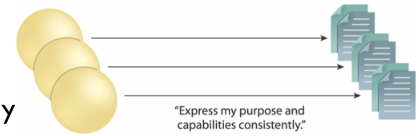
- Design Paradigm
  - bring together ideas on how to decompose and integrate components.
  - a model to define how to solve a class of problems that share a set of common characteristics.
- Expresses in terms of
  - Design Principles / Patterns
  - Components
  - Software Architecture
- Different design paradigms:
  - Object Orientation is the most frequently known
  - Structured Analysis and Design – Functional decomposition

## Service Design Principles

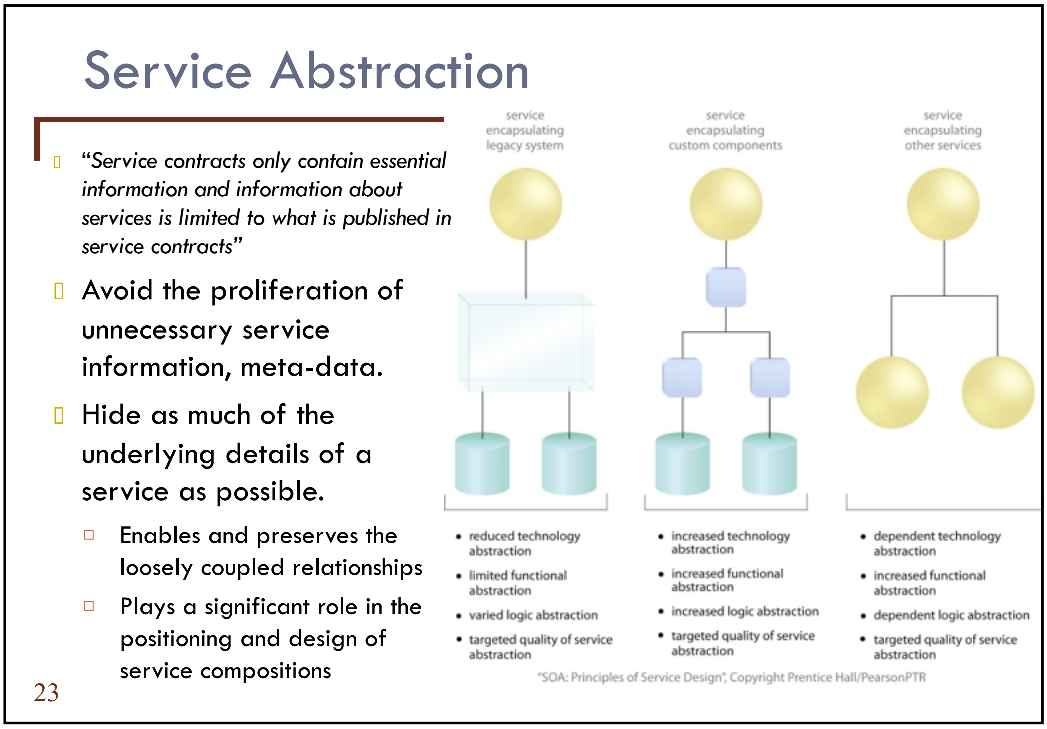
- Standardized Service Contract
- Service Abstraction
- Service Loose Coupling
- Service Reusability
- Service Autonomy
- Service Statelessness
- Service Discoverability
- Service Composability

## Standardized Service Contracts

- Services express their **purpose and capabilities** via a service contract.
- Contract design emphasize:
  - How services express functionality
  - How data types and models are defined
  - How policies are attached
- It is the most fundamental principle.
  - Contract standard determines a service’s public technical interface.



*Source: Thomas Erl*



## Service Abstraction

- *“Service contracts only contain essential information and information about services is limited to what is published in service contracts”*
- Avoid the proliferation of unnecessary service information, meta-data.
- Hide as much of the underlying details of a service as possible.
  - Enables and preserves the loosely coupled relationships
  - Plays a significant role in the positioning and design of service compositions

service encapsulating legacy system
service encapsulating custom components
service encapsulating other services
• reduced technology abstraction
• limited functional abstraction
• varied logic abstraction
• targeted quality of service abstraction
• increased technology abstraction
• increased functional abstraction
• increased logic abstraction
• targeted quality of service abstraction
• dependent technology abstraction
• increased functional abstraction
• dependent logic abstraction
• targeted quality of service abstraction

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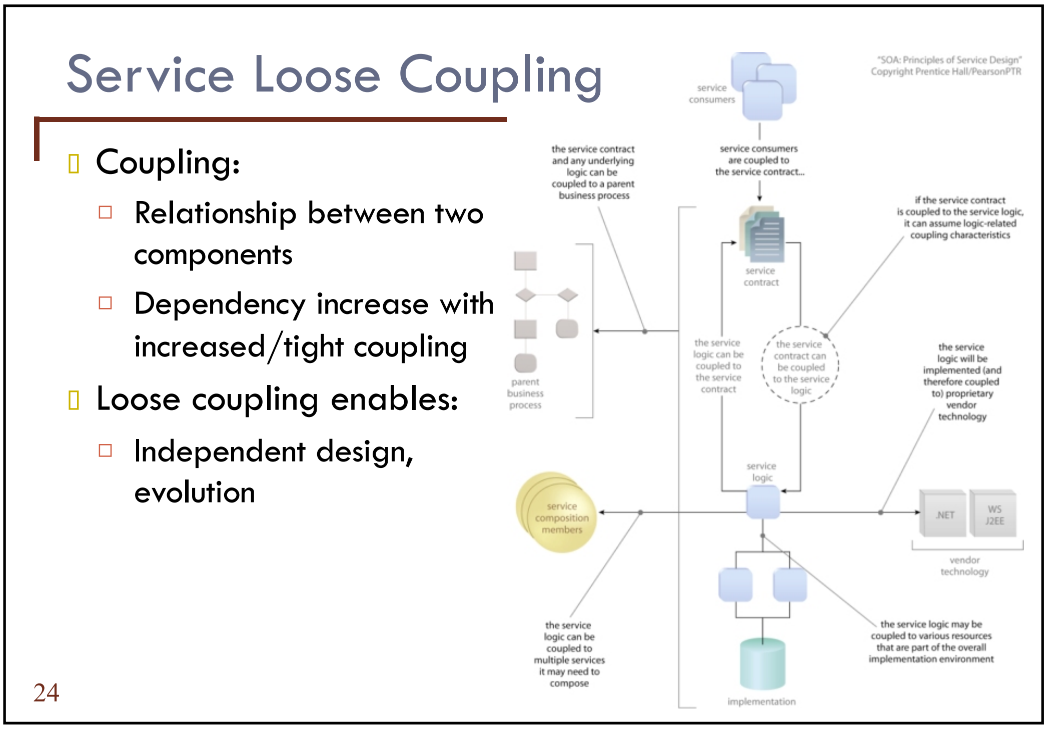

## Service Loose Coupling

- Coupling:
  - Relationship between two components
  - Dependency increase with increased/tight coupling
- Loose coupling enables:
  - Independent design, evolution

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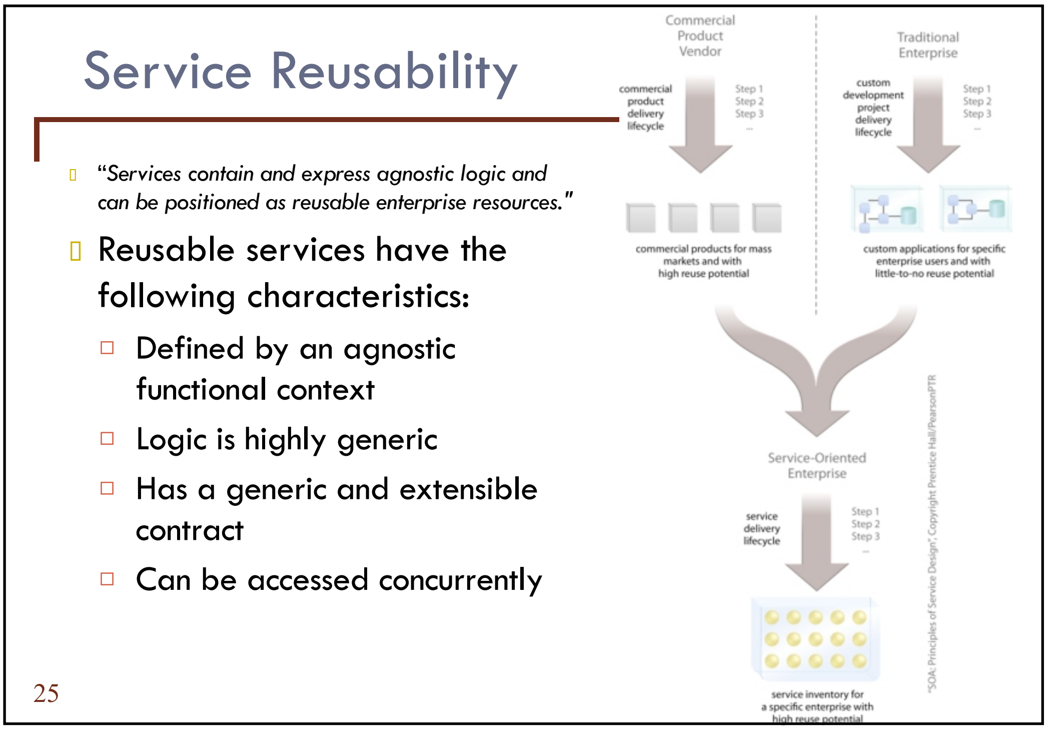
service consumers
service consumers are coupled to the service contract...
the service contract and any underlying logic can be coupled to a parent business process
service contract
if the service contract is coupled to the service logic, it can assume logic-related coupling characteristics
parent business process
the service logic can be coupled to the service contract
the service contract can be coupled to the service logic
the service logic will be implemented (and therefore coupled to) proprietary vendor technology
service logic
service composition members
.NET
WS J2EE
vendor technology
the service logic can be coupled to multiple services it may need to compose
the service logic may be coupled to various resources that are part of the overall implementation environment
implementation



## Service Reusability

- *“Services contain and express agnostic logic and can be positioned as reusable enterprise resources.”*
- Reusable services have the following characteristics:
  - Defined by an agnostic functional context
  - Logic is highly generic
  - Has a generic and extensible contract
  - Can be accessed concurrently

Commercial Product Vendor
commercial product delivery lifecycle
Step 1
Step 2
Step 3
...
Traditional Enterprise
custom development project delivery lifecycle
Step 1
Step 2
Step 3
...
commercial products for mass markets and with high reuse potential
custom applications for specific enterprise users and with little-to-no reuse potential
Service-Oriented Enterprise
service delivery lifecycle
Step 1
Step 2
Step 3
...
service inventory for a specific enterprise with high reuse potential
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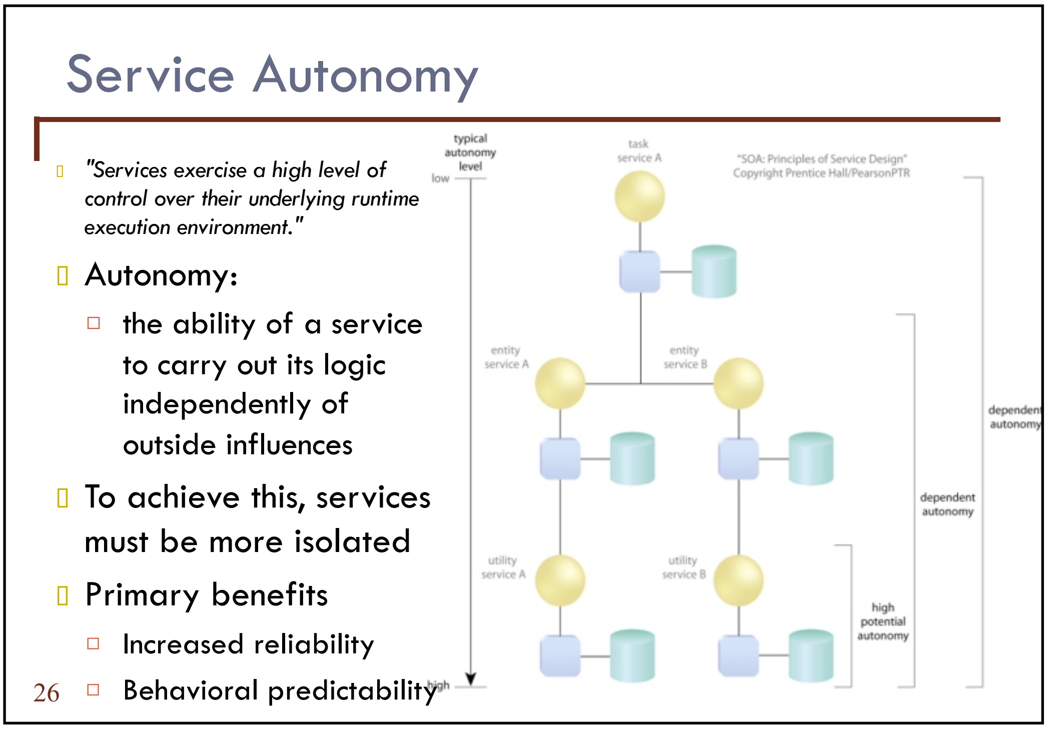

## Service Autonomy

- *"Services exercise a high level of control over their underlying runtime execution environment."*
- Autonomy:
  - the ability of a service to carry out its logic independently of outside influences
- To achieve this, services must be more isolated
- Primary benefits
  - Increased reliability
  - Behavioral predictability

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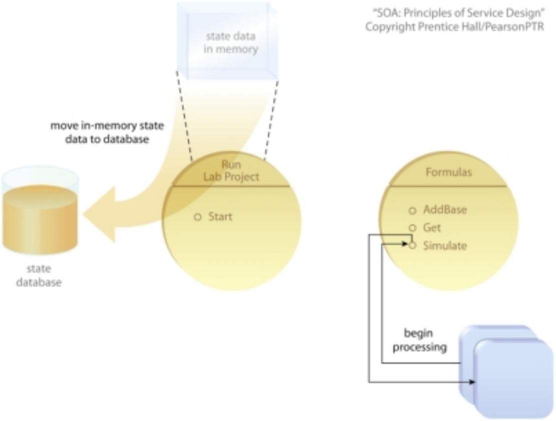
# Service Statelessness

- *"Services minimize resource consumption by deferring the management of state information when necessary."*
- Services incorporate state management deferral extensions within a service design
- Goals:
  - Increase service scalability
  - Support design of agnostic logic and improve service reuse



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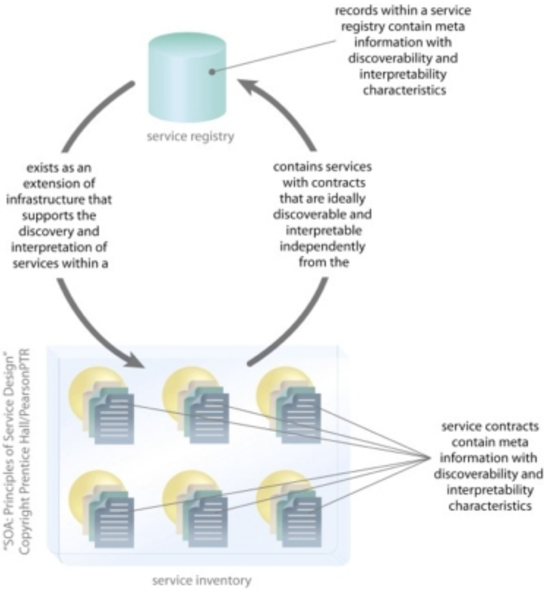
# Discoverability

- *"Services are supplemented with communicative meta data by which they car be effectively discovered and interpreted."*
- Services need to be easily:
  - Identified
  - Understood
- Service design needs to take the "communications quality» of the service into account


records within a service registry contain meta information with discoverability and interpretability characteristics
service registry
exists as an extension of infrastructure that supports the discovery and interpretation of services within a
contains services with contracts that are ideally discoverable and interpretable independently from the
service contracts contain meta information with discoverability and interpretability characteristics
service inventory

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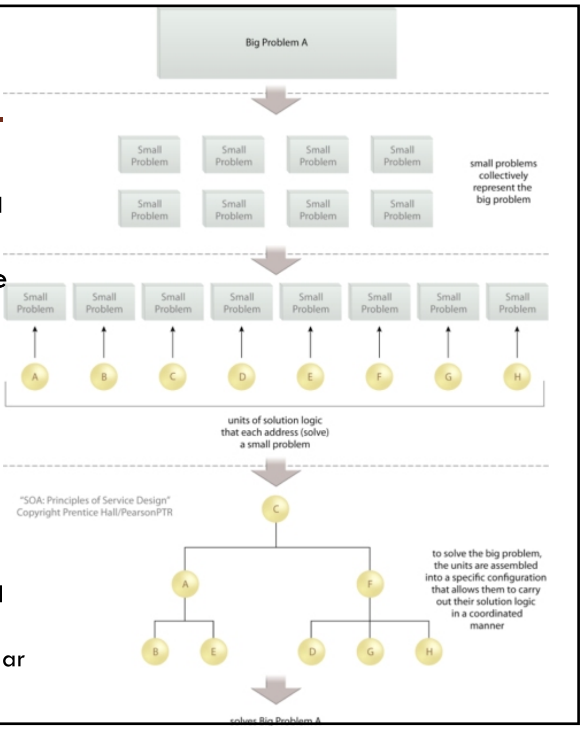
# Composability

- "Services are effective composition participants, regardless of the size and complexity of the composition."
- In the figure we solve a single problem
- Services need to be able to participate in multiple compositions to solve multiple larger problems
  - Individual processing should be highly tuned
  - Flexible service contracts should allow different types of data exchange requirements for similar functions



small problems collectively represent the big problem

units of solution logic that each address (solve) a small problem

to solve the big problem, the units are assembled into a specific configuration that allows them to carry out their solution logic in a coordinated manner

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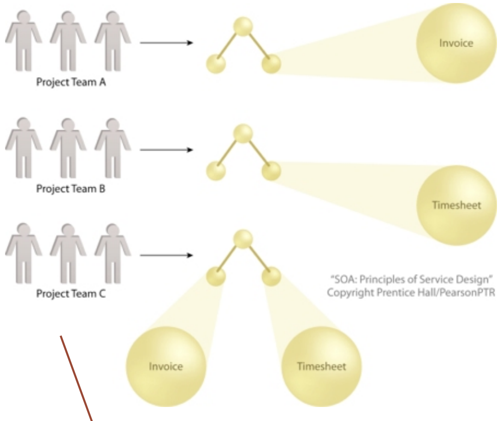
# Discussion

- What is the most fundamental design principle?

## Benefits of Service-Orientation

- Increasing Intrinsic Interoperability
- Increasing Federation
- Increasing Vendor Diversification Options
- Increasing Business and Technology Domain Alignment
- Increasing ROI
- Increasing Organizational Efficiency
- Reducing IT Burden

## Increased Intrinsic Interoperability



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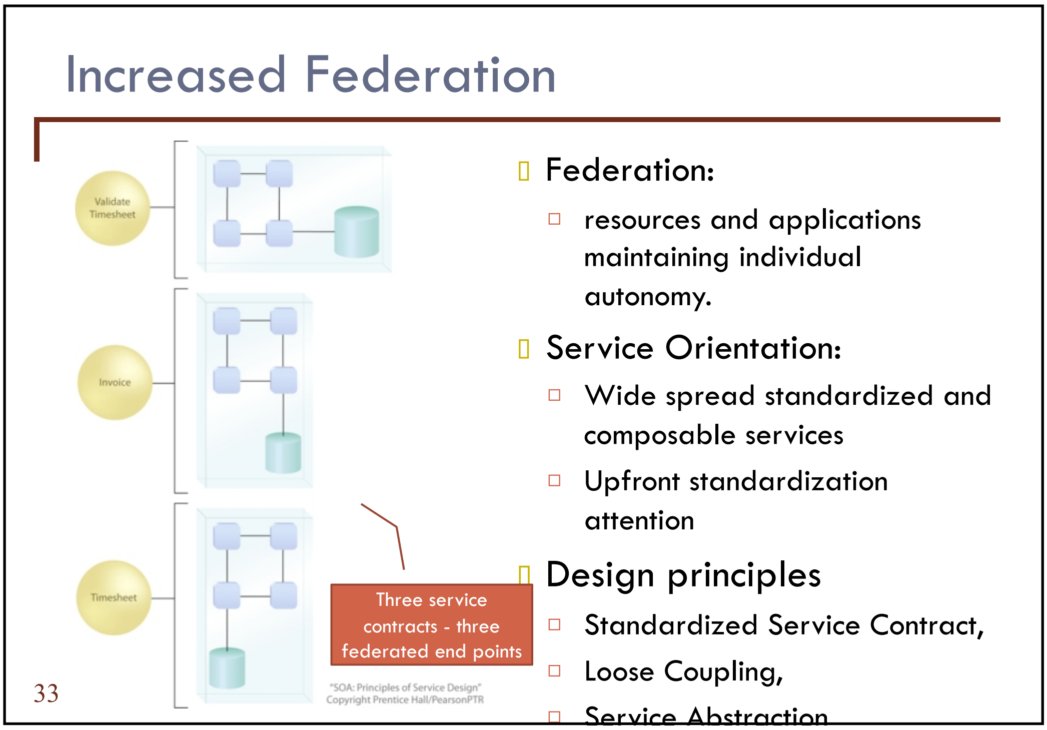
Project Team C can compose a new application using Invoice and Timesheet

- Interoperability:
  - Is the ability to share information
- SO establish a native mechanism to share information within services.
- Design principles foster interoperability:
  - Contract standardization
  - Discoverability
  - Composability



## Increased Federation

Validate Timesheet
Invoice
Timesheet

Three service contracts - three federated end points

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- Federation:
  - resources and applications maintaining individual autonomy.
- Service Orientation:
  - Wide spread standardized and composable services
  - Upfront standardization attention
- Design principles
  - Standardized Service Contract,
  - Loose Coupling,
  - Service Abstraction

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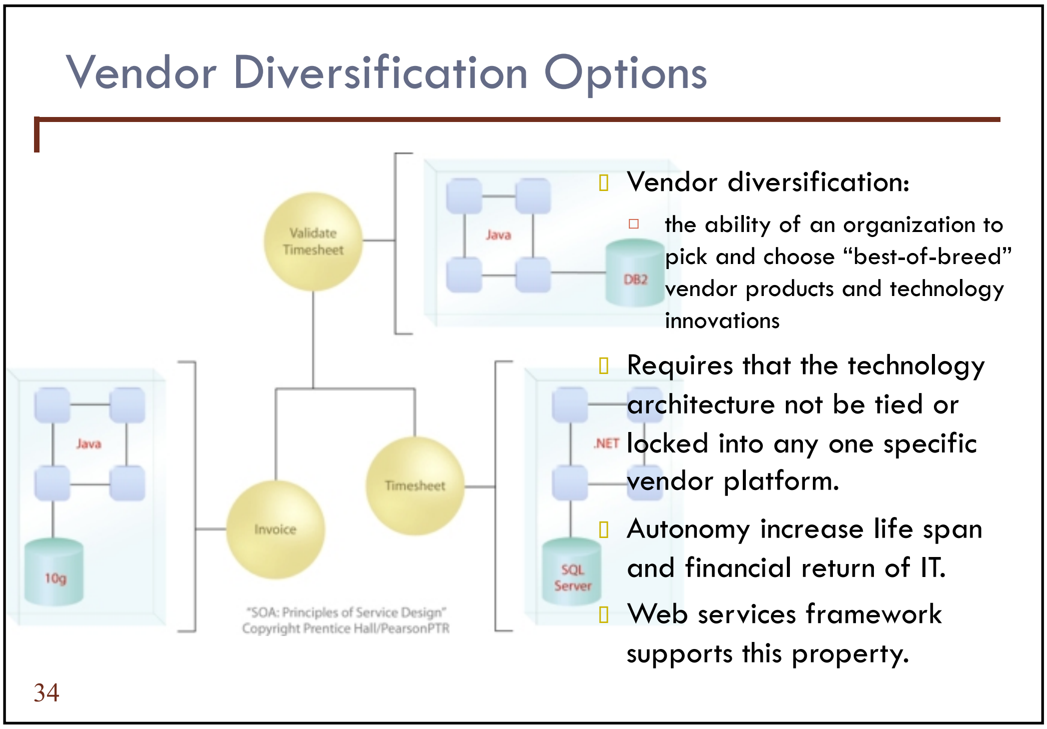

## Vendor Diversification Options

Validate Timesheet
Java
DB2
Java
10g
Invoice
Timesheet
.NET
SQL Server

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- Vendor diversification:
  - the ability of an organization to pick and choose "best-of-breed" vendor products and technology innovations
- Requires that the technology architecture not be tied or locked into any one specific vendor platform.
- Autonomy increase life span and financial return of IT.
- Web services framework supports this property.

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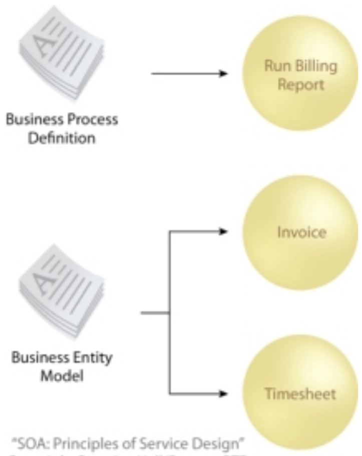
## Business and Technology Domain Alignment

- Services are identified based on the business entities and business processes.
- Service are designed to be interoperable.

→ As a consequence they are capable of aligning to new demands by means of new compositions.



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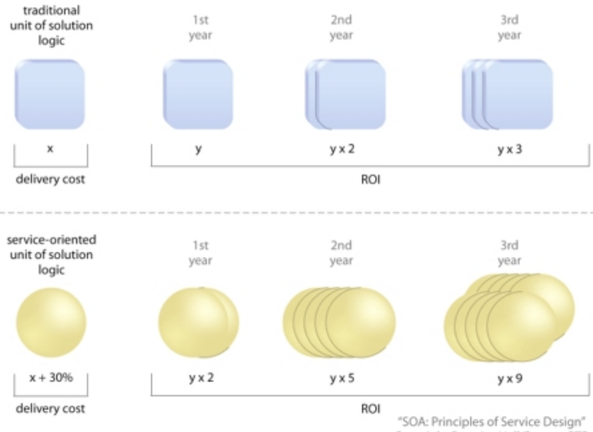
## Return On Investment

- ROI
  - is a measure to understand how cost effective the solution is
- Reusability requires investment
  - Designing the agnostic solution using service orientation principles requires more upfront effort



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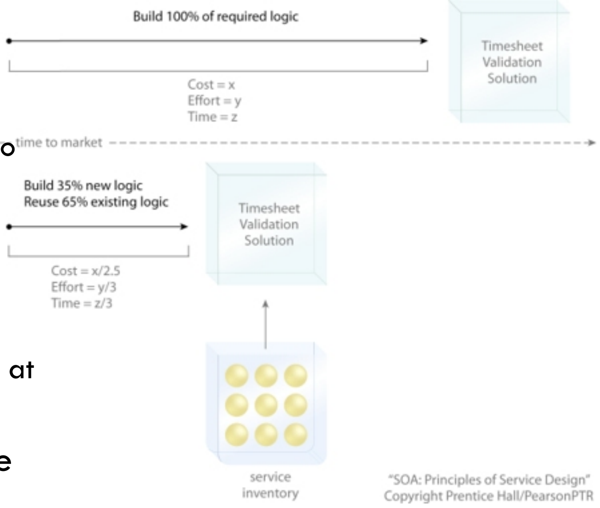
## Organizational Efficiency

- Efficency:
  - How fast can we deliver?
  - How much we need to spend?
- We have agnostic services
  - reusable assetes reduce time and cost at the same time.
- However we increase upfront costs to built services properly



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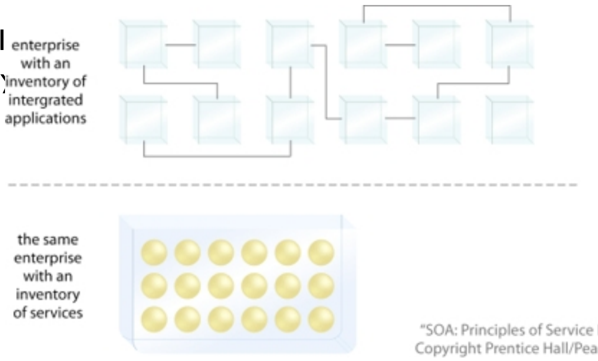
## Reduced IT Burden

- As reuse become the norm
  - The overall size will reduce considerably
- Together with it the overhead for managing multiple environments will reduce.
- Result:
  - Reduced operational costs


enterprise with an inventory of intergrated applications
the same enterprise with an inventory of services

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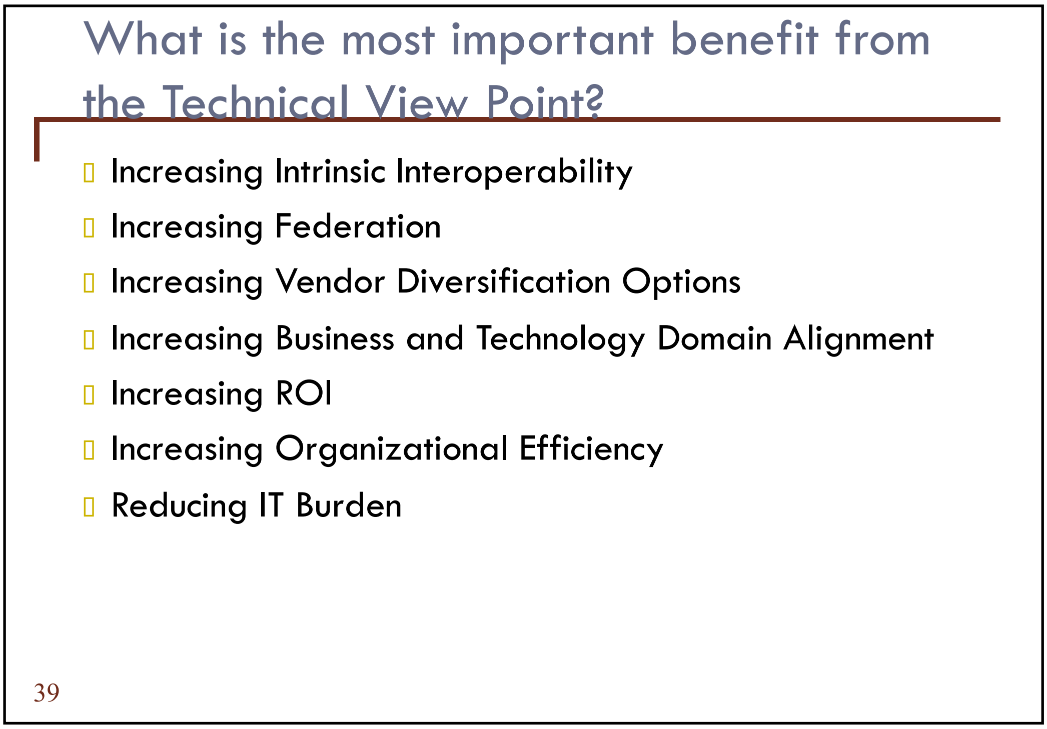
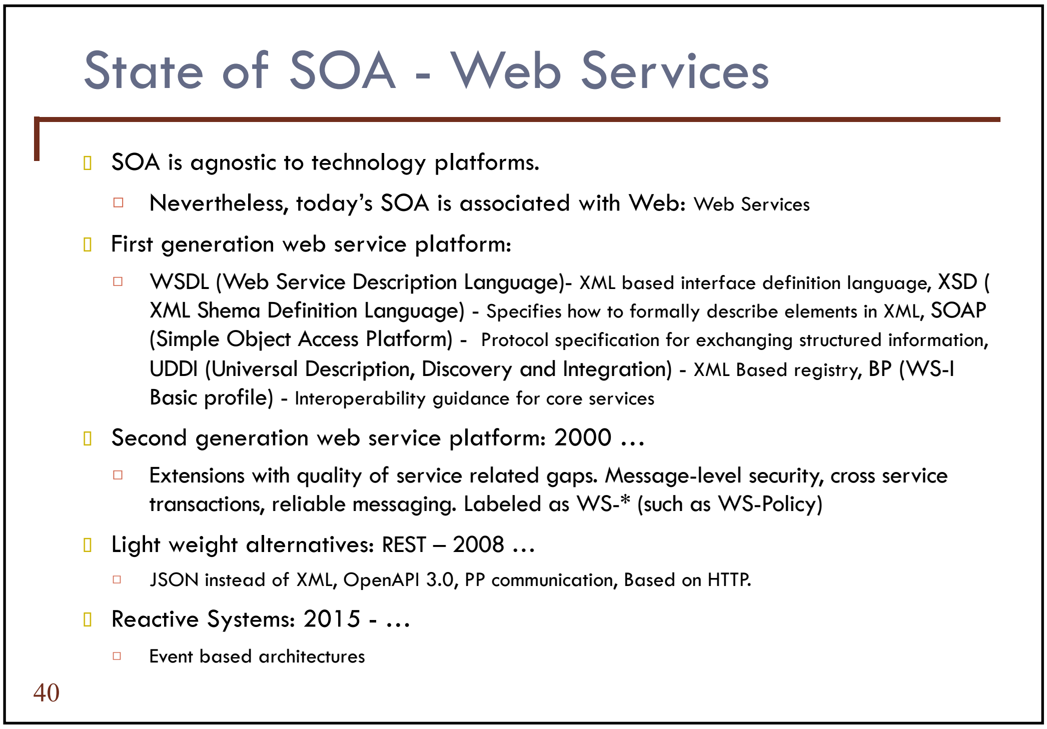


## What is the most important benefit from the Technical View Point?

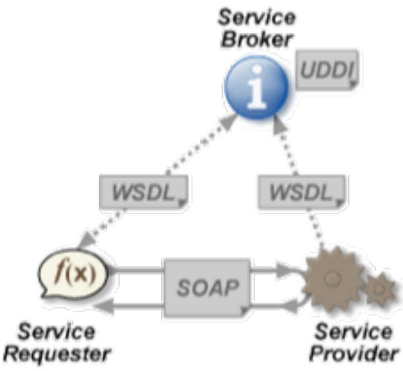
- Increasing Intrinsic Interoperability
- Increasing Federation
- Increasing Vendor Diversification Options
- Increasing Business and Technology Domain Alignment
- Increasing ROI
- Increasing Organizational Efficiency
- Reducing IT Burden



## State of SOA - Web Services

- SOA is agnostic to technology platforms.
  - Nevertheless, today's SOA is associated with Web: Web Services
- First generation web service platform:
  - WSDL (Web Service Description Language)- XML based interface definition language, XSD ( XML Shema Definition Language) - Specifies how to formally describe elements in XML, SOAP (Simple Object Access Platform) - Protocol specification for exchanging structured information, UDDI (Universal Description, Discovery and Integration) - XML Based registry, BP (WS-I Basic profile) - Interoperability guidance for core services
- Second generation web service platform: 2000 …
  - Extensions with quality of service related gaps. Message-level security, cross service transactions, reliable messaging. Labeled as WS-* (such as WS-Policy)
- Light weight alternatives: REST – 2008 …
  - JSON instead of XML, OpenAPI 3.0, PP communication, Based on HTTP.
- Reactive Systems: 2015 - …
  - Event based architectures

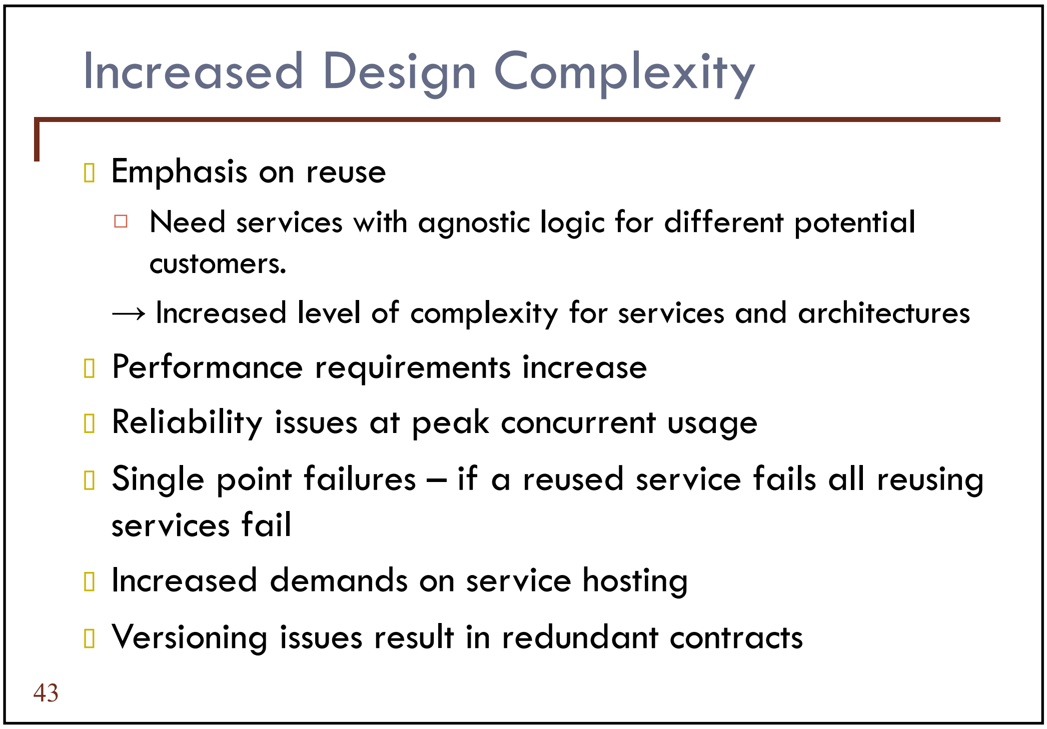
## Web Services Architecture – 2nd Gen



- The service provider sends a WSDL file to UDDI.
- The service requester contacts UDDI to find out who is the provider and contacts the service provider using the SOAP protocol.
- The service provider validates the service request and sends data using the SOAP protocol.
- This data would be validated again by the service requester using an XSD file.

## Challenges of Service Orientation

- Increased design complexity
- The need for design standards
- The need to identify requirements in advance
- The need for a counter-agile development approach
- The need for a specific governance structure



## Increased Design Complexity

- Emphasis on reuse
  - Need services with agnostic logic for different potential customers.

  → Increased level of complexity for services and architectures
- Performance requirements increase
- Reliability issues at peak concurrent usage
- Single point failures – if a reused service fails all reusing services fail
- Increased demands on service hosting
- Versioning issues result in redundant contracts

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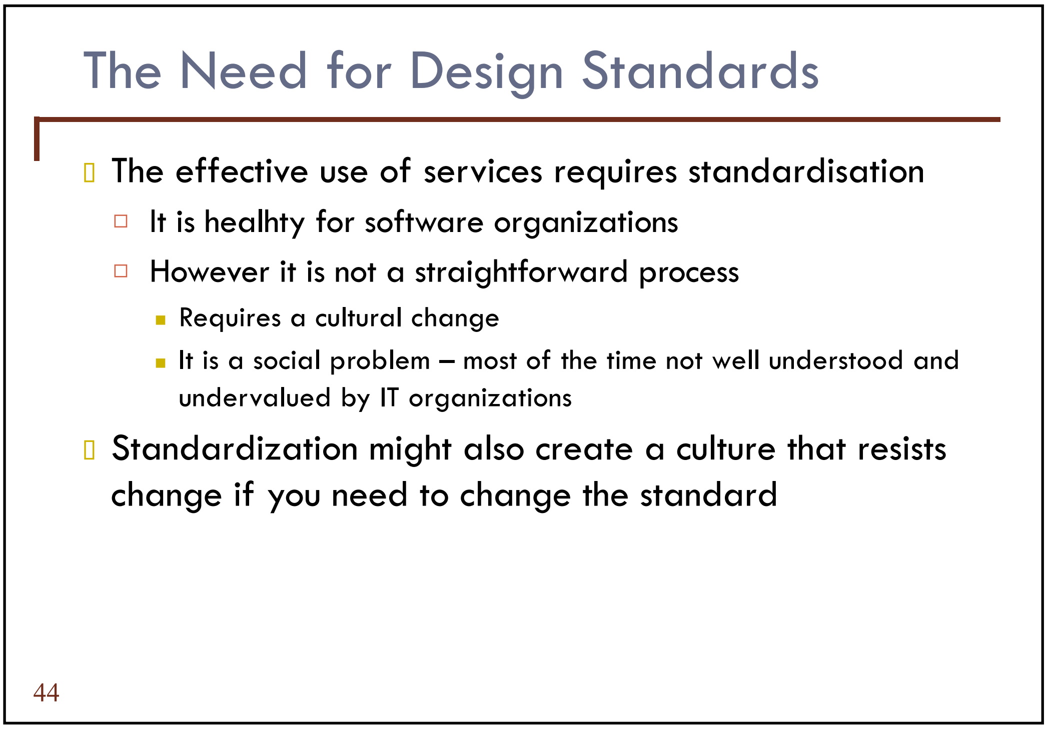

## The Need for Design Standards

- The effective use of services requires standardisation
  - It is healhty for software organizations
  - However it is not a straightforward process
    - Requires a cultural change
    - It is a social problem – most of the time not well understood and undervalued by IT organizations
- Standardization might also create a culture that resists change if you need to change the standard

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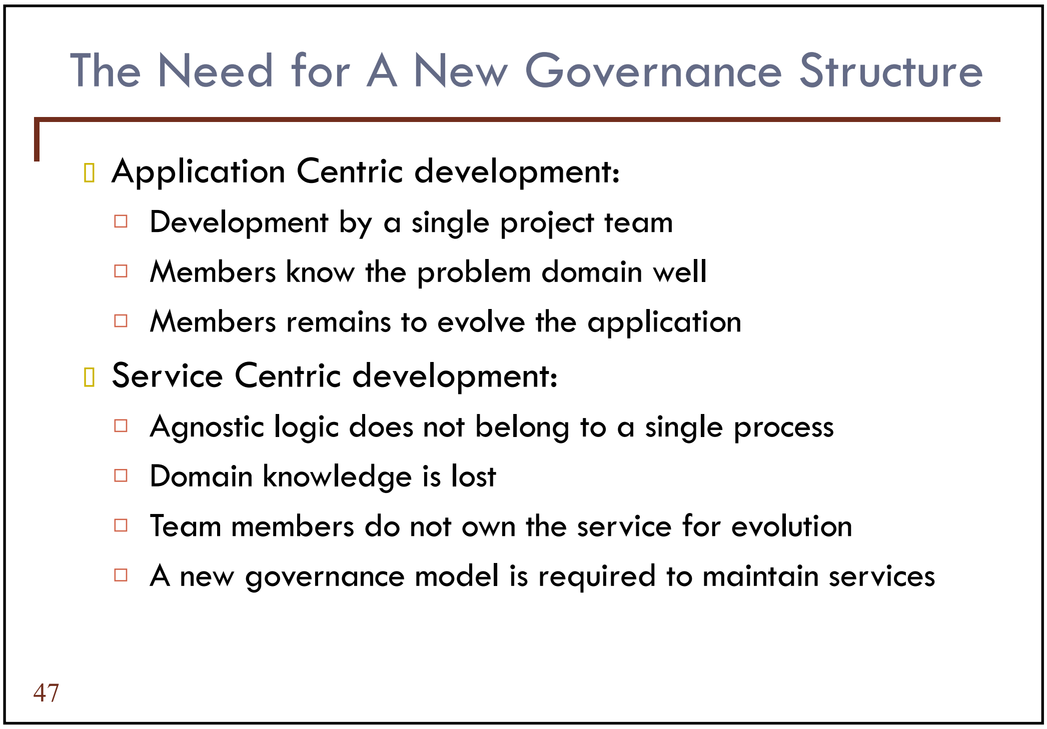
## Requirements First

- It is highly beneficial to create a blueprint for all planned services upfront.
  - Top down - waterfall like - delivery strategy.
  - High level upfront analysis effort is required.
  - Frequently the problems software solves are un-structured
    - We don't know the formulation before we have the solution
  - Using iterative development approaches might be expensive as major changes can be costly

## Counter-Agile Approach

- Additional design considerations increases the cost and time to build the service logic.
- Together with the need for upfront requirements effort and the need for standardization the development process becomes counter agile.



## The Need for A New Governance Structure

- Application Centric development:
  - Development by a single project team
  - Members know the problem domain well
  - Members remains to evolve the application
- Service Centric development:
  - Agnostic logic does not belong to a single process
  - Domain knowledge is lost
  - Team members do not own the service for evolution
  - A new governance model is required to maintain services

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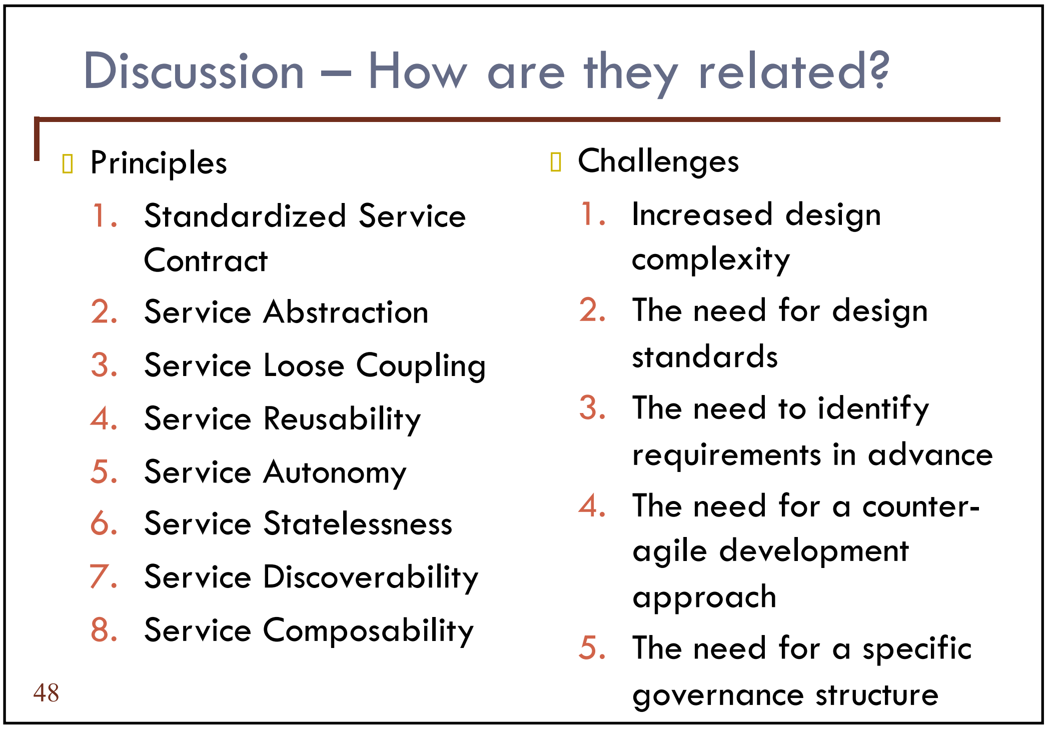

## Discussion – How are they related?

- Principles
  1. Standardized Service Contract
  2. Service Abstraction
  3. Service Loose Coupling
  4. Service Reusability
  5. Service Autonomy
  6. Service Statelessness
  7. Service Discoverability
  8. Service Composability
- Challenges
  1. Increased design complexity
  2. The need for design standards
  3. The need to identify requirements in advance
  4. The need for a counter-agile development approach
  5. The need for a specific governance structure

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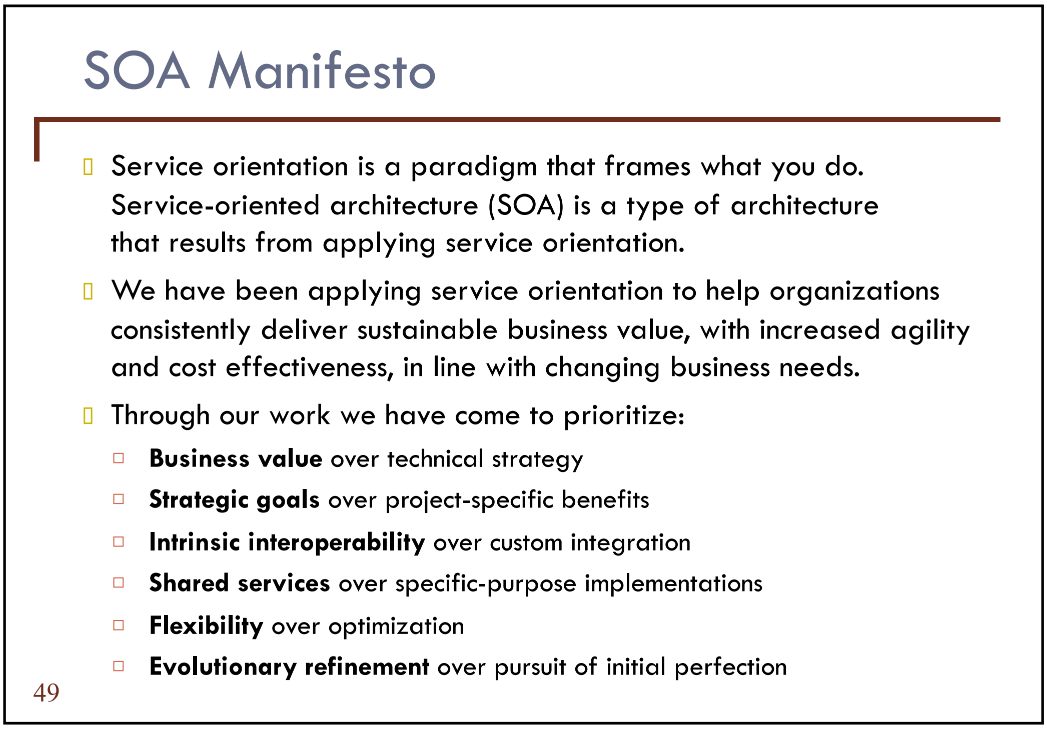
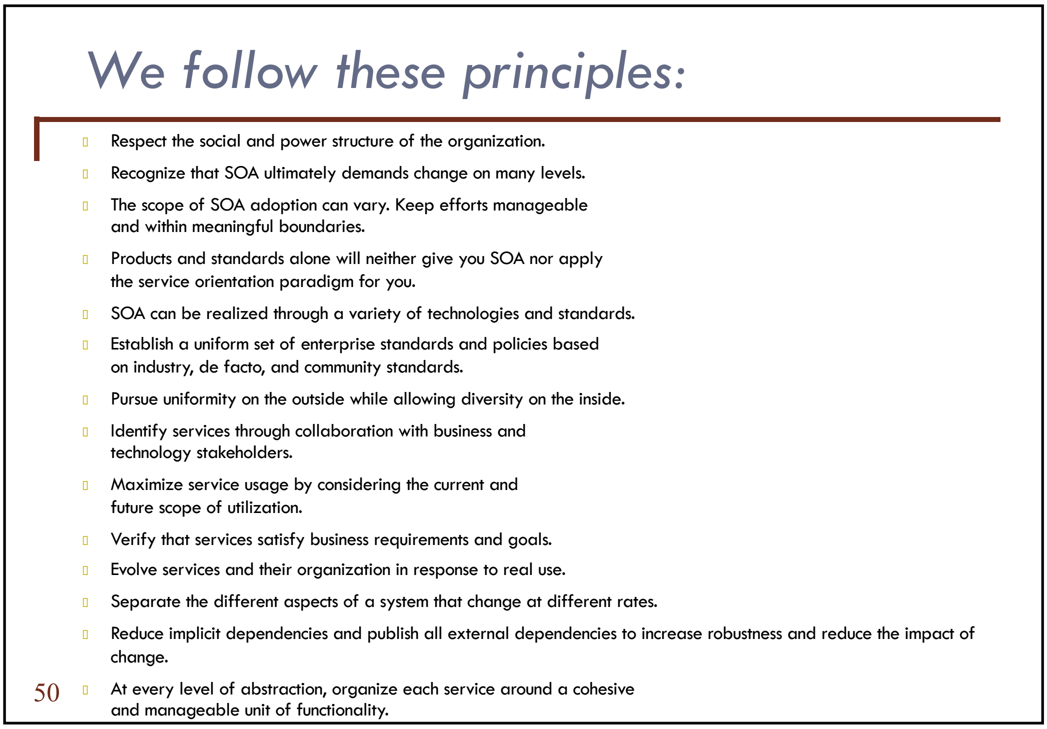


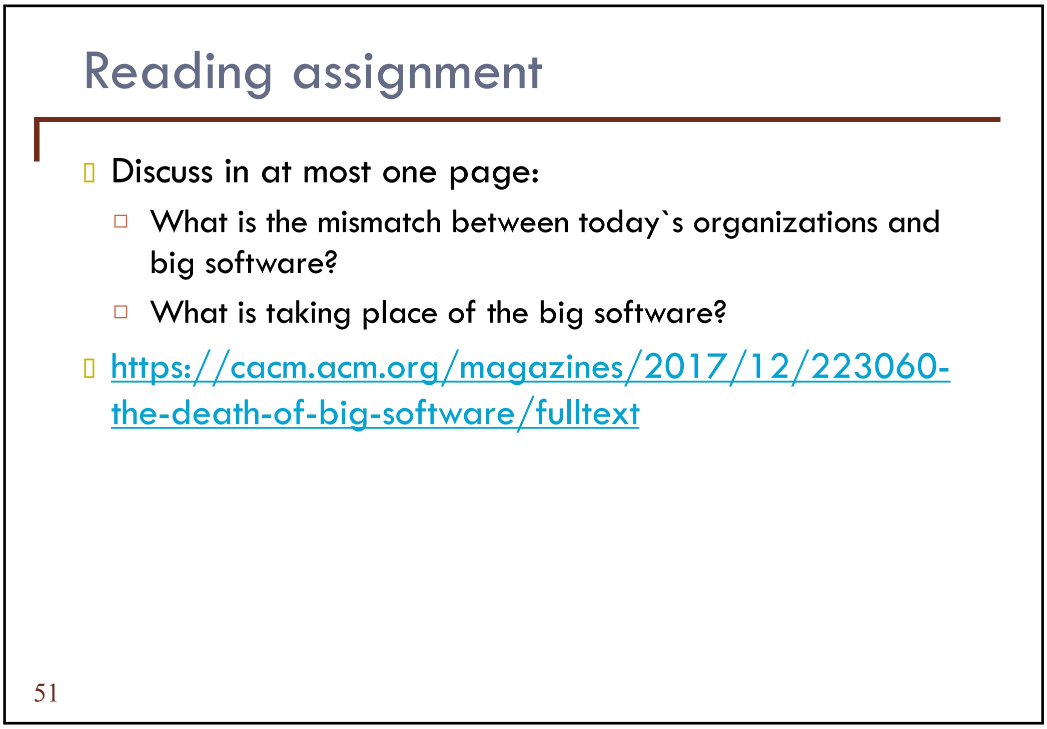
# SOA Manifesto

- Service orientation is a paradigm that frames what you do. Service-oriented architecture (SOA) is a type of architecture that results from applying service orientation.
- We have been applying service orientation to help organizations consistently deliver sustainable business value, with increased agility and cost effectiveness, in line with changing business needs.
- Through our work we have come to prioritize:
  - **Business value** over technical strategy
  - **Strategic goals** over project-specific benefits
  - **Intrinsic interoperability** over custom integration
  - **Shared services** over specific-purpose implementations
  - **Flexibility** over optimization
  - **Evolutionary refinement** over pursuit of initial perfection



# *We follow these principles:*

- Respect the social and power structure of the organization.
- Recognize that SOA ultimately demands change on many levels.
- The scope of SOA adoption can vary. Keep efforts manageable and within meaningful boundaries.
- Products and standards alone will neither give you SOA nor apply the service orientation paradigm for you.
- SOA can be realized through a variety of technologies and standards.
- Establish a uniform set of enterprise standards and policies based on industry, de facto, and community standards.
- Pursue uniformity on the outside while allowing diversity on the inside.
- Identify services through collaboration with business and technology stakeholders.
- Maximize service usage by considering the current and future scope of utilization.
- Verify that services satisfy business requirements and goals.
- Evolve services and their organization in response to real use.
- Separate the different aspects of a system that change at different rates.
- Reduce implicit dependencies and publish all external dependencies to increase robustness and reduce the impact of change.
- At every level of abstraction, organize each service around a cohesive and manageable unit of functionality.



## Reading assignment

- Discuss in at most one page:
  - What is the mismatch between today`s organizations and big software?
  - What is taking place of the big software?
- https://cacm.acm.org/magazines/2017/12/223060-the-death-of-big-software/fulltext