

Architecting Real Time Systems Using UML-PPOOA Process, Guidelines and Tool

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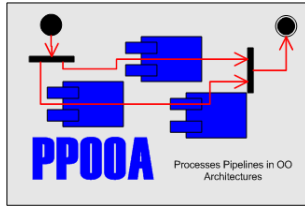
Proposed Approach: Agility + Quality

- An agile design must be continually verified, in the same manner that the implementation must be continually tested. Verification must occur from two perspectives:
 - agreement between design and the implementation
 - verification that the design meets quality requirements
- The design should address how each quality requirement is satisfied. This should include a discussion of the intent of each design element, in the context of any applicable abstract models that were developed¹

¹ Assurance & agile Processes. Does agility conflict with security or reliability? Cliff Berg and Scott Ambler. DrDobb's Journal July 2006

Content

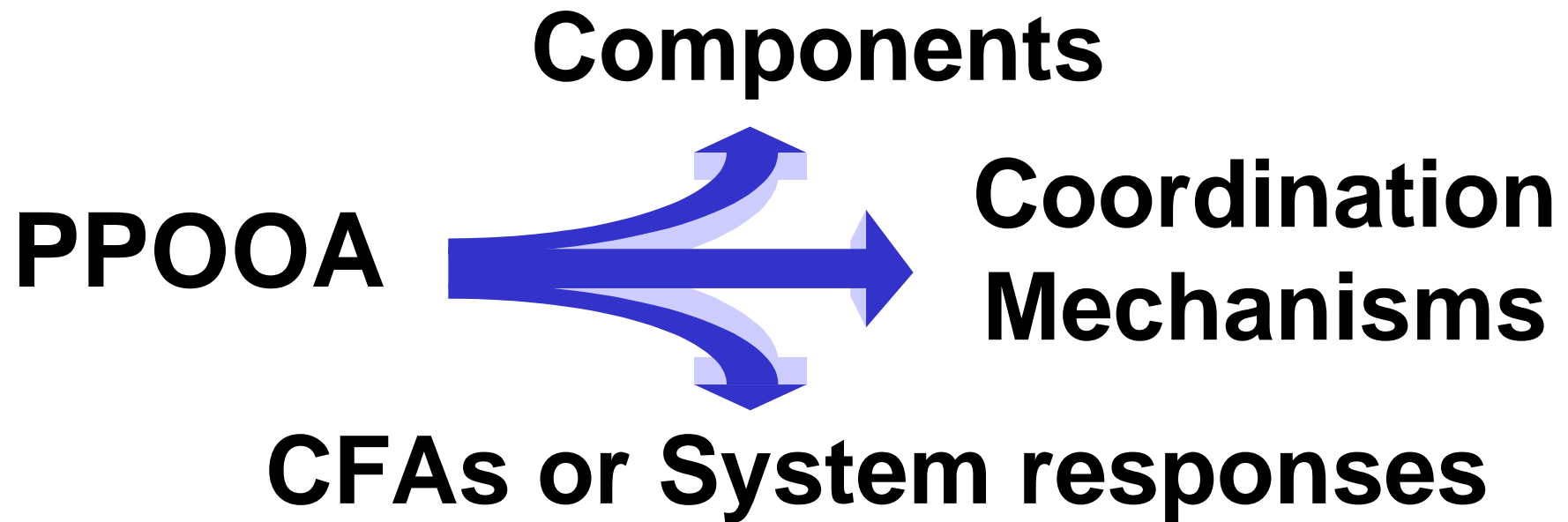
- **PPOOA**
- **PPOOA building elements**
- **PPOOA Architecting Process (PPOOA_AP)**
- **PPOOA_AP Guidelines**
- **Experiences of using PPOOA and PPOOA_AP**
- **PPOOA implementation on Visio CASE tool**
- **Next PPOOA tool features**
- **To conclude**



PPOOA-UML

- A model based approach for architecting real-time systems
 - Based on **UML** notation
 - Supports a diversity of components and coordination mechanisms (for synchronization and communication) not found in UML.
 - Describes the system architecture using two views: one **structural view** (UML class diagram), and one **behavioral view** (UML activity diagram)
 - It is supported by an **architecting process** (PPOOA_AP), defining the steps to build the architecture
 - A **CASE** tool (PPOOA-Visio) may be used

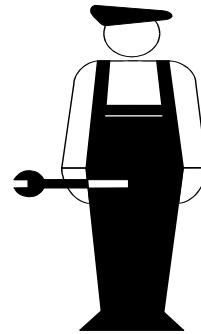
PPOOA Building Elements



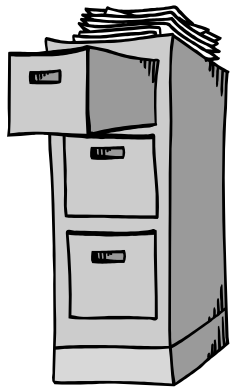
Components included in PPOOA vocabulary



Controller :
Manages external events



**Domain component/
Algorithmic component:**
Performs operations



Structure:
Maintains relations between objects

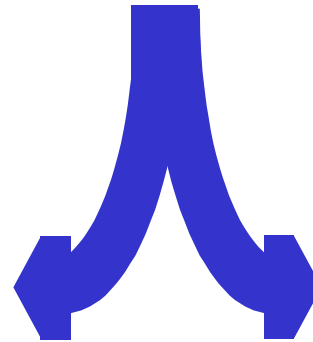


Process:
Coordinates work to others

Coordination Mechanisms

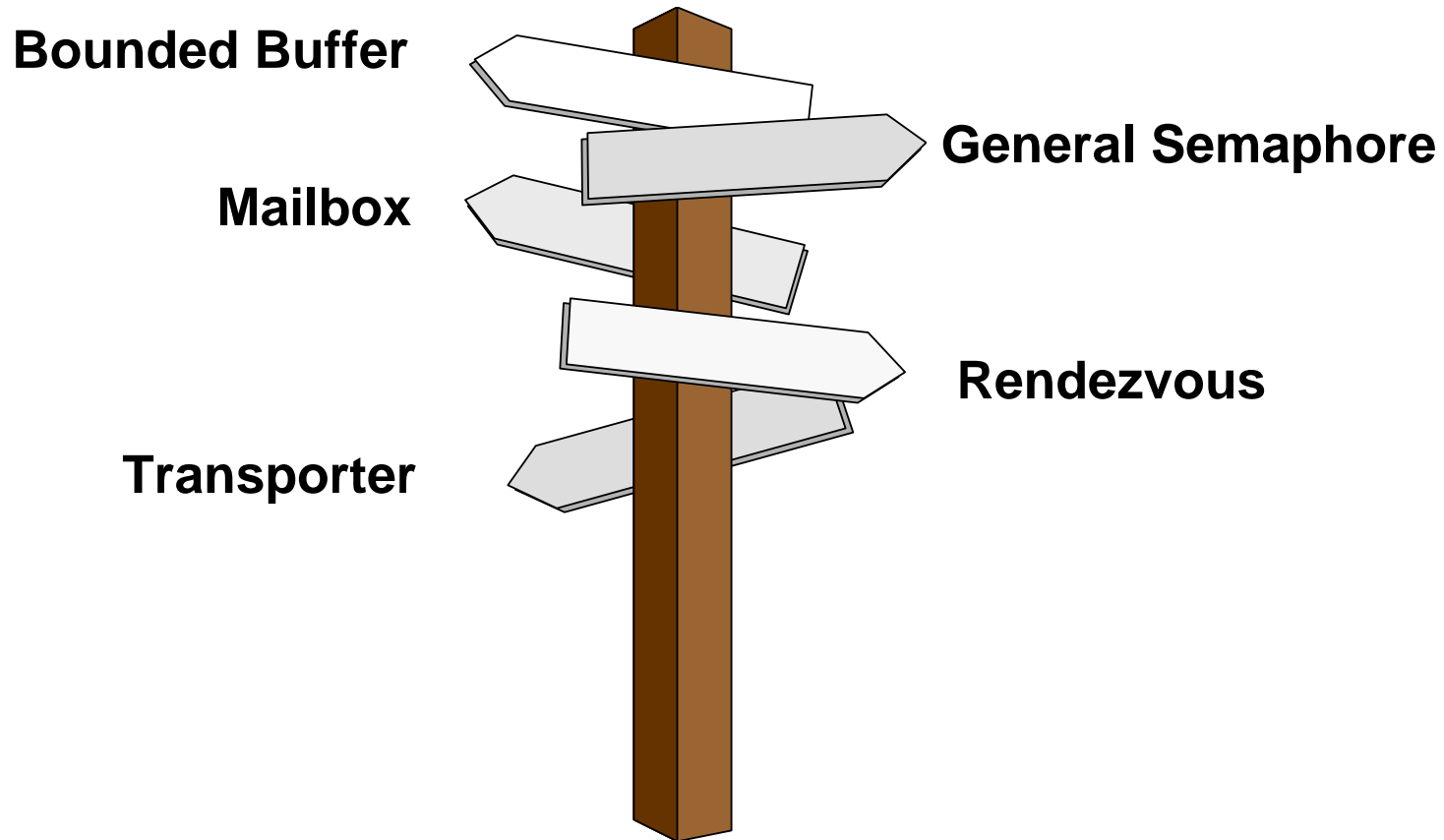
Coordination Mechanisms support two major issues of real-time systems: *synchronization* of flows of activities and *asynchronous communication* between the components of the system.

Synchronization is the blocking of a process until a certain condition is met.



Communication is the transfer of information between components.

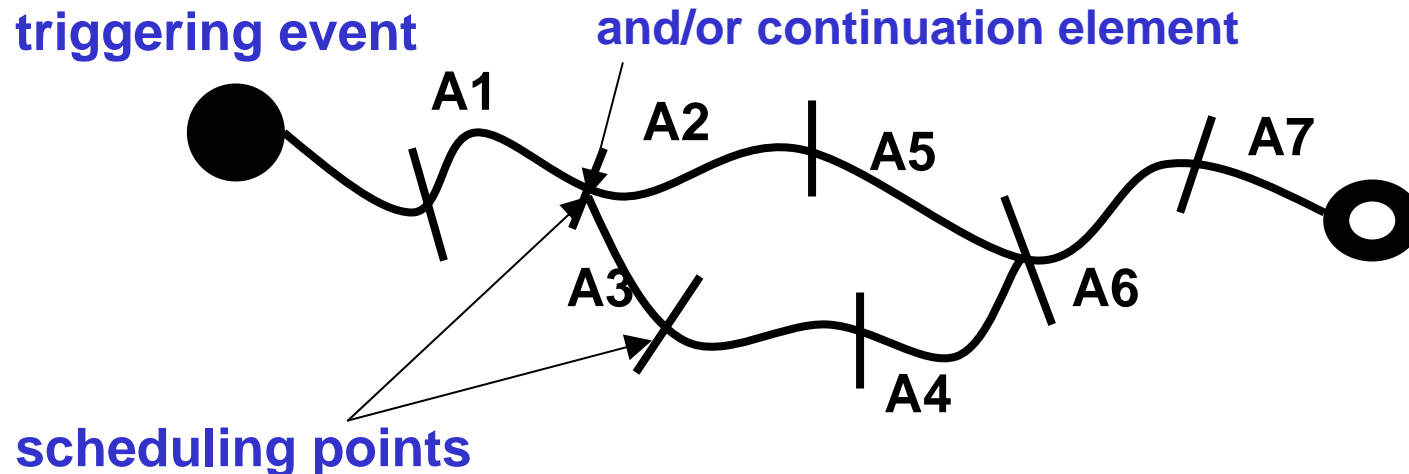
Coordination Mechanisms included in PPOOA vocabulary



CFA or System response (I)

DEFINITION

CFA means Causal Flow of Activities. Therefore, a CFA is a chain of activities that is triggered by an event.

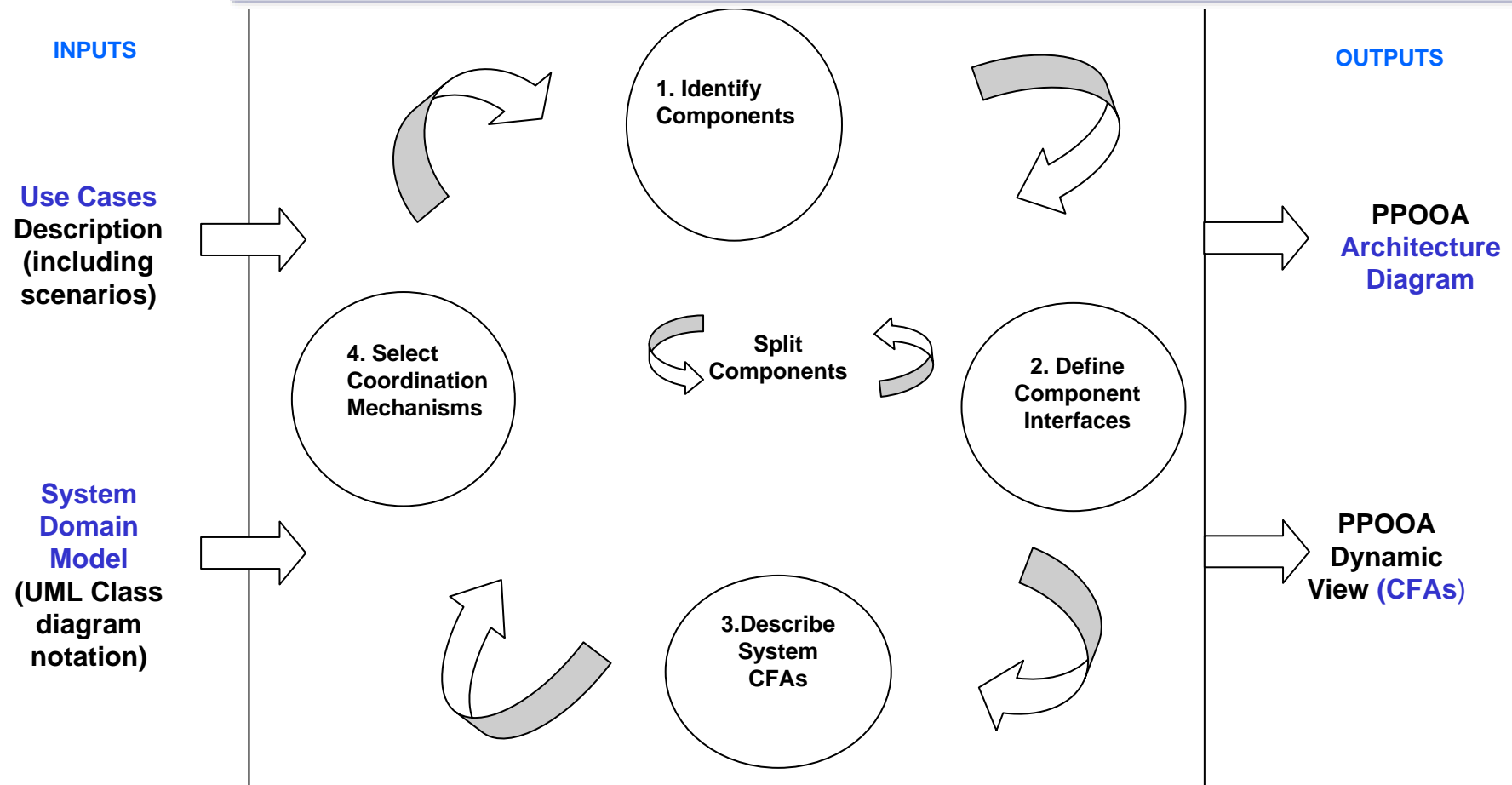


PPOOA_AP: PPOOA Architecting Process

Why a new architecting process?

- Traditional CBD and OO architecting approaches focus upon producing encapsulations and abstractions for system componentry.
- The effort of the resulting architecture on the ability of a system to meet its time responsiveness expectations requires additional understanding well beyond functionalities and their combined computational timing requirements.
- Concurrency modeling and synchronization behavior become a dominant concern early in the architecture development whenever time is a critical factor
- Object definition and collaboration strategies should reflect meaningful timing constraints.

PPOOA Architecting Process



PPOOA_AP Guidelines

- **Architecture design principles and component selection criteria are described as **guidelines or tactics****
- **25 guidelines are proposed in PPOOA_AP document**

Groups of Guidelines

- **Guidelines relative to PPOOA Architectural Style**
- **Guidelines relative to the Use of PPOOA Components**
- **Guidelines relative to the use of PPOOA Coordination Mechanisms**
- **Guidelines for CFA Construction**
- **Guidelines for process Scheduling**

Experiences of Using PPOOA and PPOOA_AP

- Diverse systems were developed using PPOOA and PPOOA_AP architecting approach
 - SCADA (Supervisory Control and Data Acquisition) System developed at UPM (Spain).
 - Underwater Autonomous Robot developed by Qinetiq (UK) and presented at ICSSEA 2002
 - Space System developed by ARTAL (France) as part of CARTS, 5th Framework Programme, IST funded project (IST-1999-2068).
 - Airbus A400, some avionics functionalities developed by CASA-EADS (Spain) (Since May 2005)

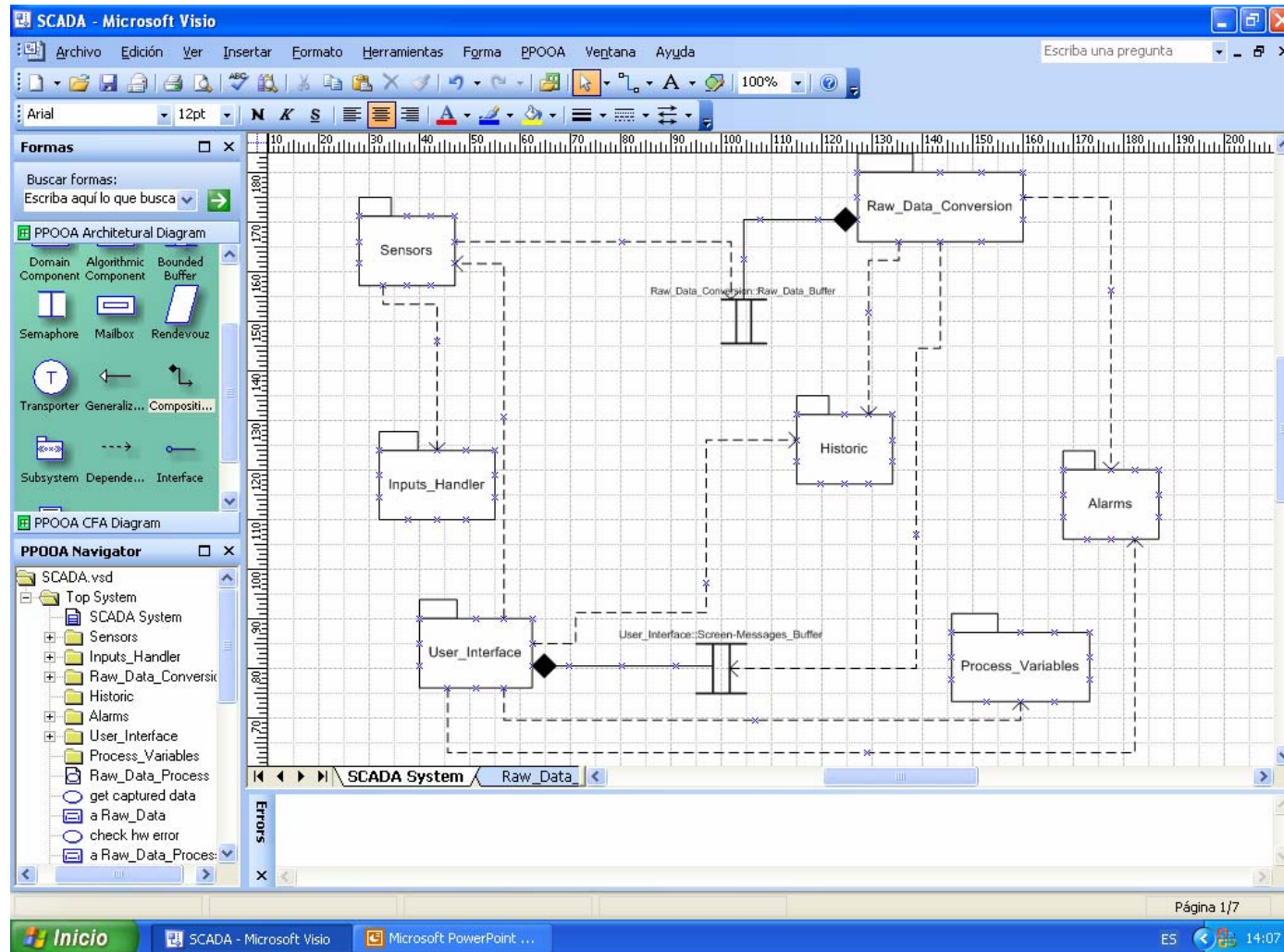
Implementing PPOOA in Microsoft Visio

Microsoft Visio

- A Visio solution is a combination of Visio shapes and programs that model the real world and solve specific modelling problems
- A Visio solution usually includes:
 - **Stencils** of master shapes
 - **Templates** that provide stencils of specific shapes

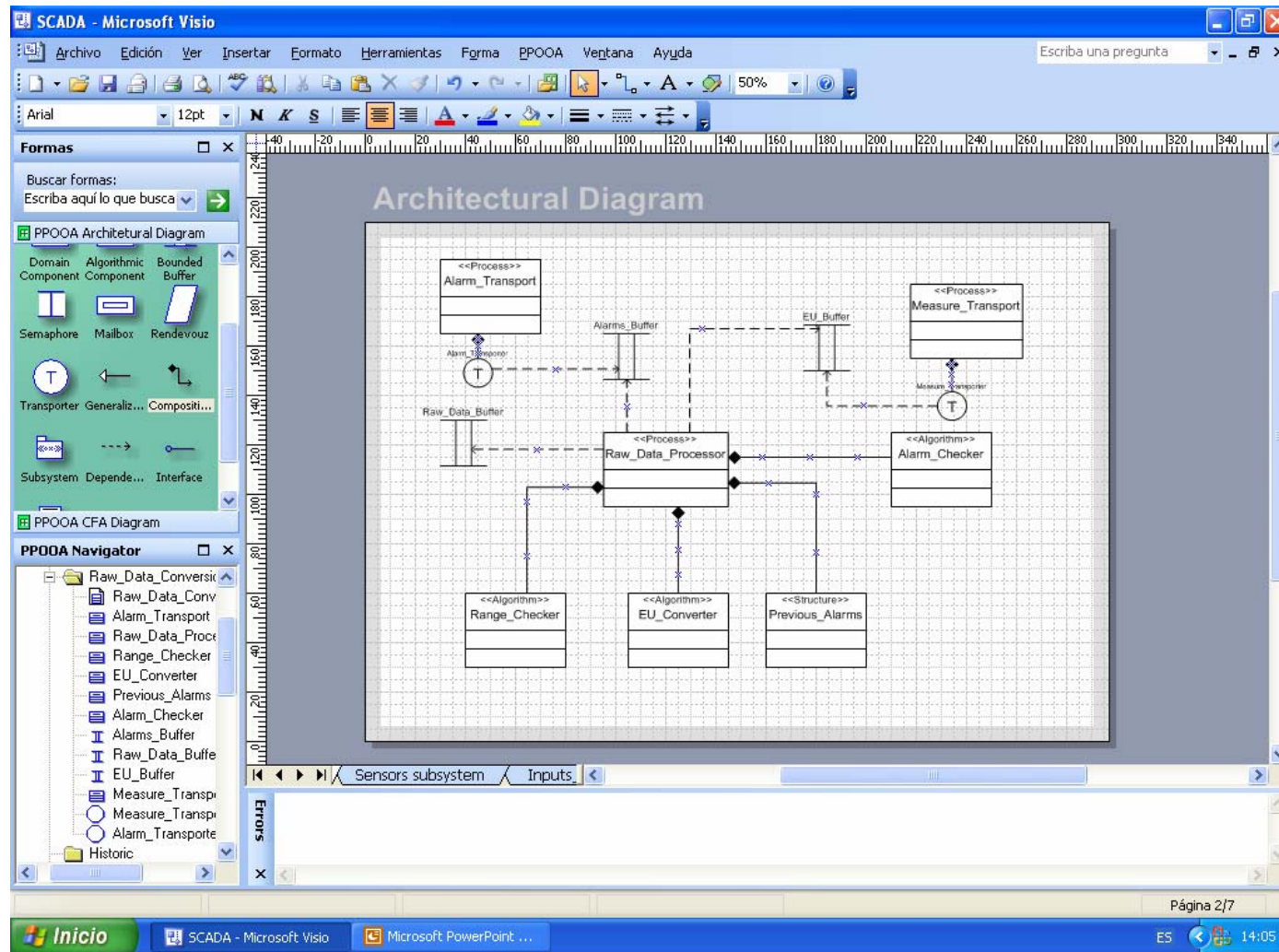
PPOOA - Visio

(Modelling a System Architecture Diagram)



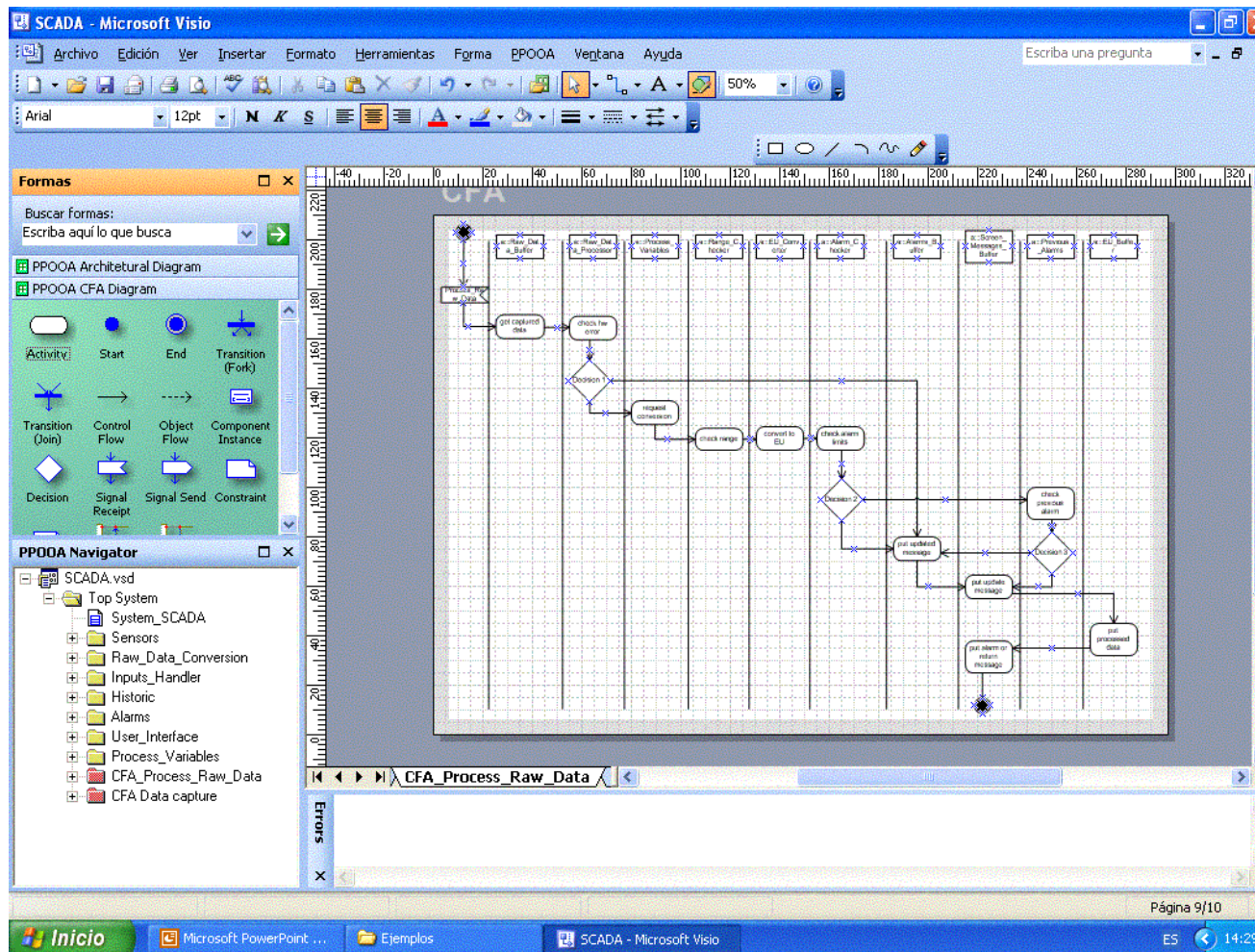
PPOOA - Visio

(Modelling a Subsystem Architecture Diagram)



PPOOA – Visio

(Modelling a system response, “CFA Diagram”)



PPOOA-Visio (Tool Features)

- Automatic generation of documentation
- Automatic model checking based on PPOOA building guidelines
- Contextual help

Automatic generation of architecture documentation

- The PPOOA Visio Tool generates automatically the documentation of the system architecture developed
 - Description of each building element, its domain attributes, interface and real time attributes
 - Generated in HTML format

Automatic Model Checking based on PPOOA building rules

- The PPOOA-Visio tool supports automatic checking of PPOOA building guidelines
 - Composition relations between two building elements
 - Dependency (“usage”) relations between two building elements

Checking PPOOA Rules

The screenshot displays the Microsoft Visio interface for a SCADA system. The main window shows an "Architectural Diagram" with the following components and relationships:

- Processes:** Alarm_Transport, Raw_Data_Processor, Measure_Transport.
- Algorithms:** Range_Checker, EU_Converter, Alarm_Checker.
- Structures:** Previous_Alarms.
- Buffers:** Alarms_Buffer, EU_Buffer, Raw_Data_Buffer.

Relationships include dependencies (dashed lines with 'x' markers) and associations (solid lines with diamond markers). A red error message is visible at the bottom of the diagram area:

Composition.81[Composition]:PPOOA Composition rule violated.

The left sidebar contains the "PPOOA Architectural Diagram" palette with various shapes like Semaphore, Mailbox, and Rendezvous. The "PPOOA Navigator" shows a tree view of the system components. The bottom status bar indicates "Página 2/7" and the system clock shows "14:17".

PPOOA-Visio Help


- PPOOA architecting method PPOOA_AP is implemented as part of the Visio help and in a contextual form
 - Architecting process steps
 - Description of the PPOOA building elements
 - Composition rules
 - Dependency rules
 - References to other documents and papers

Contextual help

The screenshot displays the SCADA - Microsoft Visio application interface. The main window shows an "Architectural Diagram" with various components and their interconnections. A contextual help window titled "Ayuda de Microsoft Of..." is open over the diagram, displaying the "Process" help page. The help page includes the following content:

Process

1. Abstraction supported

The process  is a building element of the architecture that implements an activity or group of activities that can be executed at the same time as other processes. Its execution can be scheduled.

Attributes

- Execution time of each activity.
- Priority.
- Shared resources blocking time (optional).
- Offset(optional).

The SCADA - Microsoft Visio interface also shows a "Formas" (Shapes) task pane on the left with categories like "PPOOA Architectural Diagram" and "PPOOA CFA Diagram". A "PPOOA Navigator" pane is also visible, showing a tree view of the system components. The Windows taskbar at the bottom shows the Start button and several open applications: SCADA - Microsoft Visio, Microsoft PowerPoint..., Dibujo - Paint, and Ayuda de Microsoft O...

Next tool features

- Implement performance engineering and “time response analysis” (RMA) capabilities
- Implement import and export mechanisms (XMI) to other CASE tools and Integrated Development Environments
- Improve automatic evaluation of models
- Create and implement a “developer assistant” that will help novice users to apply the PPOOA method and tool.

To Conclude (I)

- **PPOOA is an architectural style that solves some **UML limitations**.**
 - better support for CBD (Taxonomy of Components)
 - emphasizes coordination mechanisms usage
 - allows time responsiveness assessment (by using CFAs models)
- **PPOOA is complemented by an architecting process called PPOOA_AP.**
 - major and minor steps to be followed
 - guidelines or strategies to be applied
- **PPOOA is already implemented in a well known CASE tool (**Microsoft Visio 2003**)**

To Conclude (II)

PPOOA supports the **easy adoption by industry** of Real Time and Embedded Systems architecting techniques:

- A **free trial version** of PPOOA tool is offered by request
- Free publications and reports may be downloaded from ppooa web page (www.ppooa.com.es)
- On-site training dealing with UML and PPOOA may be negotiated per customer
- Maintenance of PPOOA tool may be negotiated per customer
- Consultancy dealing with PPOOA adoption (pilot project + next steps) may be negotiated per customer

Contact us

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