



# Towards an Ontological Foundation for Services Science

Roberta Ferrario and **Nicola Guarino**

Institute of Cognitive Sciences and Technology  
Italian National Research Council

## Towards a *Services Science*?

---

- Services are everywhere...
- Notion of service still relatively new in the general literature, need of an accurate definition mostly ignored in economy:
  - Serious confusions and inconsistencies in terminology
- The *internet of services* is one of the FP7 priorities. Yet semantic interoperability across services risks to become a *myth*...
- ...unless we realize the need for a *highly interdisciplinary* work, with solid foundations! [Petrie 2008]

Chesbrough & Spohrer, *A Research Manifesto for Services Science*.  
Communications of the ACM, 2006

# Clarifying the intended meaning of “service”

---

- What is a **service**?
  - An action
  - A generic type of action
  - The capability to perform some action
  - A computational procedure capable to perform some action
  - An agent in charge of performing an action
  - The result of an action
  - The (subjective) result of an action
- What is a **service provider**?
  - The authority which guarantees the service execution
  - The actual agent who executes the service actions (possibly on behalf of somebody else)
- What is a **service consumer**?
  - The one who requests the service
  - The one who benefits of the service

## The problem: subtle distinctions in meaning...

- What is a service?
- What is an application to a public administration?
- What is a working place?
- What is an unemployed person?
- What is a customer?
- What is a passenger?
- What is an organization?
- What is a document?
- What is a contract?
- What is a spare part?
- What is a missing part?

(this is what computational ontologies should be concerned with....)

# The case of web services

---

- *C. Petrie, C. Bussler, The Myth of Open Web Services, IEEE Internet Computing 2008:*

*“run-time interoperability is **technically feasible only within service parks**, where [...] services are very constrained, and [...] the semantics will be common because the objects are common”*

*“some interoperability among service parks might emerge, but could take a long time”*

- *K. Sykara, Unthethering Semantic Web Services, IEEE Intelligent Systems 2007:*

*“current Web services proposals **don't enable the semantic representation of business relations, contracts, or business rules** in a machine-understandable way”, while “current business-process languages [...] are at a low abstraction level and don't provide formal business semantics”.*

# The need for a global view of services

---

- Current semantic web services modeling formalisms focus on the *external interface*, advocating its strict separation from the internal view: a service is described in terms of its behavior (transfer function from an input state to an output state).
- Yet, business applications need to specify
  - *how* the service is performed at the business level, referring to *internal* details whose nature varies a lot from service to service
  - *when* the various processes involved in a service occur
- Business applications need to *monitor* and *evaluate* services quality w.r.t. their actual impact on the whole *service system*, which includes external events, objects, people, organizations... (*context-aware services*)
- Service Level Agreements need to refer both to *internal* and *contextual* details
- Well-known gap between business services and IT

# Three common ways of understanding services

- ***Intangible goods***: something “we can buy, with no risk to drop it on our feet”
  - What about copyrights, IPRs?
- Things we pay for, but we ***don't own***
  - What about rented cars?
- Sets of ***abstract capabilities***
  - Only one service for a given set of capabilities?

# Services vs. goods

---

- Services are not kinds of goods (*immaterial goods*), since there is a radical difference between goods and services [Hill 77]:
  - Goods are **transactable** and **transferable**
  - Services are transactable, buy they are **not transferable**
- Why are they not transferable?

*because services have a temporal nature,  
they are **EVENTS!***



# DOLCE's basic taxonomy

Object (endurant)

Physical

Amount of matter

Physical object

Feature

Non-Physical

Mental object

Social object

...

Event (perdurant)

Static

State

Process

Dynamic

Achievement

Accomplishment

Quality

Physical

Spatial location

...

Temporal

Temporal location

...

Abstract

Abstract

Quality region

Time region

Space region

Color region

...

...

# Transferability and Ownership

- Owning an entity implies being in control of its *temporal behavior* (for instance, deciding to destroy it)
- Services are events in our approach
- The temporal behavior of an event is already determined: changing it would result in a different event
- Thus, *events are not ownable*
- In conclusion, it is not possible to transfer the ownership of a service, because services, being events, are not ownable

## Services are based on *commitments*

---

- How can you tell that a service is present, here and now?
- What do you *pay for*, when you invest in a service?

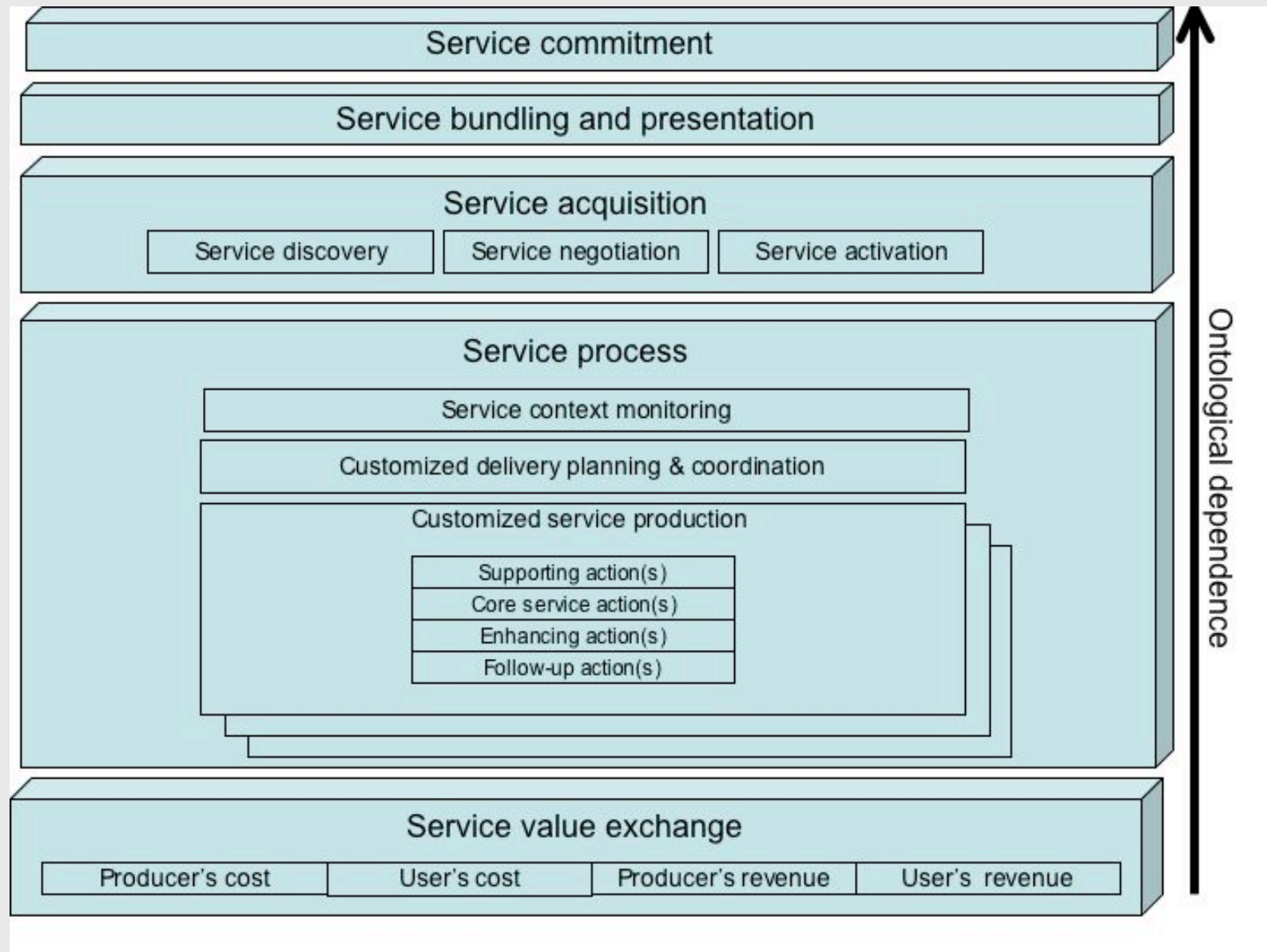
A *service commitment* is an agent's explicit commitment to guarantee the execution of some *type of actions*, on the occurrence of a certain *triggering event*, in the interest of another agent and upon prior agreement, according to a certain specification (*service description*) which constraints the way service actions will be performed (*service process*)

A service is essentially (based on) a *promise* [O'Sullivan 2006]

...which involves real people in real contexts  
(of which IT systems are only a part!)

# Service, Service Commitment, and Service Process

- ***Service commitment***: agent's explicit commitment to guarantee the execution of some type of actions, on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, according to a certain specification (the service description) which constraints the way the service actions will be performed (i.e., the service process that will be adopted).
- ***Service process***: actual implementation of a service commitment, consisting of number of interdependent actions including those necessary to monitor the trigger events, the *core actions* mentioned in the commitment, and any further actions aimed at supporting or complementing the successful execution of such core actions.
- ***Service***: the "visible part" of a service process implementing that commitment, which includes all the activities explicitly mentioned in the service description.



## Alter's Service Responsibility Table

Provider Activity or Responsibility	Customer Activity or Responsibility	Problems or Issues
Loan officer identifies businesses that might need a commercial loan.		Loan officers are not finding enough leads
Loan officer contacts potential loan applicant.	Potential loan applicant agrees to discuss the possibility of receiving a loan.	
Loan officer discusses loan applicant's financing needs and possible terms of the proposed loan.	Potential loan applicant discusses financial needs.	Loan officer is not able to be specific about loan terms, which are determined during the approval step, which occurs later.
Loan officer helps loan applicant compile a loan application.	Loan applicant compiles loan application.	Loan applicant and loan officer sometimes exaggerate the applicant's financial strength and prospects.
Loan officer and senior credit officer meet to verify that the loan application has no glaring flaws.		20% of loan applications have glaring flaws.
Credit analyst prepares a loan write-up summarizing the client's financial history, providing projections of sources of funds for loan payments, etc.		10% rate of significant errors, partly because credit analysts use an error prone combination of several spreadsheets and a word-processing program. Much rework due to experience of credit analysts.
Loan officer presents the loan write-up to a senior credit officer or loan committee.		Meetings not scheduled in a timely manner. Questions about exaggerated statements by some loan officers.
Senior credit officer or loan committee makes approval decision.		Excessive level of non-performing loans. Rationale for approval or refusal not recorded for future analysis.
Loan officer informs loan applicant of the decision.	Loan applicant accepts or declines an approved loan.	25% of refused applicants complain reason is unclear. 30% of applicants complain the process takes too long.
Loan administration clerk produces loan documents for an approved loan that the client accepts.		

# Thematic Relations

- Agent (the active role, the one who acts in the event)
- Theme/Patient (the one who undergoes the event; the patient changes its state, the theme does not)
- Goal (what the event is directed towards – typically a desired state of affairs)
- Recipient/Beneficiary (the one who receives the effects of the event)
- Instrument (something that is used in the performance of the event)
- Location (where the event takes place)
- Time/duration (when the event takes place, or how long it lasts)

## An Example

- Let's show through an example how we can represent the layered structure of services by a revised version of Alter's responsibility tables which makes explicit the thematic roles identifiable in each sub-event composing a service event.
- Example: *service of car repair offered by a mechanic*



		<i>Agent</i>	<i>Theme/ Patient</i>	<i>Goal</i>	<i>Recipient/ Beneficiary</i>	<i>Instrument</i>	<i>Location</i>	<i>Time/ Duration</i>
<i>Service Commitment</i>		<i>Mechanic</i>	<i>Job description</i>		<i>PA (Chamber of Commerce)</i>	<i>Subscription act</i>	<i>Province/ Region</i>	<i>Starting from a fixed date before the opening of the garage and until the duration of the license</i>
<i>Service Acquisition</i>	<i>Discovery</i>	<i>Customer</i>	<i>Mechanic</i>	<i>Car repaired</i>				<i>After opening and before actual repair</i>
	<i>Negotiation</i>	<i>Customer, Mechanic</i>	<i>Service customization</i>	<i>(Agreement)</i>			<i>Garage</i>	
	<i>Activation</i>	<i>Mechanic</i>	<i>Internal execution plan</i>				<i>Garage</i>	
<i>Service Process</i>		<i>Mechanic</i>	<i>Car</i>	<i>Car repaired</i>	<i>Customer</i>		<i>Garage</i>	<i>Period in which the repair actually occurs</i>
<i>Service Value Exchange</i>	<i>Producer's sacrifice</i>	<i>Mechanic</i>	<i>Working hours</i>	<i>Being paid</i>			<i>Garage, bank...</i>	<i>A certain time (usually) after that the car has been repaired</i>
	<i>Customer's sacrifice</i>	<i>Customer</i>	<i>Money, car's unavailability , time to pick up car...</i>	<i>Car repaired</i>				
	<i>Producer's revenue</i>	<i>Mechanic</i>	<i>Money</i>					
	<i>Customer's revenue</i>	<i>Customer</i>	<i>Car repaired/ car availability</i>					

		Agent	Theme/ Patient	Goal	Recipient/ Beneficiary	Instrument	Location	Time/ Duration
<b>Service Commitment</b>		Mechanic	Job description		PA (Chamber of Commerce)	Subscription act	Province/Region	Starting from a fixed date before the opening of the garage and until the duration of the license
<b>Service Acquisition</b>	<b>Discovery</b>	Customer	Mechanic	Car repaired				After opening and before actual repair
	<b>Negotiation</b>	Customer, Mechanic	Service customization	(Agreement)			Garage	
	<b>Activation</b>	Mechanic	Internal execution plan				Garage	
<b>Service Process</b>		Mechanic	Car	Car repaired	Customer		Garage	Period in which the repair actually occurs
<b>Service Value Exchange</b>	<b>Producer's sacrifice</b>	Mechanic	Working hours	Being payed			Garage, bank...	A certain time (usually) after that the car has been repaired
	<b>Customer's sacrifice</b>	Customer	Money, car's unavailability, time to pick up car...	Car repaired				
	<b>Producer's revenue</b>	Mechanic	Money					
	<b>Customer's revenue</b>	Customer	Car repaired/ car					

**Co-reference needed!**

# Main Results

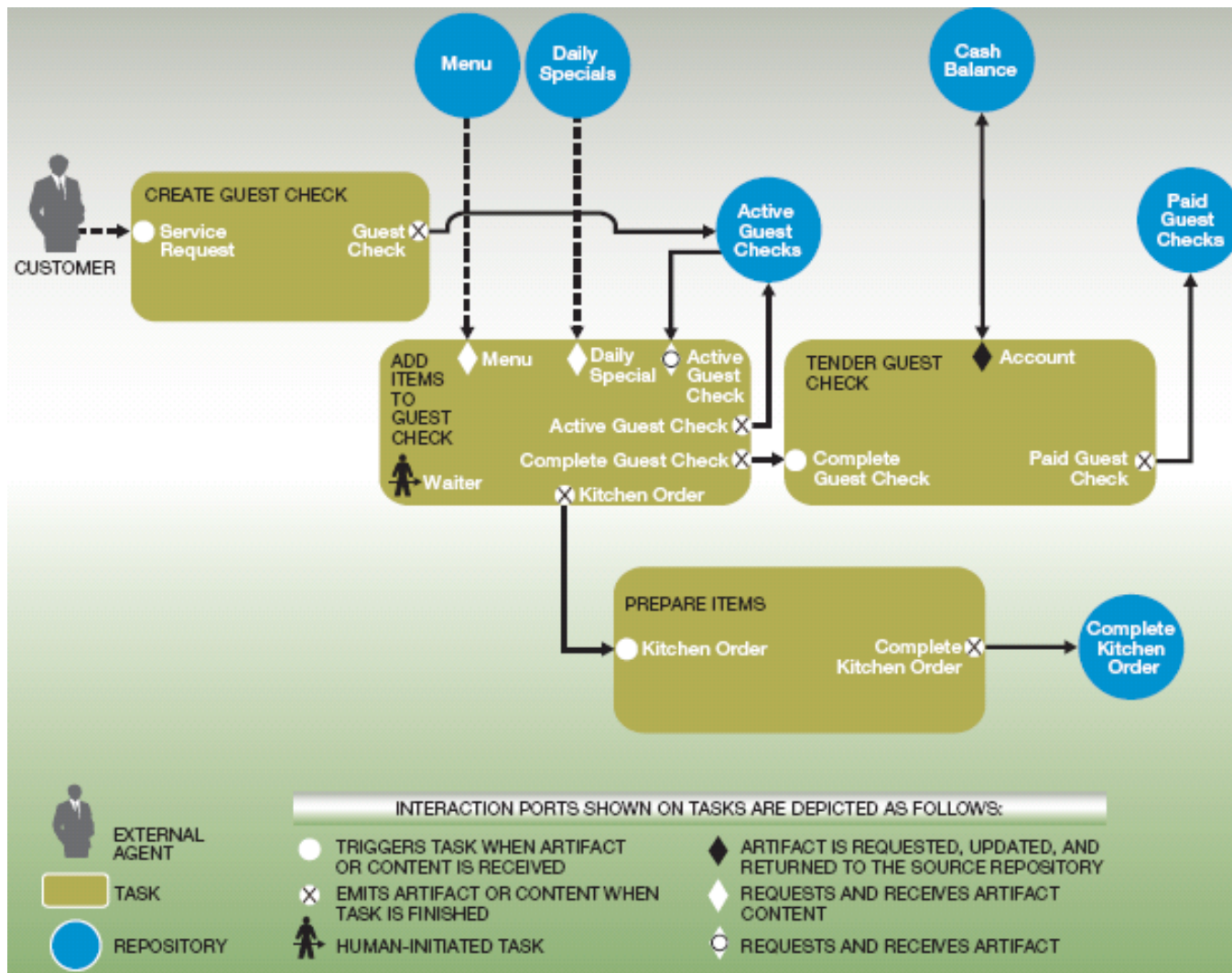
---

- *Rethinking of the difference between **internal** and **external** service views: the black box model is too limited*
- *Improvement of the classic **definition** of services coming from economics*
- *Focus on **core actions** instead of pre- and post conditions*
- ***Layered model** based on interdependent events*
- *Comprehensive **business-oriented** approach*
- *Common framework to describe service according to **different views***
- *Detailed account of **non-functional properties***

## Digression on business artifacts

- Artifact-centric vs. event-centric business modeling:
- What are the basic events (out of the box)?
- Where are they located, in space and time?
- Which are their participants (human and non-human)
- What are their natural boundaries
- What's the relevant information concerning their evolution (to be recorded as a "business artifact")?
- E-government example: the central registry of Public Administrations: the service quality crucially depends on the update process...

# Modeling Resources



- ❖ Measurable
- ❖ Ownership
- ❖ Human

# Modeling Organization

- ❖ Org. structure
- ❖ Roles

