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# Cooperative Decision Support Systems

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# Decision Support

- Decision Making Rational Methodologies
  - Alternatives perfect evaluation, criteria
  - Limited Rationality Principle
- Decision Making Non Rational Methodologies
  - Implicit Favourite Model
  - Organisational Anarchy
- *Roy and Bouyssou (1993)* :
  - First Order Reality Postulate
  - Decision Maker Postulate
  - Optimum Postulate

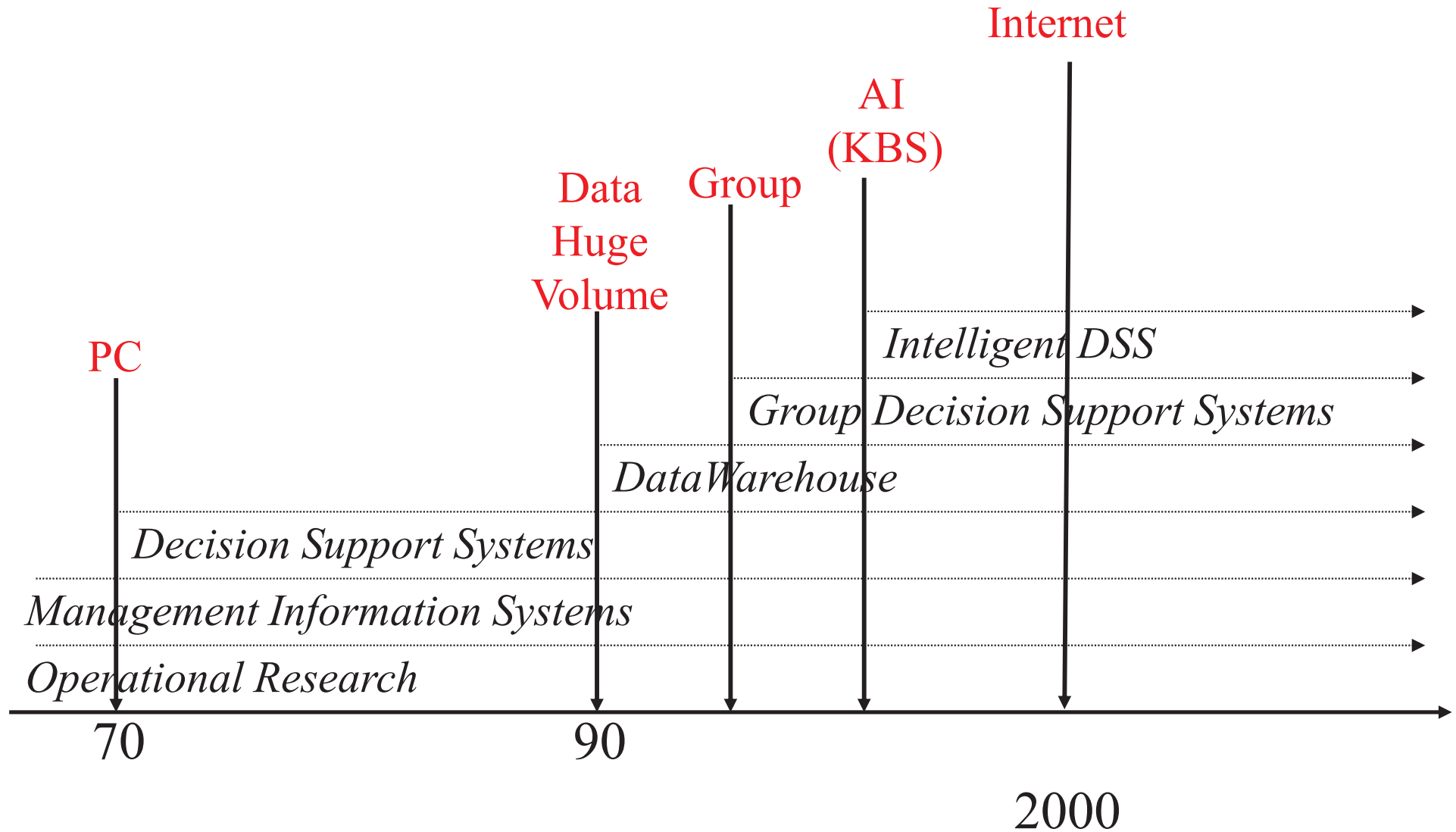


# Decision Support

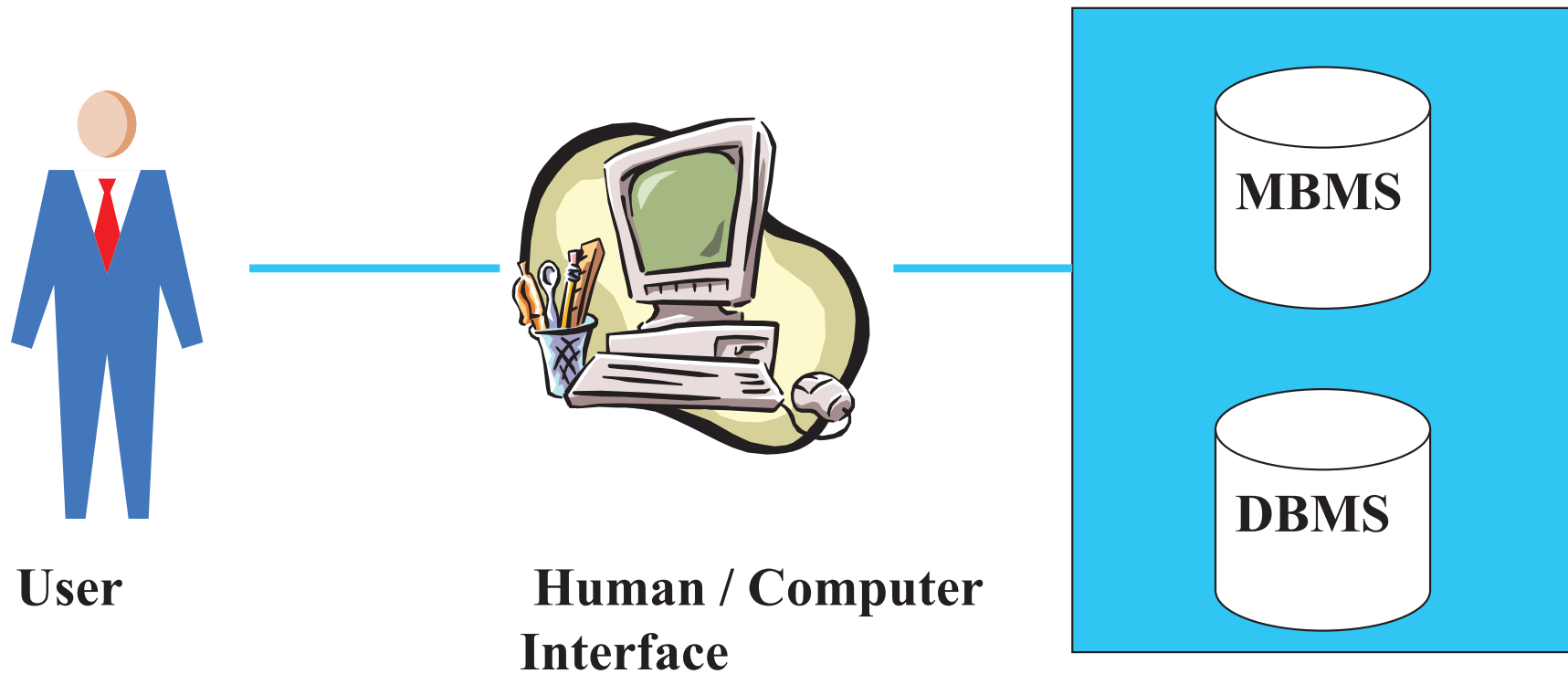
- Limited Rationality Principle (*H. Simon, 1969*)
  - No optimisation but satisficing solution research (best consensus) : **satisficing**
  - Decisions Made one by one in a limited area
  - Progressive Process
  - Decision Makers can use contradictory criteria
  - No more Global Utility Function (Contradiction with *Von Neumann and Morgenstern*'s hypothesis)



# Decision Support Systems (DSS)



# DSS



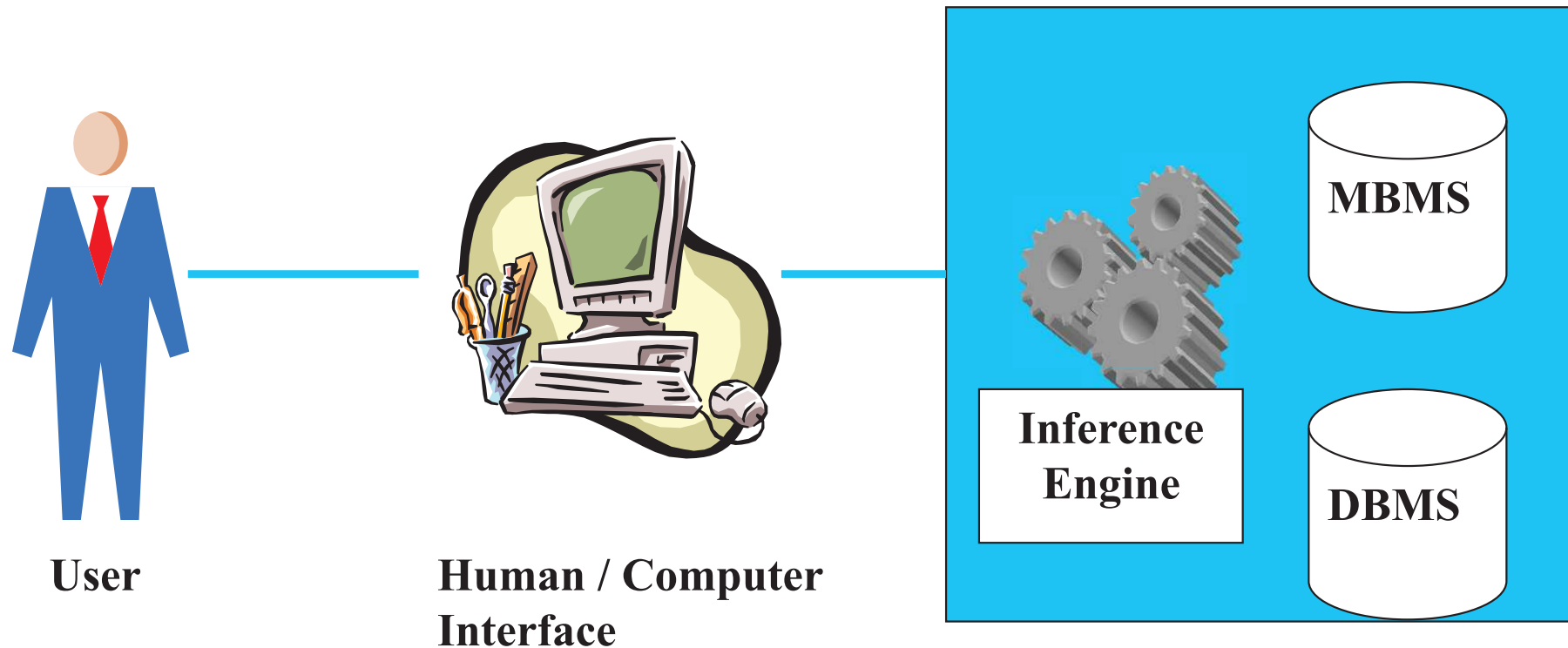
*Sprague and Carlsson (1982)*

➔ **Interactive Optimization**

# DSS

- *Keen and Scott Morton (1978)* :
  - Support decision makers in their **semi-structured** decision making processes
  - **Help** rather than replace decision makers judgment
  - **Improve** effectiveness(+) and efficiency of decision making.

# Intelligent DSS



*Marakas (2003)*

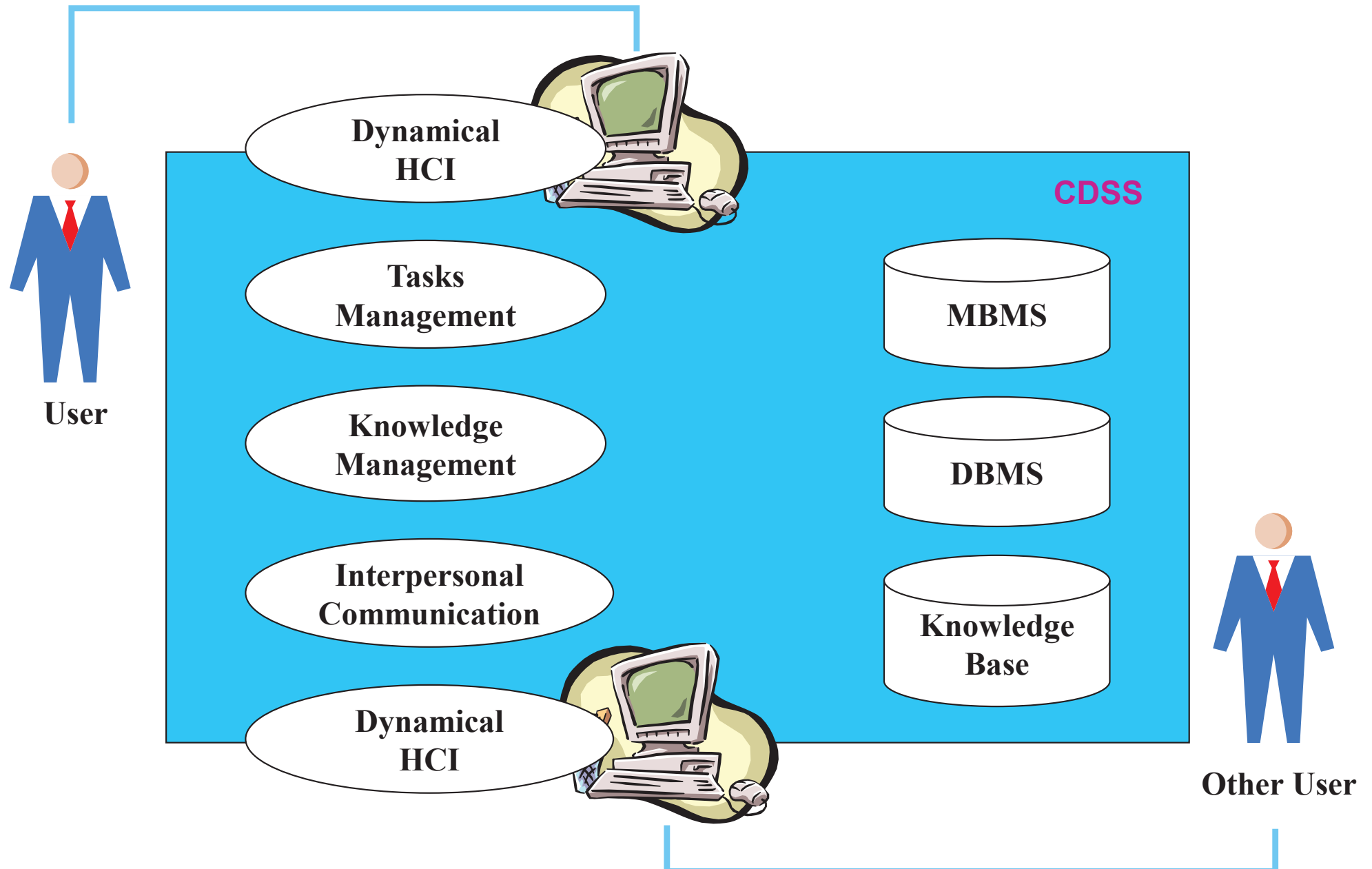
➔ Cooperative Designing Approach



# ICT Introduction

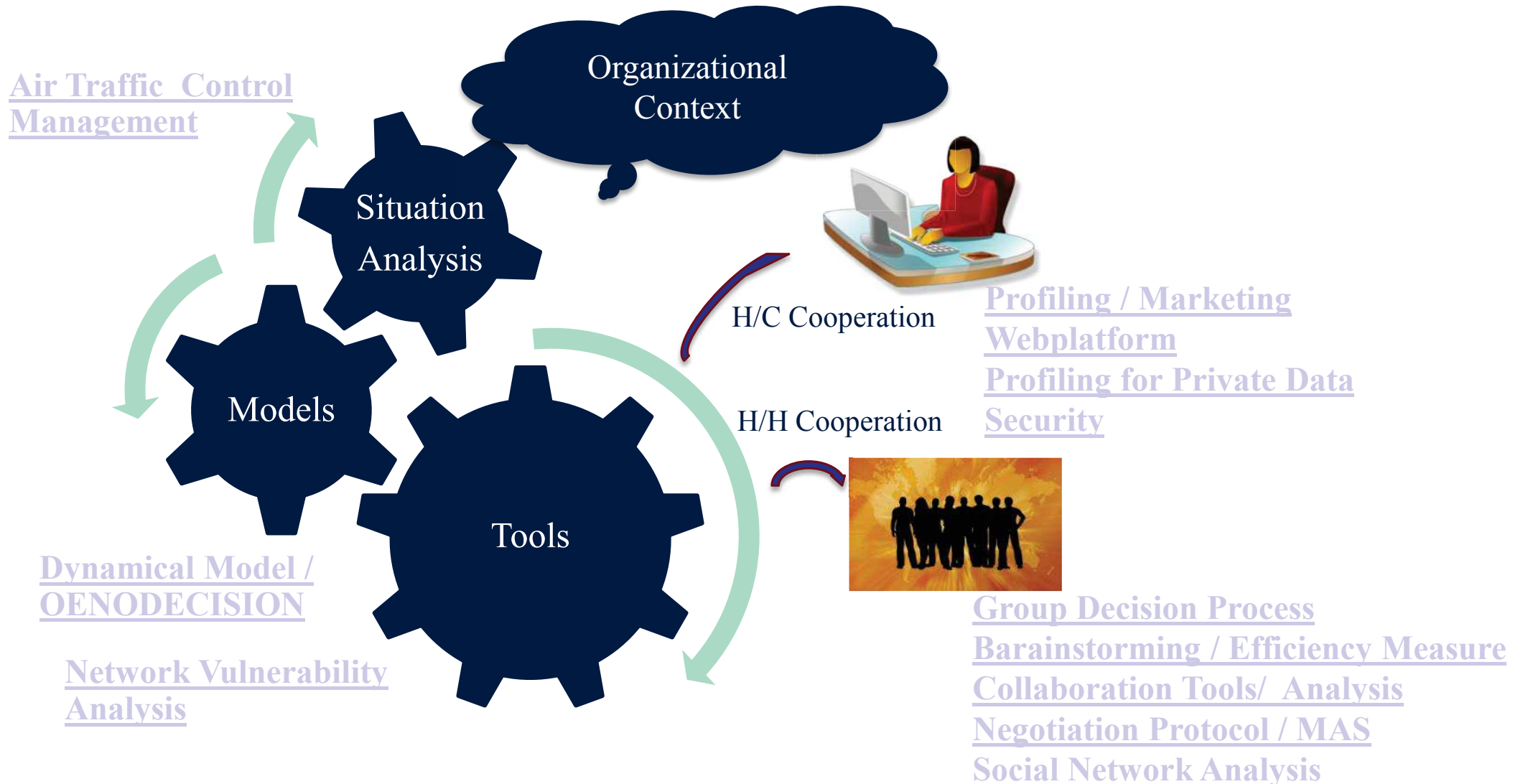
- ICT : Decision Making processes modification
  - Organisational : Multi-actors
  - Cognitive : Sorting Step reinforcement
- Cooperative Decision

# Cooperative DSS

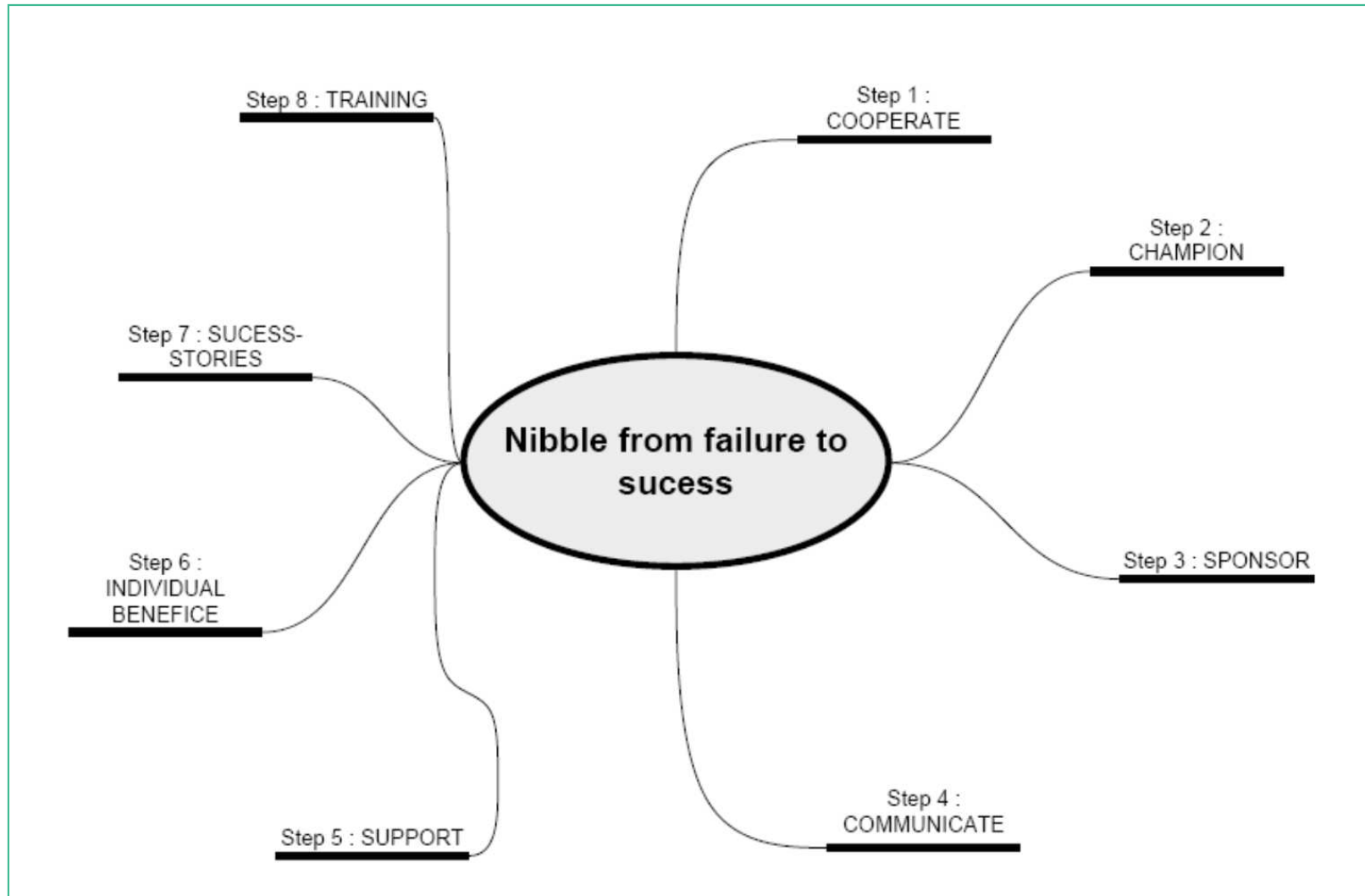


# Research Paradigm

Organisational Management Methodology / European Large Bank  
Tool for Annotation Management



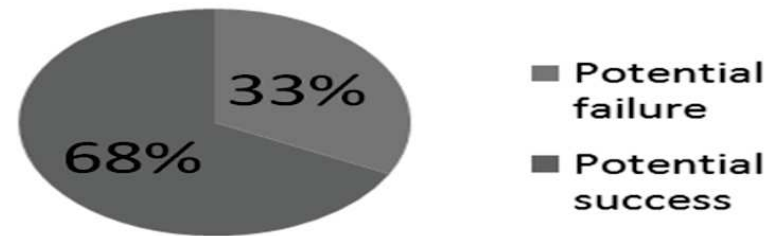
# Nibbling Methodology : MPG



# Dashboard

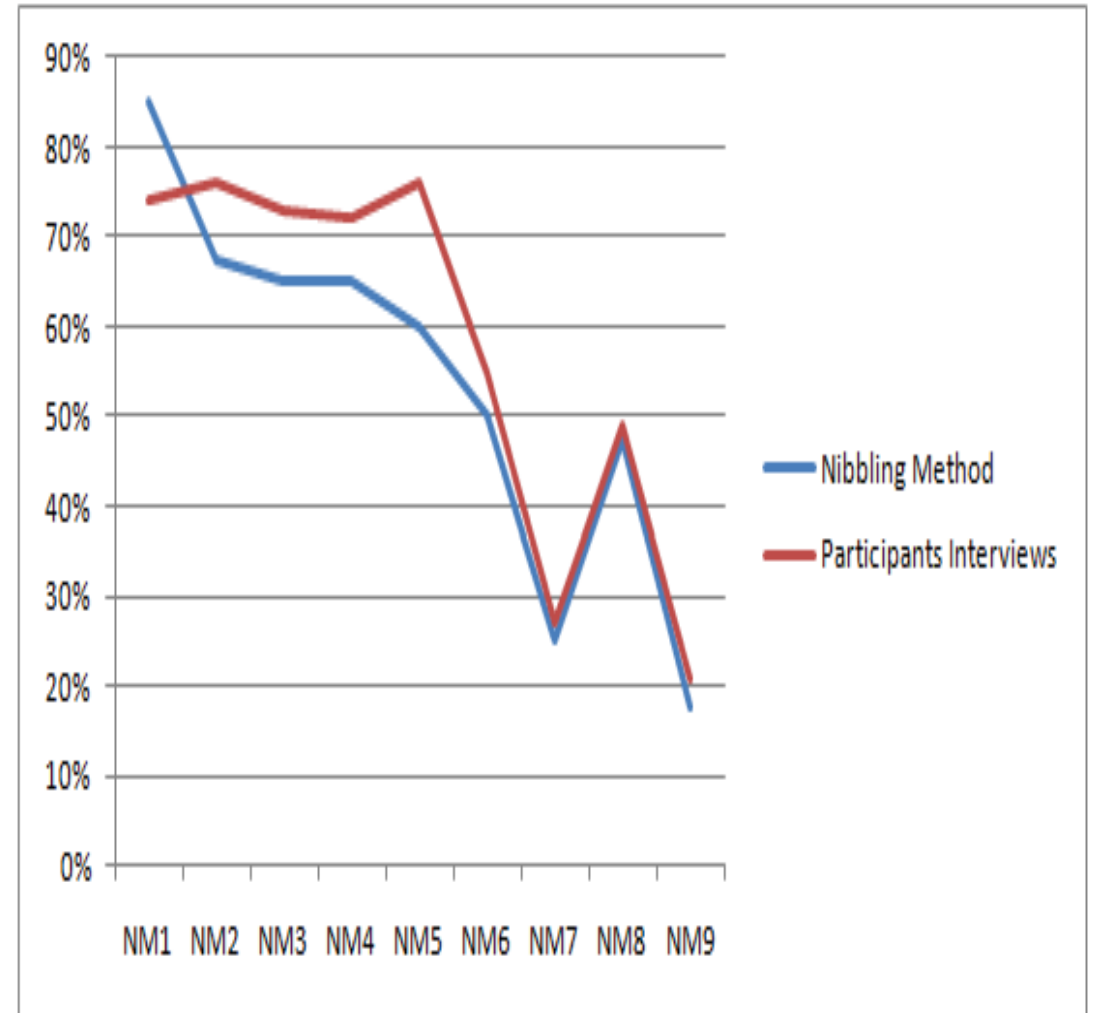
- Tools Experimentations  
CSCW :
  - Netmeeting
  - WSS
  - FacilitatePro

NetMeeting Experiment 2 : NM2	Indicator value
Step 1 : COOPERATE : no implementation without willingness to cooperate	3
Step 2 : CHAMPION : Inquire the project champion and good pilot groups	5
Step 3 : SPONSOR : Be sure of your executive sponsor	5
Step 4 : COMMUNICATE : Build a strong marketing plan	2
Step 5 : SUPPORT : the human support infrastructure	5
Step 6 : INDIVIDUAL BENEFICE : one of the important success factors	4
Step 7 : SUCCESS-STORIES : the potentiality of the technology	3
Step 8 : TRAINING : how this tool can be used for supporting collaboration ?	0



# MPG Validation

- Indicators evolution
- A posteriori interviews



# MPG Conclusion

- EADS Experimentation
  - Knowledge Management Tool Designing



# Tool for Annotation Management

- Health Care Activities
  - Information Transmission
  - Dynamical Information
  - Mock-Up development
    - Information Co-design
    - Collaborative Tool
- Multi-View approach



# Annotation Management Tool

The screenshot displays the Annotation Management Tool interface. At the top, there is a toolbar with various editing tools like bold, italic, underline, and list. Below the toolbar, a text area contains the sentence: "Annotations are both containers and content objects that can handle *embedded texts*, videos, images, pdf and so on thanks to authorized files extensions rules."

A video player is embedded in the text, showing a scene with a person and the text "Tom Wujec: Build a tower, build a team". Below the video, another text area contains: "Demonstration of autocomplete feature to access for example a patient:" followed by the text "jean".

An autocomplete dropdown menu is open, listing patient names and birth dates:

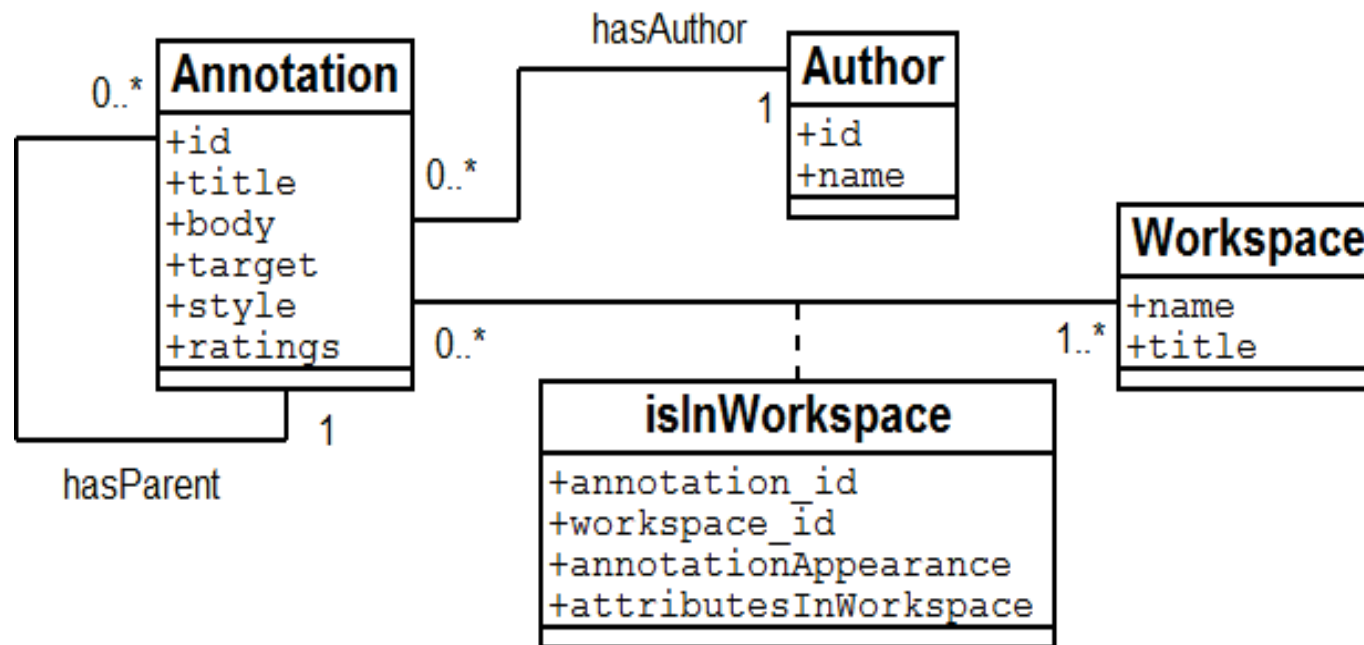
- Patient
- Mr. Martin, Jean, ne le : 4/6/1968
- Mr. Jean, Henrichon, ne le : 8/20/1960**
- Mrs. Inès, St-Jean, ne le : 2/11/1967
- Mr. Jean, Fortier, ne le : 1/1/1992
- Ms. Trinette, St-Jean, ne le : 9/8/1976
- Ms. Jeannine, Bussière, ne le : 12/16/1933
- Mr. Élisabeth, St-Jean, ne le : 7/25/1985

Three time-based annotation boxes are overlaid on the interface:

- Time 1** (pink box): "Inner annotations can be created through time".
- Time 2** (pink box): "Inner annotations manipulations are stored thanks to timeline".
- Time 3** (green box): "These features allow to build knowledge through time and to store this construction for educational purpose or for posterior analysis."

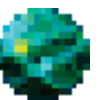
At the bottom, a timeline shows three time slots labeled "Time 1", "Time 2", and "Time 3", each with a magnifying glass icon.

# Simplified annotation Class Diagram



# Communication Analysis

- Crisis Management : Air Traffic Control Management
- Official experience feedback
- Non-official experience feedback
  - newsgroup between pilots and air-traffic controllers
- Semantic analysis : TermoWeb, TermoStat, Alceste
- Comparison between the two approaches



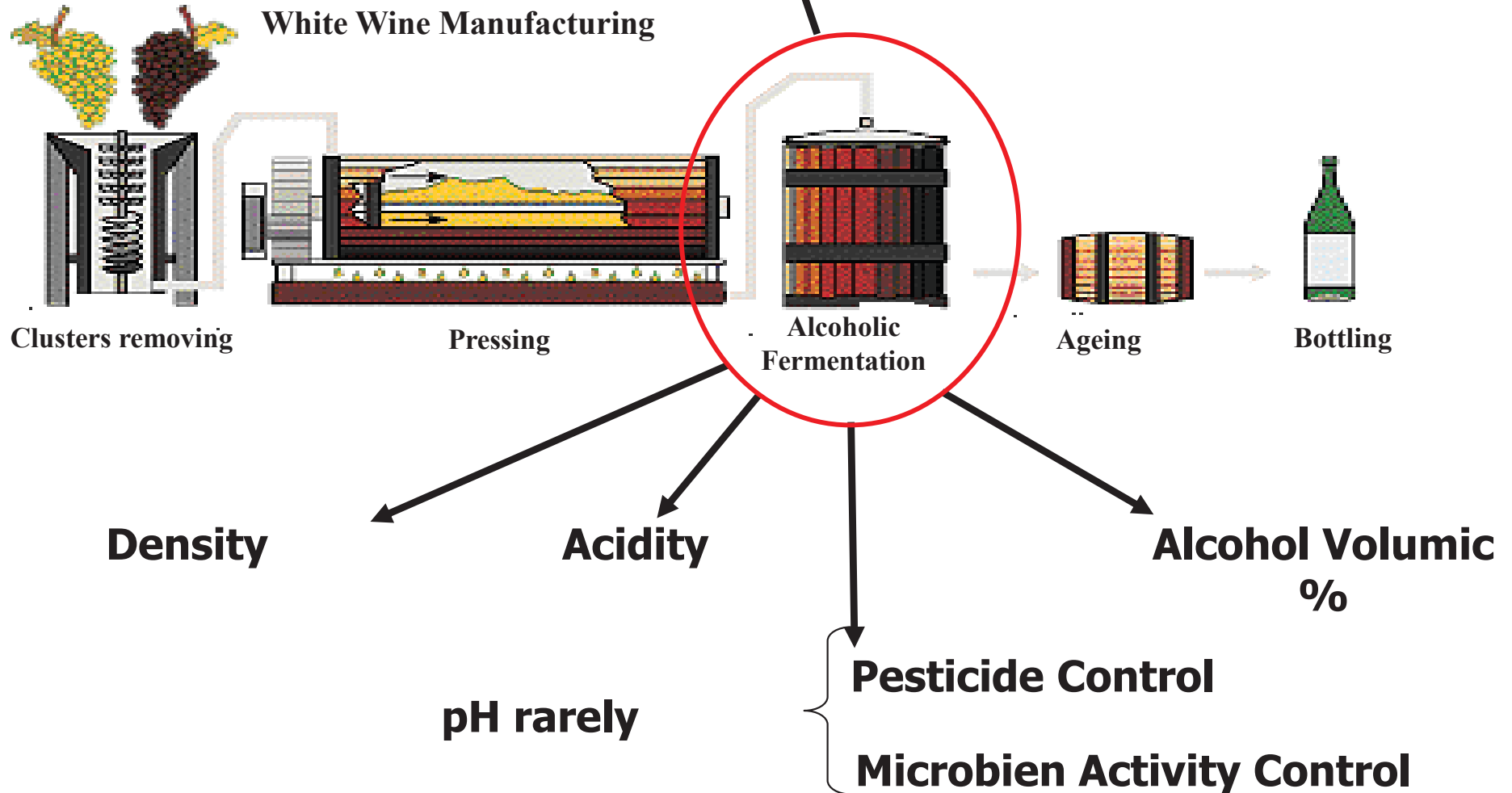
# OENODECISION

- Alcoholic fermentation dynamical models
- Collaboration LGC – INPT
- 2 models :
  - Ph Calculation
  - Ph dynamical forecasting at delta T

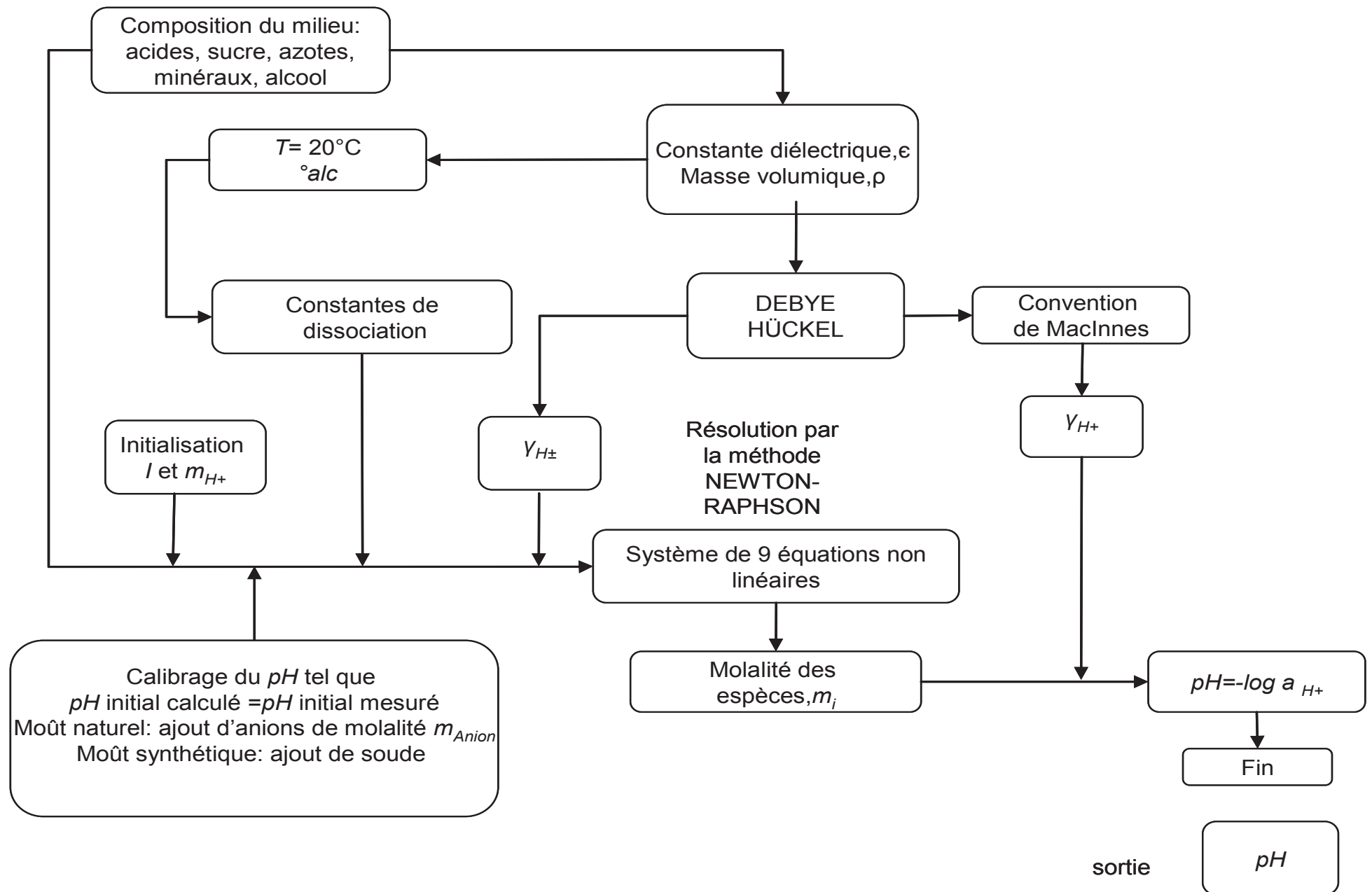
# Context and methodology

Industrial Process → 5 steps

Ethanol, CO<sub>2</sub>, Glycerol,  
Organic acid, Biomass  
et other small members



# Model 1 : Ph Calculating



# Model 2 : Ph Evolution

- Reactional function
- Sensibility analysis : sugar, ethanol, Nitrogen, biomass, CO2 et Amino acids

# Model 2: Integration of an equations system

Speed explicit variables r1, r2 and r3.

$$\left\{ \begin{array}{l} \frac{dX}{dt} = 5.73 \mu_{\max} \frac{[S]}{[S]+k_2} \frac{[NH_3]}{[NH_3]+k_4} + e.k_3[AA] \\ \frac{dS}{dt} = -k_1[X][S] - \mu_{\max} \frac{[S]}{[S]+k_2} \frac{[NH_3]}{[NH_3]+k_4} - i.k_3[AA] \\ \frac{dEth}{dt} = 2k_1[X][S] \\ \frac{dCO_2}{dt} = 2k_1[X][S] + 0.27.\mu_{\max} \frac{[S]}{[S]+k_2} \frac{[NH_3]}{[NH_3]+k_4} + gk_3[AA] \\ \frac{dNH_3}{dt} = -1.15\mu_{\max} \frac{[S]}{[S]+k_2} \frac{[NH_3]}{[NH_3]+k_4} + h.k[AA] \\ \frac{dAA}{dt} = -k_3[AA] \end{array} \right.$$



# Model 2: Parameters Identification

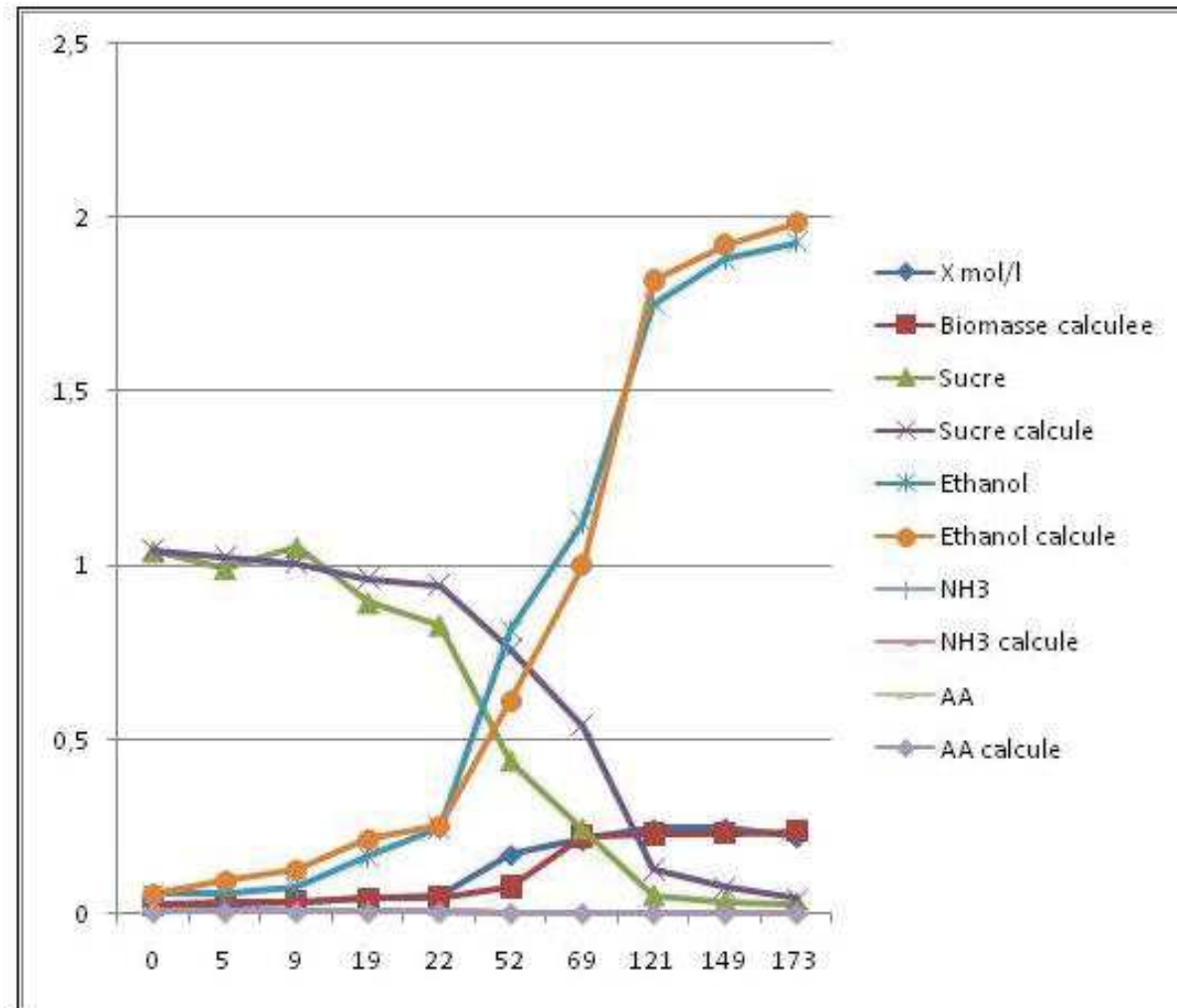
## Parameters and stoichiometric coefficients optimization

$\mu_{max}$	0.17
$k_1$	0.02
$k_2$	1.06
$k_3$	0.01
$k_4$	0.02

f	g	h	i
0.61	2.04	0.01	1.03

# Model 2 : Validation

## Measured and calculated concentrations comparison



# OENODECISION



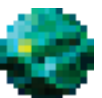
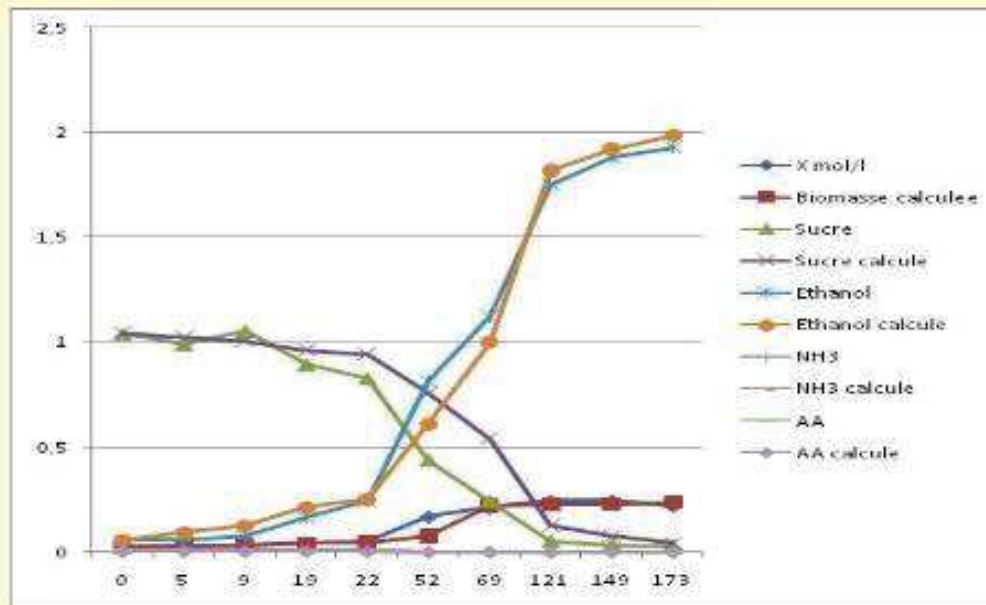
[Inscription](#)

[Identification](#)

[Accueil](#)

[Aide](#)

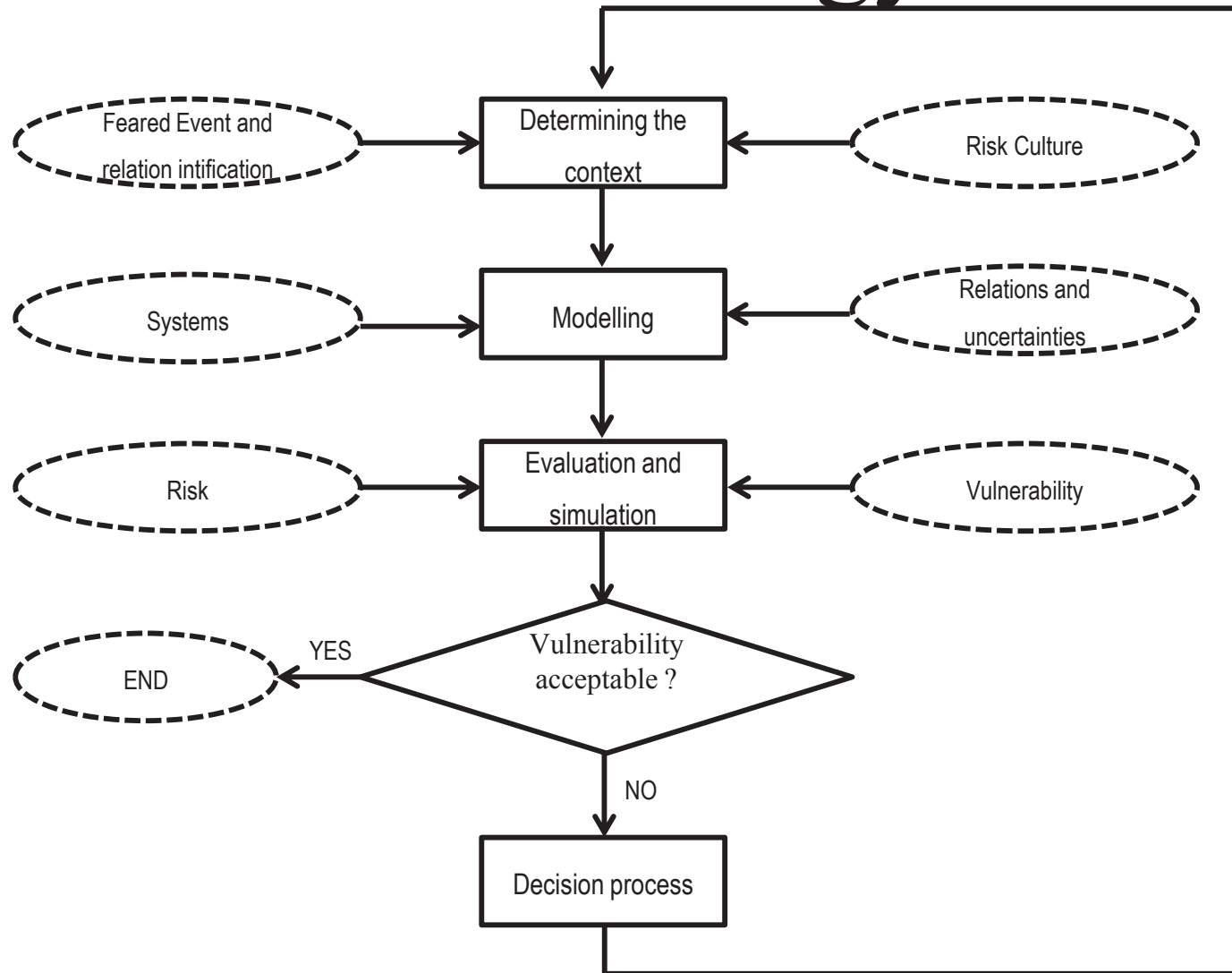
## *Simulateur fermentation alcoolique*



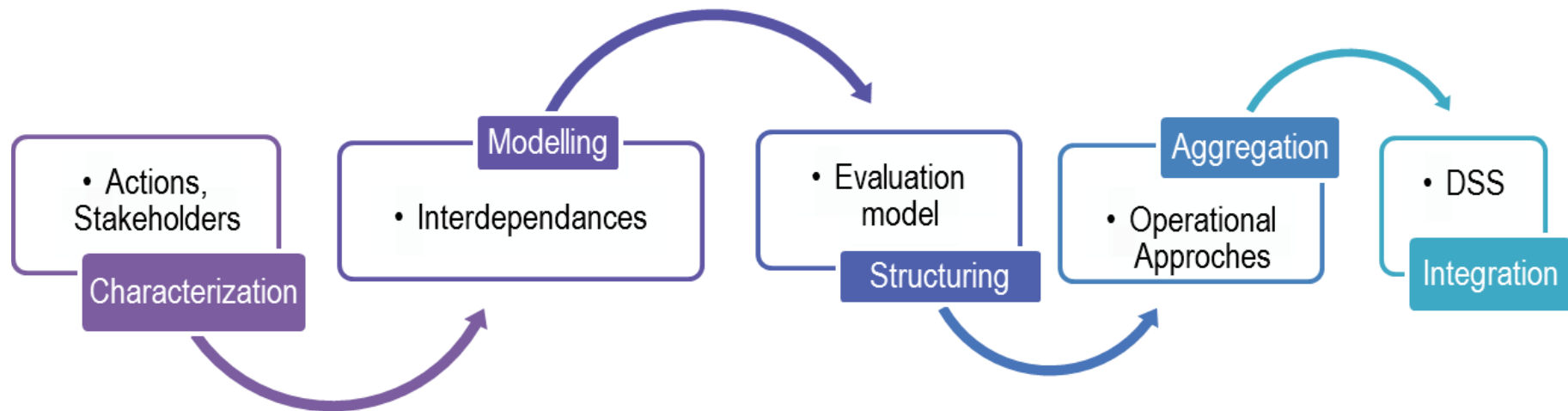
# Network Vulnerability Analysis

- Model and methodology to analyze interdependent critical systems risk
- Any kinds of networks
  - Electricity network
  - Communication Network
  - ...
- Model of risk analysis based on risk management
- Decision Support for limitation of damages in case of natural disasters

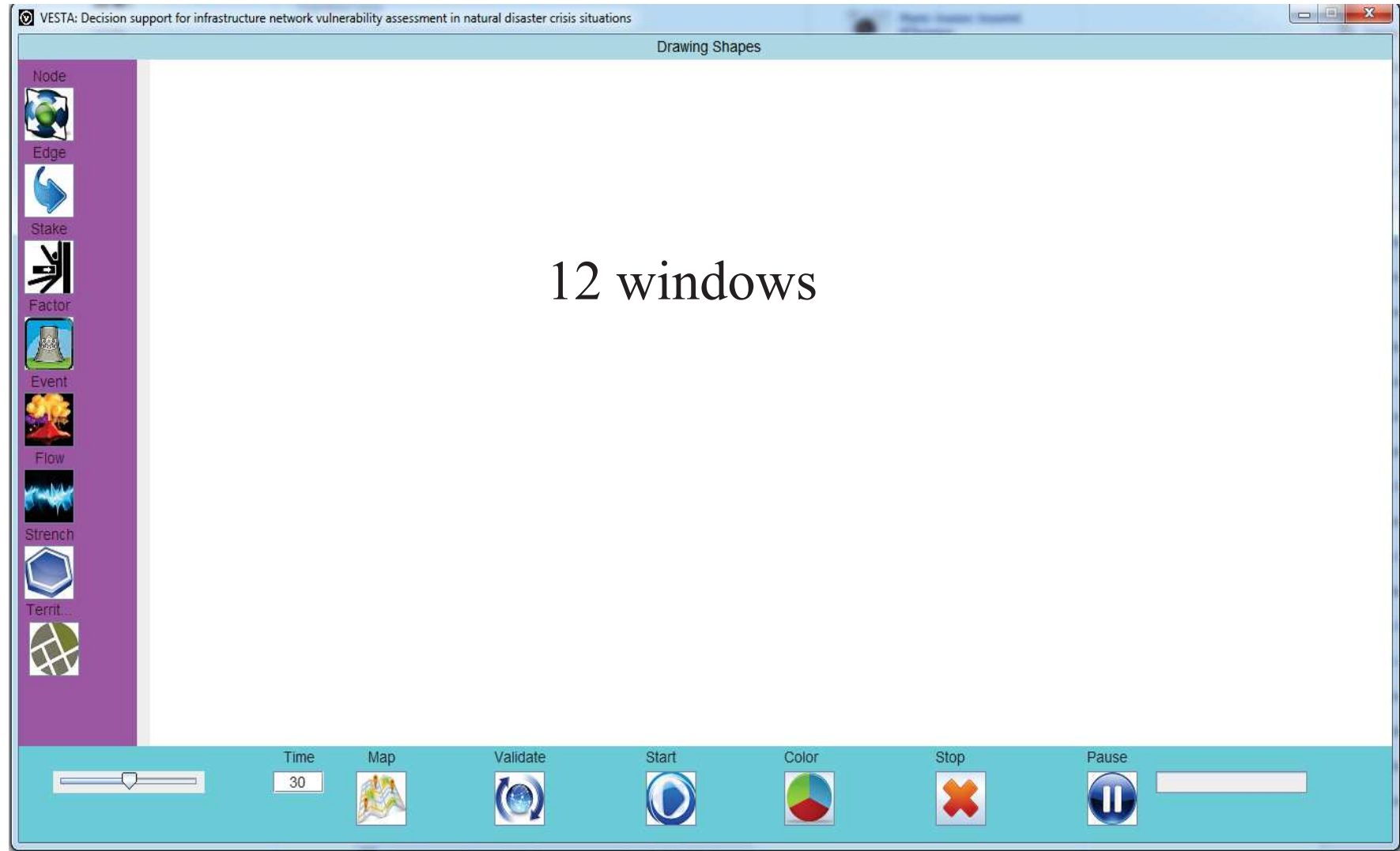
# Vulnerability Analysis Methodology



# Decision Aiding Process



# DSS



20 classes  
Erlang uses classes  
Erlang with Erlang

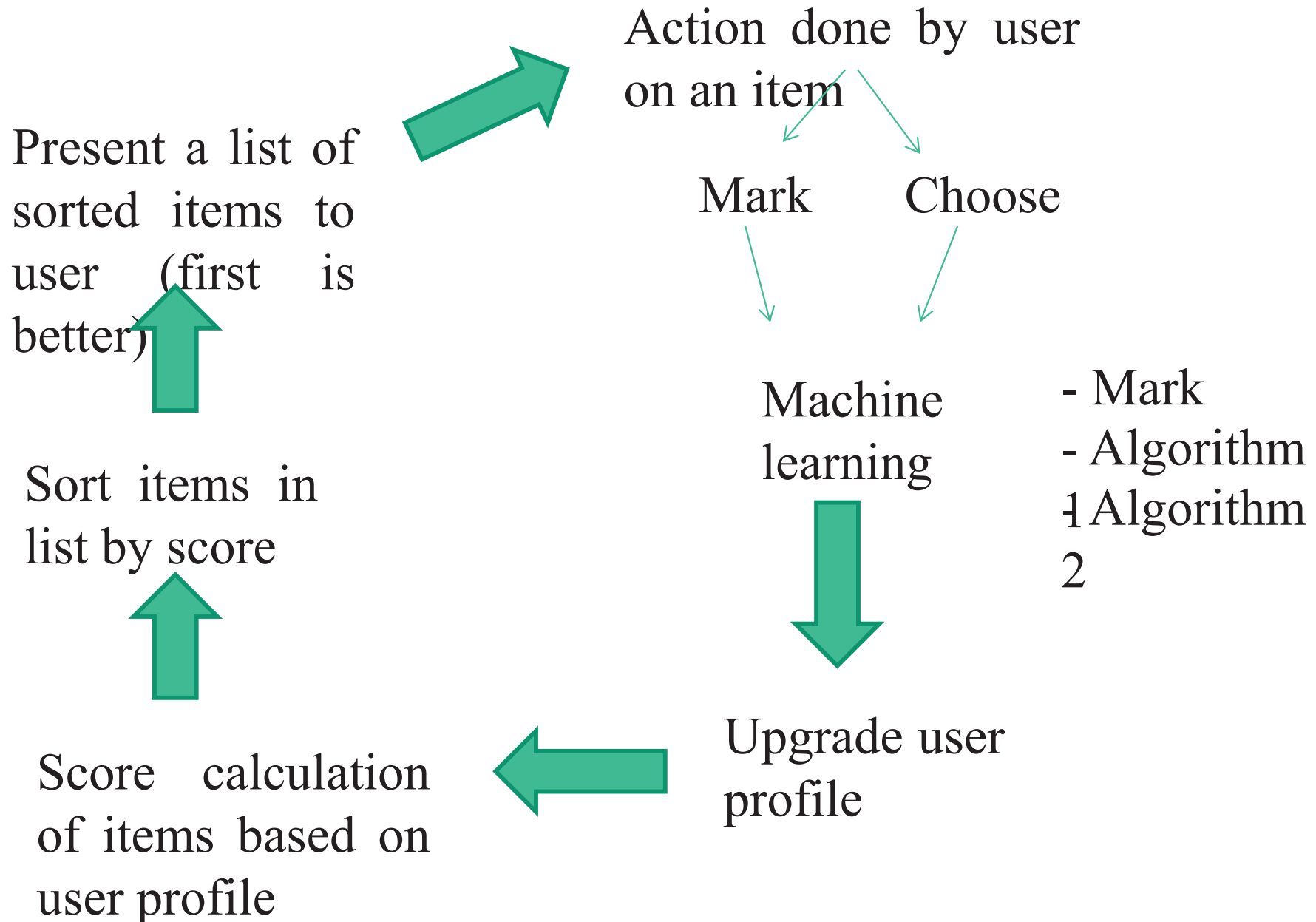


# Profiling Agent

- Web Marketplace
- Developed approach
  - Reinforcement algorithm : Information Retrieval
  - Scoring : Only Incrementation
- Scientific Bottlenecks
  - Information unaggregation
  - Double automatic learning
    - Actions / Criteria value
    - Criteria weight



# Users' Feedback



# Algorithm N°1

- Initialize temporary vector
- Repartition calculation of current item and upgrade of temporary vector
- Work on the list
- Upgrade of user profile

# Upgrade of User profile

$$s(t+1)_i = s(t)_i + 0.01 * \alpha * \log(1 + sc(t)_i)$$

With  $\alpha = \frac{1}{\text{number of item in list}}$

- $s(t+1)_i$  corresponds to the score of criterion “i” at time “t+1” in user profile
- $s(t)_i$  corresponds to the score of criterion “i” at time “t” in user profile
- $sc(t)_i$  is the score calculated for the criterion “i” from the current element at time “t”

# Repartition calculation

We have:

$$\sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ij} > \sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ik}$$

We want:

$$\sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ij} < \sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ik}$$

We need to calculate:

$$\text{Score to obtain} = \sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ik} + (\text{Delta} + X)$$

With

$$\text{Delta} = \sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ij} - \sum_{i=0}^{i=\text{number of criteria in item}} s(t)_{ik}$$

$$sc(t)_i = \frac{\text{Delta} + X}{\text{number of criteria in item}}$$

- X = little value to add for that selected item (k) be higher than current (j)  
(determined depending on the accuracy Delta)
- sc(t)<sub>i</sub> is the score calculated for the criterion “i” from the current element at time “t”

# Algorithm N°2

- Initialize temporary vector
- Removing non-discriminating criteria
- Repartition calculation of current item and upgrade of temporary vector
- Work on the list
- Upgrade of user profile

# Algorithm N°1 vs. Algorithm N°2

$$S(\text{rank}) = \sum_{i=1}^{i=\text{number of choice}} \text{ind}_i$$

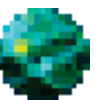
ind  $i$  is the index of the selected item in the list of items proposed

$$\text{Algorithm utility} = -S(\text{rank})$$

Intuitively it would seem that we should use algorithm 1 where the choices are consistent with the profile and the algorithm 2 in the other cases .

# Conclusion

- Algorithm able to update users' profiles
- Application to Privacy Data protection for Ambient Systems

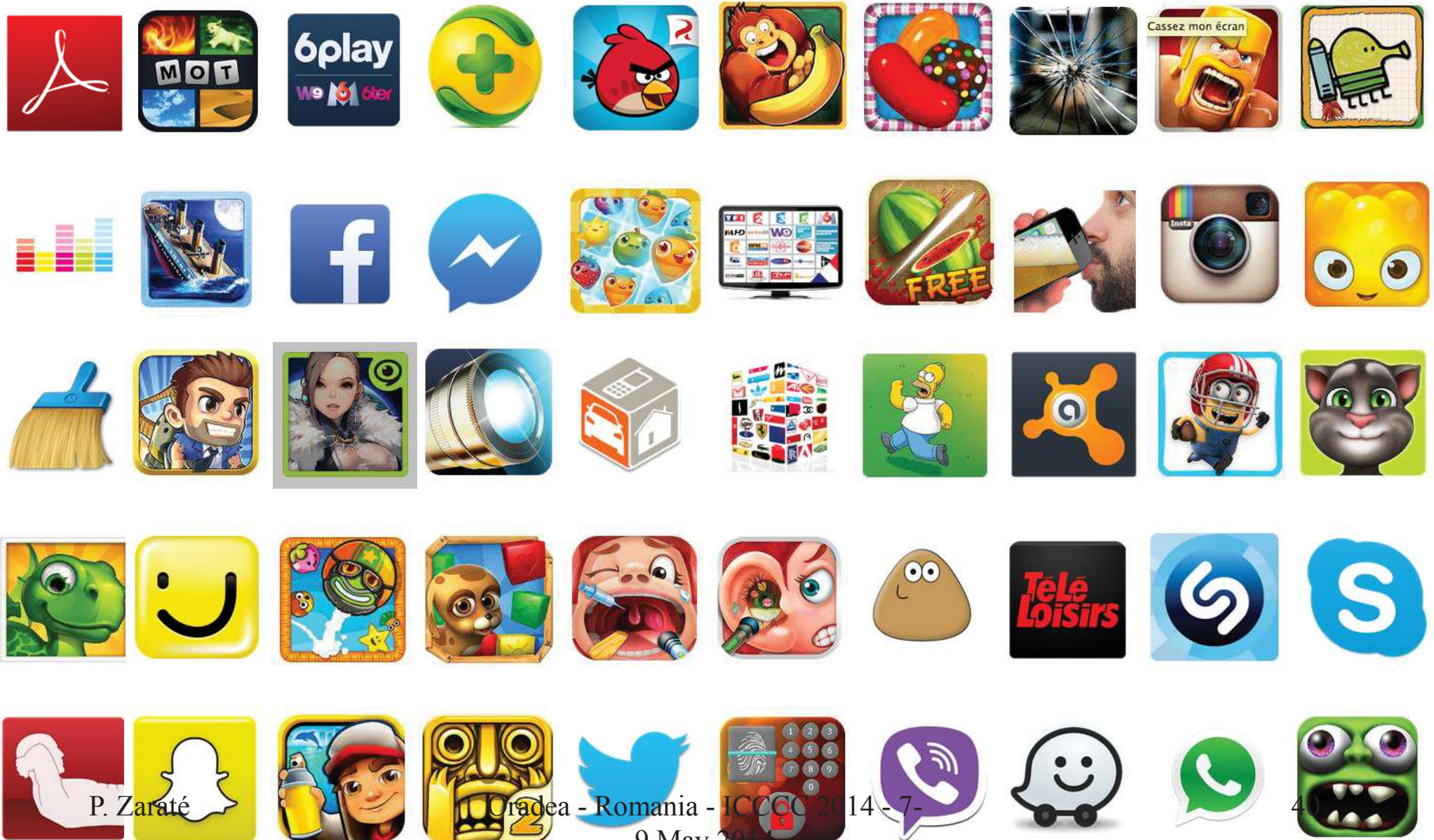


# KAPUER

A DSS for protecting Privacy



# 50 well known applications



# ...Grouped in 8 categories

Games



Social



Entertainment



Communication



Tools



Gadget



Music & Audio

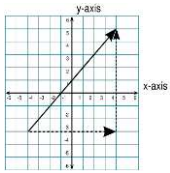


Travels &  
Information  
P. Zarate



# 15 Sensitive resources...

GPS  
Position



Camera



Telephon



Audio



Planning



Address



Account



SMS



3G

**3G**

Wifi



NFC



Bluetooth



Log



Parameters

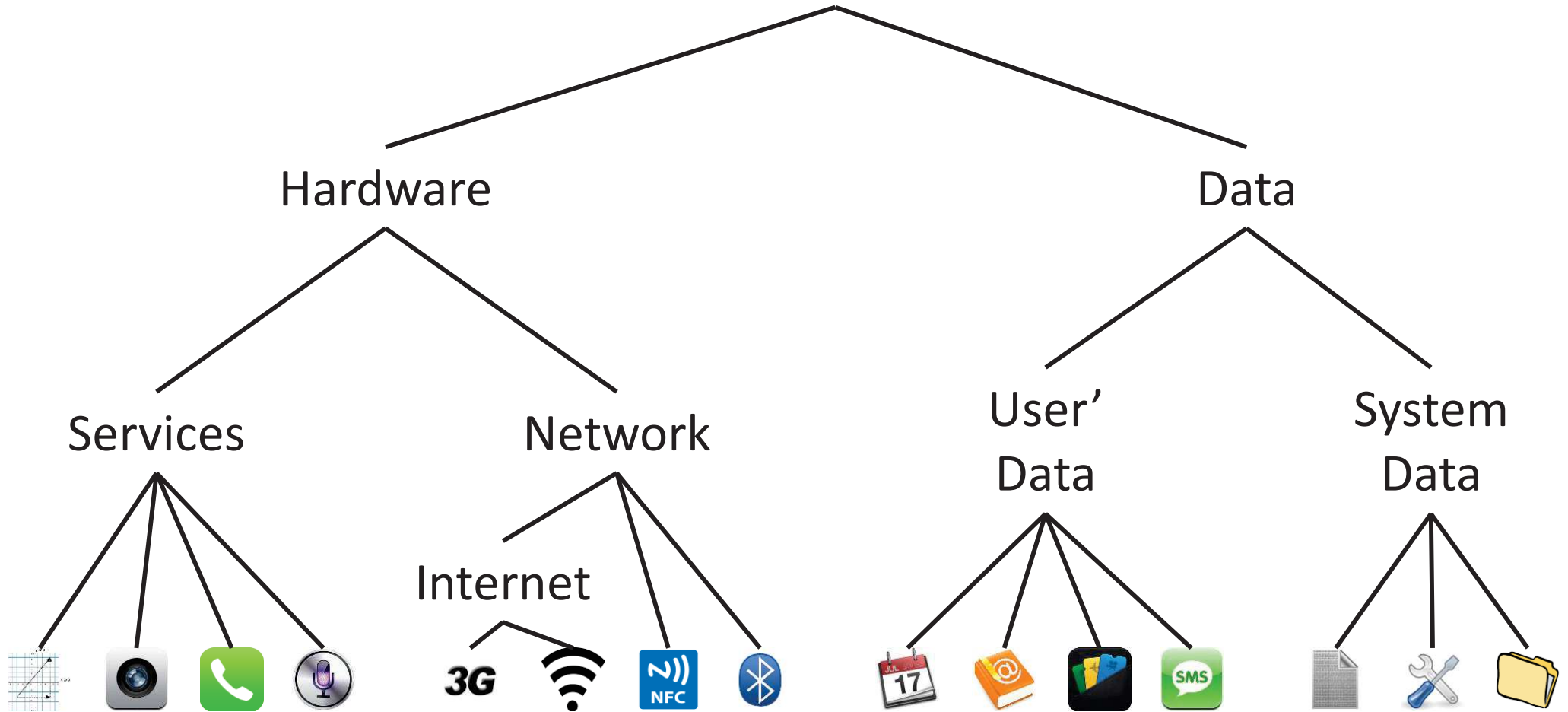


Files



# ...Sorted Out

Resources



# 5 actions...

- Read
- Write
- Execute
- Send
- Receive

# ...For hundred requests for Sensitive Data!

Escape-The-Titanic Les-Simpson-Springfield Vous-avez-cassé-mon-écran  
Log Dragons-World Jelly-Splash  
Rescue-Saga Audio Banana-Kong Twitter Exécuter  
Candy-Crush-Saga Skype Wifi Pou iBière-Gratuite  
Petite-oreille-médecin Calendrier Contact Pages-Jaunes NFC Facebook Téléphone  
Subway-Starfen Bluetooth Instagram Leboncoin SMS Petite-gorge-Médecins  
Facebook-Monster Verrouillage-de-l'écran 360-Security-Antivirus Compte Kaizin-Rumble France-TV Temple-Run-2  
Envoyer Fichier Papa-Pear-Saga Pet APN Paramètre  
Doodle-Jump 3G Clear-Master Shazam Mon-Tom-qui-parle 6Play  
Waze-Social-GPS-Maps Ecrire Adobe-Reader  
Angry-Birds Jeptack-Joyride Coordonnées  
Clash-of-Clans Mobile-Security-&-Antivirus Lampe-Torche-LED-HD-Flash

# How to protect oneself

- Need to know what we want to do for each resource
- Authorization for each request asks a cognitive workload

# How to protect yourself

- 3 possible approaches
  - Through a graphical interface
  - Through a parameters file
  - Through Kapuer

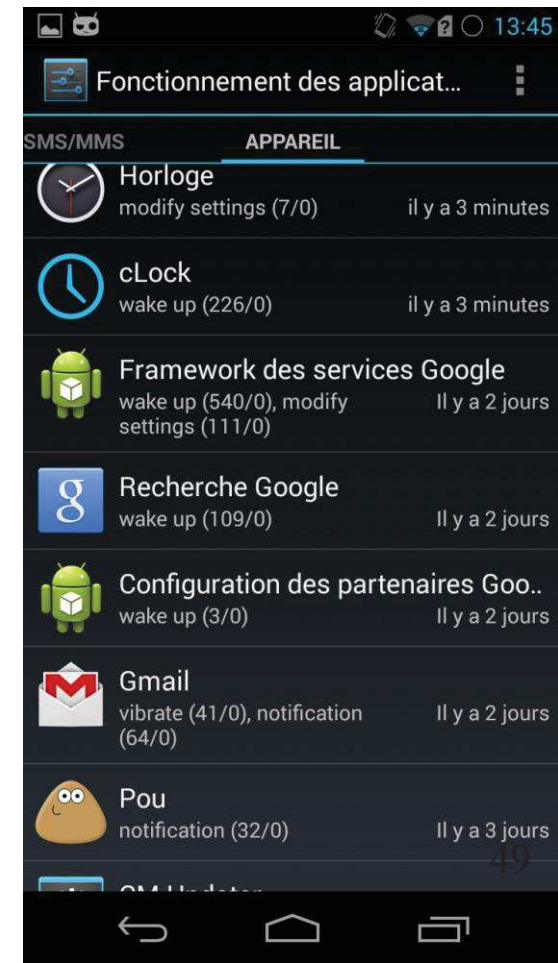
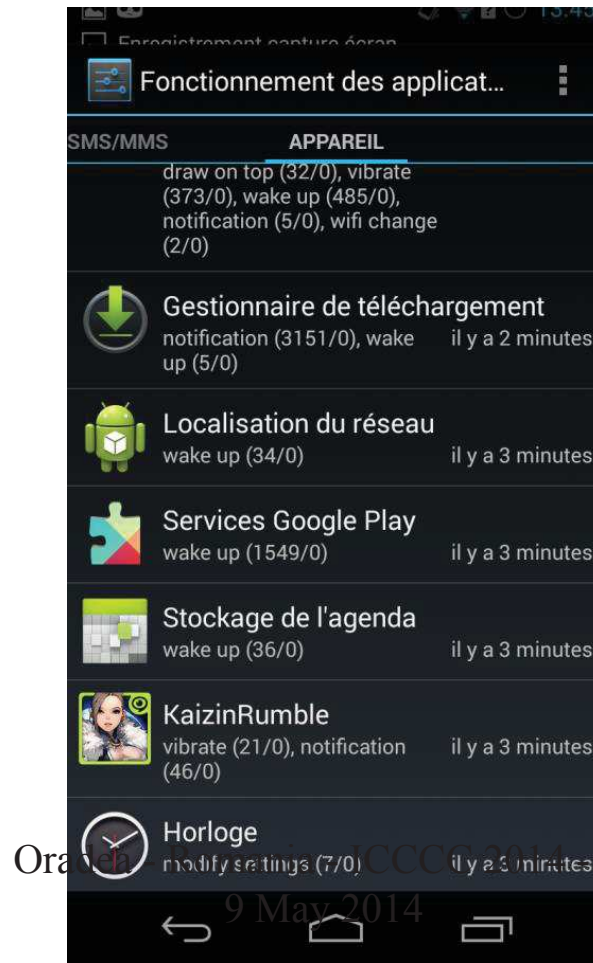
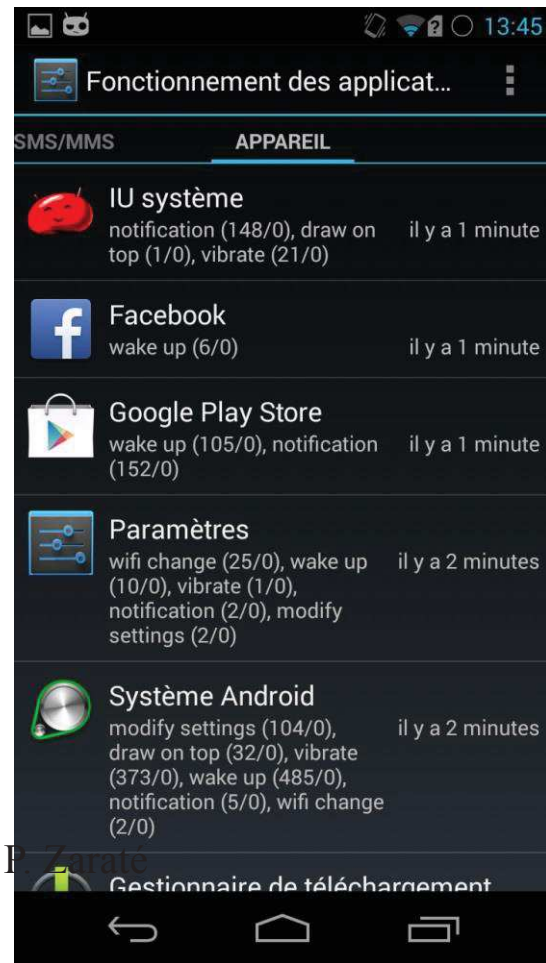


# Graphical Interface

- Accessible with CyanogenMod ou LBE Privacy Guard
- Allows to manage the authorizations application by application

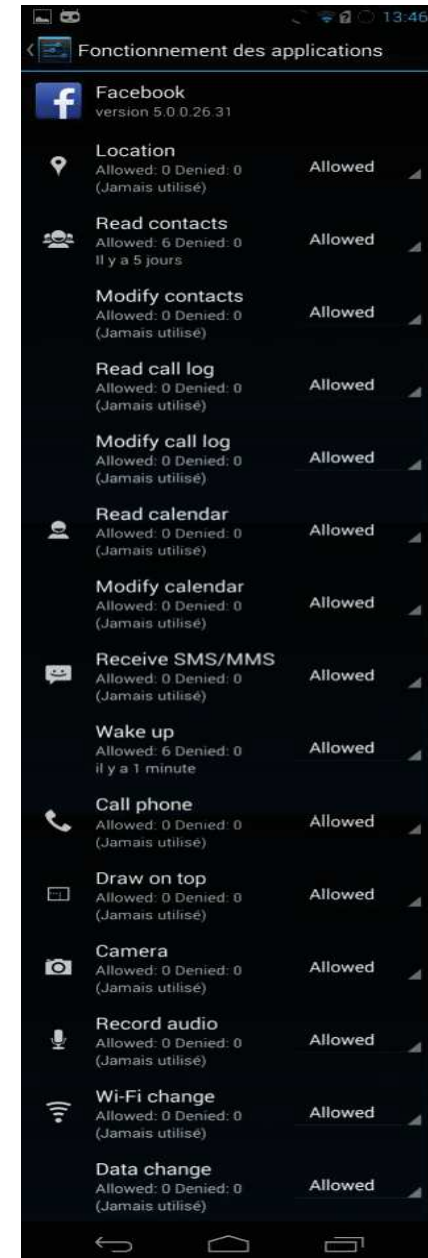
# One example : CyanogenMod

- Around 10 pages of application in which user, system and requests are mixed



# One example : CyanogenMod

- For each application
  - List of authorizations for the user and the system
  - Need to sort out among these resources
- Impossible to manage group of applications or resources



# Parameters File

- Technology used with Linux or Access Control Language (ex: XACML)
- Allows a precise management of resources

# One example : XACML

- Writing authorization policies for the management of resources access
- Language based on XML

# One example : XACML

- Rule n°1 allows the access to games on Internet, the XACML rule becomes :

```
<Rule RuleId="Rule1" Effect="Permit">
  <Target>
    <Subjects>
      <SubjectMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
        <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">Jeux</AttributeValue>
        <ActionAttributeDesignator DataType="http://www.w3.org/2001/XMLSchema#string"
          AttributeId="urn:oasis:names:tc:xacml:1.0:subject:subject-metacriterion"/>
      </SubjectMatch>
    </Subjects>
    <Resources>
      <ResourceMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
        <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">Internet</AttributeValue>
        <ActionAttributeDesignator DataType="http://www.w3.org/2001/XMLSchema#string"
          AttributeId="urn:oasis:names:tc:xacml:1.0:resource:resource-metacriterion"/>
      </ResourceMatch>
    </Resources>
    <Actions>
      <AnyAction/>
    </Action>
  </Target>
</Rule>
```

P. Zaraté

# XACML

- Pour se protéger complètement, après avoir réfléchi à toutes les règles, il faut les écrire. Au final 8 règles comme la précédente.
- Peu de difficultés pour quelqu'un connaissant XACML et la sécurité. Mais pour les autres...

# Balance of the 2 first approaches

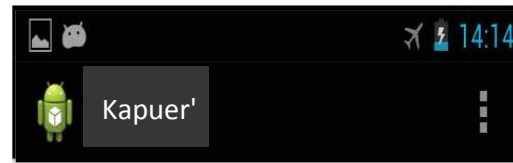
- Graphical User Interface(GUI)
  - Accessible to everyone
  - Ask a lot of time and a huge cognitive workload to be well protected
  - Fix authorization independant of the use context
- Parameters File
  - Allows to be more precise rather thenGUI
  - Asks a huge cognitive workload
  - Requests to know programming language -> Unsable for every users



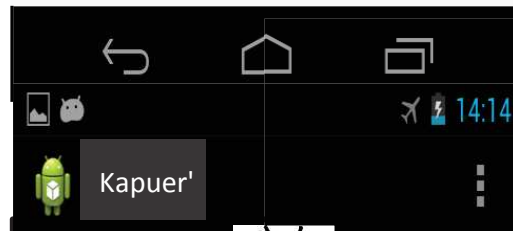
# Kapuer

- Advantages of the previous approaches
  - Development of a GUI easy to use
  - Use of XACML for precise rules
- Without the inconveniences
  - No cognitive overload thanks to :
    - User Preferences Learning
    - Decision Made by the user during the application use
  - No need to know programming language

# Kapuer : Functioning



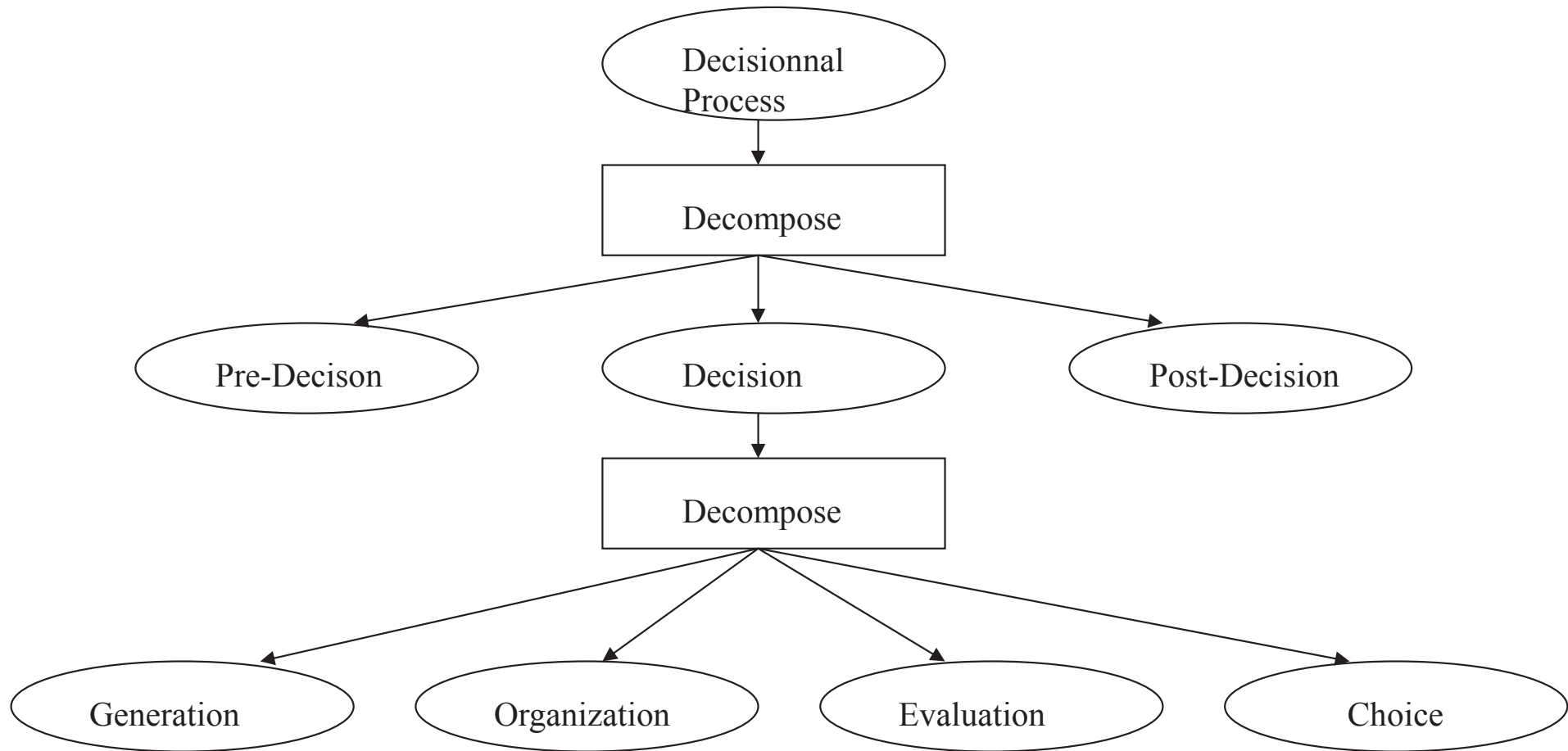
Instagram makes camera access



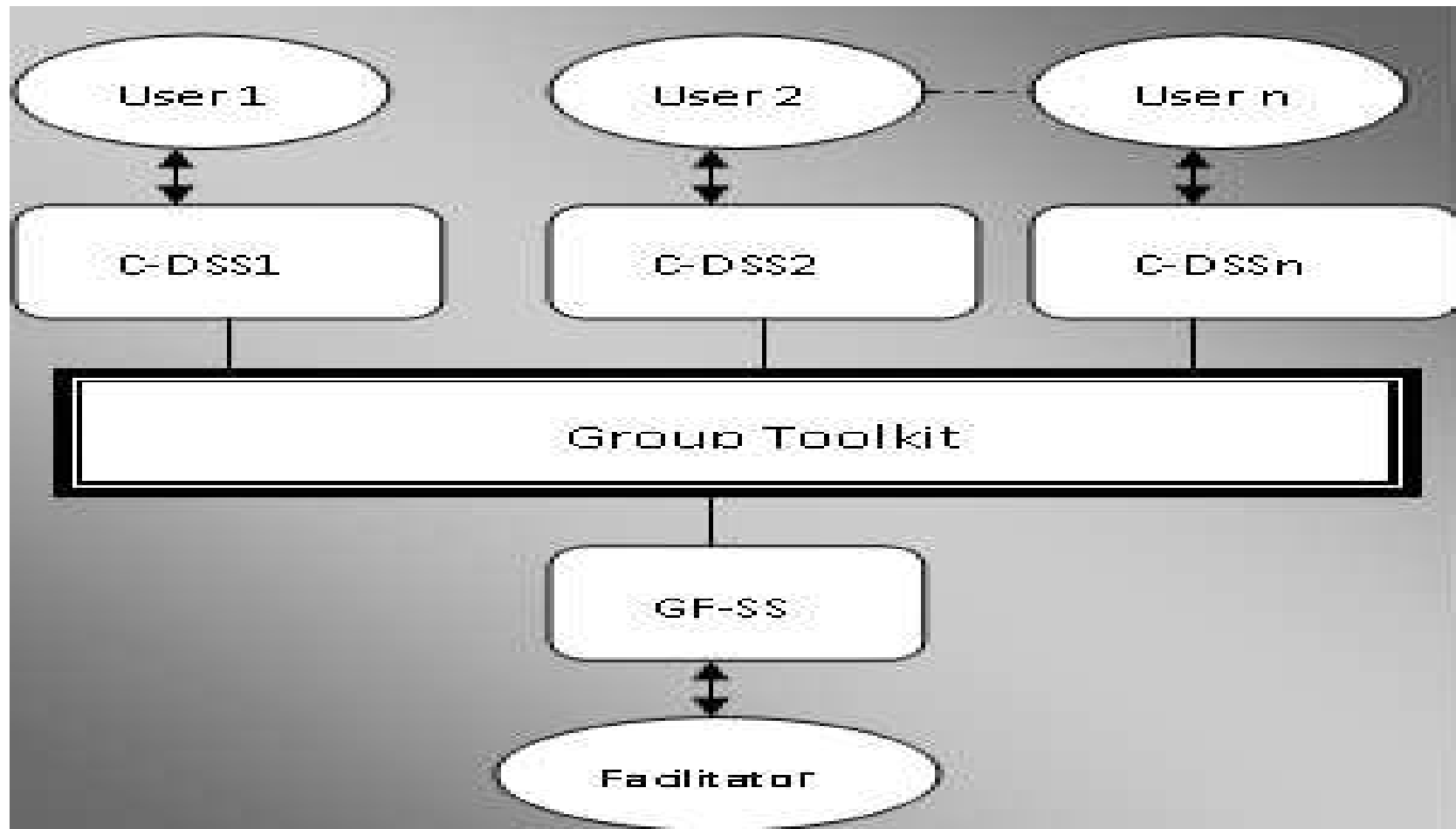
Authorized Access



# Group Decision Process

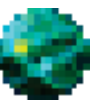


# The Framework for Group Decision-Making



# Group Decision Process

- Framework developed by parts
- Tools are reusable in different contexts of Group decision Making



# Brainstorming Facilitation Support System

- Ideas generation step : Brainstorming
- Designing a brainstorming facilitation support system
- Based on social psychology studies (Osborn, Brown et Paulus)
- Group Decision Making meeting efficiency definition
  - Efficiency estimation
  - Dynamical models use => Production evaluation => Efficiency evolution
- Determine the ideas number and its evolution during a group decision making meeting

# Non Cognitive Model

- Weighted sum of previous factors

$$\frac{do_i(t)}{dt} = -a_i o_i(t) - b_i \sum_{j \neq i} o_j(t) + m_i \left[ \frac{1}{n-1} \sum_{j \neq i} o_j(t) - o_i(t) \right] \text{ and } o_i(t) \geq 0$$

- $o_i(t)$  is the ideas rate (ideas number per time unit) generated by the participant  $i$ ,
- $o_i(t)$  the ideas number rate function,
- $a_i$  the decay rate,
- $b_i$  the blocking rate,
- $m_i$  the tendency to match,
- $n$  the size of the group

# Cognitive Model

$$\frac{dg_i(t)}{dt} = -a_i g_i(t) - b_i \sum_{j \neq i} o_j(t), \text{ and } g_i(t) \geq 0$$

$$\frac{ds_i(t)}{dt} = -c_i s_i(t) + g_i(t) - o_i(t), \text{ and } 0 \leq s_i(t) \leq K$$

$$\frac{do_i(t)}{dt} = -d_i o_i(t) + r_i s_i(t) - f_i \sum_{j \neq i} o_j(t) + m_i \left[ \frac{1}{n-1} \sum_{j \neq i} o_j(t) - o_i(t) \right], \text{ and } o_i(t) \geq 0$$

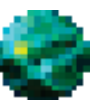
with

- $g_i(t)$  describes the rate of generated ideas by the participant  $i$  over time,
- $a_i$  is the decay rate,
- $b_i$  is the blocking rate,
- $s_i(t)$  is the number of ideas in the short-term memory,
- $c_i$  is the forget rate,
- $o_i(t)$  is the ideas rate which decay at the rate  $d_i$ ;  $f_i$  and  $m_i$  are respectively the blocking and the matching influences,
- $r_i$ , represents the rate of ideas extracted from the memory.



# Brainstorming Facilitation

- Approach to find parameters of dynamic model of brainstorming based on Euler and fourth order Runge-Kutta
- Fourth order Runge-Kutta model be used for small group
- Validation of the method/model(s)
  - Test dynamic models and optimization problems on real brainstorming
  - Integrate models obtained by optimization to our efficiency measure



# Collaboration Tools

- Group Decision Making Process
  - Pre-decision
  - Decision
  - Post-decision
- CSCW Existing Tools analysis

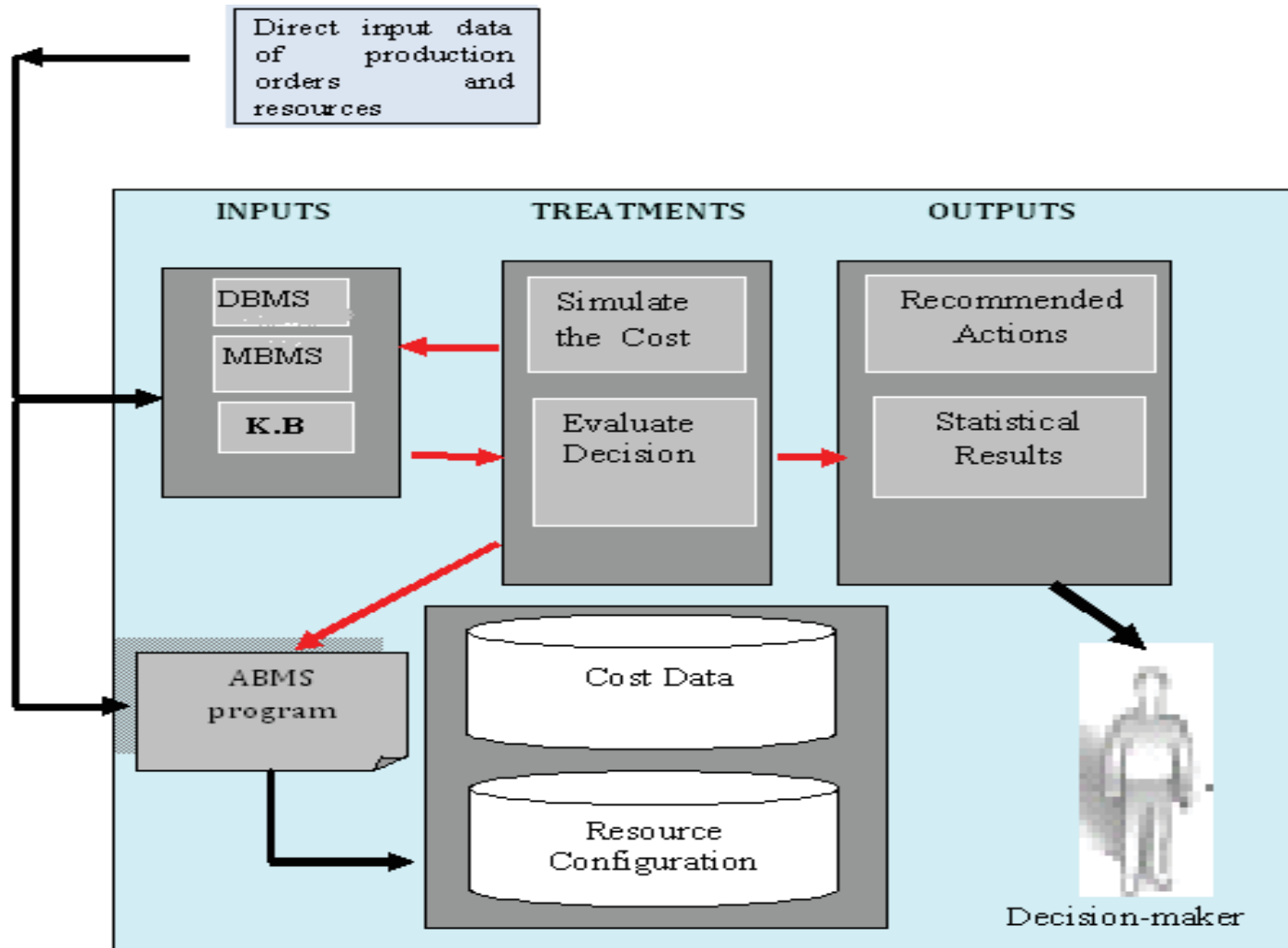
Functionalities Tools	Time Management	Organisational Memory	Anonymity	Agenda Builder	Electronic Invitation	Brainstorming	Organization	Prioritizing/ Voting	Results Analysis	Actions planning	Documenting	Decision Monitoring
Dialogr	::	-	::	::	+	+	-	+	-	::	-	-
FacilitatePro	-	+	++	++	++	++	++	++	++	++	++	++
Kindling	-	-	-	+	++	++	++	++	++	++	++	++
ThinkTank	-	+	++	++	++	++	++	++	++	++	++	++
Ideascale	::	-	::	::	+	+	+	+	-	::	+	+
Brightidea	-	+	-	-	++	++	++	++	++	+	++	+
JamespotPro	::	-	-	::	+	+	-	-	-	::	-	-
Campfire	::	-	::	-	++	+	-	::	::	-	-	-
Webcouncil	-	+	++	++	++	++	++	++	++	++	++	++
BrainReactions	::	-	::	::	+	++	-	-	::	::	-	-
CentralDesktop	::	-	::	-	++	+	+	::	::	+	+	-
MeetingWorks	++	-	++	++	++	++	++	++	++	++	++	++
ExpertChoice	::	-	::	::	::	::	::	++	+	::	+	+
Grouputer	-	-	++	++	++	++	++	++	++	++	++	+



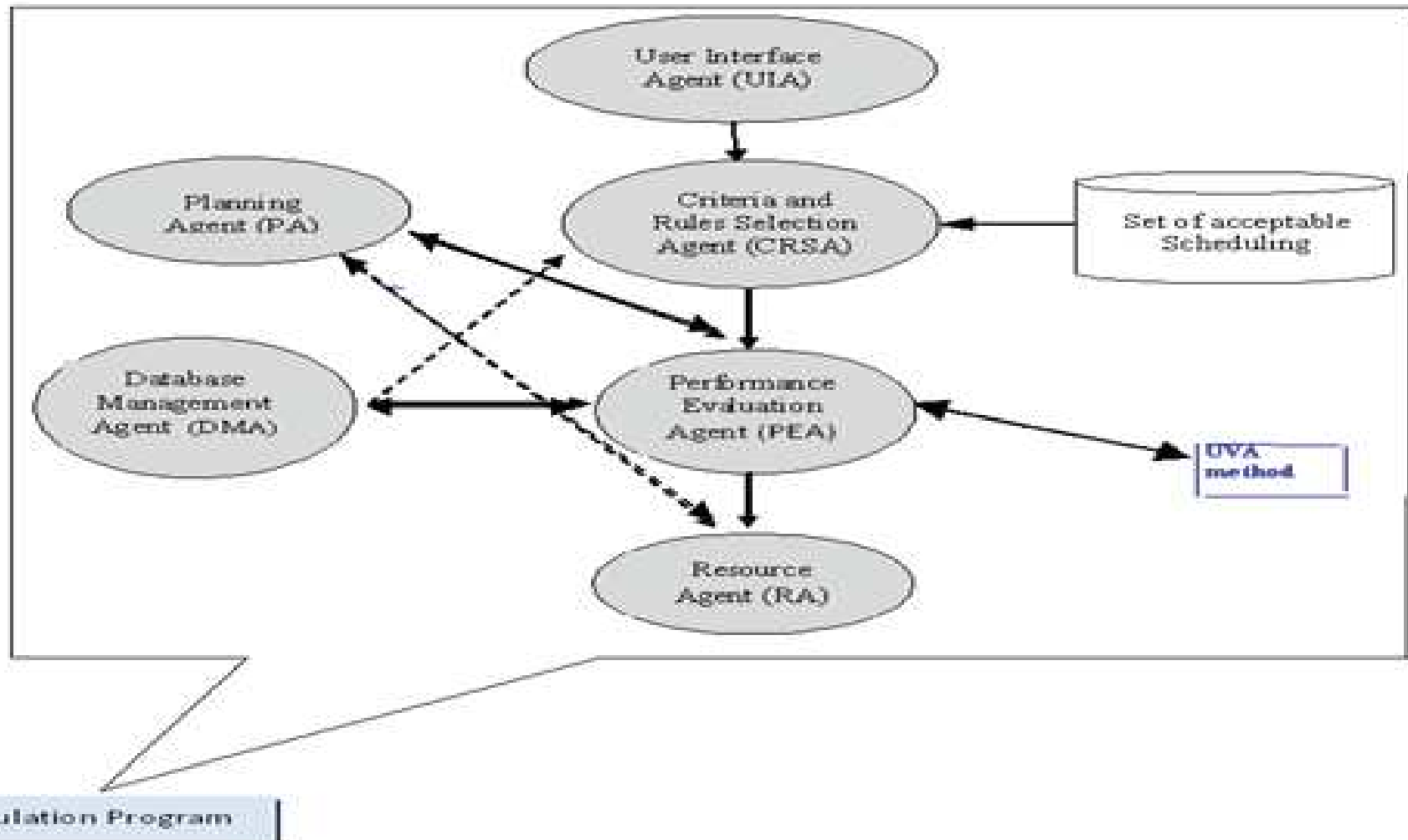
# Multi-Agents Negotiation Protocol

- Incidents Management for Production Management
- Multi-Agents negotiation protocol for tasks re-assignment
- Agents : Decision made thanks to the UVA cost calculation methodology
- JADE Plateform

# Proposed Model



# Multi-Agent Production Management System



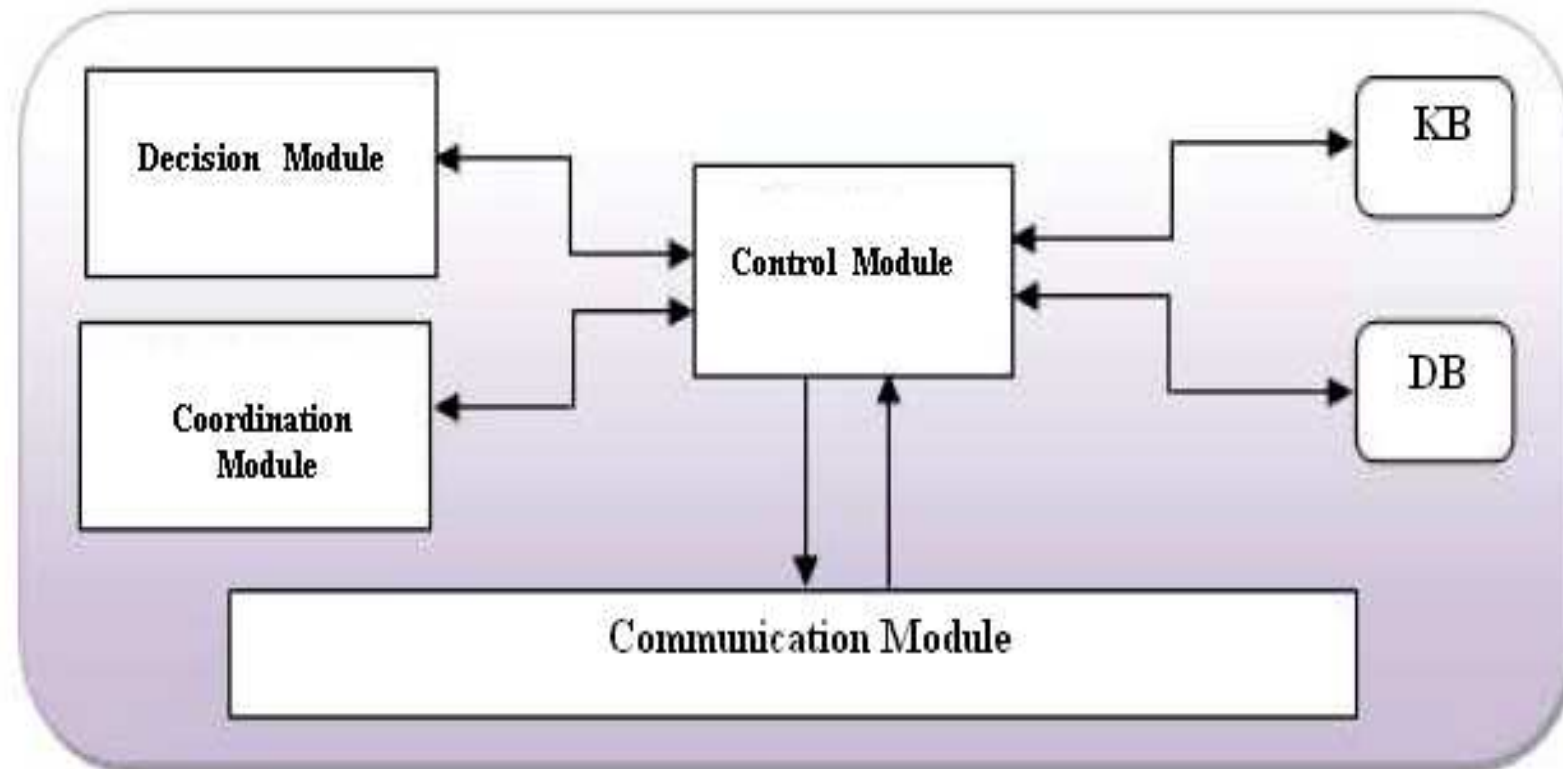
# Coordination protocol for a planning agent

```

Begin
Var j, i, n : integer ;
Var OK: boolean;
Var Timemax, PA (Coordinator Agent), H: string;
T [Ri](** Ti:      :ate**), D [Ri] = Array [R1...R2] of String (**Diagnosis state**)
Repeat
  Read (n);
  Read (T [R1]);
  For i := 1 to n do
    Begin
      Read T [Ri];
      if T [Ri] > Timemax then R1 ← Ri
    End
  Grant the request from the agent responsible of R1;
  Goto protocol given in figure 4
  N ← n-1;
  For i := 1 to n do
    Begin
      Read T [Ri];
      j:=i+1;
      If T [Ri] = T [Rj] then
        Begin
          If D [Ri] ∈ {H} then OK ← Vrai
            CA ← Ri;
            Goto protocol given in figure 4;
            n ← n-1;
          else
            if D [Rj] ∈ {H} then OK ← Vrai
              CA ← Rj;
              n ← n-1;
            else
              if D [Rj] and D [Rj] ∉ {H} then OK ← False
                CA ← choose a resource randomly;
                Goto protocol given in figure 4;
                n ← n-1;
            End
          End
        End
      Until system terminated or (n=1);
    End
  End

```

# Planning Agent Structure

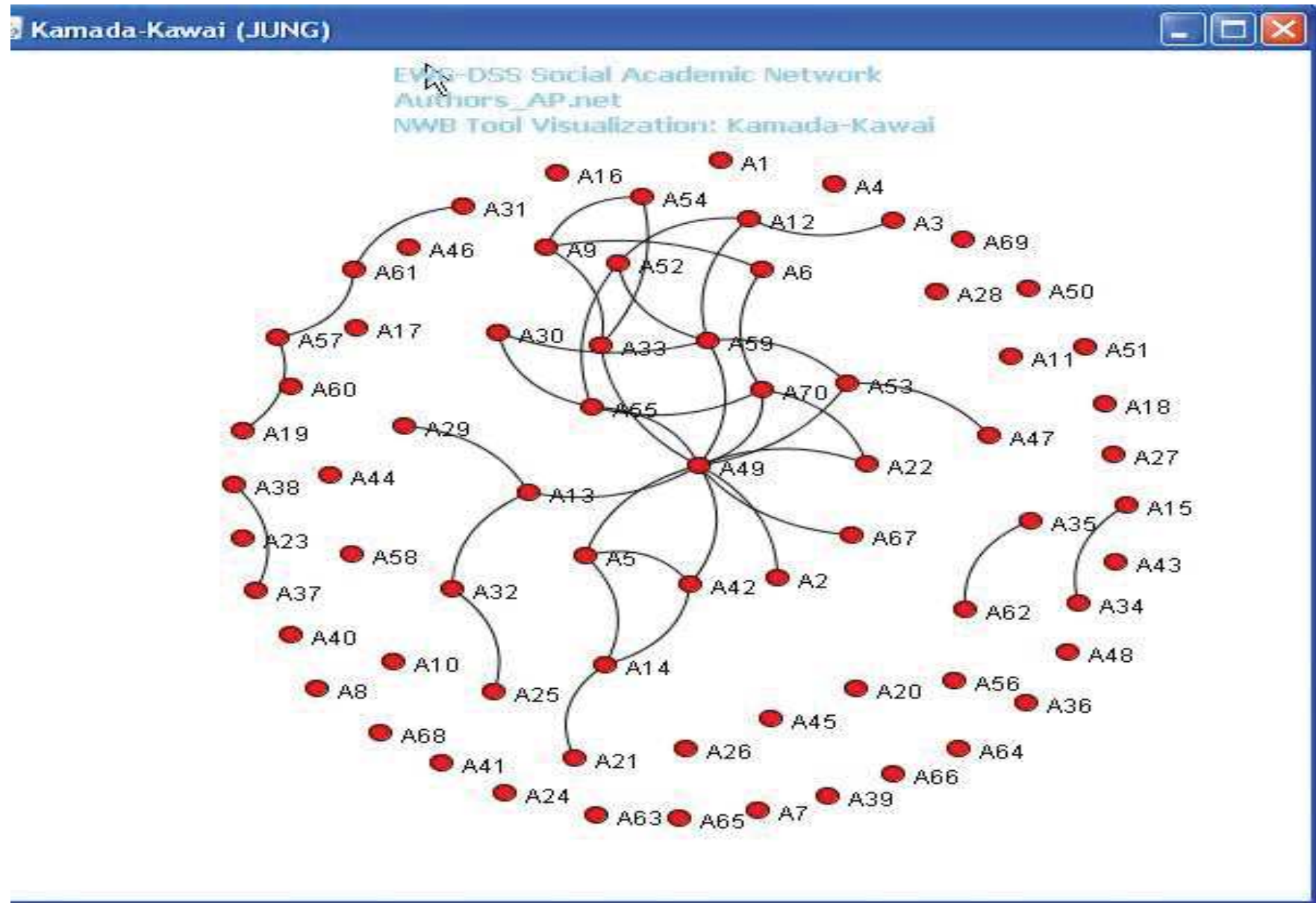




# Social Networks

- Upstream step the group decision making process
  - Actors selection
  - Networks – Coalitions Detection/Visualisation
- Facilitation Support
- EWGDSS Social Network Analysis
  - 1350 publications
  - 70 researchers
  - Collaborations

# 1<sup>st</sup> result



# EURO Working on DSS

- Since 1989
  - 150 members
  - Board : 6 persons since 2010
- 1 or 2 meetings /year : workshops
  - Special Issues : IJDSST, JDS, EJOR,...



# EURO Working on DSS



- Instruments
  - Official EURO Web Site
    - <http://www.euro-online.org/web/ewg/10/ewg-decision-support-systems>
  - EWG-DSS – Blog
    - <http://ewgdss.wordpress.com/>
  - Mailing List : [ewg-dss@irit.fr](mailto:ewg-dss@irit.fr)
  - Slideshare Account
  - 1 Newsletter edited / year

# EURO Working on DSS



- Next meeting : GDN 2014, Toulouse, France June 10th-13th 2014

<http://www.irit.fr/gdn2014>



# Conclusion

- Descendant Solving
  - Dynamical Models
  - Forecast
  - Tasks / Users / Cooperation
- Ascending Solving
  - Multi-agents coordination protocol
  - Social Network detection
- A-descendant approach

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*Thank you !*

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