WARE: a tool for the Reverse Engineering of Web Applications

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Web Applications (WA): problems and open issues

- The pressing market demand of web applications
  - WAs developed in very short time
- The continuously changing needs of the evolving application domains
  - WAs frequently and rapidly modified with *ad hoc* approaches
- The lack of method in producing and maintaining Web applications
  - low quality software, with disordered architecture, and inadequate and incomplete documentation

Web applications: a recent classification

- Class 1: primarily static web sites
- Class 2: sites providing client-side interaction
  - Based on an event model exploiting some script code
- Class 3: applications with dynamic content
  - Pages are dynamically created on the fly, with the support of various WWW rechnologies (CGI, JSP, PHP, Javascript, XML, ODBC,…ASP,…)

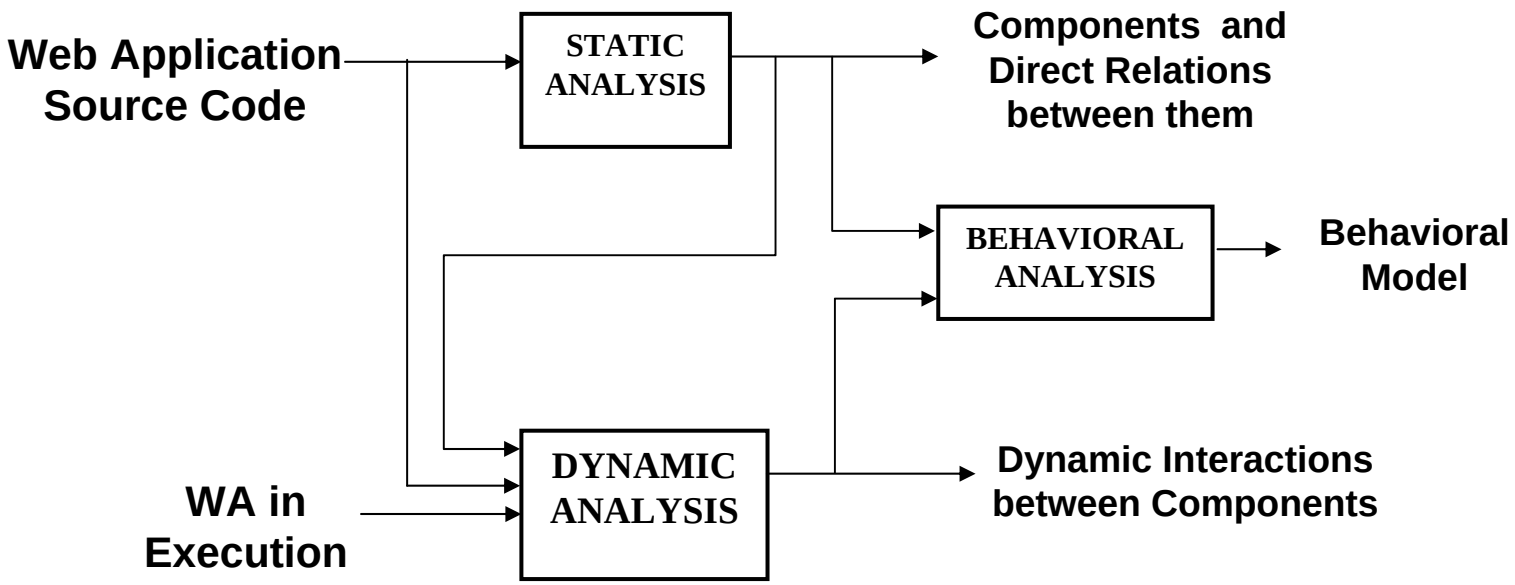
Dynamic web applications

- Due to the large number of employed technologies, understanding, maintaining and evolving a Class 3 application is a complex task
- The need for specific Reverse Engineering techniques and processes to recover:
  - Static and dynamic aspects of the applications
  - Suitable representation models
- The need for reverse engineering tools that support the extraction and the abstraction of the needed information from a WA

Reverse engineering Web Applications

- A reverse engineering process to recover the following views:
  - The static architecture of the WA
  - The dynamic interactions between its components
  - The final behavior offered
- Extended UML diagrams to represent these views
  - Class diagrams to model the architecture
  - Sequence and Collaboration diagrams to represent the dynamic model
  - Use case diagrams to describe the behavior of the WA

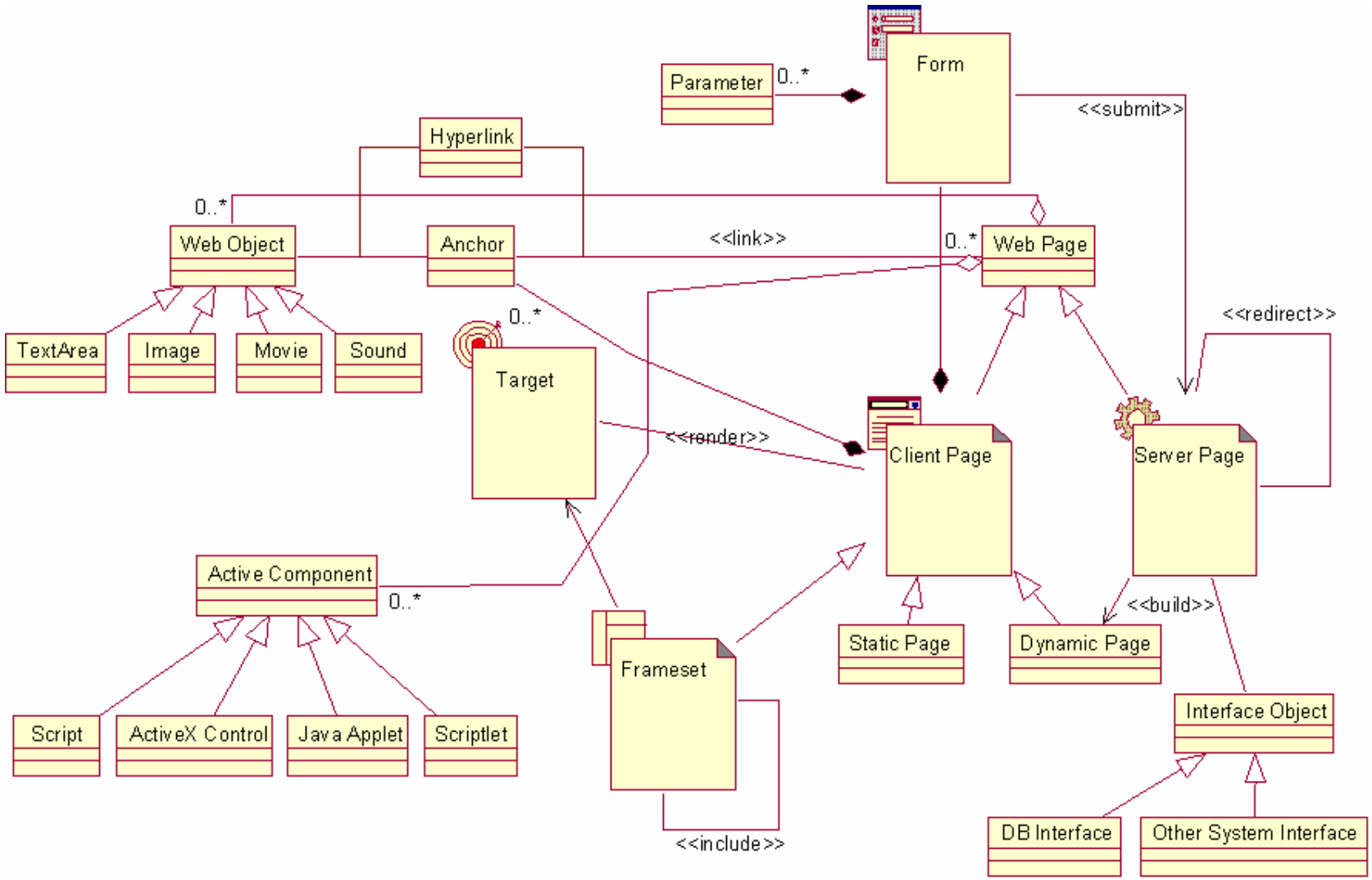
The Reverse Engineering process



Views obtainable by static analysis

- A *coarse grained view:*
  - Web pages and Hypertextual links between pages :
  - Pages are distinguished into *server* and *client pages, static* and *dynamic pages, simple* and *framed pages*
- A *finer grained view*:
  - inner page components and relationships
  - *input/output form, text box, anchors, scripts, applets*, *text, images, multimedia objects (sounds, movies),* ……
  - Page components may be *active components (e.g.,scripts or applets)*
  - The relationships include: *submit*, *build*, *redirect*, *include*
- A UML class diagram representing both views

The meta-model of a WA

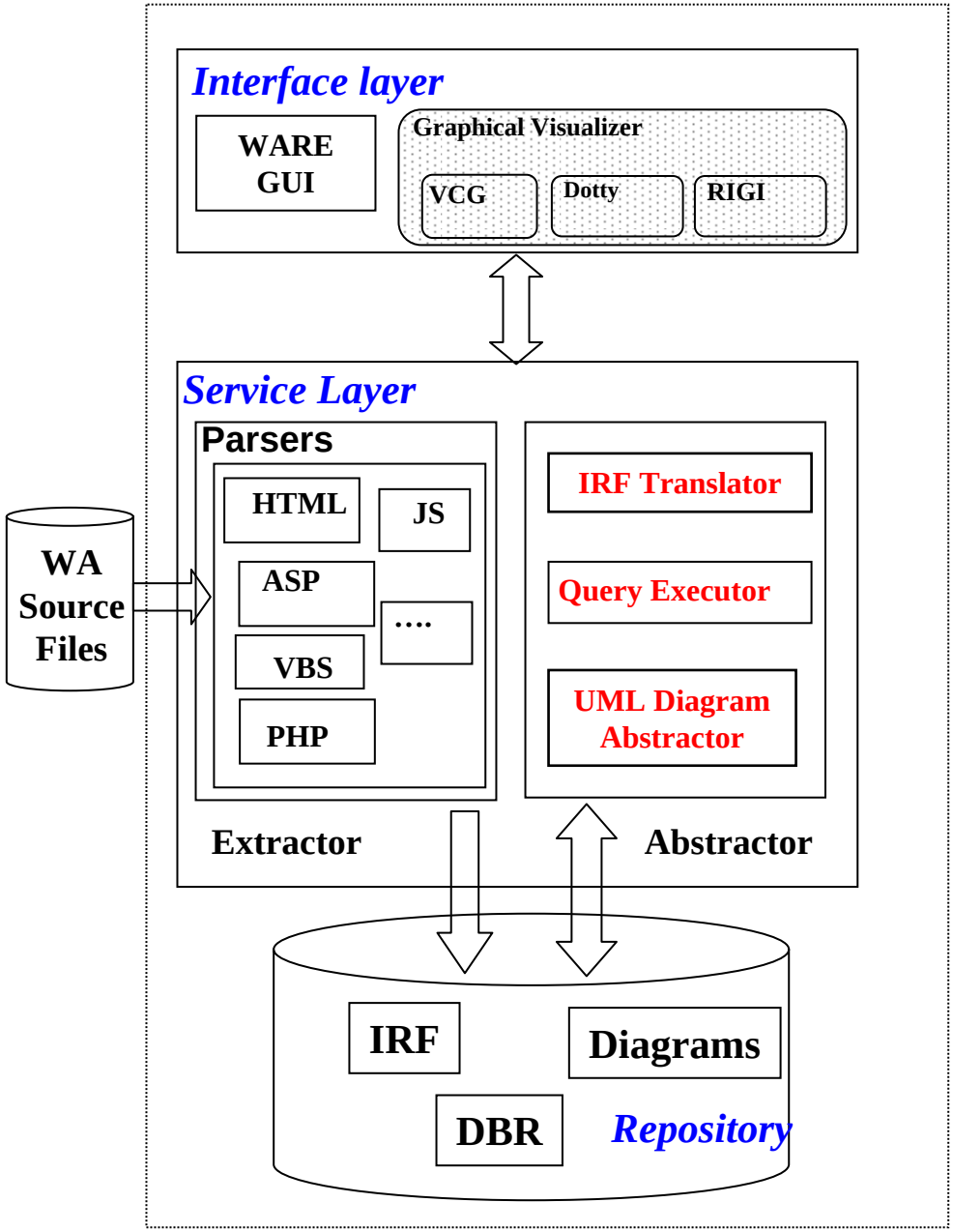


The WARE tool

- Designed to support the reverse engineering of a WA
  - executes the *static analysis* of the WA source code
  - populates a repository with the extracted information
  - supports the user in abstracting the WA models

- Three main components:
  - Interface Layer
  - Service Layer
  - Repository

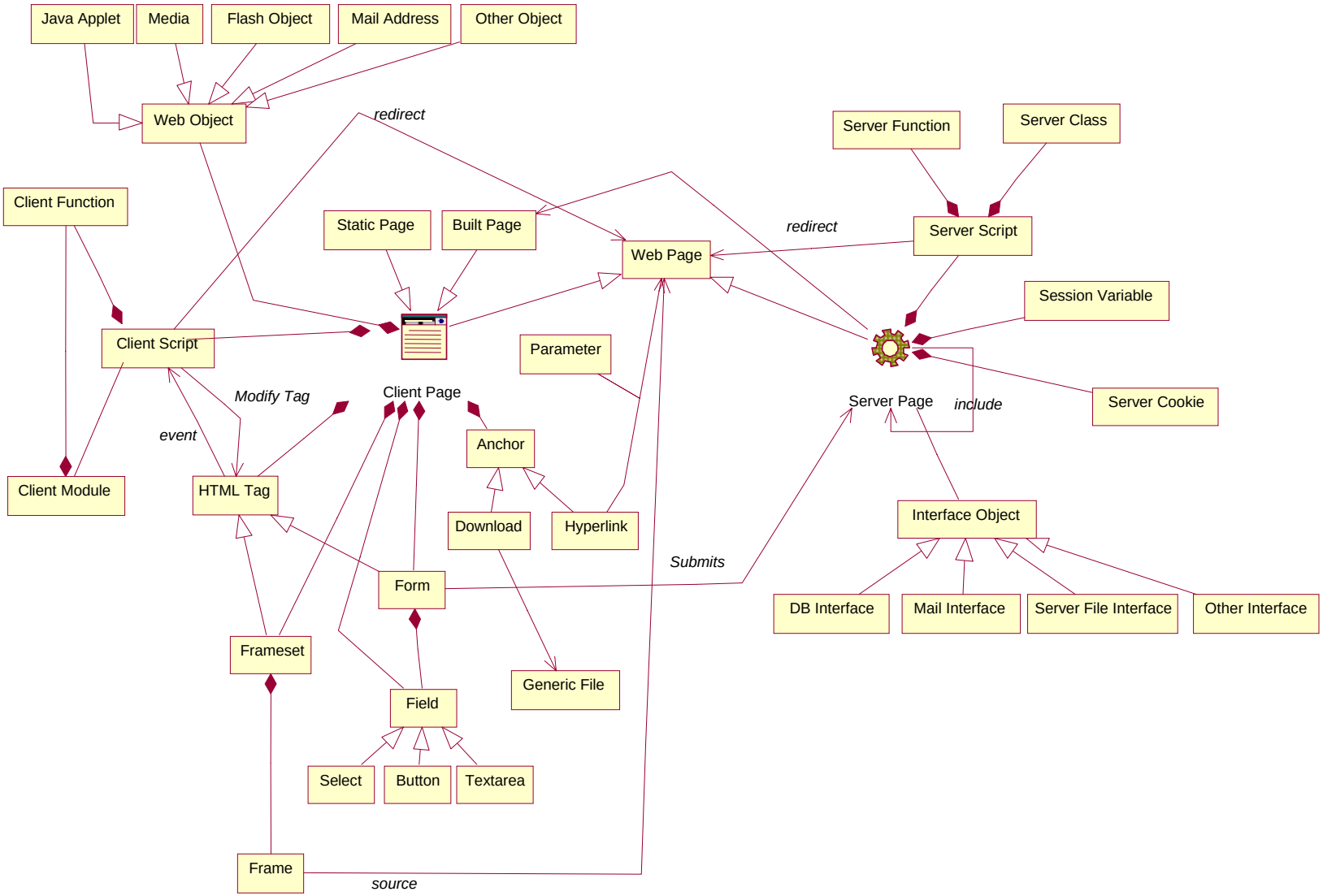
WARE Architecture



The Service layer

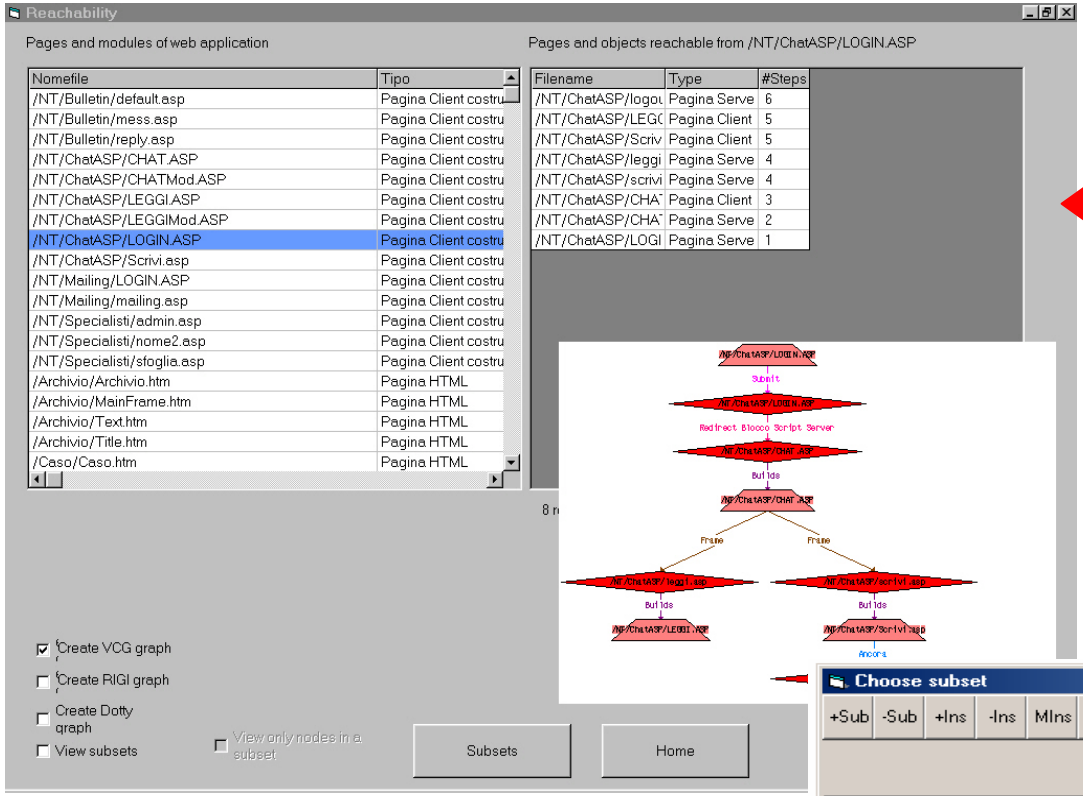
- The *Extractor* component
  - The Extractor parses the WA source code and produces an Intermediate Representation Form (IRF)
  - Several distinct parsers (for HTML, JavaScript, VBScript, ASP and PHP technologies)
  - New parsers can be added as the technology evolves
- The *Abstractor* component
  - It implements abstraction operations necessary for reconstructing the more abstract views of the WA
  - It includes three main components
    - A Translator that populates the relational database from the IRF
    - A Query Executor that implements predefined queries over the database
    - The UML Diagram Abstractor that produces the class diagrams of a WA at various degrees of detail and other relevant information

The conceptual schema of the Repository



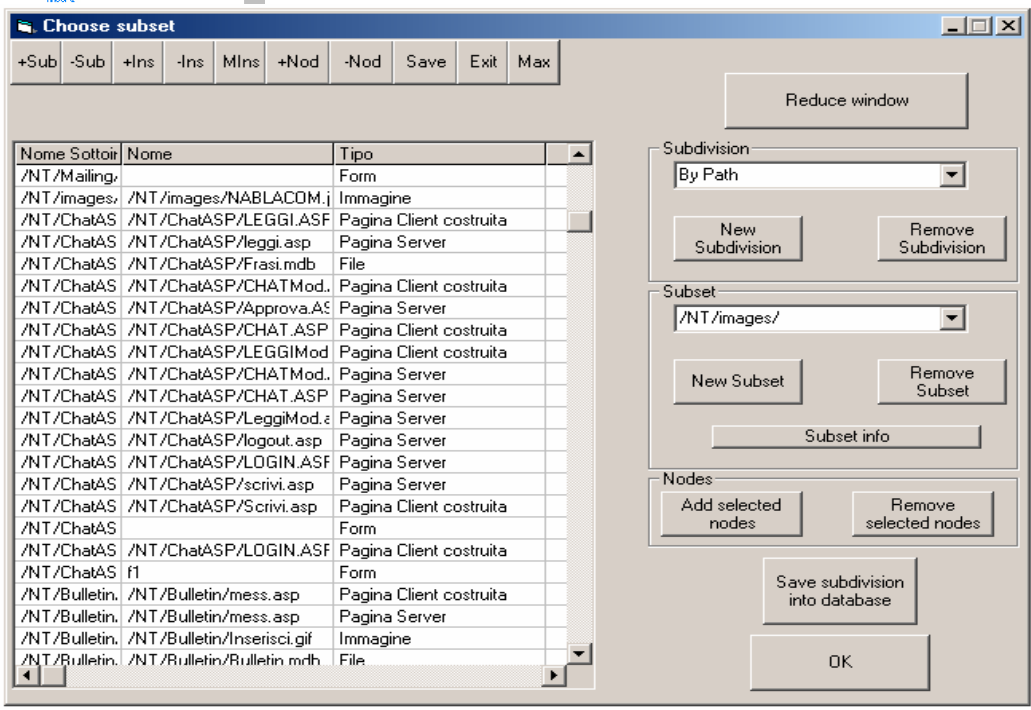
The Interface Layer

- It provides the user interface for accessing the WARE facilities:
  - *Reverse Engineering* for parsing the WA and producing the IRF
  - *Comprehension* for executing comprehension-related activities, such as *exploring the inventory* of the WA components and their source code, computing the *reachability* set of a component, creating *clusters* of related components according to a given clustering criterion
  - *Query* (Predefined query and Parametric query) for activating the Abstractor's functions, and graphically visualizing the recovered information



Computation of the Reachability set of a WA component

Grouping the WA components into cohesive clusters



CSMR 2002, Budapest, Hungary

An experiment

- Carried out for assessing the adequacy of the tool functions in supporting maintenance tasks
- The tool has been used to understand and redocument existing WAs
- An example: A WA implementing a ‘Juridical Laboratory’
  - 201 files, in 19 directories, sizing 4 Mbytes
  - 55 Static Pages (55 HTML files in 10 directories)
  - 19 Server Pages (19 ASP files in 4 directories)
  - No design documentation available
- The WARE tool was preliminarly used to perform:
  - The static analysis of the application, and for producing an inventory of the WA components

First step: the static analysis

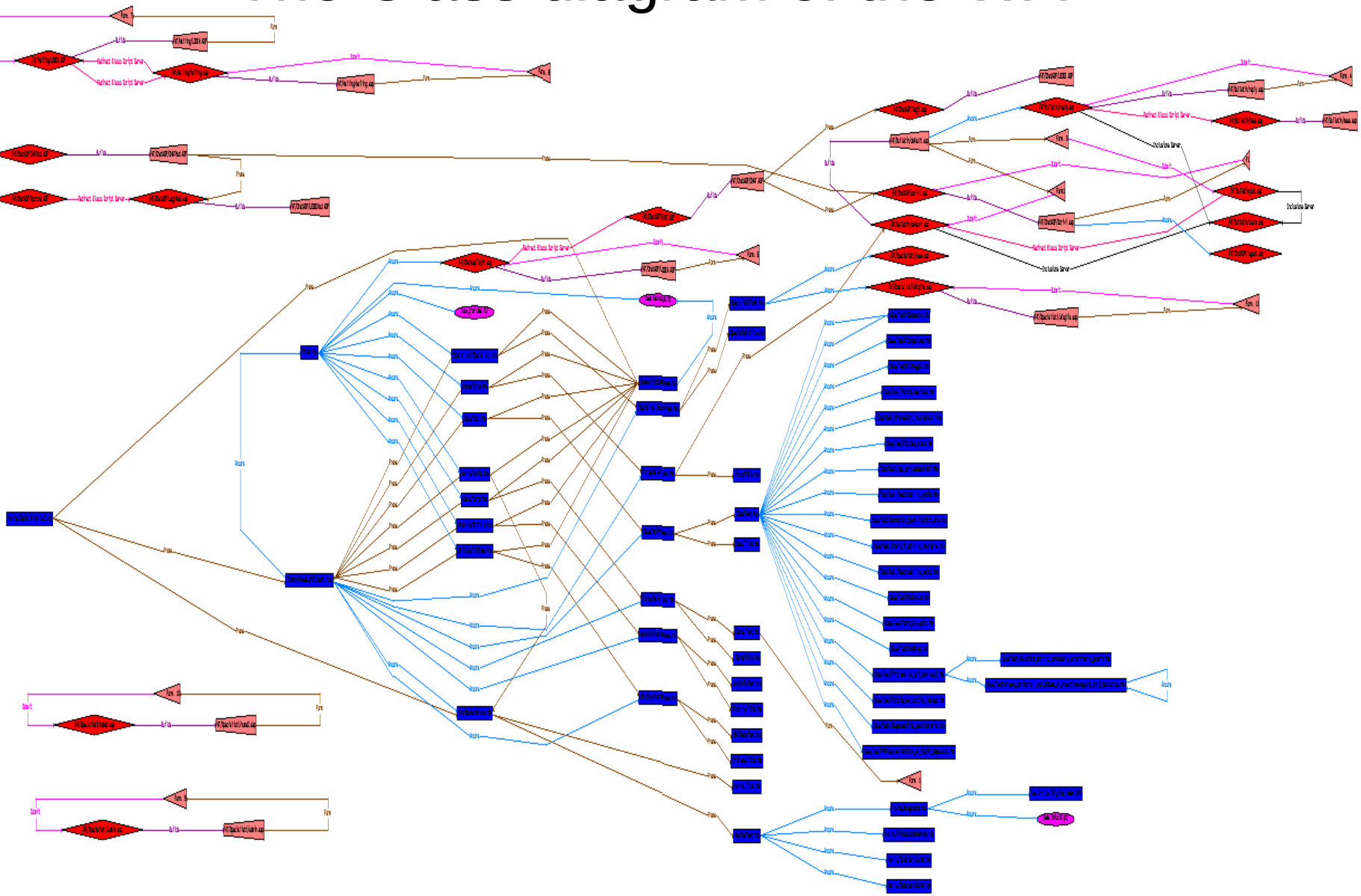
- Main results:
  - The *population* of the repository automatically produced by the tool
  - *The inventory* of the WA components
  - *Graphical representations* of the class diagram of the WA at various degrees of detail

    - Coarse-grained representations (including just the pages)
    - Fine-grained representation (including inner page components)

The inventory of the WA components

Component type	# Detected
Server page	19
Client Static page	55
Client Built page	14
External web page	3
Client script block	53
Function in Client script block	19
Form	11
Input/ output field	71
Submit Operation (POST method)	4
Submit Operation (GET method)	7
Anchor to files to be downloaded	111
Anchor to Hypertextual link	49
Data File	61
Server script block	76
Function in Server scripts	4
Database Interface Object	29
Mail Interface Object	3
Image file	65
Redirect operation in server blocks	7

The Class diagram of the WA



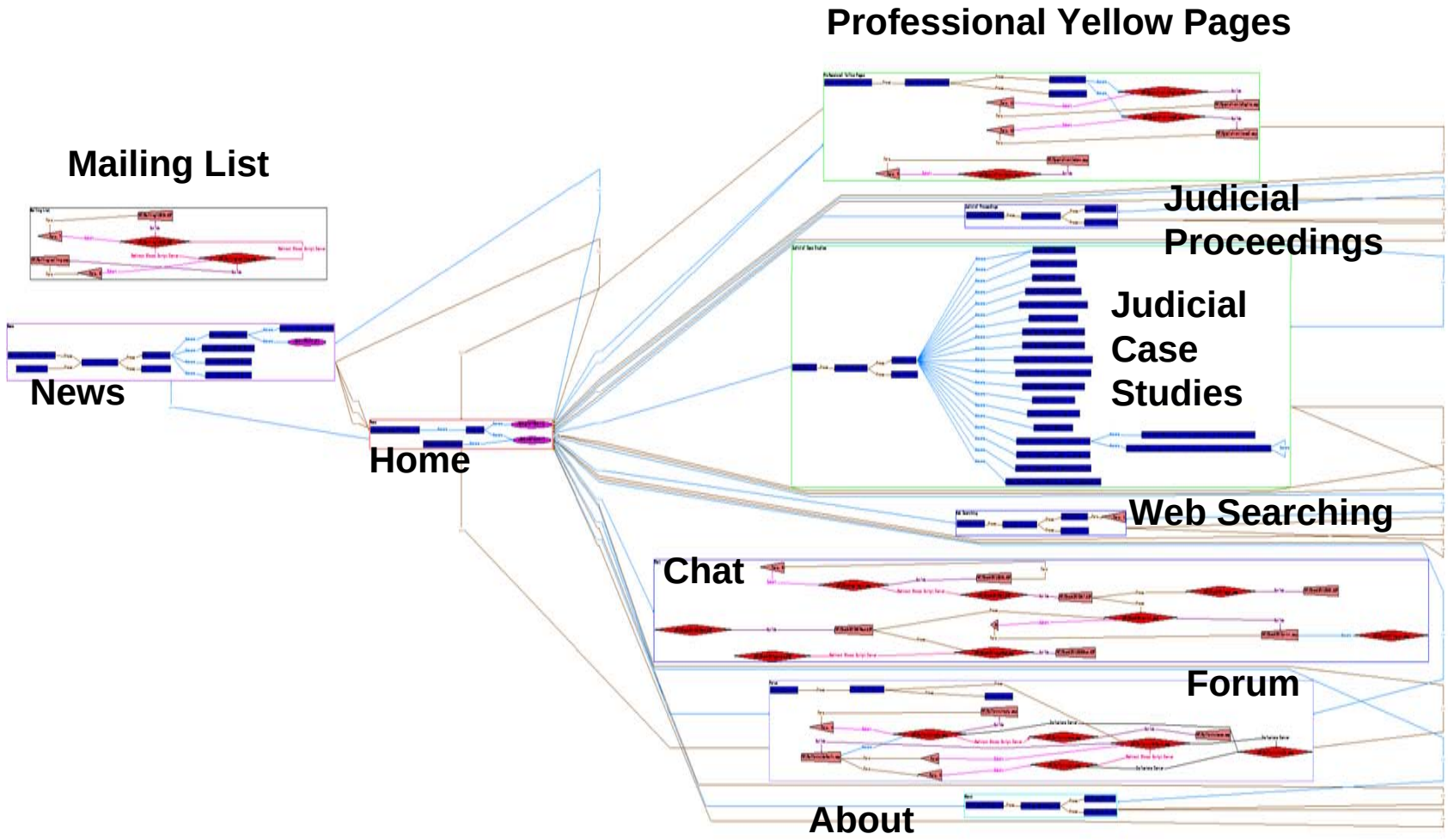
The second phase: formulating and validating hypotheses about the WA behavior

- Driven by the graphical representations, notable sub-graphs were looked for (isolated sub-graphs, sub-trees, strongly connected components, …)
- A tentative hypothesis about the behavior implemented by each sub-graph was formulated with the support of:
  - the names of the components, their source code analysis, and by tracing the application execution
- Hypotheses were validated by the source code execution

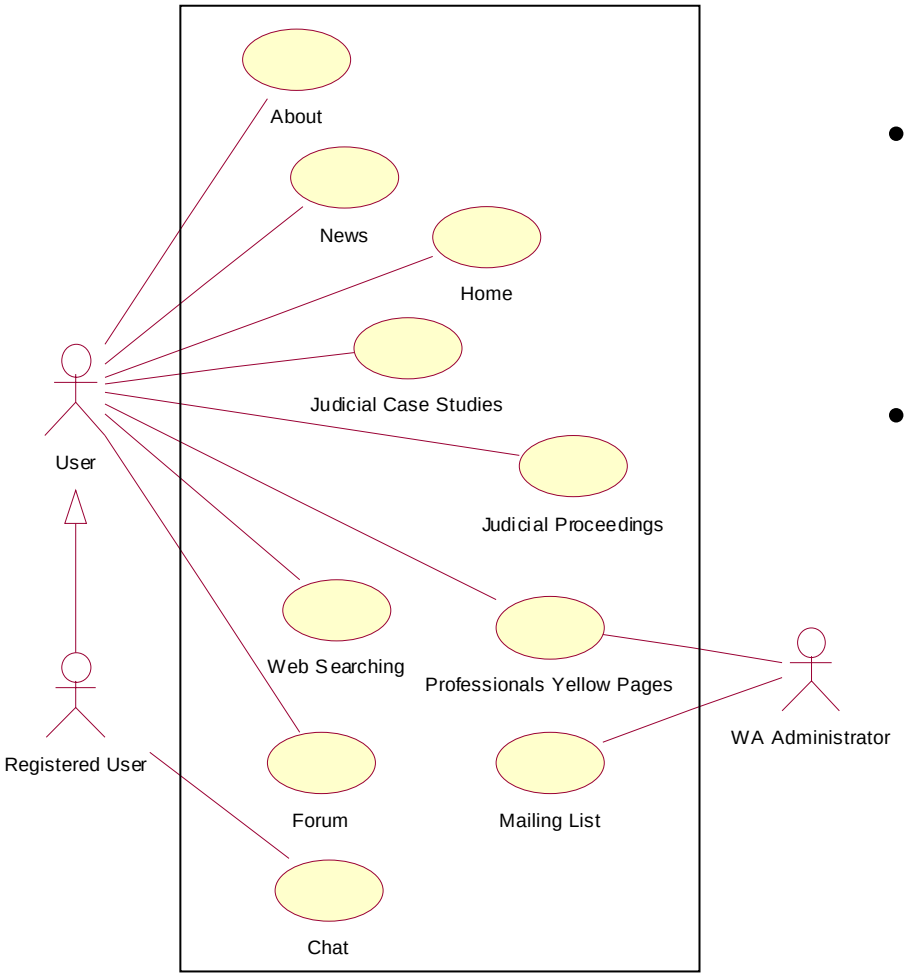
Results from the sub-graph analysis

- Four isolated sub-graphs
  - Three small ones without static client pages
    - Two of them implemented server-side functions for the web administrator (management of the mailing list, and of the registered users list)
    - The third one resulted from an incorrectly made maintenance operation
  - A large one, rooted in the home page
    - Nine user functions could be associated with nine notable sub-graphs contained in it

The sub-graphs in the WA class diagram

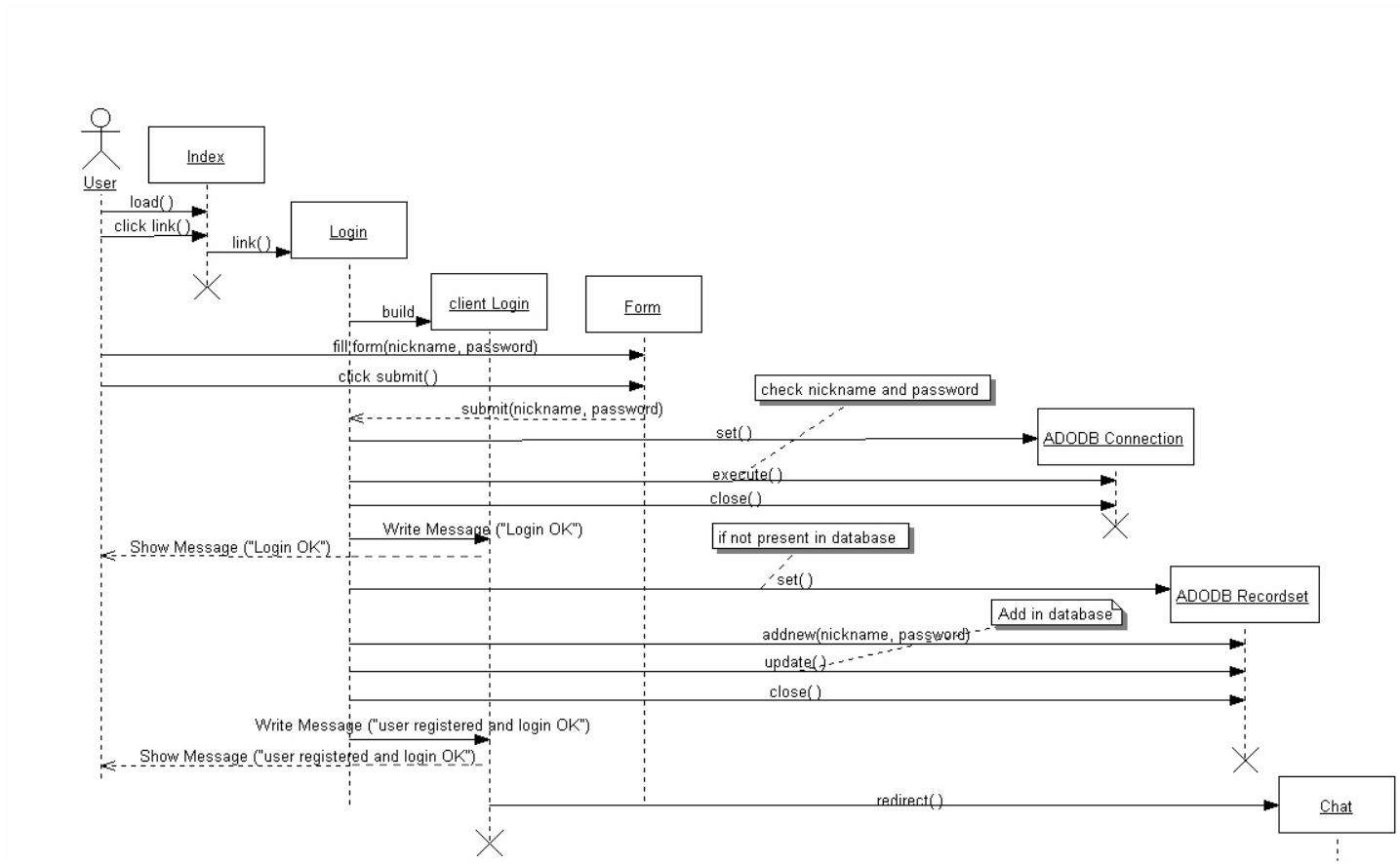


Modeling the WA behavior



- A use case was defined and associated with each notable sub-graph
- The scenarios describing the use cases were defined with the support of the tool (the interactions between objects involved in the sub-graph were searched for and analyzed)

Modeling the WA dynamic view



Conclusions

- The experiments we carried out showed that the reverse engineering tool WARE can be used to support the comprehension of Web Applications to be maintained
- It supports the reconstruction of various UML diagrams from undocumented applications:
  - Static views are automatically produced by the tool
  - Behavioral and dynamic views can be semi-automatically obtained with the tool assistance
- A reverse engineering process based on the WARE tool could be defined

Future work

- Specific clustering criteria may support a more effective analysis of the class diagrams recovered by the tool
- A clustering approach should take into account both the topology of the graphs, and the typology of the connections in the graph
- The automatic clustering of Was will be investigated in the context of large size web applications