Definición y análisis de Indicadores de rendimiento de procesos

Adela del Río Ortega
Universidad de Sevilla

www.isa.us.es


FRANCE
VIZCAYA
ASTURIAS
A CORUÑA
CANTABRIA
GUIPÚZCOA
LUGO
ÁLAVA
ANDORRA
LEÓN
NAVARRA
PALENCIA
PONTEVEDRA
LA RIOJA
HUESCA
GIRONA
OURENSE
ZAMORA
BURGOS
LLEIDA
BARCELONA
VALLADOLID
SORIA
ZARAGOZA
SEGOVIA
TARRAGONA
SALAMANCA
GUADALAJARA
TERUEL
ÁVILA
MADRID
CASTELLÓN
PORTUGAL
Toledo
CUENCA
CÁCERES
VALENCIA
BALEARES
ALBACETE
CIUDAD REAL
BADAJOZ
ALICANTE
CÓRDOBA
JAÉN
MURCIA
HUELVA
SEVILLA
GRANADA
GRAN CANARIA
ALMERÍA
TENERIFE
MÁLAGA
CÁDIZ
CEUTA
MELILLA

University of Sevilla

- **65.000** students
- **4.600** teaching staff
- **500** years

Computer Engineering School

Applied Software Engineering Research Group

www.isa.us.es

Amador Durán

Joaquín Peña

David Benavides

Antonio Ruiz

Beatriz Bernárdez

Octavio Martín

Manuel Resinas

Pablo Fernández

Sergio Segura

Carlos Müller

Jose María García

Adela del Río

Pablo Trinidad

Jose Antonio Parejo

Javier Troya

Alfonso Márquez

Jose A. Galindo

Ana B. Sánchez

Antonio M. Gutiérrez

Antonio Gámez

Bedilia Estrada

ISA in numbers

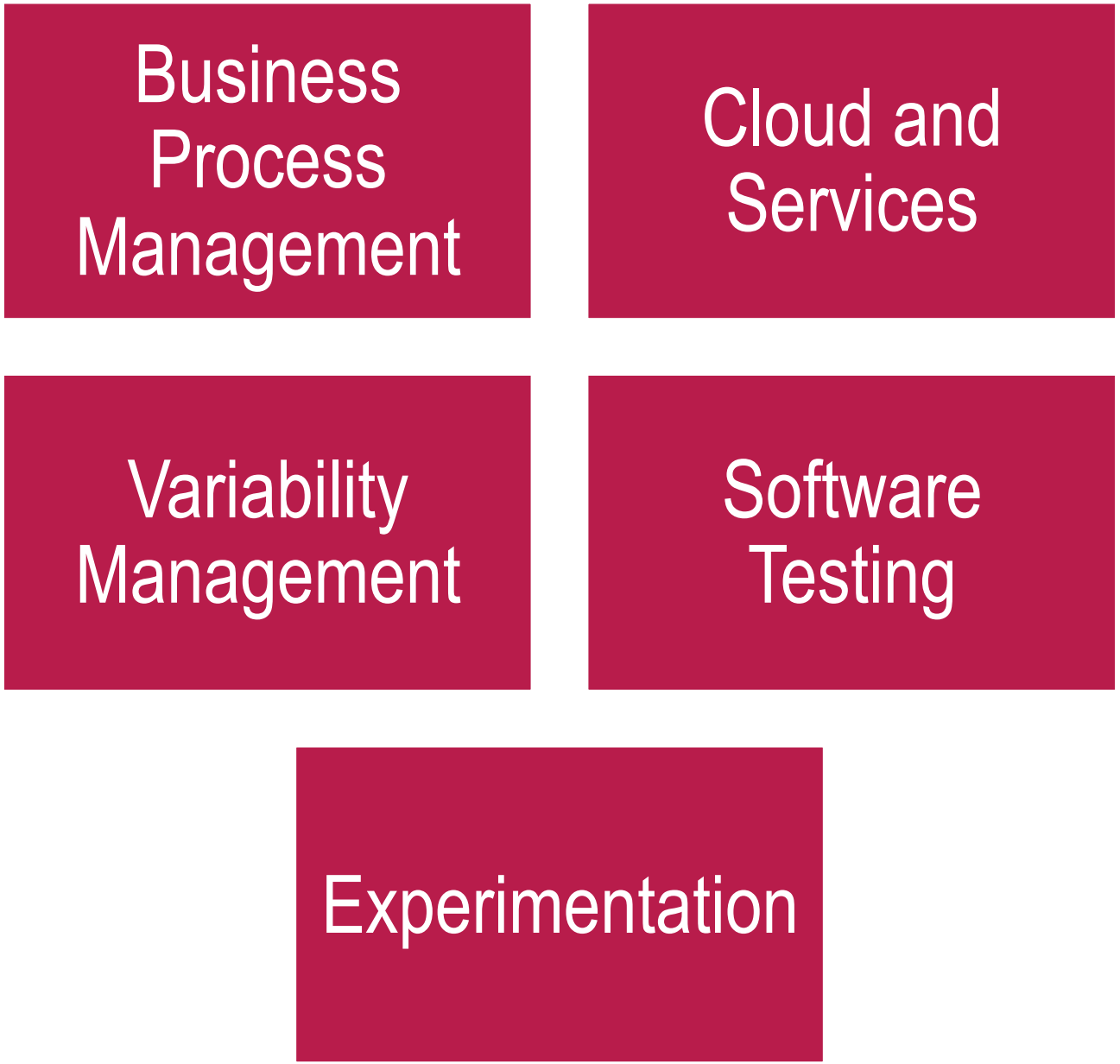
25 members

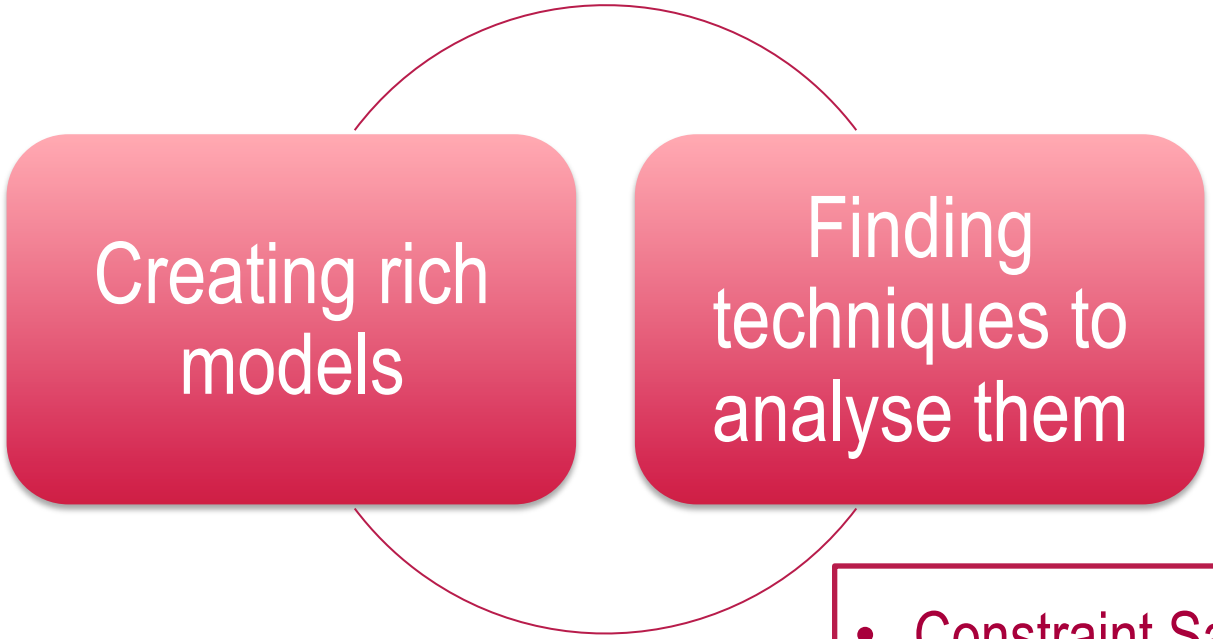
14 Senior Research Staff
4 Research Assistants,
3 PhD students,
4 Software Developers

(**>20** former members)

- **> 200** Publications in Journals and Conferences
- **3** International Patents
- **16** Software Tools developed
- **5** European Research projects
- **10** National Research projects
- **5** Research Networks
- **35** Public-Private Transfer Research Contracts
- **2** Spin-offs

ISA Research Areas



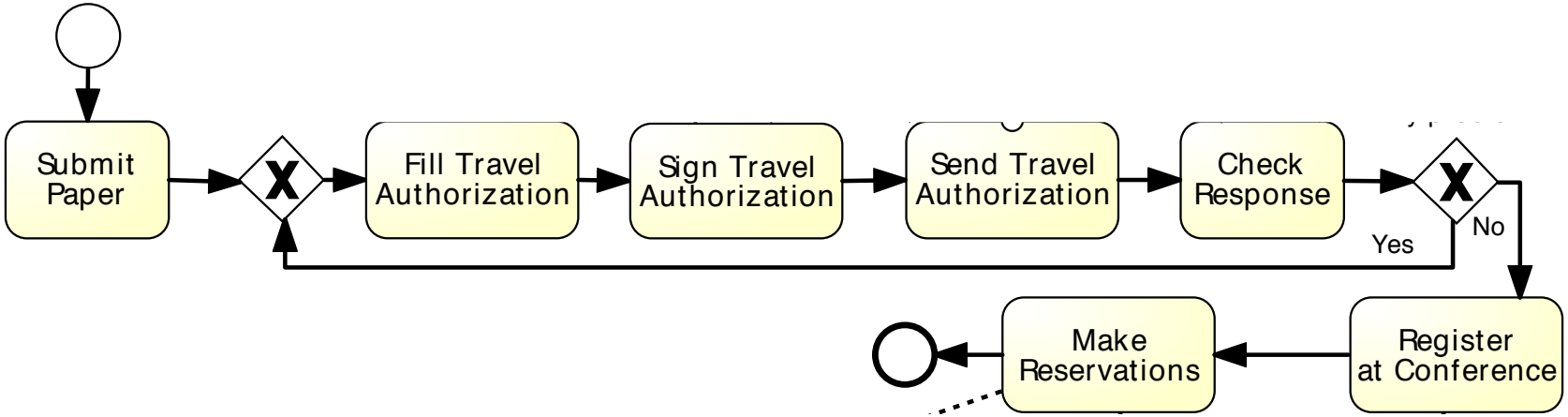


- Constraint Satisfaction Problems
- Description Logics and Ontologies
- Metaheuristics

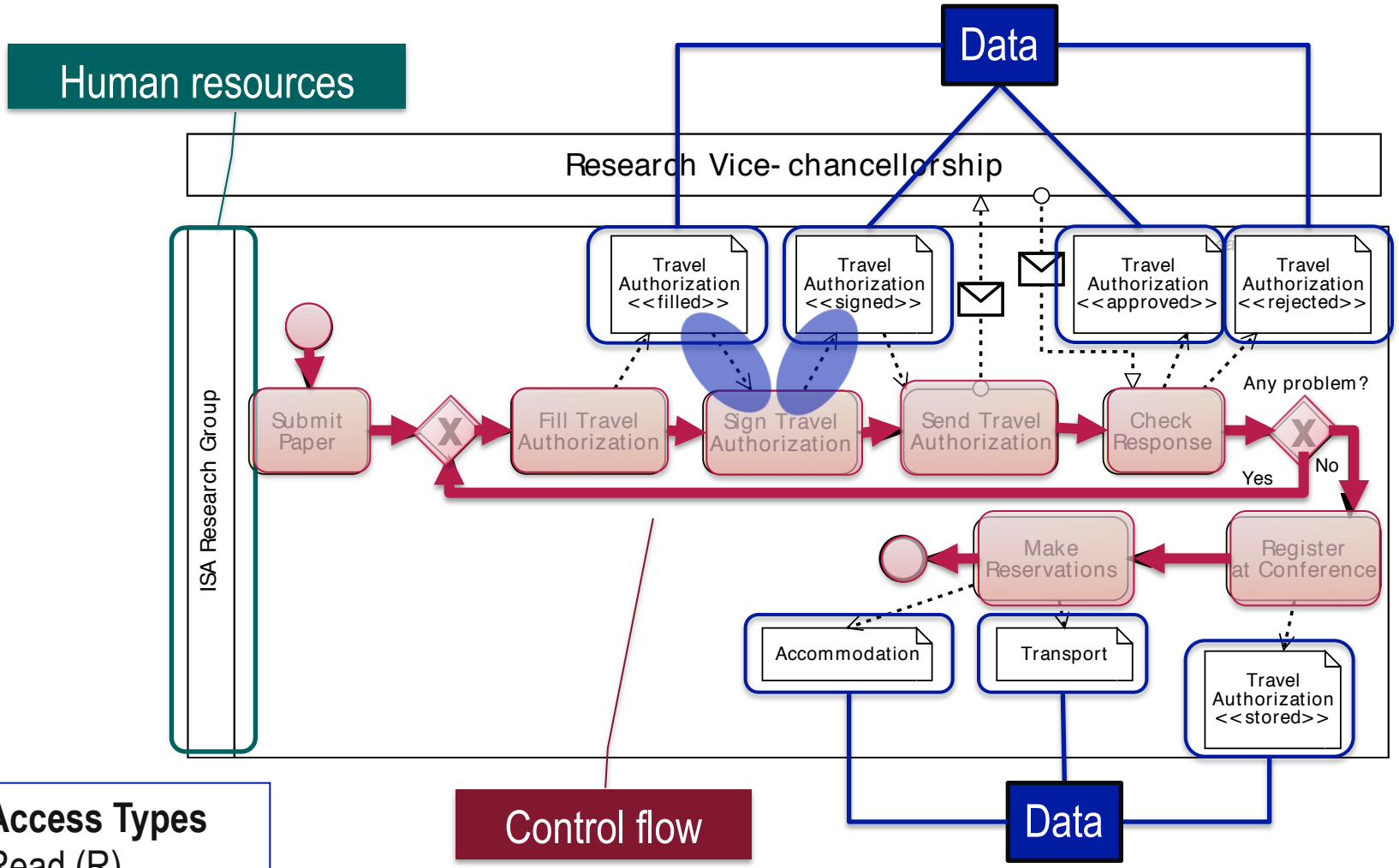
ISA Research Areas

Introduction

Business Processes (BPs)

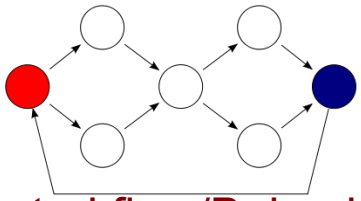


Perspectives in Business Processes



Access Types
Read (R)
Write (W)
Read/Write (R/W)

Business Process Perspectives



Control flow/Behavioural

Performance

Resources/
Organisational

Business
Process

IT systems

Functional

Data/
Informational

Introduction

Performance perspective

Need to Measure

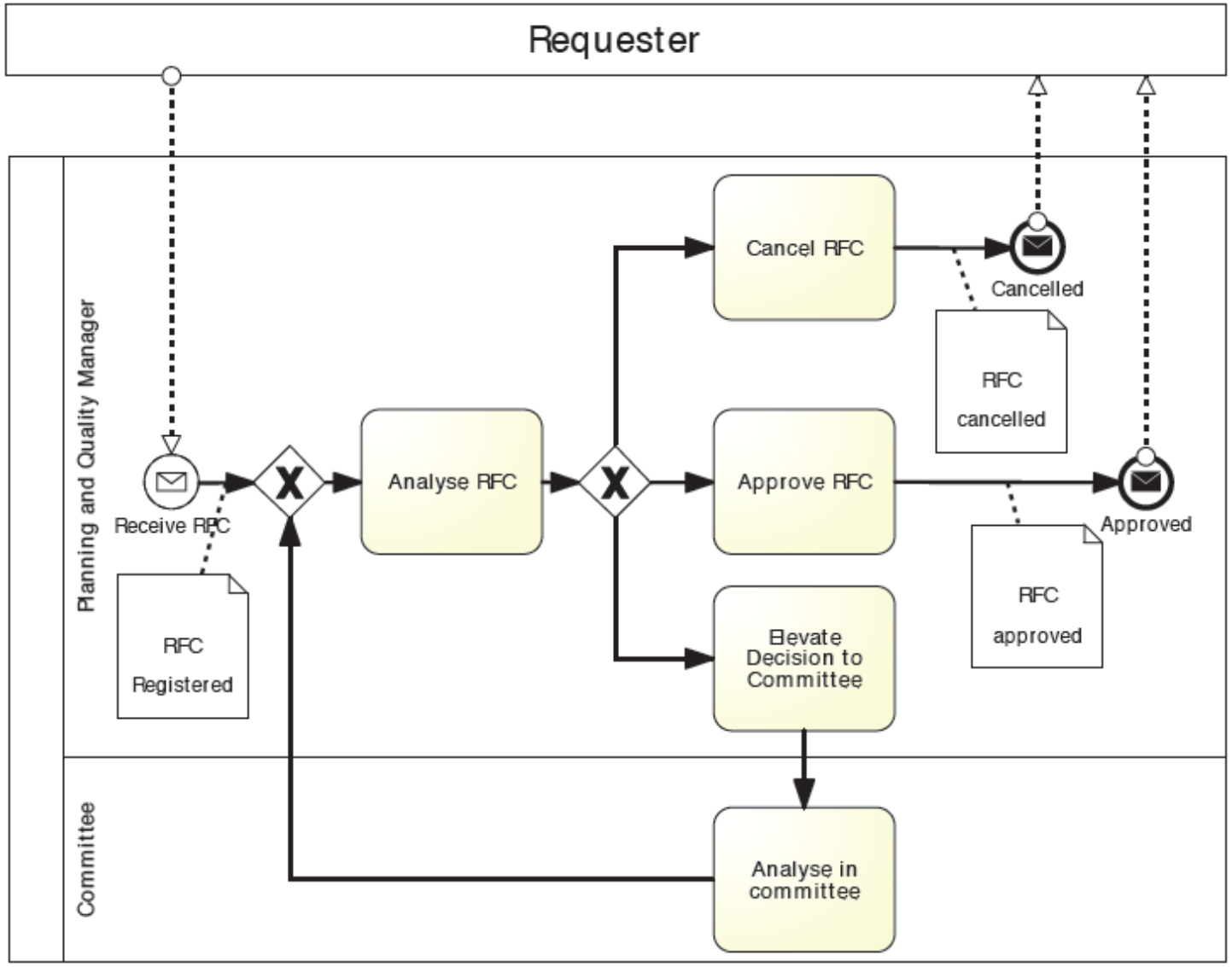
ITIL®

EFQM

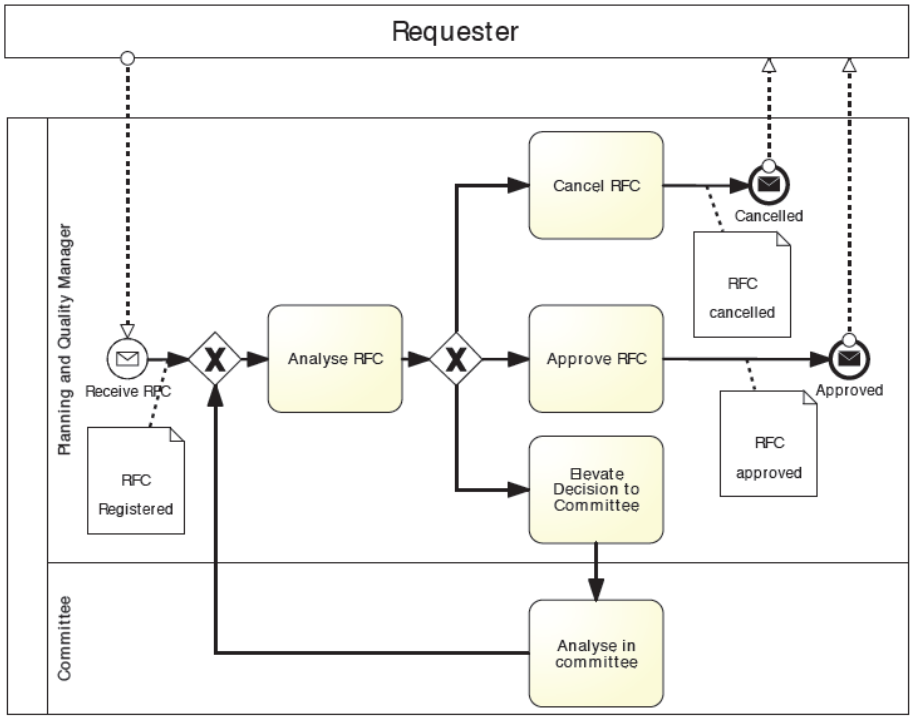
COBIT®

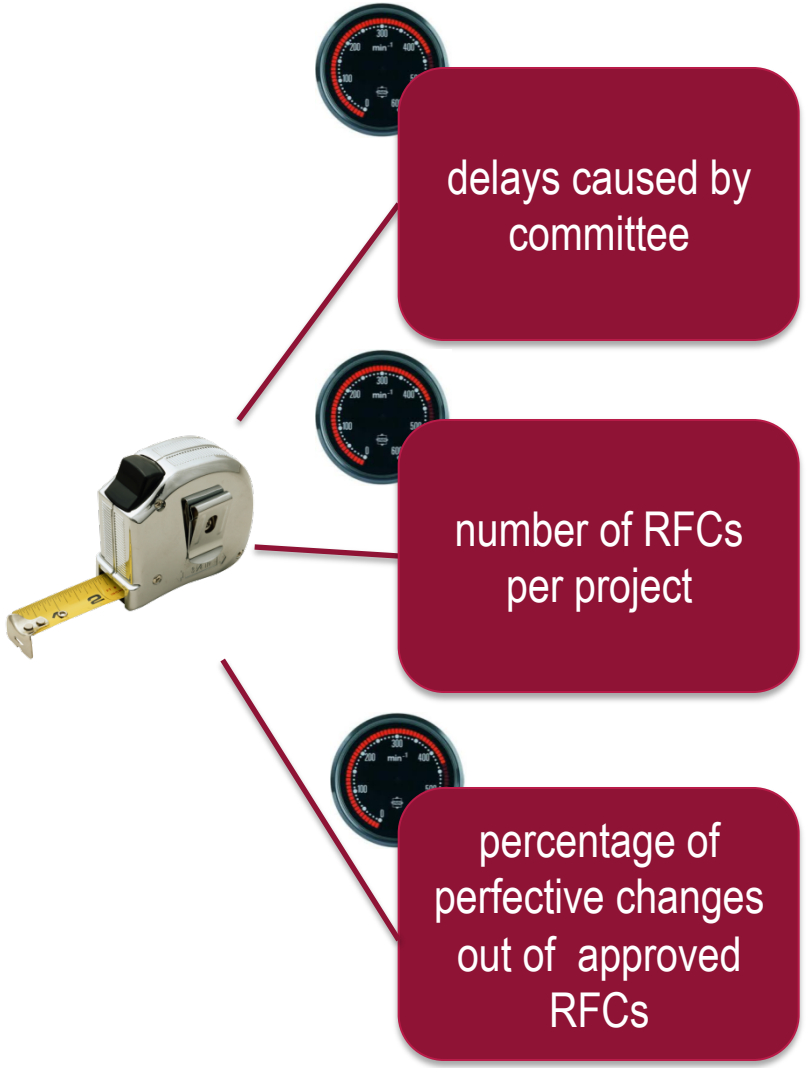
CMMI℠

RFC Management BP Diagram



Examples


Requester
Planning and Quality Manager
Committee
Receive RFC
Analyse RFC
Cancel RFC
Cancelled
RFC cancelled
Approve RFC
Approved
RFC approved
Elevate Decision to Committee
RFC Registered
Analyse in committee

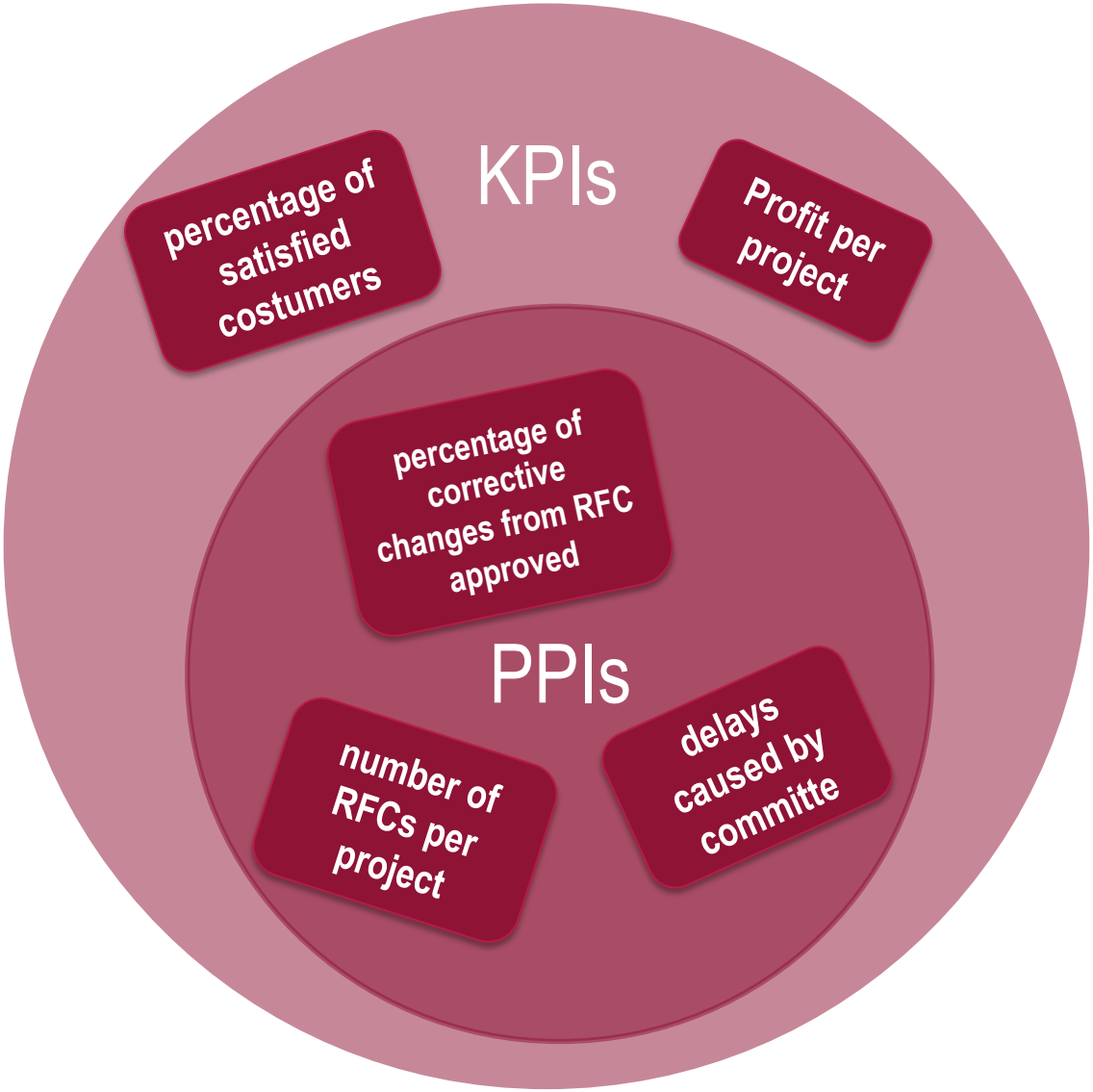

delays caused by committee
number of RFCs per project
percentage of perfective changes out of approved RFCs

Process Performance Indicator (PPI)

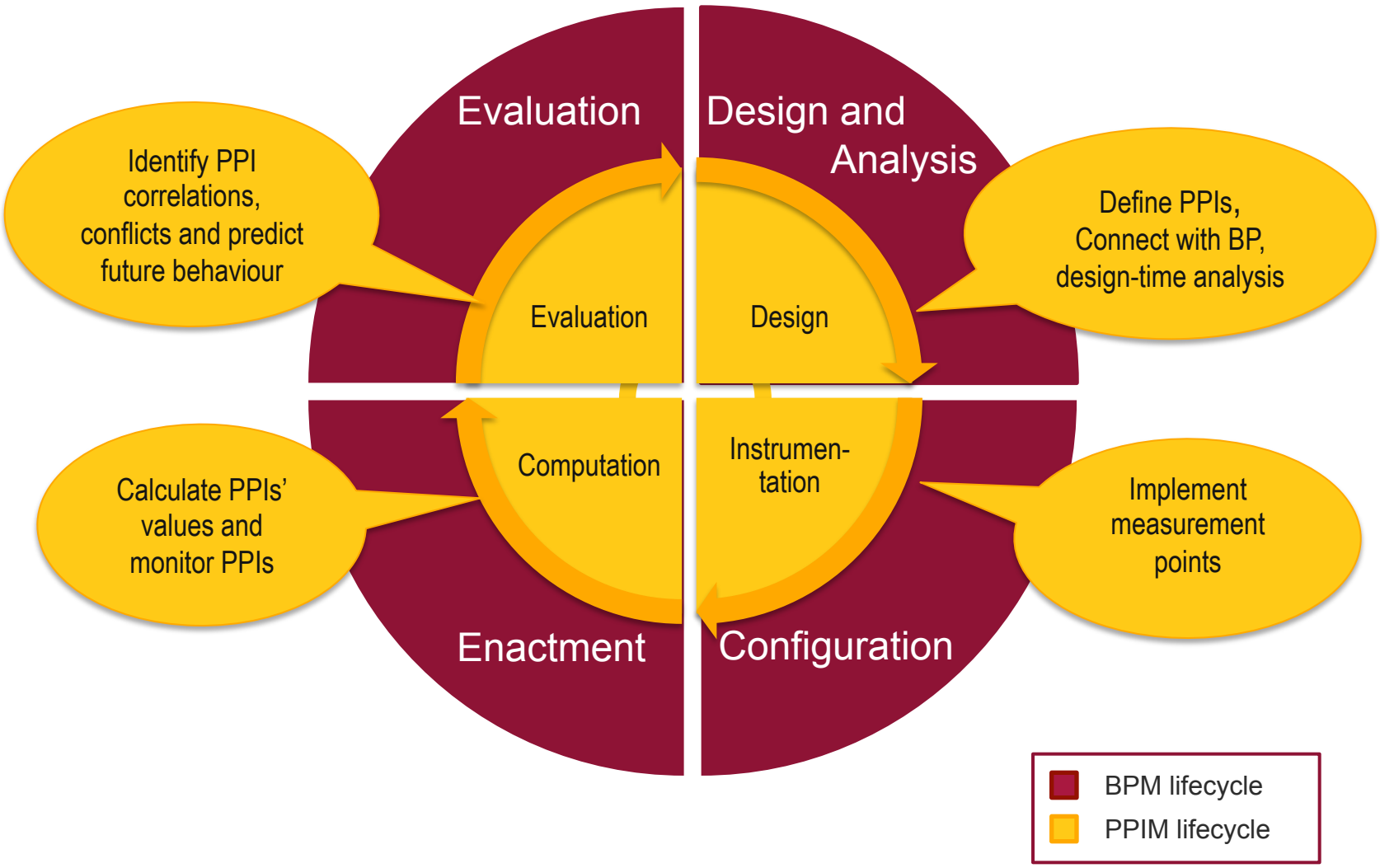
Quantifiable metrics that allow the evaluation of the **efficiency and effectiveness of business processes**. They can be measured directly by data that is generated within the process flow and are aimed at the process controlling and continuous optimization.

[G. Chase et al., 2011]

PPI vs KPIs


KPIs
percentage of satisfied costumers
Profit per project
percentage of corrective changes from RFC approved
PPIs
number of RFCs per project
delays caused by committe

The PPI Management Lifecycle



Problem statement

How to **define** PPIs to support the PPI management lifecycle?

How to extract valuable information?

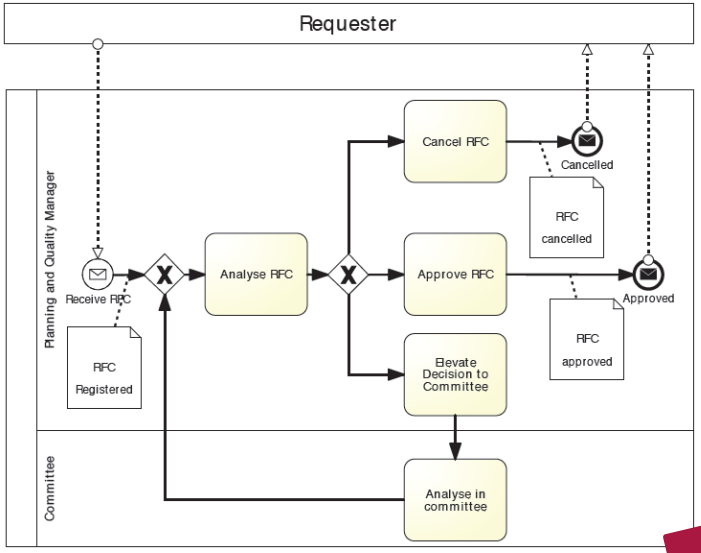
Problem statement

How to **define** PPIs to support the PPI management lifecycle?

How to extract valuable information?

How are PPIs defined nowadays?

Low level - implementation perspective



Algoritmo 1 Contracción de caras libres maximales
Entrada: Complejo simplicial $K = \{\sigma_1, \ldots, \sigma_n\}$ no vacío.
Salida: **cierto** si K es contráctil y **falso** en caso contrario.

1: **mientras** $K \neq \{(v)\}$ **hacer**
2: Elegir un símplice σ_i de K que sea maximal y que contenga una cara libre $\delta\sigma_i$.
3: **si** no hay ningún símplice de esas características **entonces**
4: **devolver falso**
5: **si no**
6: $K \leftarrow K \setminus \{\sigma_i, \delta\sigma_i\}$
7: **fin si**
8: **fin mientras**
9: **devolver cierto**

El algoritmo 1 es bastante raro, ¿qué diablos significa la línea 1.3?

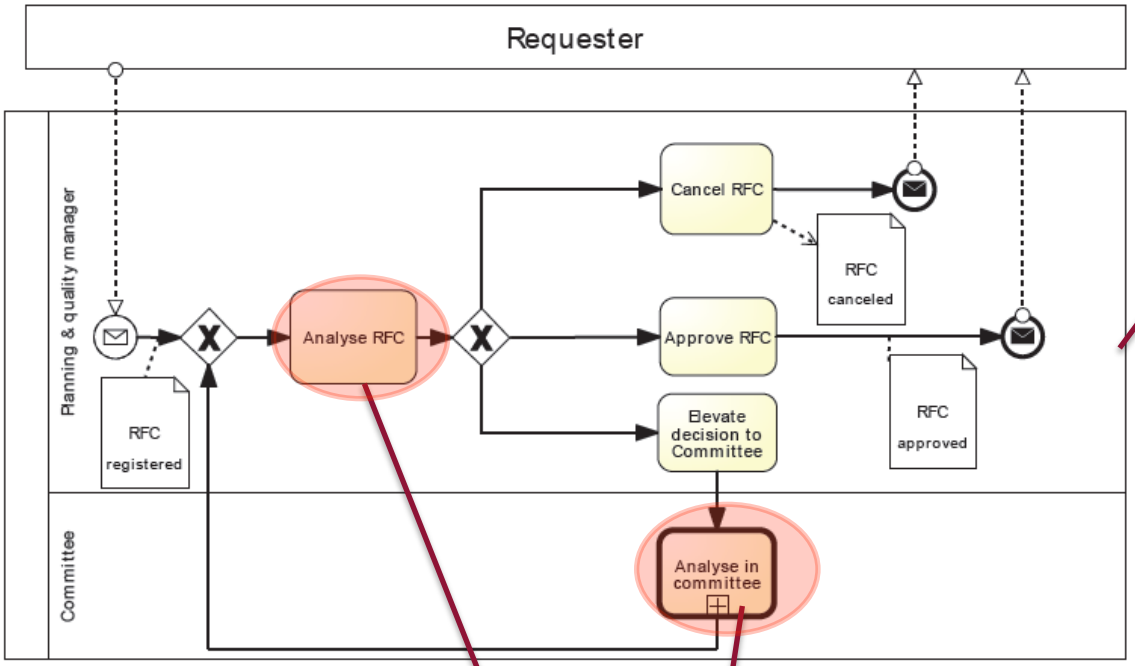
```
SELECT
      Clientes.id_Cliente AS idCliente,
      Clientes.Razon_Soc AS Cliente
FROM
      Clientes
WHERE
      (Clientes.Eliminado <> 1)
AND   (Clientes.Cta_Habilitada <> 0)
ORDER BY
      Clientes.id_Cliente,
      Clientes.Razon_Soc
```

Informal - natural language

		KPI	consultas	Indicador	Cálculo del indicador	Valor actual (SP)	Valor esperado	roles interesados	Observaciones
	Calidad del lanzamiento	1	1.1	Frecuencia de PLs "reinstaladas"	% PLs "reinstaladas" en algún entorno, con o sin Marcha Atrás, sobre el total de PLs instaladas en el sistema.			GLANZCTICO	Contamos Reinstalaciones sobre Instalaciones en cualquier entorno, independientemente de que sean sobre la misma PL
		2	1.2	Media de Ejecuciones por PL	% ejecuciones sobre el total de PLs planificadas para ese periodo			GLANZCTICO	por ejecución entendemos cualquier operación sobre una PL: instalación, reinstalación o desinstalación (que incluye la marcha atrás)

This leads to several problems

Ambiguity and Incompleteness

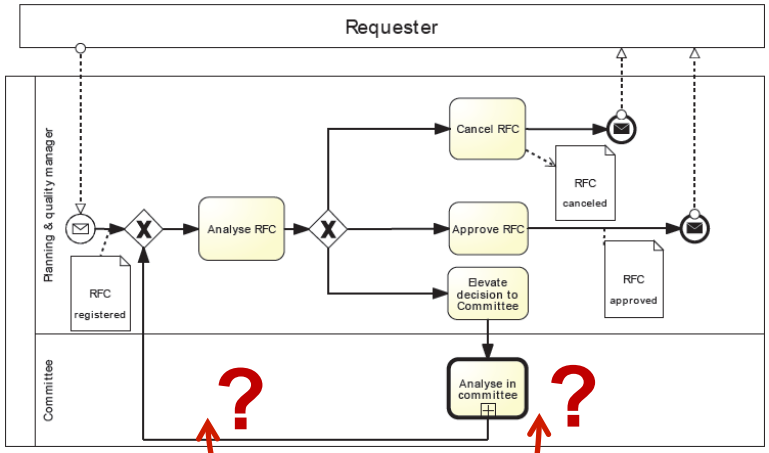


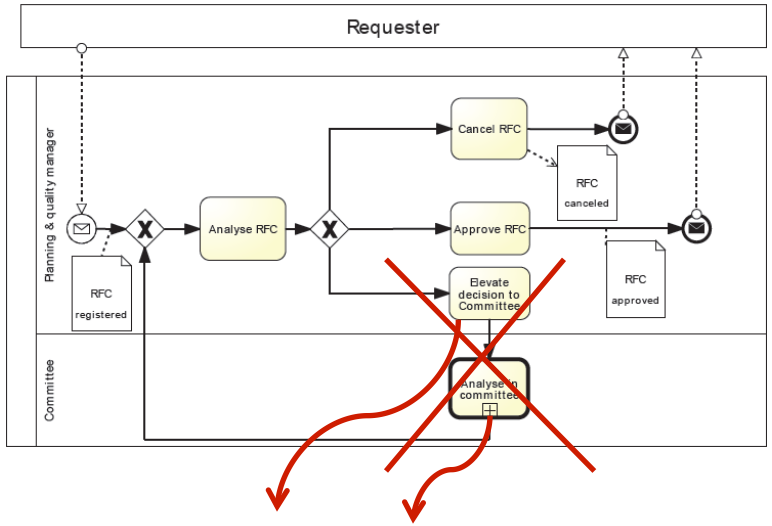
Duration of the analysis activity

When

Which analysis activity

Traceability





PROCESO	Información medida	KPI	Apartado para consultas	Indicador	Cálculo del indicador	Valor actual (SP)	Valor esperado	roles interesados	Observaciones
	Calidad del lanzamiento	1	1.1	Frecuencia de PLs "reinstaladas"	% PLs "reinstaladas" en algún entorno, con o sin Marcha Atrás, sobre el total de PLs instaladas en el sistema.			GLANZCTICO	Contamos Reinstalaciones sobre Instalaciones en cualquier entorno, independientemente de que sean sobre la misma PL
		2	1.2	Media de Ejecuciones por PL	% ejecuciones sobre el total de PLs planificadas para ese periodo			GLANZCTICO	por ejecución entendemos cualquier operación sobre una PL: instalación, reinstalación o desinstalación (que incluye la marcha atrás)

PROCESO	Información medida	KPI	Apartado para consultas	Indicador	Cálculo del indicador	Valor actual (SP)	Valor esperado	roles interesados	Observaciones
	Calidad del lanzamiento	1	1.1	Frecuencia de PLs "reinstaladas"	% PLs "reinstaladas" en algún entorno, con o sin Marcha Atrás, sobre el total de PLs instaladas en el sistema.			GLANZCTICO	Contamos Reinstalaciones sobre Instalaciones en cualquier entorno, independientemente de que sean sobre la misma PL
		2	1.2	Media de Ejecuciones por PL	% ejecuciones sobre el total de PLs planificadas para ese periodo			GLANZCTICO	por ejecución entendemos cualquier operación sobre una PL: instalación, reinstalación o desinstalación (que incluye la marcha atrás)

Understandability

```
SELECT
        Clientes.id_Cliente AS idCliente,
        Clientes.Razon_Soc AS Cliente
FROM
        Clientes
WHERE
        (Clientes.Eliminado <> 1)
AND     (Clientes.Cta_Habilitada <> 0)
ORDER BY
        Clientes.id_Cliente,
        Clientes.Razon_Soc
```

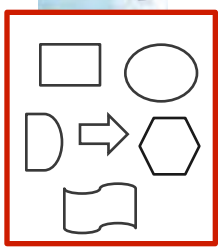
PROCESO	Información medida	KPI	Apartado para consultas	Indicador	Cálculo del indicador	Valor actual (SP)	Valor esperado	roles interesados	Observaciones
	Calidad del lanzamiento	1	1.1	Frecuencia de PLs "reinstaladas"	% PLs "reinstaladas" en algún entorno, con o sin Marcha Atrás, sobre el total de PLs instaladas en el sistema.			GLANZCTICO	Contamos Reinstalaciones sobre Instalaciones en cualquier entorno, independientemente de que sean sobre la misma PL
		2	1.2	Media de Ejecuciones por PL	% ejecuciones sobre el total de PLs planificadas para ese periodo			GLANZCTICO	por ejecución entendemos cualquier operación sobre una PL: instalación, reinstalación o desinstalación (que incluye la marcha atrás)

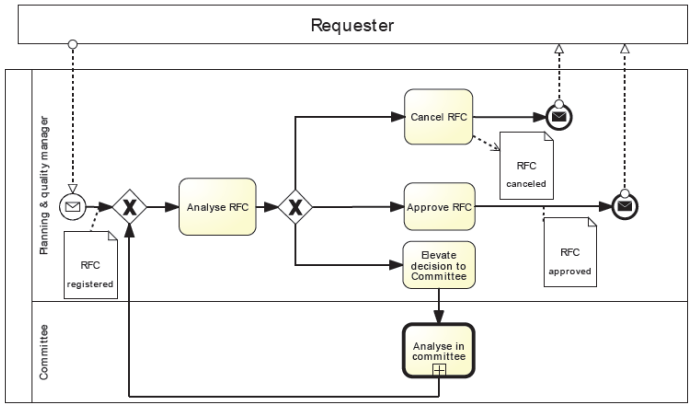
Business manager

System architect

Processable vs understandable

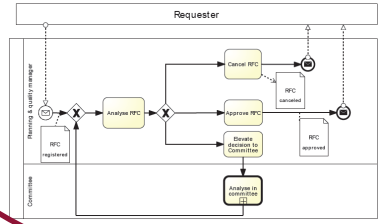
Visual Gap



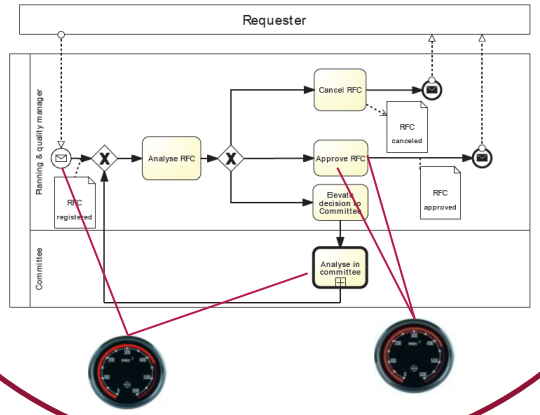


PROCESO	Información medida	KPI	Apartado para consultas	Indicador	Cálculo del indicador	Valor actual (SP)	Valor esperado	roles interesados	Observaciones
	Calidad del lanzamiento	1	1.1	Frecuencia de PLs "reinstaladas"	% PLs "reinstaladas" en algún entorno, con o sin Marcha Atrás, sobre el total de PLs instaladas en el sistema.			GLANZCTICO	Contamos Reinstalaciones sobre Instalaciones en cualquier entorno, independientemente de que sean sobre la misma PL
		2	1.2	Media de Ejecuciones por PL	% ejecuciones sobre el total de PLs planificadas para ese periodo			GLANZCTICO	por ejecución entendemos cualquier operación sobre una PL: instalación, reinstalación o desinstalación (que incluye la marcha atrás)

Partial views



Comprehensive views




ppinot
process performance indicators notation and tool

PPINOT Metamodel

1

Specific

Timed

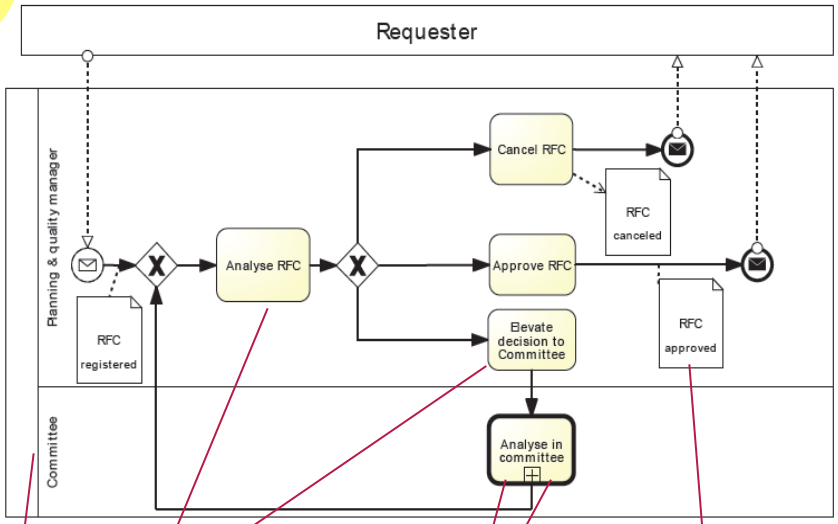
Measurable

SMART

Relevant

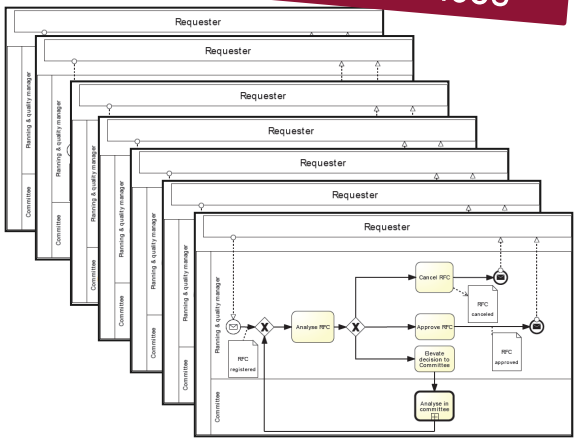
Achievable

2



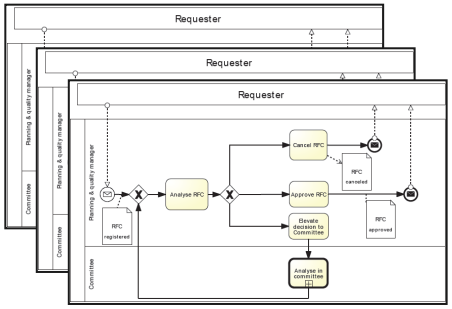
3

BP Instances



Scope

?



Features

- High expressiveness
- Traceability with BP elements
- Extensible

More details at: Adela del-Río-Ortega et al. “On the definition and design-time analysis of process performance indicators”. Information Systems 38(4): 470-490 (2013)

PPINOT Metamodel

PPINOT Graphical Notation

Visual PPINOT

PPI

Measures

Base Measure

Aggregated Measure

Derived Single-Instance Measure

Derived Multi-Instance Measure

What to measure

Time		
Count		
State Condition		SUM
Data Property Condition		SUM
Data content		

Connectors

from

to

Time connectors

state & restriction/content

Applies to

a

a/2

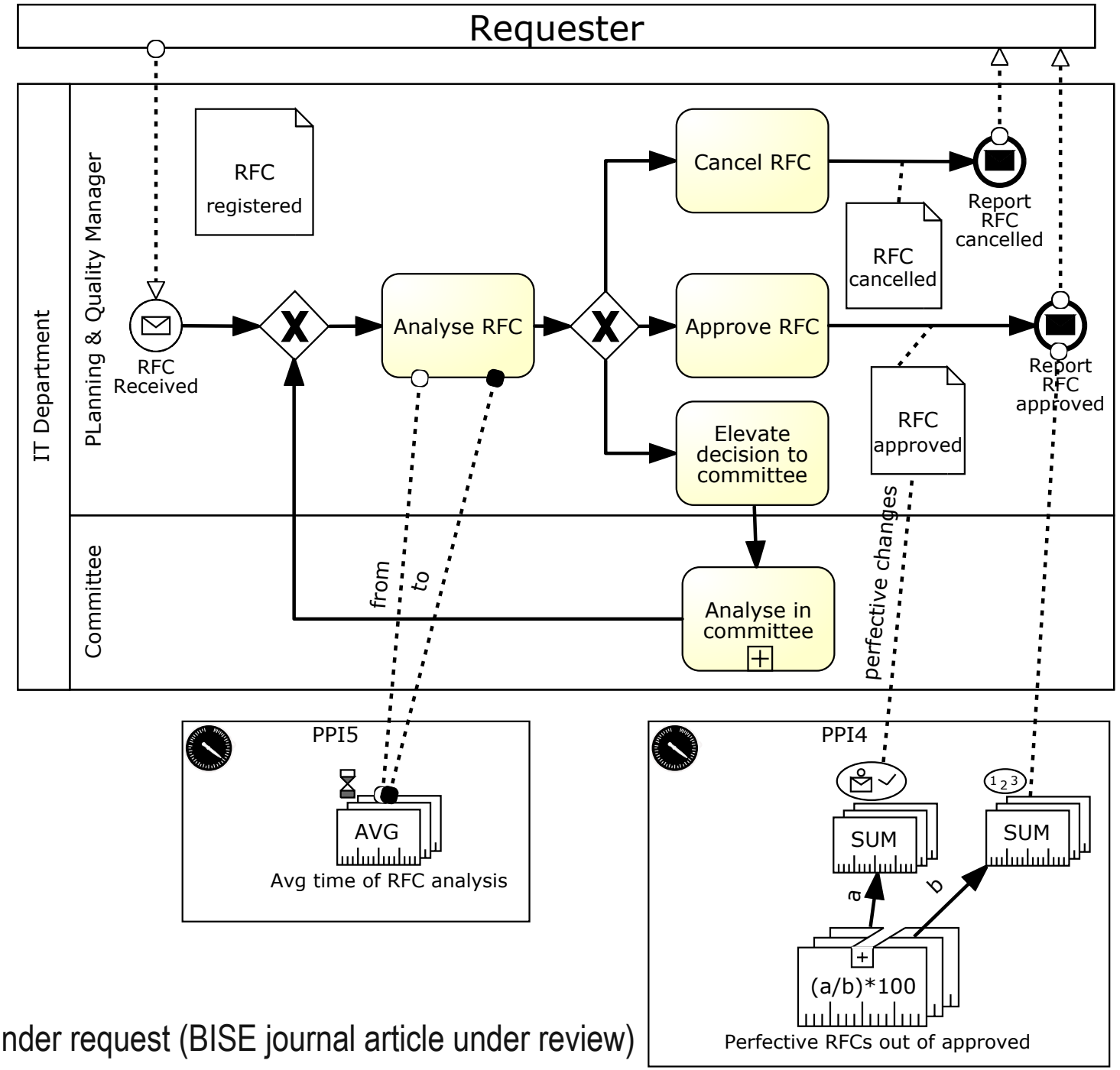
Uses

aggregates

Aggregates

isGroupedBy

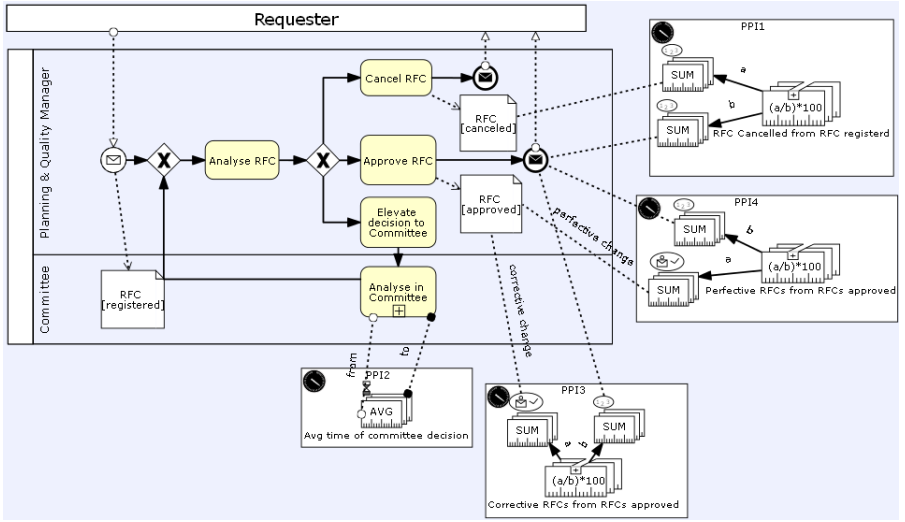
isGroupedBy



More details under request (BISE journal article under review)

Problems

Scalability



Learning curve

Business manager

PPINOT Metamodel
PPINOT Graphical Notation
PPINOT Templates

Templates

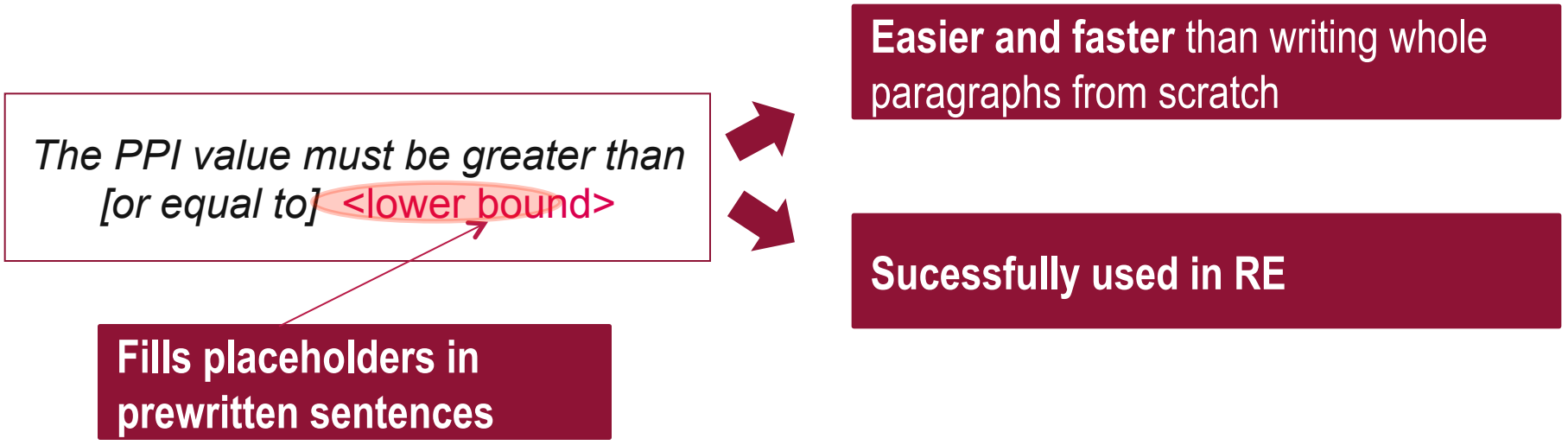
PPI-<ID>	*<PPI descriptive name>*
Process	*<process ID the PPI is related to>*
Goals	*<strategic or operational goals the PPI is related to>*
MeasureDefinition	The PPI is calculated as{ *<TimeMeasure>*|*<CountMeasure>*|*<ConditionMeasure>*| *<DataMeasure>*|*<DerivedMeasure>*|*<AggregatedMeasure>*}
Target	The PPI value must{ *<SimpleTargetValue>*|*<ComposedTargetValue>*| *<CustomTargetValue>*}
Scope	The process instances considered for this PPI are • All • those in <descriptive name (*S-x*)>
Source	*<source from whcih the PPI measure can be taken>*
Responsible	{*<role>*|*<department>*|*<organisation>*|*<person>*}
Informed	{*<role>*|*<department>*|*<organisation>*|*<person>*}
Comments	*<additional comments about the PPI>*

Helps to structure information

Serves as a guide

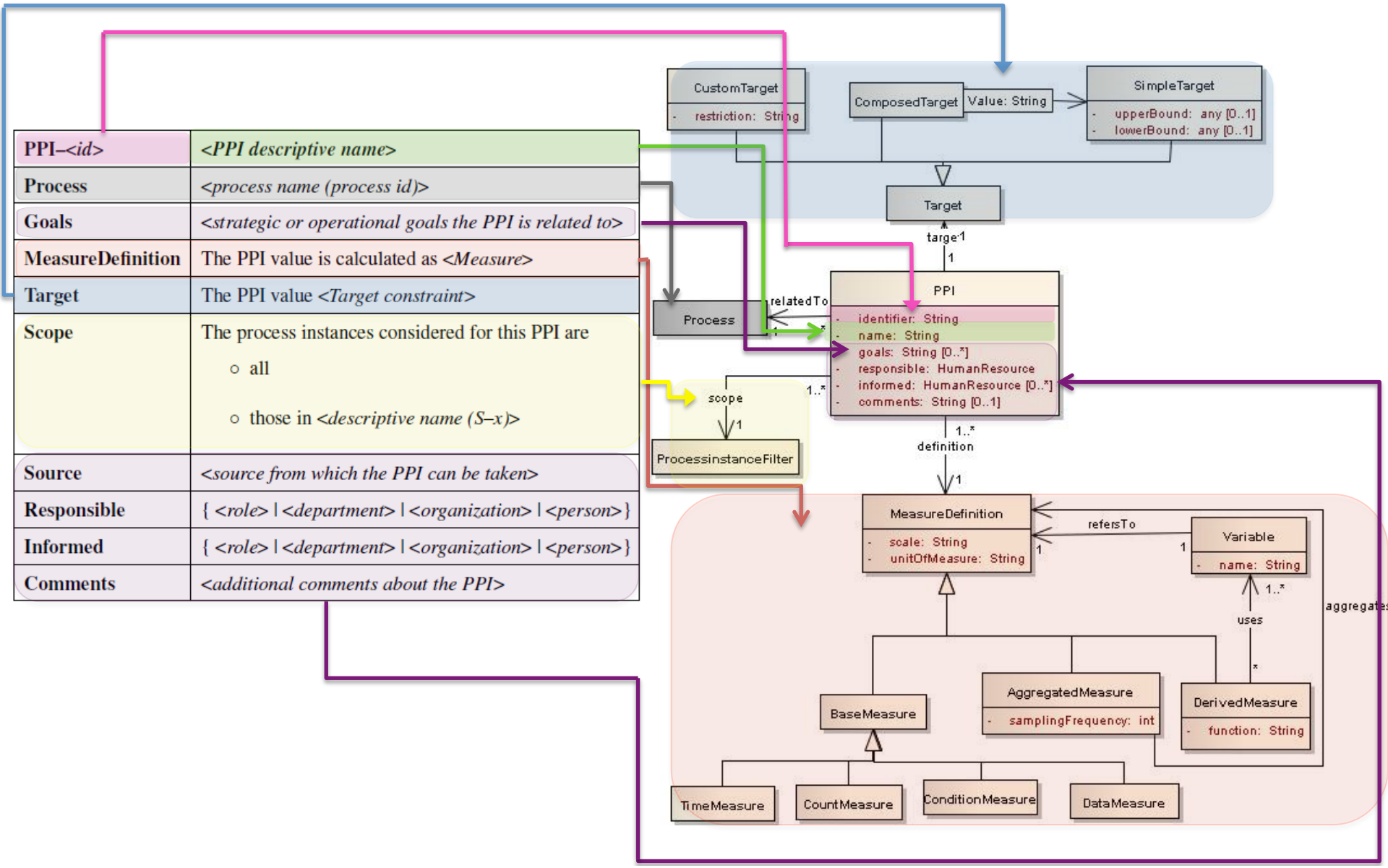
Uses (structured) natural language

Linguistic Patterns



Mapping to the metamodel

PPI–<*id*>	*<PPI descriptive name>*
Process	*<process name (process id)>*
Goals	*<strategic or operational goals the PPI is related to>*
MeasureDefinition	The PPI value is calculated as *<Measure>*
Target	The PPI value *<Target constraint>*
Scope	The process instances considered for this PPI are ○ all ○ those in *<descriptive name (S–x)>*
Source	*<source from which the PPI can be taken>*
Responsible	{ *<role>* | *<department>* | *<organization>* | *<person>* }
Informed	{ *<role>* | *<department>* | *<organization>* | *<person>* }
Comments	*<additional comments about the PPI>*



PPI Template Example

***PPI*-005**	Average time of RFC analysis
Process	Request for change (RFC)
Goals	• BG-002: Improve customer satisfaction • BG-014: Reduce RFC response time
MeasureDefinition	The PPI is calculated as the average of the duration between the time instants when activity RFC analysis becomes active and when activity RFC analysis becomes completed
Target	The PPI value must be lower than or equal to 1 working day
Scope	The process instances considered for this PPI are those in Last 100 instances scope
Source	Event logs of BPMS
Responsible	Planning and quality manager
Informed	Chief Information Officer (CIO)
Comments	Most RFCs are created after 12:00

More details at: Adela del-Río-Ortega et al. “Using templates and linguistic patterns to define process performance indicators”. Enterprise Information Systems 10(2): 159-192 (2016)

Problem statement

- How to **define** PPIs to support the PPI management lifecycle?

- How to extract valuable information?

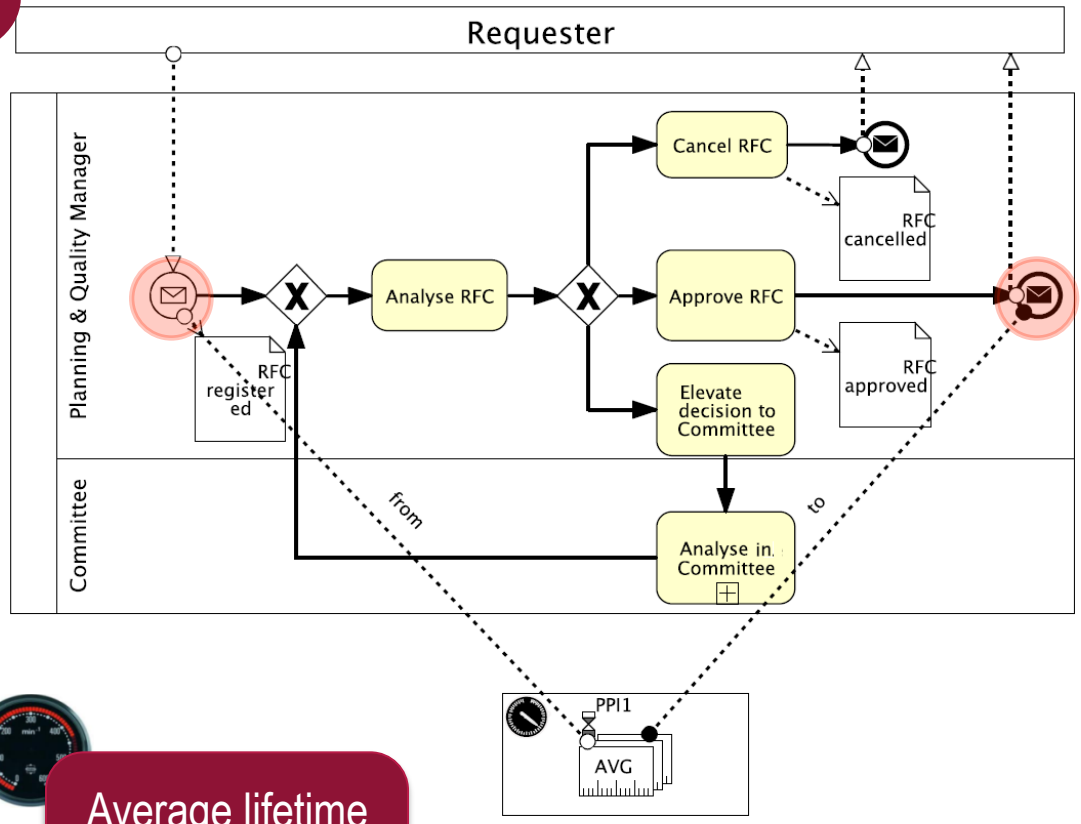
How do I instrument this process?

If I change this activity, which PPIs might be affected?

Measured By Relationship

How do I instrument this indicator?

Which process elements are measured by this PPI?

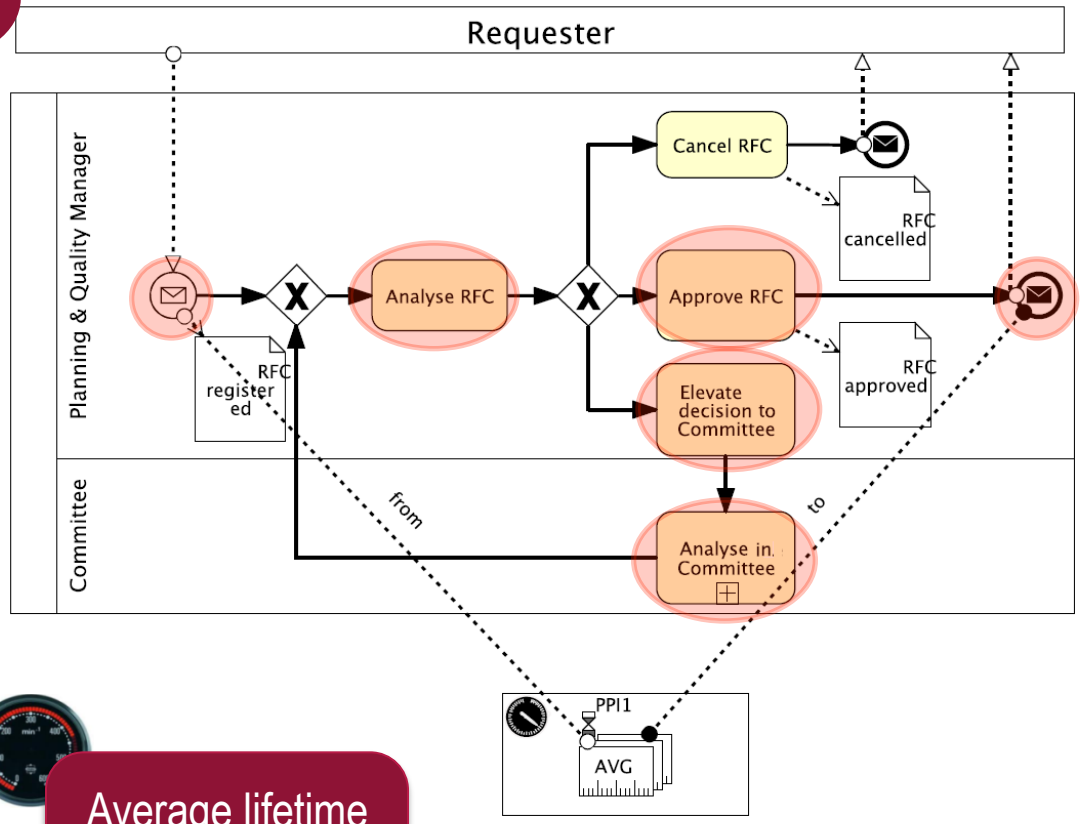


Average lifetime of approved RFCs

Involved In Relationship

This PPI is too costly. We need to replace it

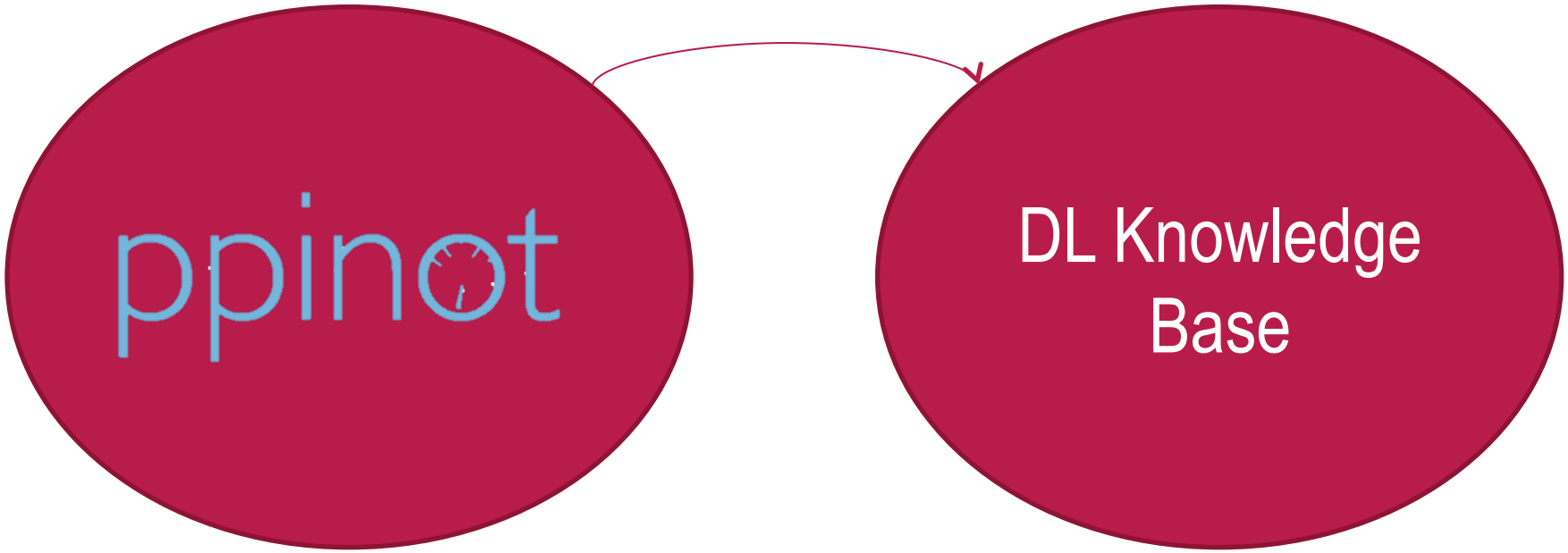
Which process elements are involved in this PPI?



Average lifetime of approved RFCs

Relationship	Operations
Measured By	**MeasuredBPElement:** Which process elements are measured by this PPI?
	MeasuredPPI: Which PPIs are defined over this process element?
Involved In	**InvolvedBPElements**: Which process elements are involved in a given PPI? **NotInvolvedBPElements:** Which process elements are not involved in any PPI? **InvolvedInAllBPElements:** Which process elements are involved in all PPIs?
	Associated PPI: Which PPIs are involved in a given process element?

DL-based implementation



Formulate operations in terms of DL reasoning operations (e.g. satisfiability, subsumption, realization, etc.)

DL reasoners

- Hermit
- Racer
- Pellet
- Etc.

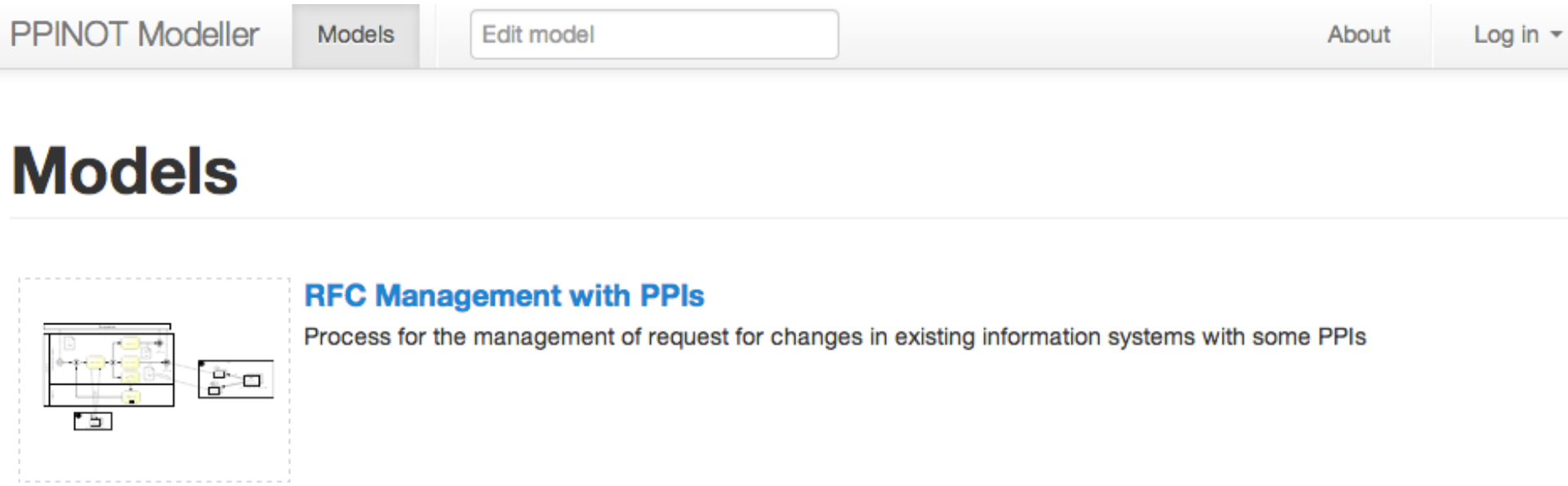
More details at: Adela del-Río-Ortega et al. “On the definition and design-time analysis of process performance indicators”. Information Systems 38(4): 470-490 (2013)

Applied to several use cases

- IT department of the Andalusian Health Service
- Company for training health professionals
- Information and Communication service of the University of Seville
- A part of the administration of the Andalusian Regional Government

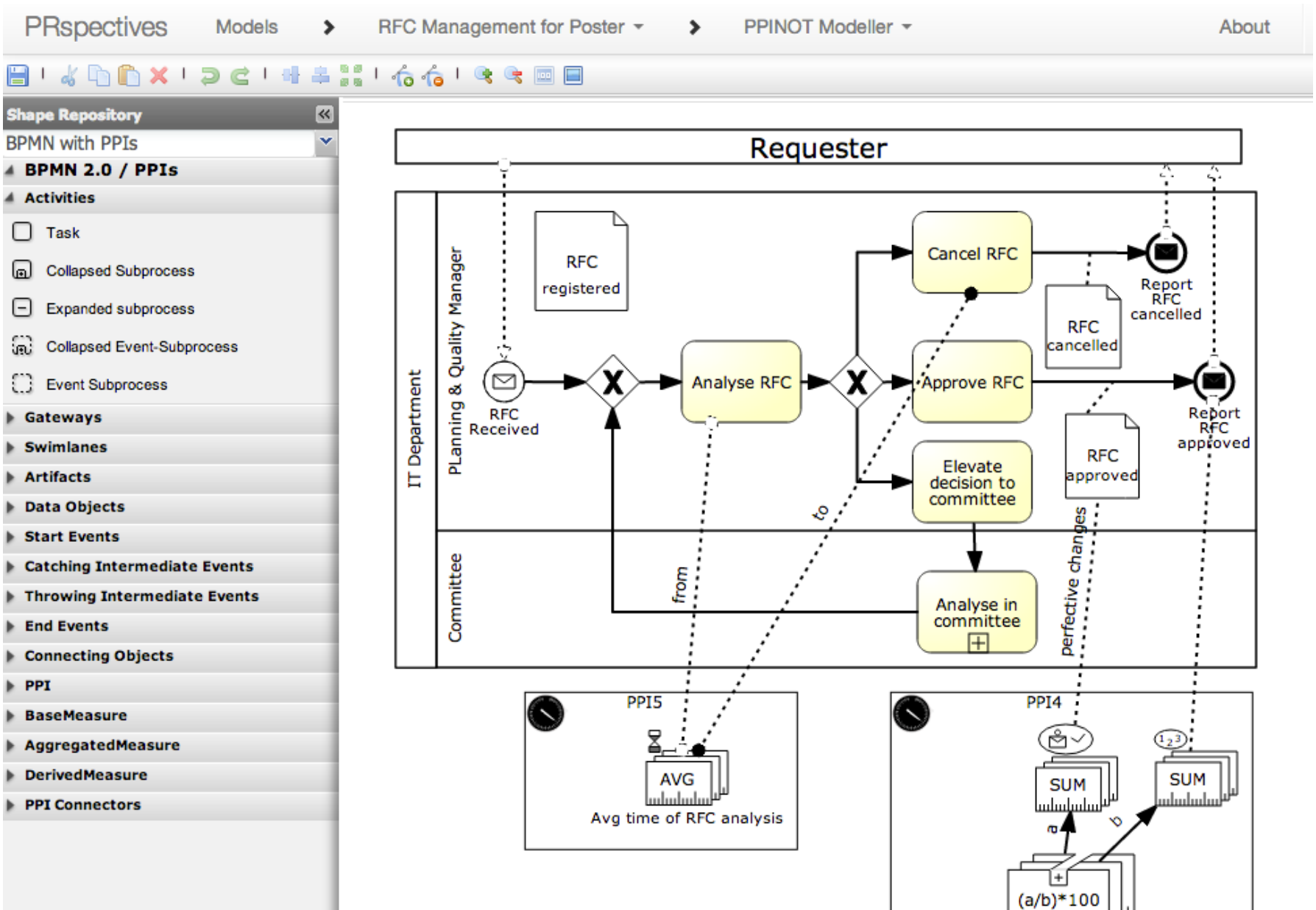
Introduction
Performance perspective
Tooling support

PRspectives

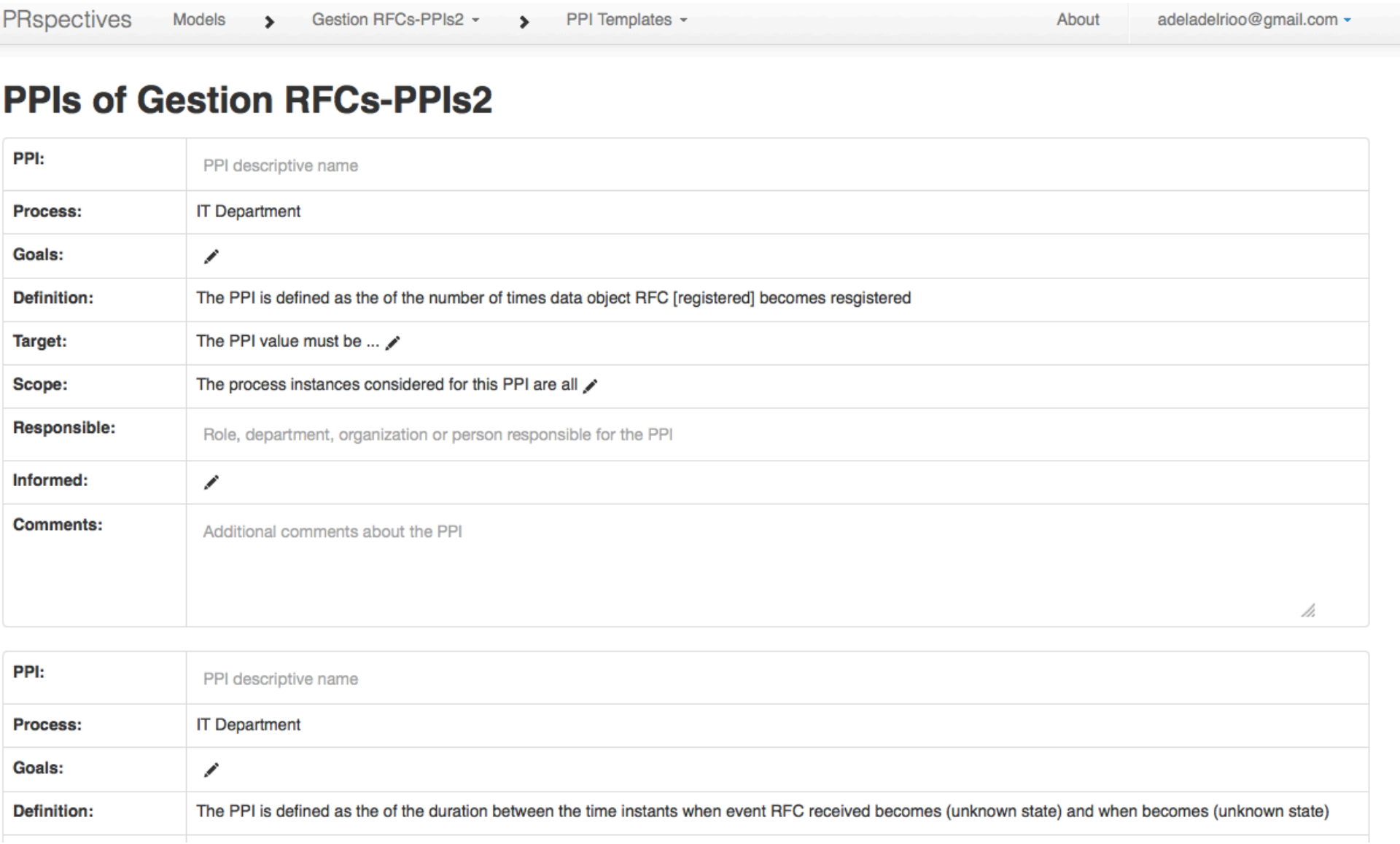


Available at: http://labs.isa.us.es:8080/prspectives

PRspectives



PRspectives



Introduction
Performance perspective
Tooling support
Ongoing work

Ongoing work

- SLA modelling for BPO services
- Automatic establishment of links between natural language PPIs and their implementation
- PPI variability management
- PPI Thresholds determination based on execution data

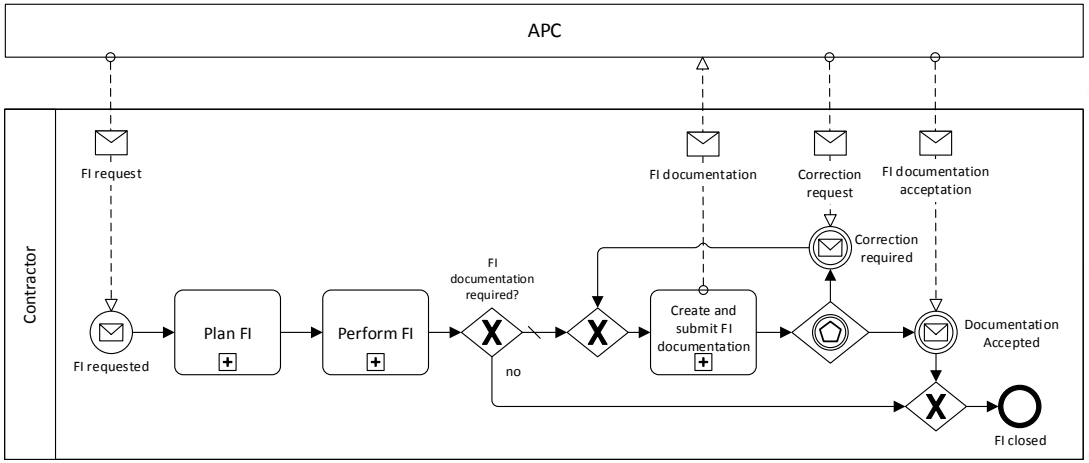
Ongoing work

- **SLA modelling for BPO services**
- Automatic establishment of links between natural language PPIs and their implementation
- PPI variability management
- PPI Thresholds determination based on execution data

SLA modelling for BPO services

Criticality Level	Response Time	Presence Time	Resolution Time	Document. Time	Timetable	Calendar
Critical	0.5	4	2	4	8:00 – 20:00	Local
High	2	8	4	12	8:00 – 20:00	Local
Mild	5	30	6	24	8:00 – 20:00	Local
Low	5	60	8	48	8:00 – 20:00	Local

Metrics



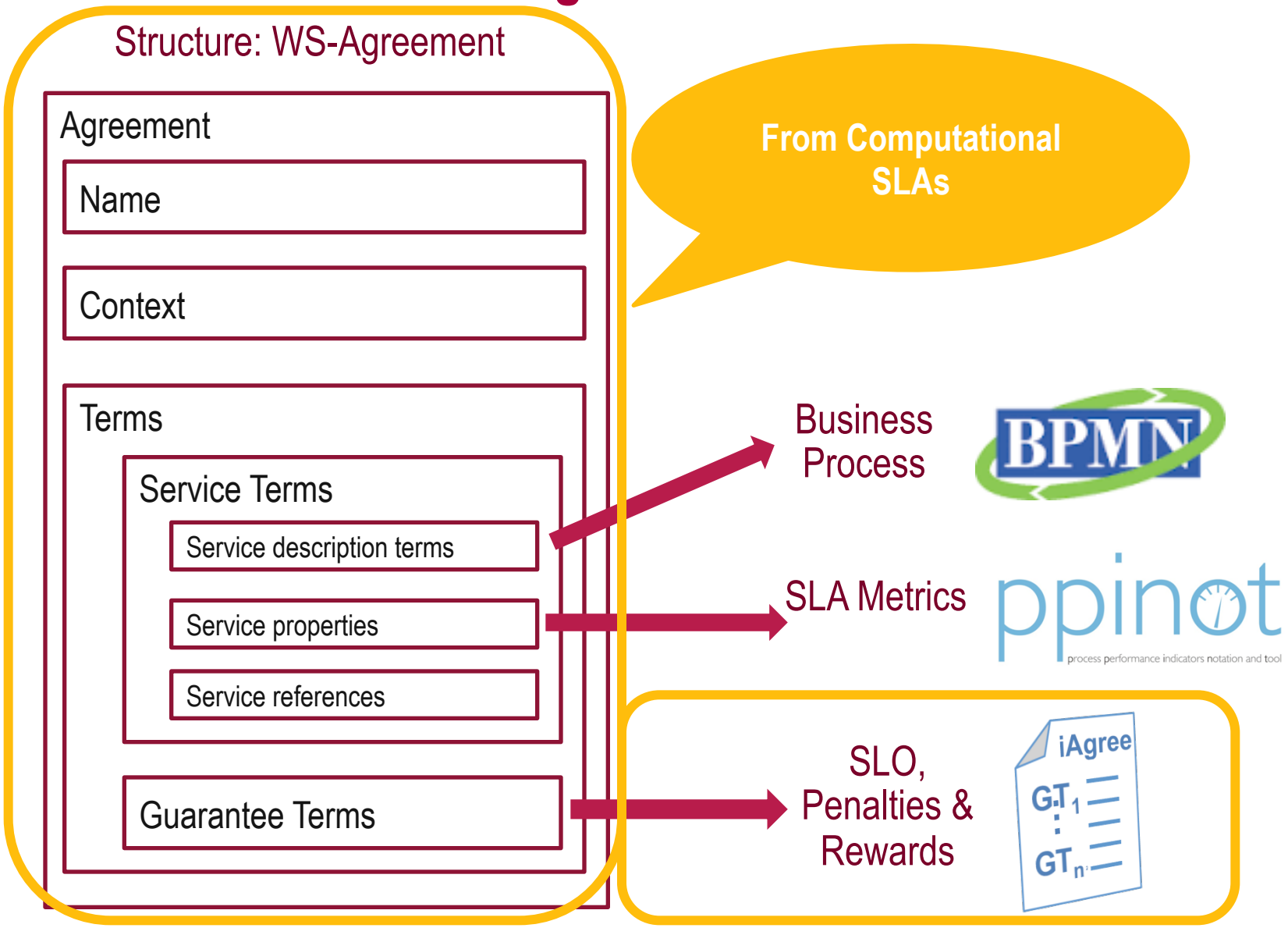
AFIP	Penalty
$94\% \leq \text{AFIP} < 95\%$	-1%
$93\% \leq \text{AFIP} < 94\%$	-2%
$92\% \leq \text{AFIP} < 93\%$	-3%
$91\% \leq \text{AFIP} < 92\%$	-4%
$90\% \leq \text{AFIP} < 91\%$	-5%
$\text{AFIP} < 90\%$	-10%

Penalties & Rewards

$$\text{AFIP} = \frac{\#\text{ accomplished FIs}}{\#\text{ FIs}} \times 100 \quad >95\%$$

Service Level Objective (SLOs)

SLA modelling for BPO services



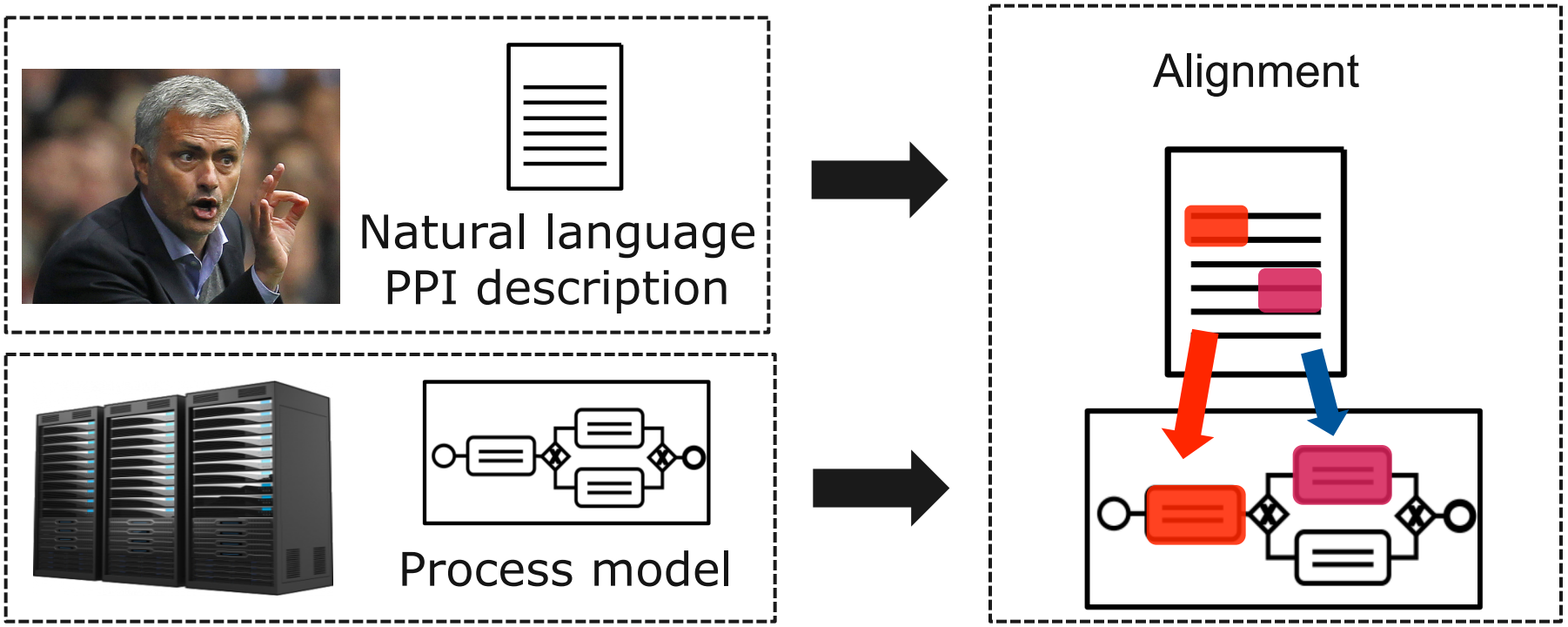
Published at: Adela del-Río-Ortega et al. “Modelling Service Level Agreement for Business Process Outsourcing Services”. CAiSE 2015: 485-500

Ongoing work

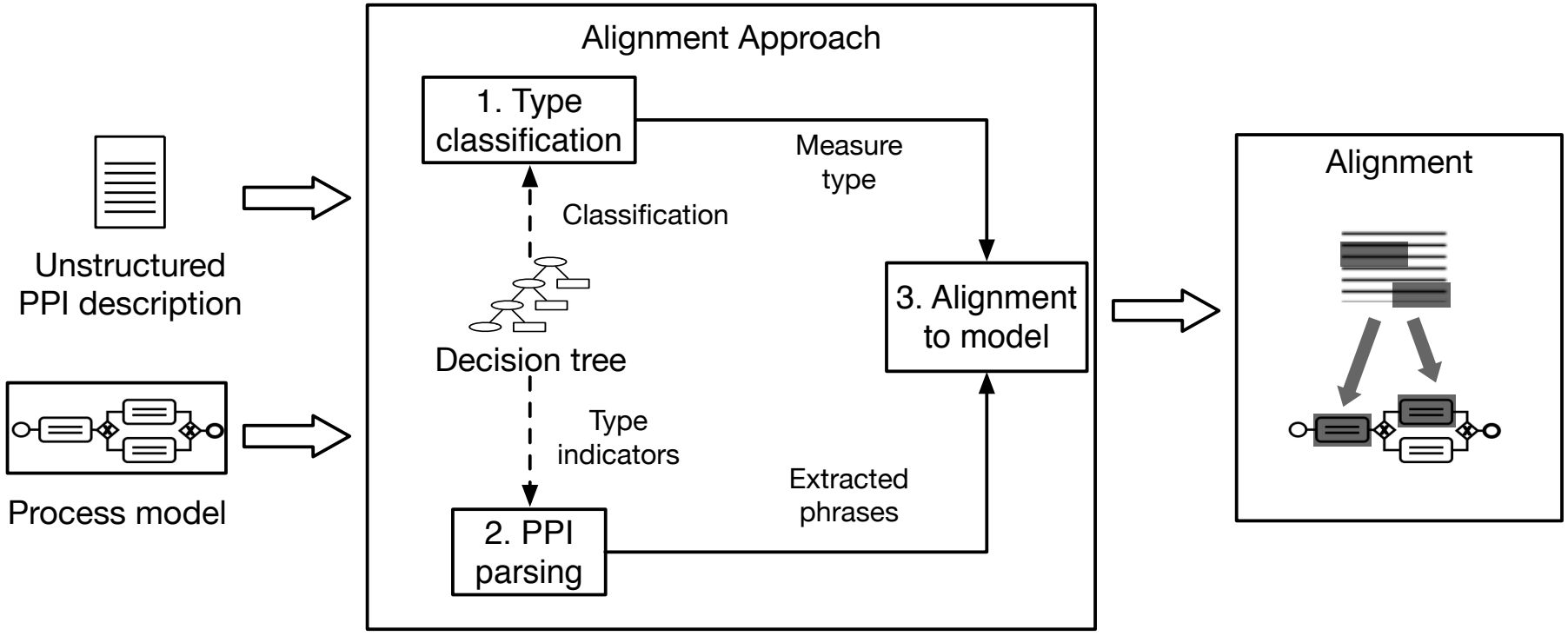
- SLA modelling for BPO services
- **Automatic establishment of links between natural language PPIs and their implementation**
- PPI variability management
- PPI Thresholds determination based on execution data

Automatic establishment of links between natural language PPIs and their implementation

- The formulation of PPIs is typically a *managerial concern*
- Monitoring PPIs requires a *technical perspective* on a process



Automatic establishment of links between natural language PPIs and their implementation



Published at: Han van der Aa et al. “Narrowing the Business-IT Gap in Process Performance Measurement”. CAiSE 2016: 543-557

Ongoing work

- SLA modelling for BPO services
- Automatic establishment of links between natural language PPIs and their implementation
- **PPI variability management**
- PPI Thresholds determination based on execution data

PPI variability management

Performance perspective subject to variation

Needs of models and tools

Dimensions: result of analysis

First Step

- Avoid redundancy
- Reduce efforts
- Increase clarity

Published at: Bedilia Estrada-Torres et al. “Identifying Variability in Process Performance Indicators”. BPM (Forum) 2016: 91-107

Ongoing work

- SLA modelling for BPO services
- Automatic establishment of links between natural language PPIs and their implementation
- PPI variability management
- **PPI Thresholds determination based on execution data**

PPI Thresholds determination based on execution data

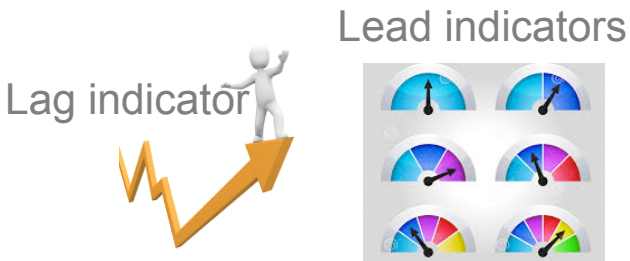
Lagging Indicators

Measures goal accomplishment, easy to measure but hard to influence.

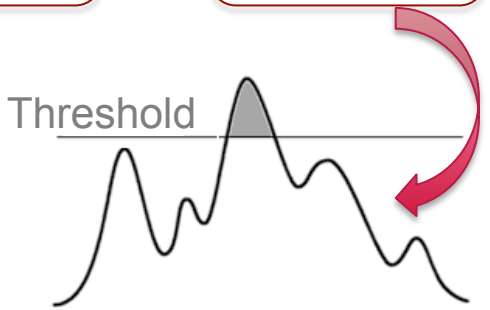
Leading Indicators

Predict goal achievement, you can influence them but can be more difficult to measure.

Method for PPI Threshold Determination



Data Preprocessing → Relationship checking → Threshold extraction: ROC Curve → Error probabilities: Bender method → Thresholds validation



To be published: Adela del-Río-Ortega et al. “Enriching decision making with Data-Based Thresholds of Process-Related KPIs”. CAiSE 2017: TBD

Ongoing work

- And much more…

Thanks


Adela del Río Ortega
adeladelrio@us.es
www.isa.us.es/ppinot
Dept. of Computer Languages and Systems
ETSI Informática, University of Seville, Spain