Inteligencia Artificial en Aplicaciones Aeroespaciales

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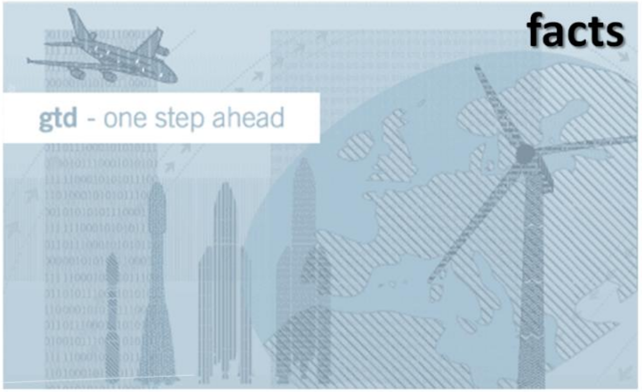
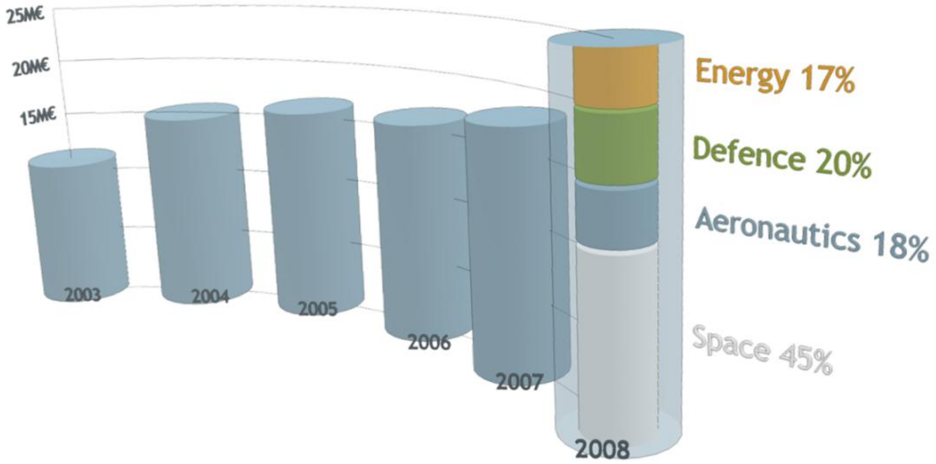
SPACE
Space systems, with particular focus in commercial launchers, thus including ground-segment and onboard applications.

AERONAUTICS
Onboard software: avionics and certification.

DEFENCE & SECURITY
Integral security, including control centers and facility supervision.

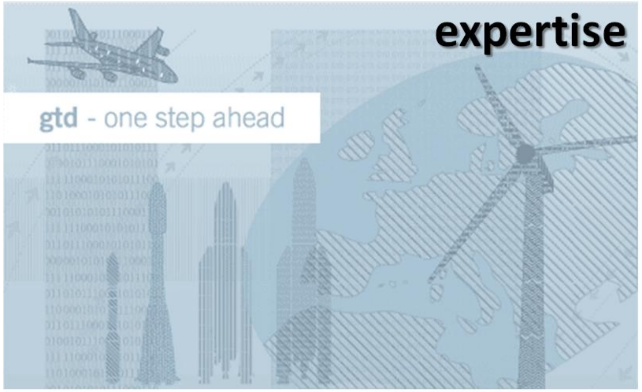
(COMPLEX) UTILITIES
Command & Control systems; large, real-time distributed systems. Applications in nuclear-safety and scientific laboratories.



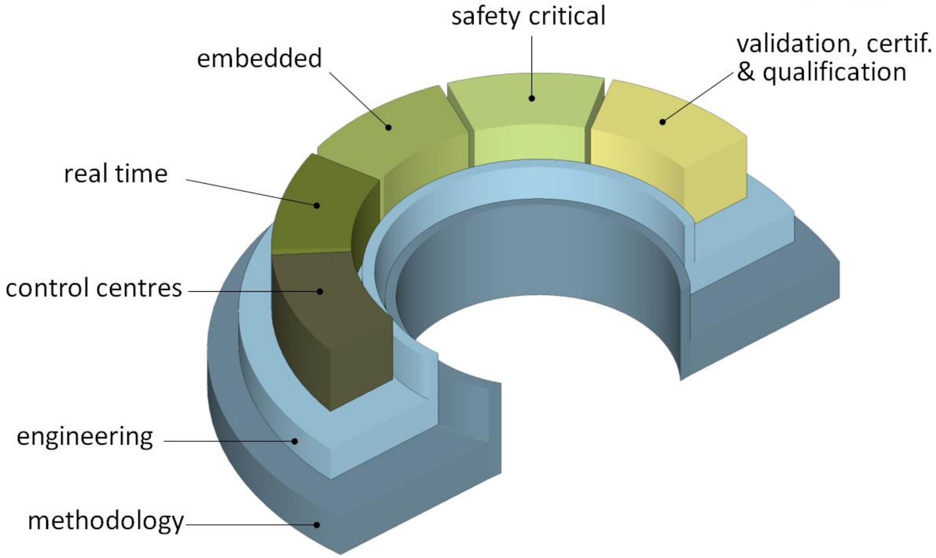


GTD main figures (2008):

- 25MEuros turnover
  - Space: 45%
  - Aeronautics: 18%
  - Defence & Security: 20%
  - Energy: 17%
- 60% export
- 250 employees
- 85% engineers & high degree
- R&D investment: 2.5MEuros



Experience in GTD has grew-up by means of continuous participation in large, demanding, cutting-edge projects.
By the way, GTD has become a reference in fine engineering and wise application of the most demanding methodologies.



<u>Technical Basis:</u>

- Methodology
- Engineering skills

<u>Areas of Expertise</u>:

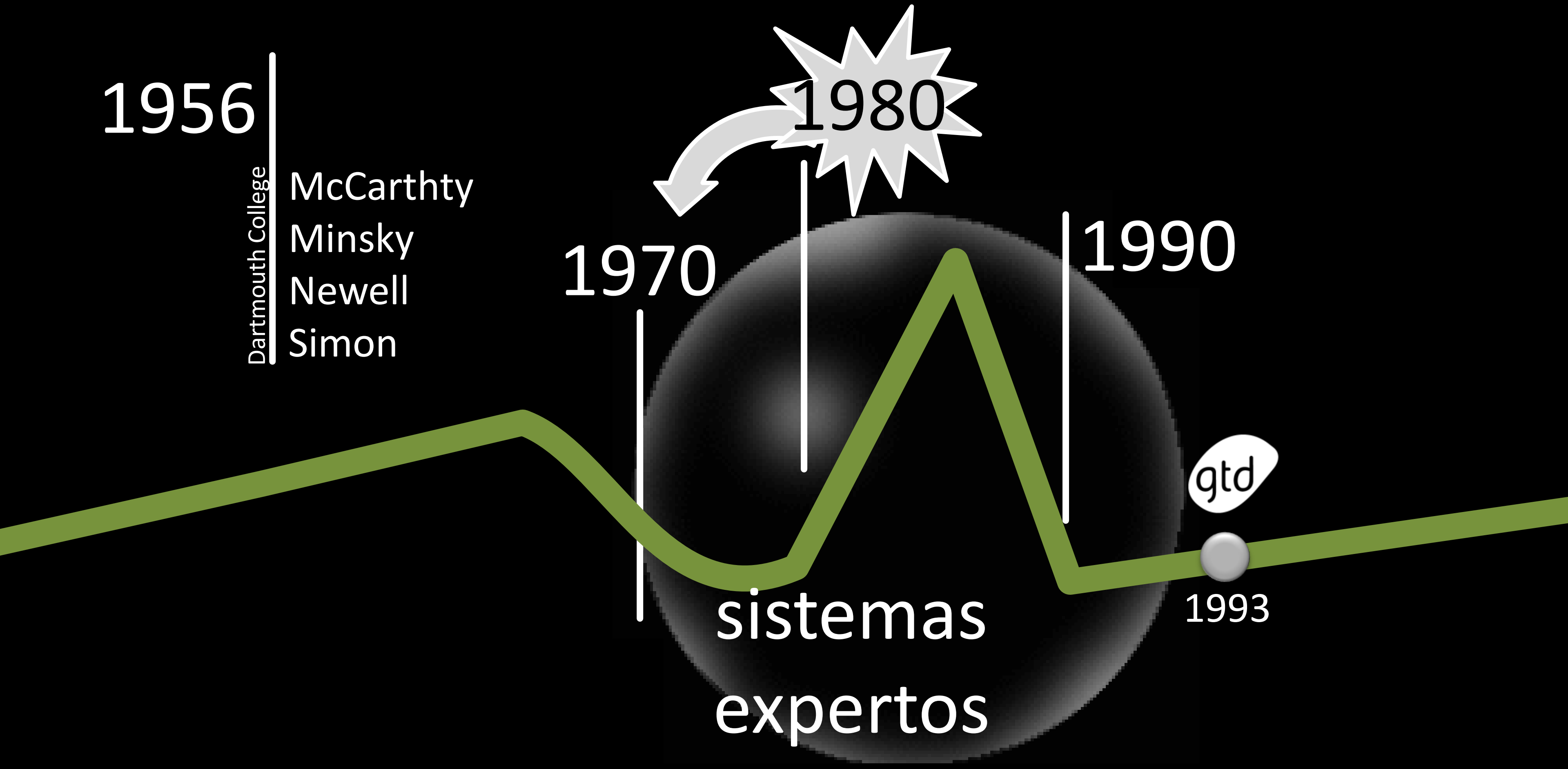
- Validation, Certification & Qualification
- Safety Critical
- Embedded
- Real-Time
- Control Centers

Inteligencia Artificial en

Aplicaciones

Aeroespaciales

1. Sistemas Críticos y Complejos
2. Centros de Control
3. Aplicaciones Operativas de Inteligencia Artificial


1956
Dartmouth College
McCarthty
Minsky
Newell
Simon
1970
1980
1990
gtd
1993
sistemas
expertos

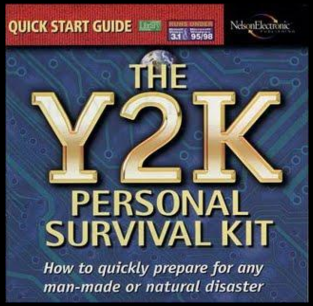
<html>

1990

1993

1995,97

1. Euforia Sistemas Expertos
2. Pinchazo de la burbuja
3. Potencial innovador de la I.A.



1993 … 1997

CORBA

eufemismo

KES

AGENTES

knowledge

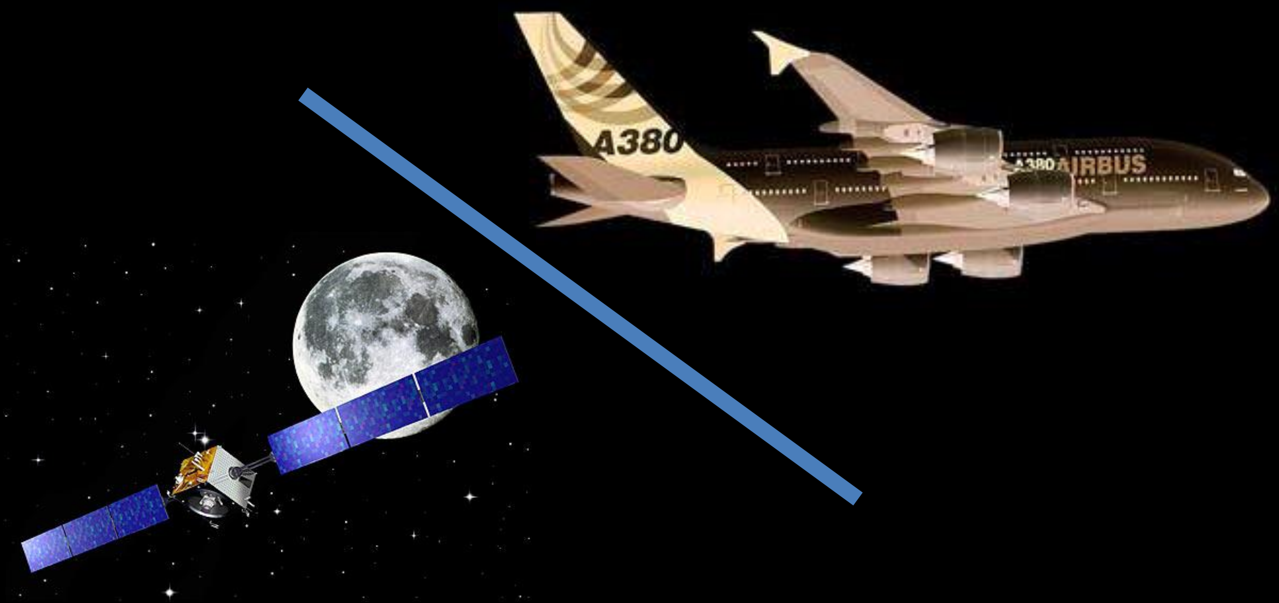
enabled

services

SOA

Web Services

- innovación
- inteligencia artificial



innovación

12/11/2009

NO TURNING BACK

"Spain should not use the recession as an excuse to stall plans to boost its scientific enterprise".

"In the long-term, industry will be poorly served by a failure to develop and maintain a strong basic-research base. Spain is ill-advised to wed itself to the simplistic and outdated notion that a country can live on transferring knowledge while running down the knowledge generator. This is not a wise way to respond to the financial crisis".

www.nature.com/nature/journal/v462/n7270/full/462137b.html

innovación

EL PAÍS

EL PERIÓDICO GLOBAL EN ESPAÑOL

TRIBUNA: JAVIER LÓPEZ FACAL

Cuando la innovación estaba muy mal vista

Los romanos, que importaban aplicadamente mitos y conceptos griegos, acabaron creyendo que todo lo nuevo era sospechoso y, en el fondo, malo

17/11/2009

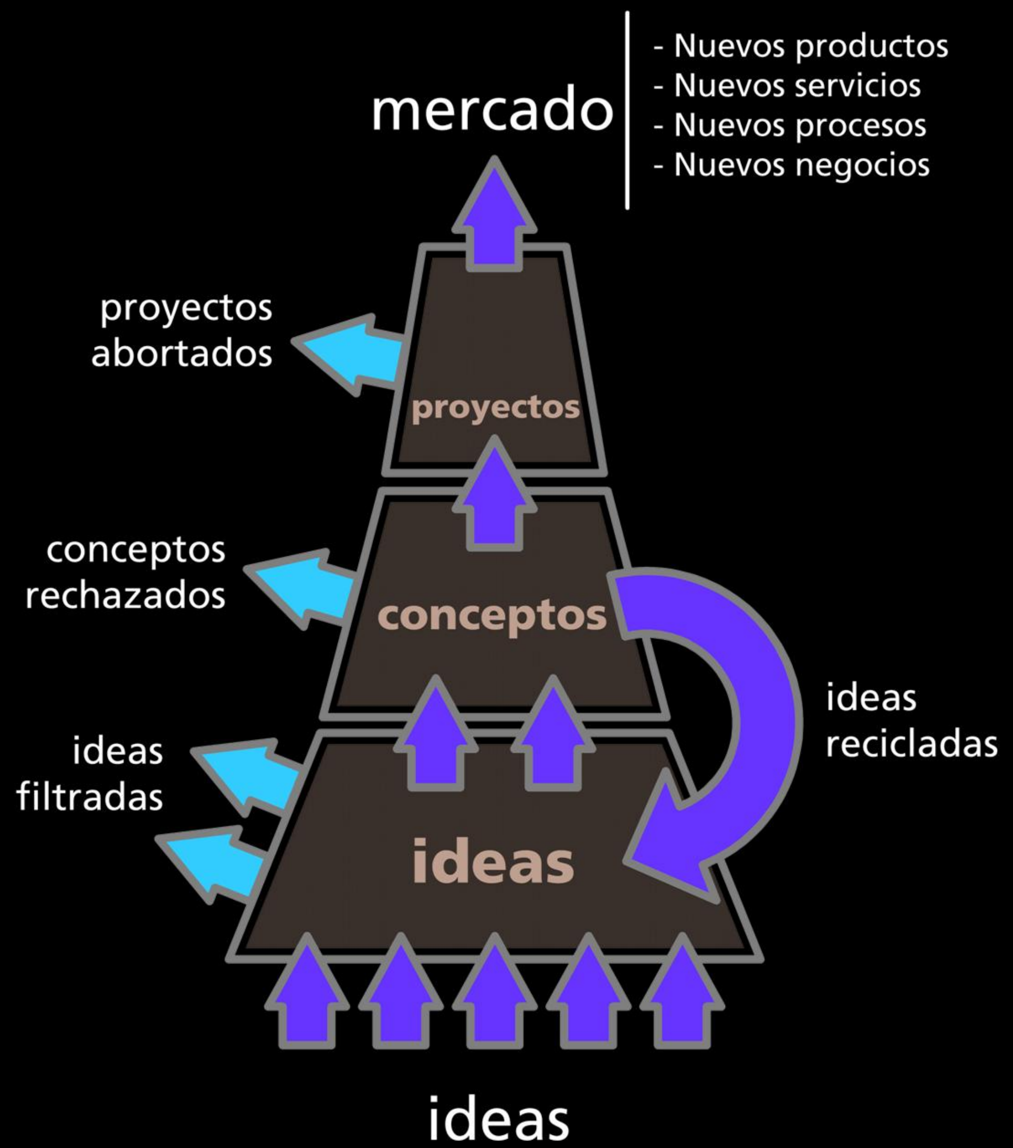
CUANDO LA INNOVACIÓN ESTABA MUY MAL VISTA

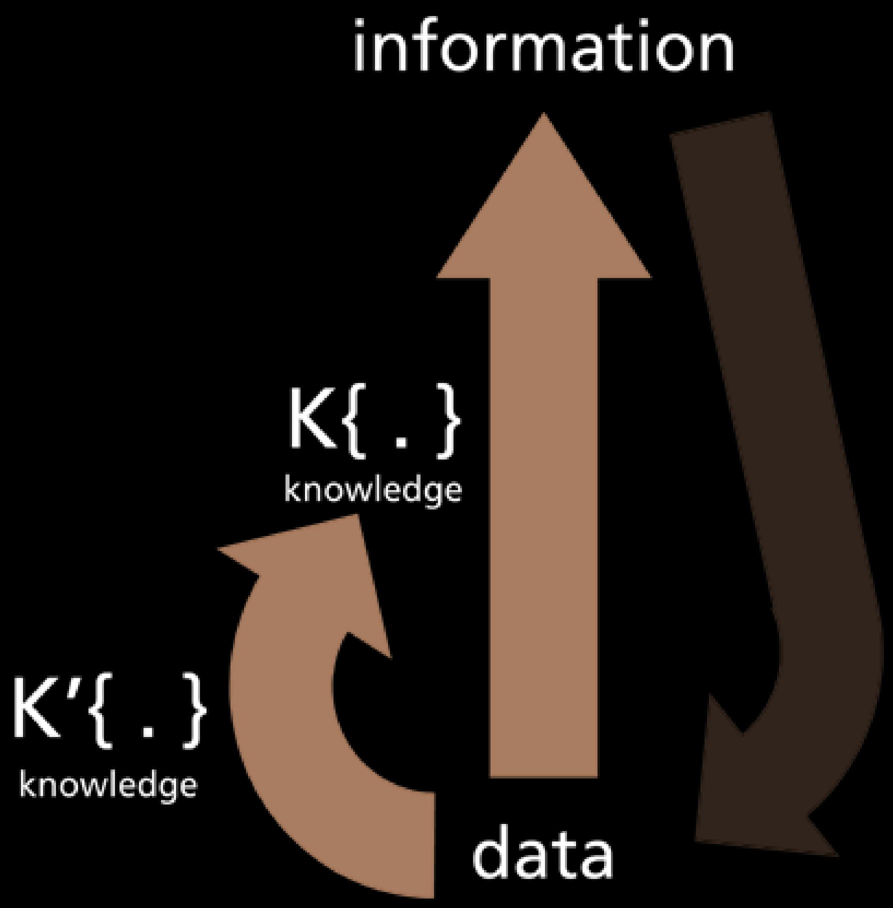
“El pobre fraile oxoniense Roger Bacon (1214-1294) fue condenado a la cárcel propter quasdam novitates suspectas, "a causa de algunas sospechosas novedades“

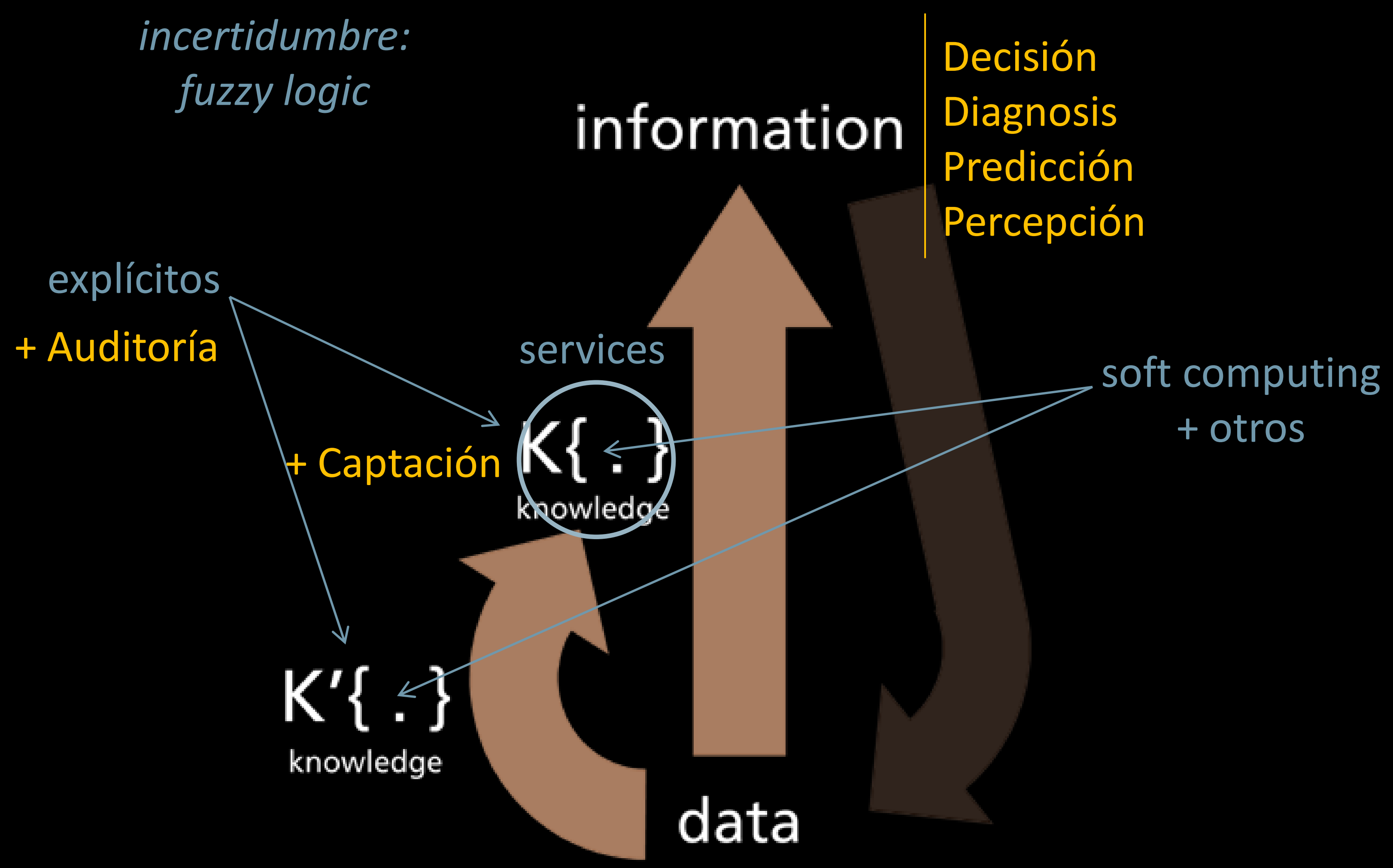
“[…] que cuando se acaba creando el neologismo "innovación", allá por el siglo XIV, aparezca siempre en contextos condenatorios”.

“[…]víctimas cuyo único delito consistía en su deseo de conocer, de descubrir, de producir cosas nuevas, es decir, en su cupido rerum novarum”.

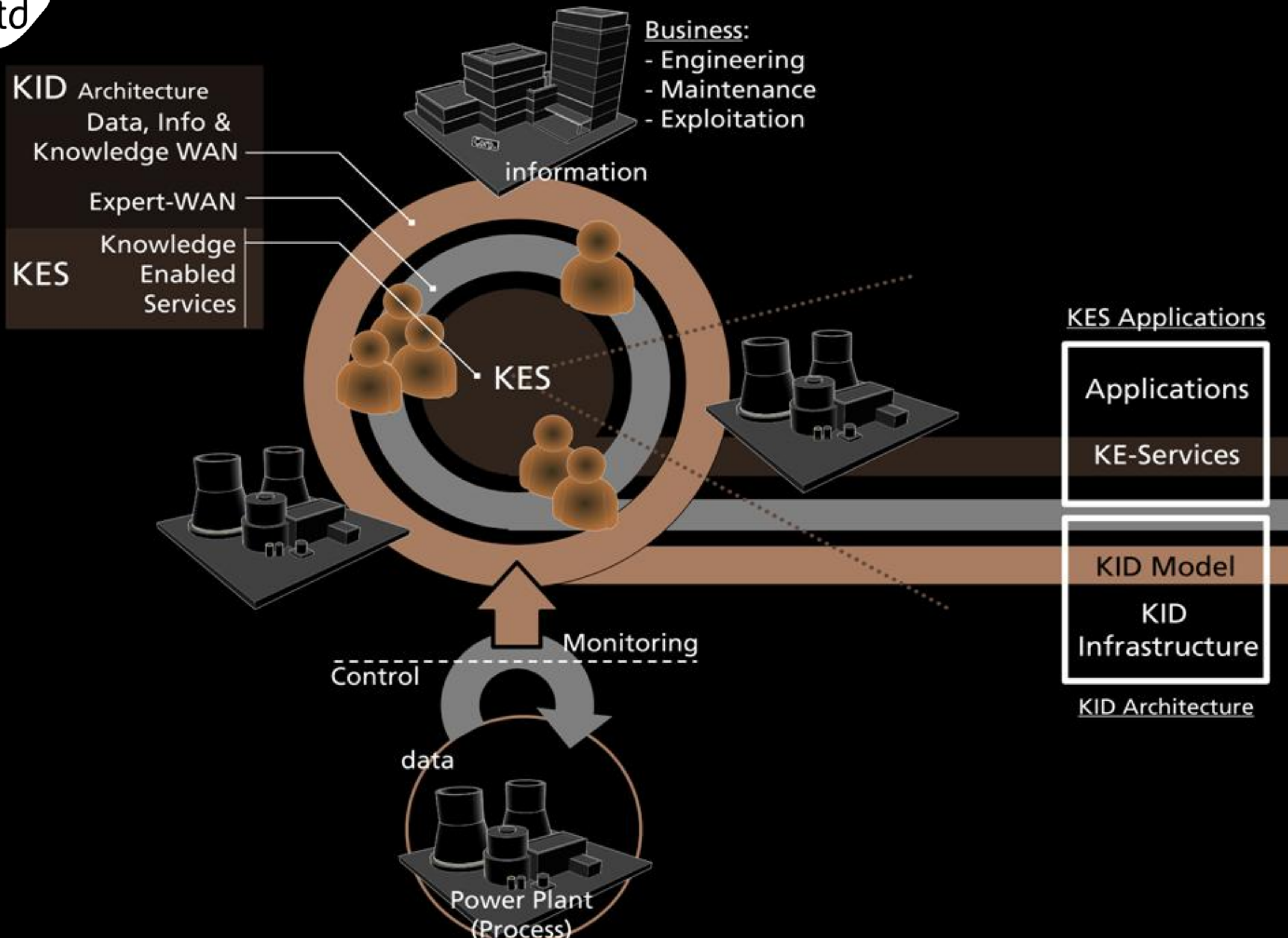
http://www.elpais.com/articulo/sociedad/innovacion/estaba/mal/vista/elpepusoc/20091117elpepusoc_12/Tes


mercado
- Nuevos productos
- Nuevos servicios
- Nuevos procesos
- Nuevos negocios
proyectos abortados
proyectos
conceptos rechazados
conceptos
ideas recicladas
ideas filtradas
ideas
ideas


information
K{ . }
knowledge
K'{ . }
knowledge
data



incertidumbre:
fuzzy logic
information
Decisión
Diagnosis
Predicción
Percepción
explícitos
+ Auditoría
services
soft computing
+ otros
+ Captación
K{ . }
knowledge
K'{ . }
knowledge
data



KID Architecture
Data, Info &
Knowledge WAN
Expert-WAN
Knowledge
Enabled
Services
KES
Business:
- Engineering
- Maintenance
- Exploitation
information
KES
KES Applications
Applications
KE-Services
KID Model
KID
Infrastructure
KID Architecture
Monitoring
Control
data
Power Plant
(Process)

UAV

Unmanned
Aerial
Vehicle

Inserción del UAV en el espacio aéreo no segregado: "see & avoid"

UGV Unmanned Ground Vehicle

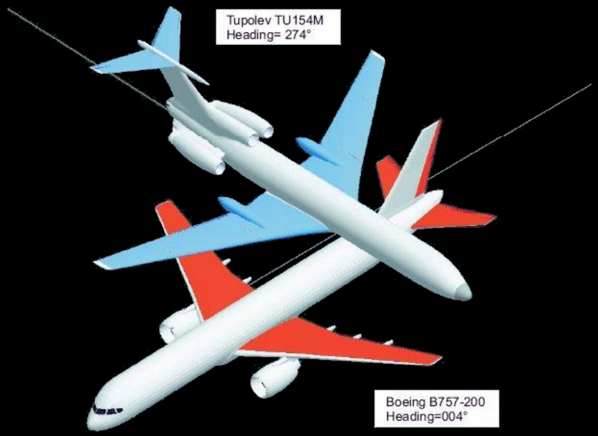
paralelismo

www.arc.vub.ac.be/html/system.htm

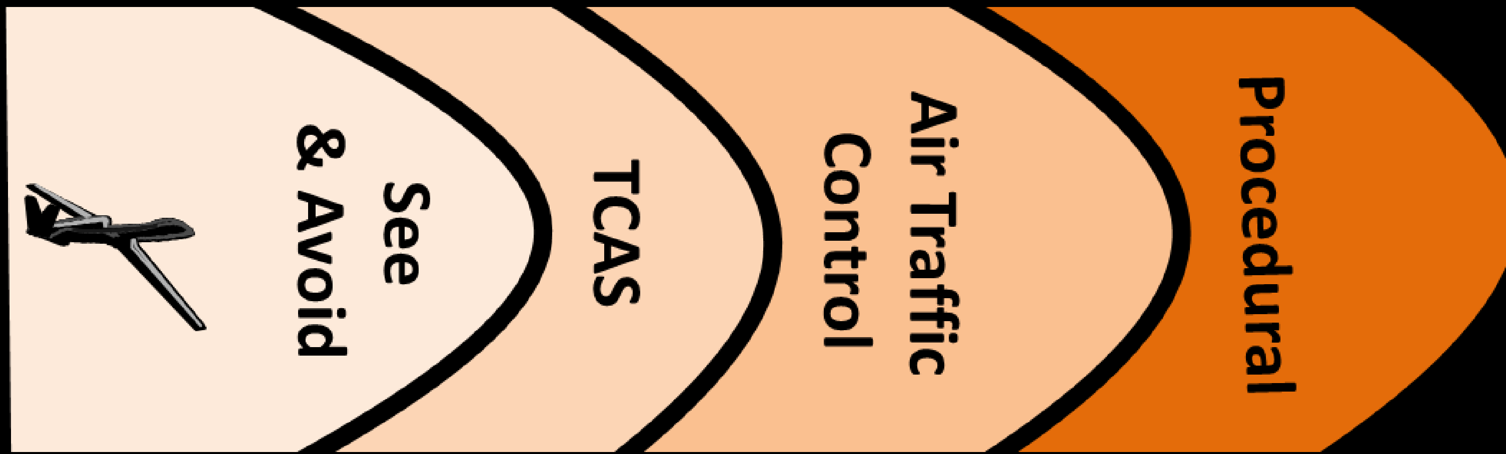
“Los pilotos del Airbus A320 de la Northwest Airlines no sólo se olvidaron, la noche del miércoles, de aterrizar en el aeropuerto de Minneapolis, que es donde marcaba la ruta procedente de San Diego, sino que durante 78 minutos respondieron con el silencio a los controladores. Recorrieron unos 240 kilómetros de más –150 millas–, se adentraron en el cielo de Wisconsin antes de girar en redondo y regresar al punto establecido.

http://www.lavanguardia.es/internacional/noticias/20091024/53810598567/dos-pilotos-se-despistan-y-se-pasan-de-largo-el-aeropuerto-de-destino-minneapolis-airbus-a320-the-wa.html

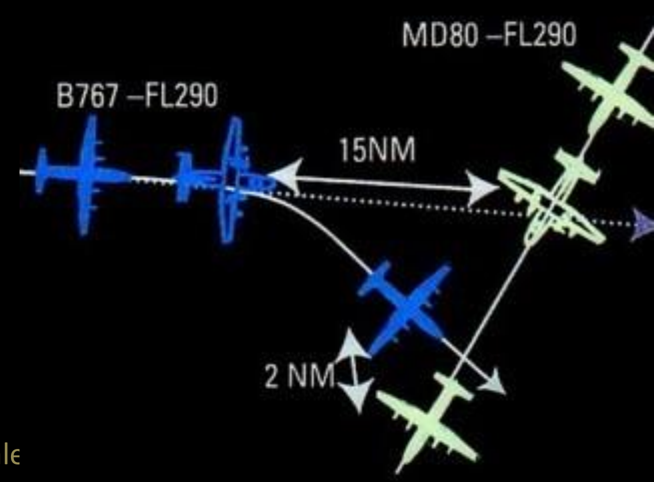
21/10/2009



http://en.wikipedia.org/wiki/2002_Überlingen_mid-air_collision

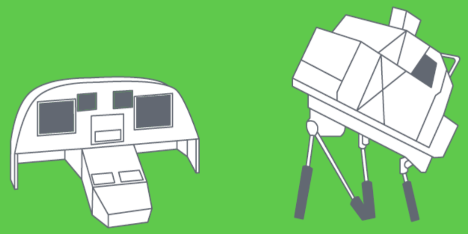


TCAS
Traffic alert and
Collision
Avoidance
System



VIDEO DE PRESENTACIÓN

- The two **simulations** are performed with the involvement of pilots: a Part Task Evaluation (PTE) held in year 3 of the project and a Main Task Evaluation (MTE) held at the end of the project. The PTE aims to assess each of the three single functions (weather, traffic, terrain). Following the PTE, a selection of tools will be chosen to be integrated in the NG-ISS and then assessed during the final evaluation.



Within FLYSAFE, together with the PTE and MTE simulations, two **flight test** campaigns are also organised in the final project phase. The flight tests are mainly aimed at verifying the technical aspects of the airborne weather tools. In fact FLYSAFE will also launch research activities on a ground-based Weather Information Management System (WIMS) as it constitutes a major stakeholder for safety data relating to weather phenomena. Although the solutions proposed by the WIMS will be targeting the on-board safety requirements of the crew, their applicability also extends to the Flight Management System (FMS) and ATM.

THE FLYSAFE CONSORTIUM

Coordinated by Thales, the FLYSAFE project is co-funded by the European Commission and launched as part of the 6th Framework Programme of the European Commission. It groups 36 partners from 14 countries for a 4 year joint effort and a total cost of 53 million Euros.

Airframers: Airbus Deutschland, Airbus France, Eurocopter Deutschland, Dassault Aviation

System providers: Thales Avionics, BAE Systems, Diehl Avionik Systeme GmbH

Research centres: DLR Oberpfaffenhofen, NLR, ONERA, CNRS, TsAGI

Meteorological Offices: UK Met Office, Météo France

Universities: University of Hanover, Université Catholique de Louvain, Technische Universität Darmstadt, Cranfield University, University of Malta

Airlines: Adria Airways, Air Malta

Air Traffic Control authorities: AustroControl

Specialised companies: GTD Sistemas de Informaciòn, Euro Telematik AG, Galileo Avionica, Hellenic Aerospace Industry, Jeppesen GmbH, Rockwell Collins France, Thales Air Defence

Specialised SMEs: Avitronics Research, AVTECH, Deep Blue, Skysoft Portugal, Hovemere, USE2ACES, Thales Laser

www.eu-flysafe.org | flysafe@eu-flysafe.org

This leaflet is produced under the EC contract AIP4-CT-2005-516167

FLYSAFE

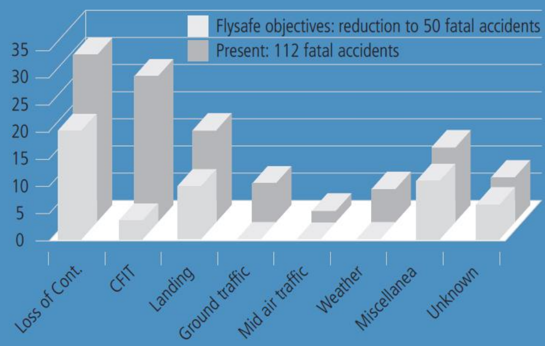
AIRBORNE INTEGRATED SYSTEMS FOR SAFETY IMPROVEMENT, FLIGHT HAZARD PROTECTION AND ALL WEATHER OPERATIONS

FLYSAFE is the Project federating the most relevant skills across Europe to provide solutions for safety in airspace as defined by the ACARE VISION 2020. FLYSAFE intends to design, develop, implement, test and validate a complete **Next Generation Integrated Surveillance System** and to develop, validate and test **Weather Information Management Systems** to provide aircraft with weather related information and prove that they increase safety.

SIXTH FRAMEWORK PROGRAMME

FUTURE SITUATION IN AIR TRAFFIC

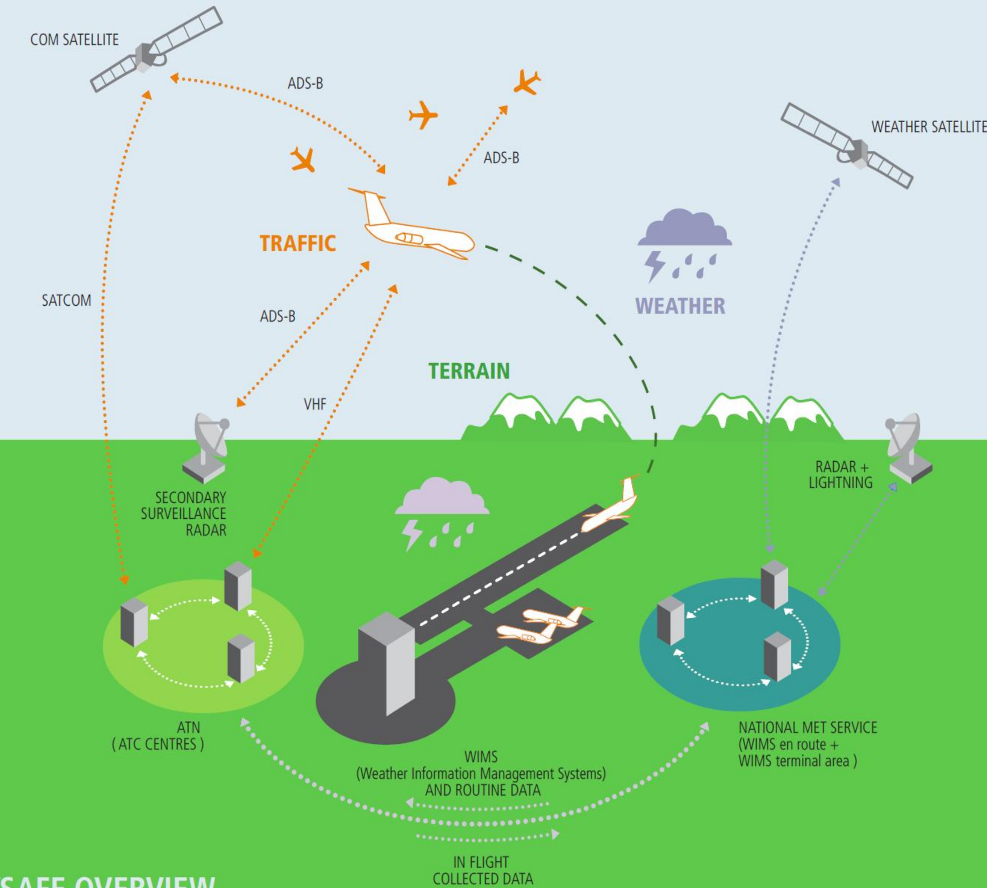
Air traffic is expected to triple world-wide within the next 20 years. With the existing on-board and on-ground systems, this would lead to an increase of aircraft accidents in the same, or possibly even a higher proportion. Despite the fact that accidents are rare, this increase is perceived as unacceptable by society and new systems and solutions must be found to maintain the accident rate at its current low level, or preferably reduce it.



FLYSAFE GOAL

FLYSAFE will be the first decisive step towards the "VISION 2020" produced by the ACARE, for safety in airspace, with implementation of solutions ranging from 2 to 5 years after project end. FLYSAFE will focus particularly on three types of threats: adverse weather conditions, traffic collision and flight into terrain, covering all phases of flight. Each area is considered separately, but brought together by innovative fusion functions into a **Next Generation Integrated Surveillance System, NG-ISS**, that will be interfaced with the other aircraft systems. The NG-ISS will allow the pilot to have a detailed, accurate, homogeneous and unambiguous presentation of the aircraft safety situation during all phases of flight. It will include such capabilities as situation awareness; advance warning; alert prioritization and innovative human-machine interface.

A particular emphasis is given to the weather aspects through the development of the **Weather Information Management Systems** (WIMS), which will allow to provide information about small volumes of airspace and small time periods.



FLYSAFE OVERVIEW

FLYSAFE is mainly concentrating on large transport aeroplanes operated in commercial air transport. However, some solutions will potentially address the commuter and helicopter market, possibilities of applications to these sectors will be studied in the project.

Within the project the activity is related to three principal type of hazards: Weather, Traffic and Terrain. To achieve the FLYSAFE objective the project is composed of 7 **workpackages**: WP1 deals with the operational assessment, WP2 with atmospheric hazards, WP3 with traffic hazards, WP4 with terrain hazards, WP5 with the development of the NG-ISS, WP6 with the evaluation and results assessment, WP7 with exploitation, standards and dissemination. WP2, WP3 and WP4 also deal with the development of their relative functions.

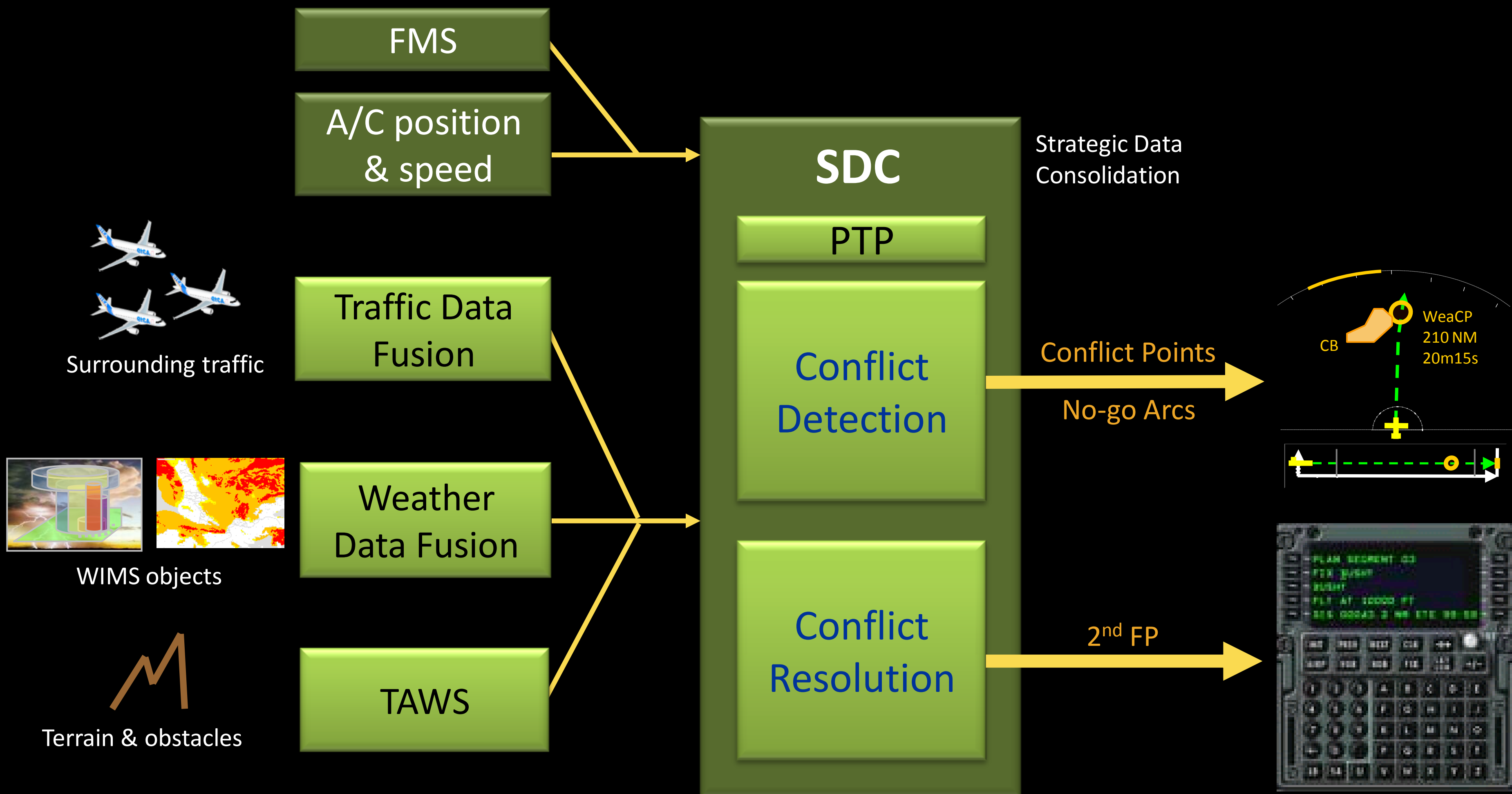
To assess the tools developed along the project, FLYSAFE includes a safety assessment process, 2 simulation sessions and 2 flight test campaigns. The **safety** assessment process is divided in 3 main sub-processes: qualitative safety assessment, risk assessment modelling and a quantitative safety assessment. The process aims at identifying aircraft operation hazards that can be reduced by the NG-ISS and possible hazards generated by the system itself. Each hazard is classified according to its severity and frequency; appropriate mitigation means are identified to ensure an agreed level of safety to all aircraft operations.

Airborne Integrated Systems for Safety Improvement, Flight Hazard Protection and All Weather Operations

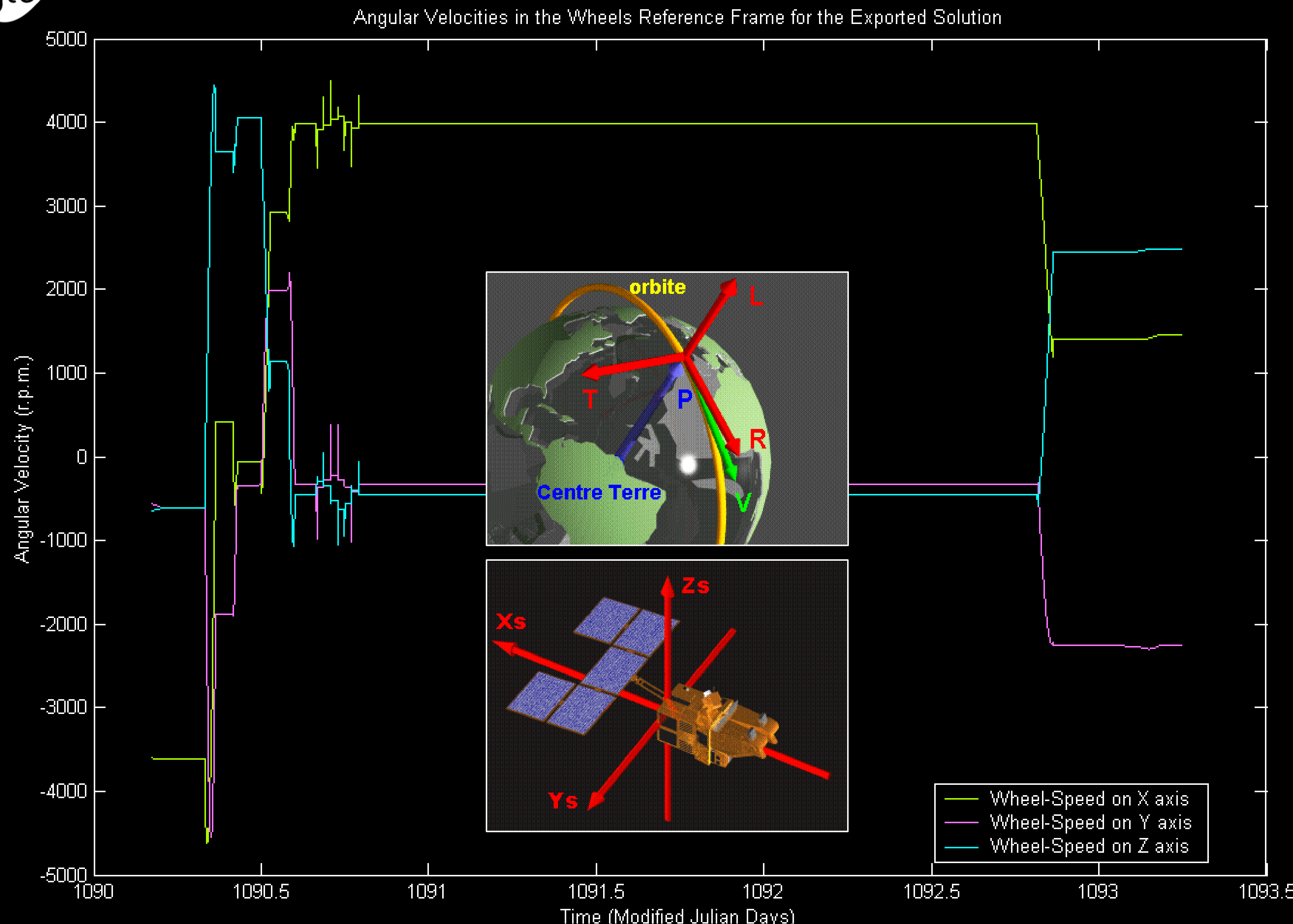
EC contract AIP4-CT-2005-516167

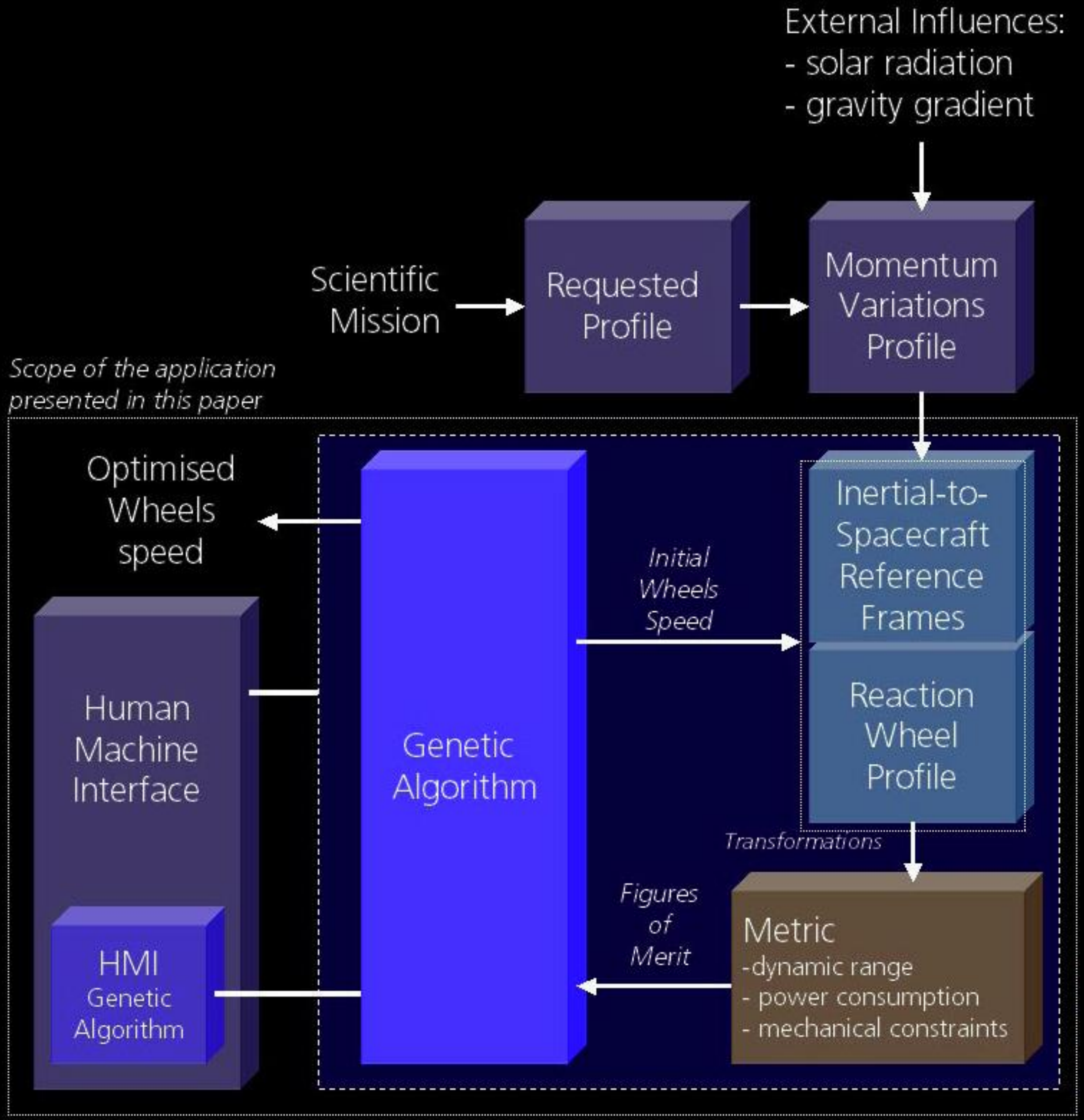
Detectados dos conflictos potenciales a 125NM y a 180NM

Vuelo de pruebas “Paris-Innsbruck”, 17 de Agosto de 2008

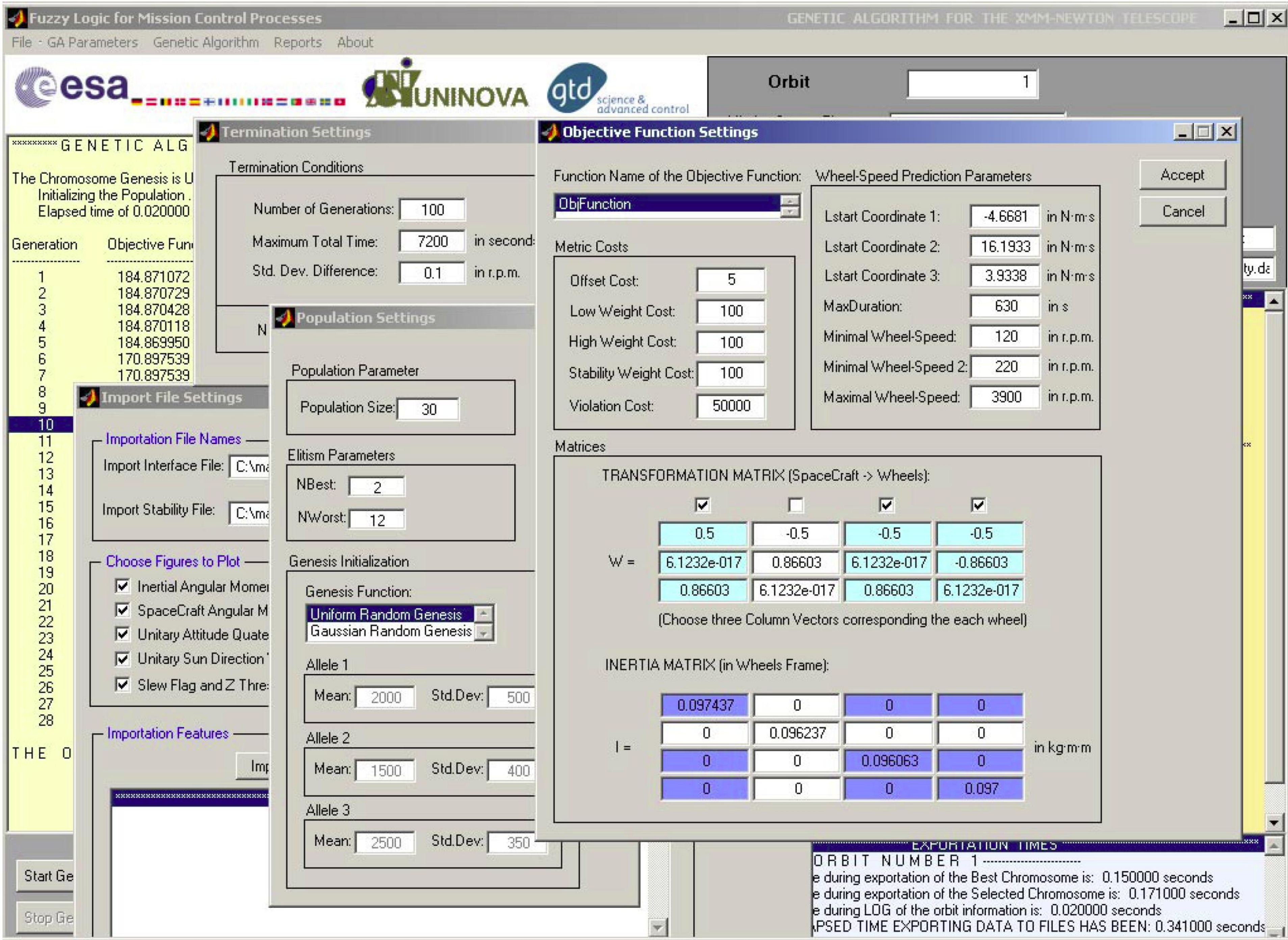

FMS
A/C position & speed
Surrounding traffic
Traffic Data Fusion
WIMS objects
Weather Data Fusion
Terrain & obstacles
TAWS
SDC
Strategic Data Consolidation
PTP
Conflict Detection
Conflict Resolution
Conflict Points
No-go Arcs
2nd FP
CB
WeaCP
210 NM
20m15s

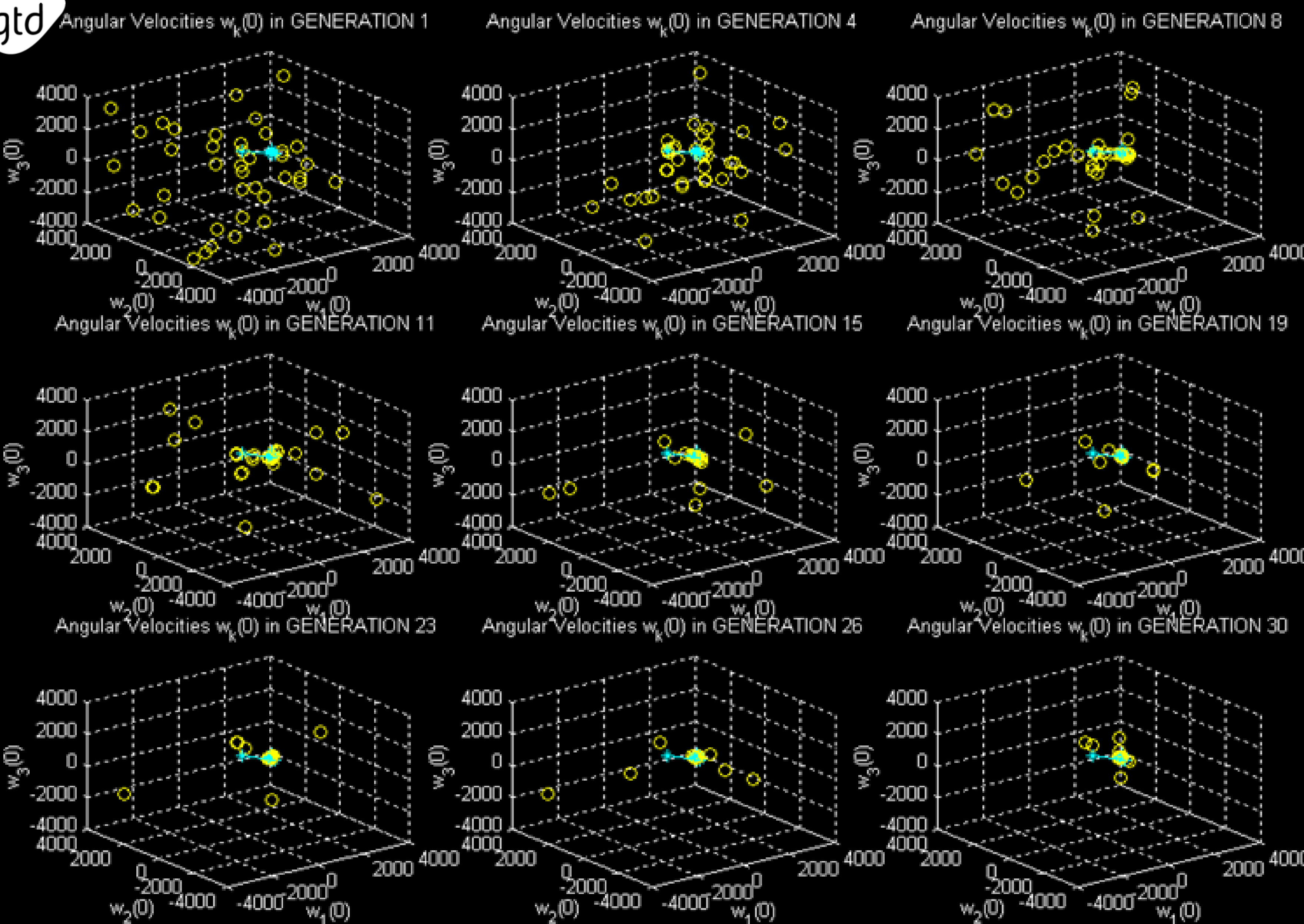

XMM
http://xmm.vilspa.esa.es/


Angular Velocities in the Wheels Reference Frame for the Exported Solution
Angular Velocity (r.p.m.)
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1090
1090.5
1091
1091.5
1092
1092.5
1093
1093.5
Time (Modified Julian Days)
Wheel-Speed on X axis
Wheel-Speed on Y axis
Wheel-Speed on Z axis
orbite
L
T
P
R
V
Centre Terre
Zs
Xs
Ys



ESM'2002 - 16th EUROPEAN SIMULATION MULTICONFERENCE


Fuzzy Logic for Mission Control Processes
GENETIC ALGORITHM FOR THE XMM-NEWTON TELESCOPE
File - GA Parameters
Genetic Algorithm
Reports
About
esa
UNINOVA
gtd science & advanced control
Orbit
1
GENETIC ALG
The Chromosome Genesis is U
Initializing the Population
Elapsed time of 0.020000
Generation
Objective Fun
1 184.871072
2 184.870729
3 184.870428
4 184.870118
5 184.869950
6 170.897539
7 170.897539
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
THE O
Start Ge
Stop Ge
Termination Settings
Termination Conditions
Number of Generations: 100
Maximum Total Time: 7200 in second
Std. Dev. Difference: 0.1 in r.p.m.
Population Settings
Population Parameter
Population Size: 30
Elitism Parameters
NBest: 2
NWorst: 12
Genesis Initialization
Genesis Function:
Uniform Random Genesis
Gaussian Random Genesis
Allele 1
Mean: 2000 Std.Dev: 500
Allele 2
Mean: 1500 Std.Dev: 400
Allele 3
Mean: 2500 Std.Dev: 350
Import File Settings
Importation File Names
Import Interface File: C:\ma
Import Stability File: C:\ma
Choose Figures to Plot
Inertial Angular Momen
SpaceCraft Angular M
Unitary Attitude Quate
Unitary Sun Direction
Slew Flag and Z Thre
Importation Features
Imp
Objective Function Settings
Function Name of the Objective Function:
ObjFunction
Metric Costs
Offset Cost: 5
Low Weight Cost: 100
High Weight Cost: 100
Stability Weight Cost: 100
Violation Cost: 50000
Wheel-Speed Prediction Parameters
Lstart Coordinate 1: -4.6681 in N·m·s
Lstart Coordinate 2: 16.1933 in N·m·s
Lstart Coordinate 3: 3.9338 in N·m·s
MaxDuration: 630 in s
Minimal Wheel-Speed: 120 in r.p.m.
Minimal Wheel-Speed 2: 220 in r.p.m.
Maximal Wheel-Speed: 3900 in r.p.m.
Accept
Cancel
Matrices
TRANSFORMATION MATRIX (SpaceCraft -> Wheels):
W =
0.5 -0.5 -0.5 -0.5
6.1232e-017 0.86603 6.1232e-017 -0.86603
0.86603 6.1232e-017 0.86603 6.1232e-017
(Choose three Column Vectors corresponding the each wheel)
INERTIA MATRIX (in Wheels Frame):
I =
0.097437 0 0 0
0 0.096237 0 0
0 0 0.096063 0
0 0 0 0.097
in kg·m·m
EXPORTATION TIMES
ORBIT NUMBER 1
e during exportation of the Best Chromosome is: 0.150000 seconds
e during exportation of the Selected Chromosome is: 0.171000 seconds
e during LOG of the orbit information is: 0.020000 seconds
PSED TIME EXPORTING DATA TO FILES HAS BEEN: 0.341000 seconds


Angular Velocities w_k(0) in GENERATION 1
Angular Velocities w_k(0) in GENERATION 4
Angular Velocities w_k(0) in GENERATION 8
Angular Velocities w_k(0) in GENERATION 11
Angular Velocities w_k(0) in GENERATION 15
Angular Velocities w_k(0) in GENERATION 19
Angular Velocities w_k(0) in GENERATION 23
Angular Velocities w_k(0) in GENERATION 26
Angular Velocities w_k(0) in GENERATION 30
w_1(0)
w_2(0)
w_3(0)

Radiation Monitoring & Diagnostic Tool for Observatory Spacecraft

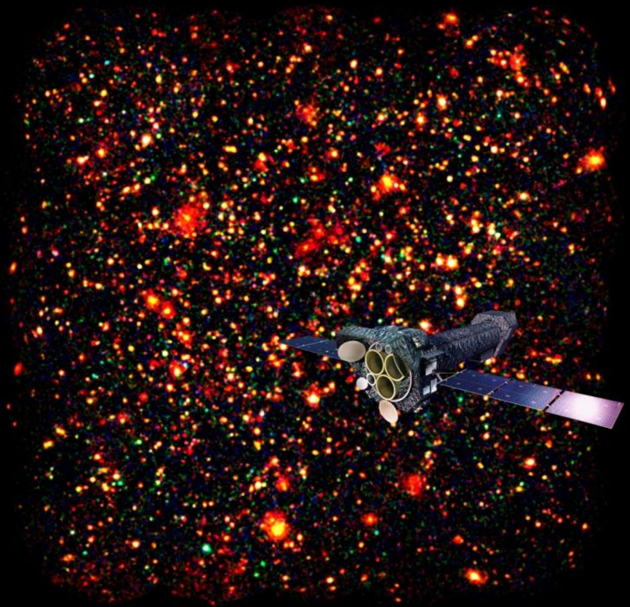
E.Serpell
XMM-Newton Spacecraft Operations Engineer

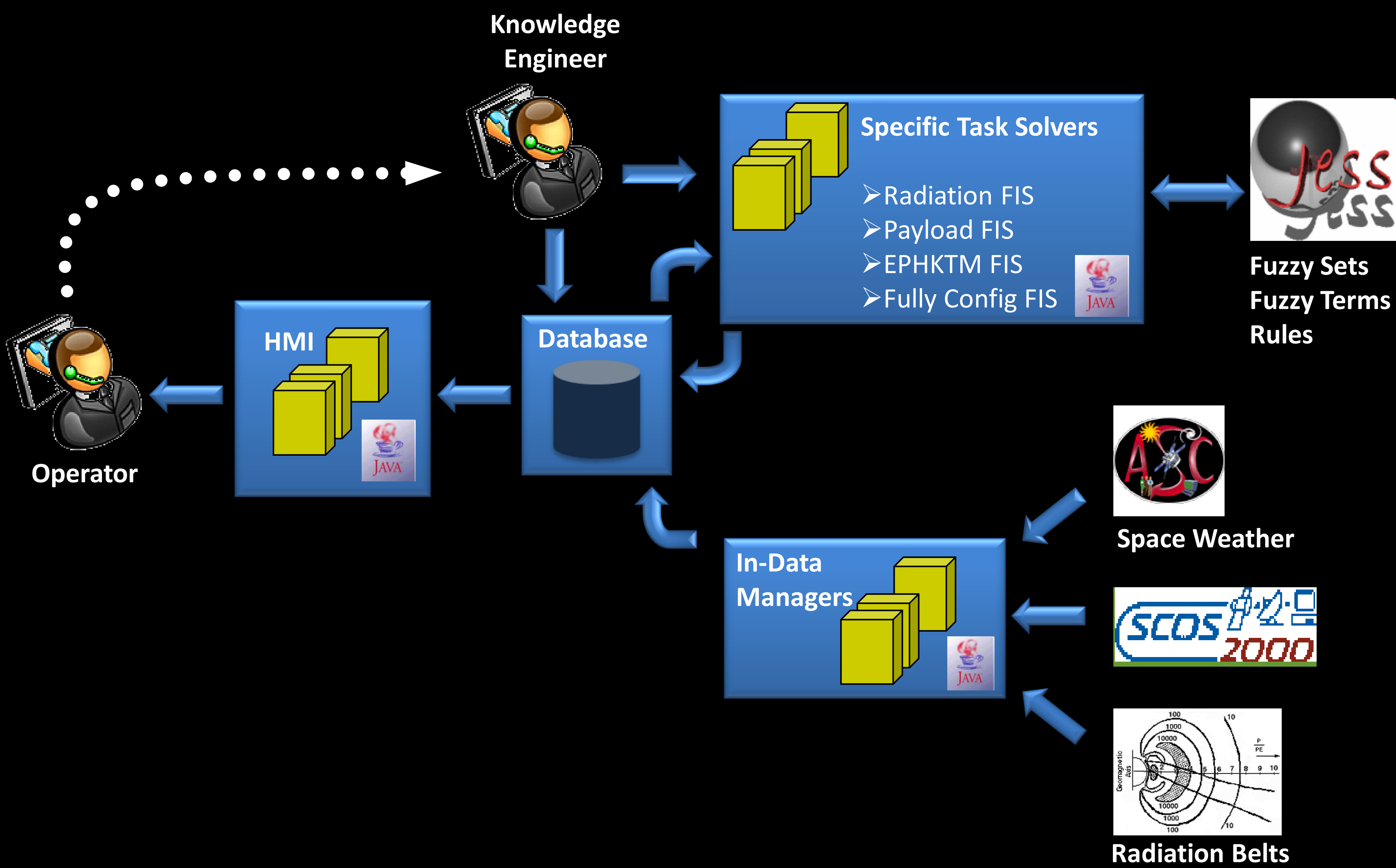
esa XMM-Newton

The Radiation Hazard

- **The space environment is notoriously hazardous for electrical components. These are continually bombarded with a stream of “cosmic rays”, mostly protons, that degrade performance. There is additionally a problem of Single Event Upset (SEU).**
- **Although designed to operate in the space environment for many years there are often actions that can be performed by spacecraft operators to minimise damage in extreme conditions.**
  - Switch off sensitive equipment and high voltages
  - Close protective mechanisms
  - Maintain a “safe” configuration and attitude

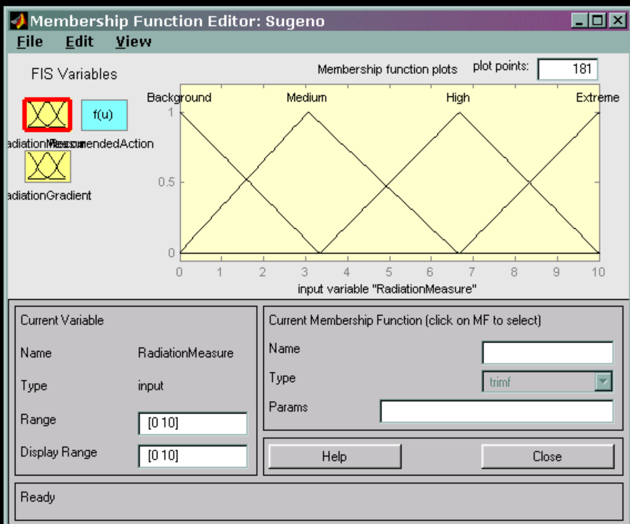
esa XMM-Newton

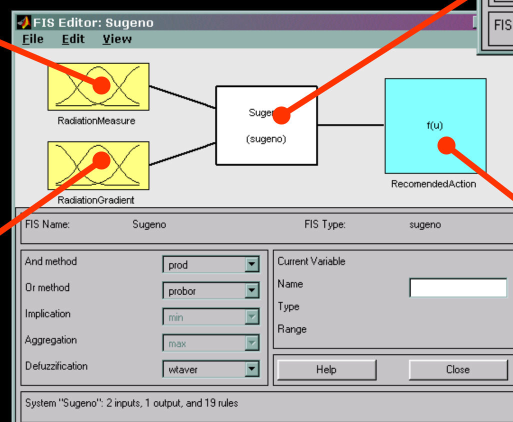




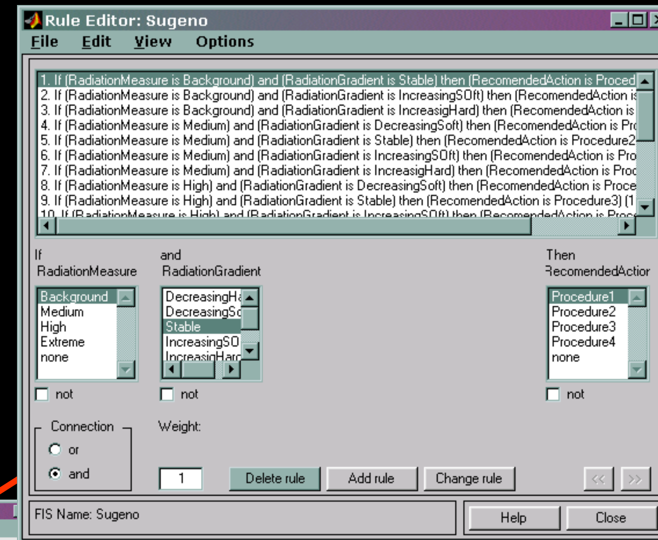
Knowledge Engineer
Specific Task Solvers
➢Radiation FIS
➢Payload FIS
➢EPHKTM FIS
➢Fully Config FIS
Fuzzy Sets
Fuzzy Terms
Rules
Operator
HMI
Database
In-Data Managers
Space Weather
Radiation Belts

Input 1: Current Radiation

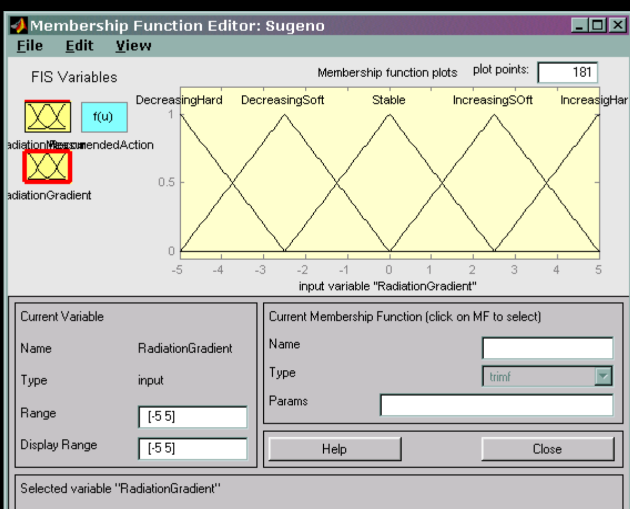




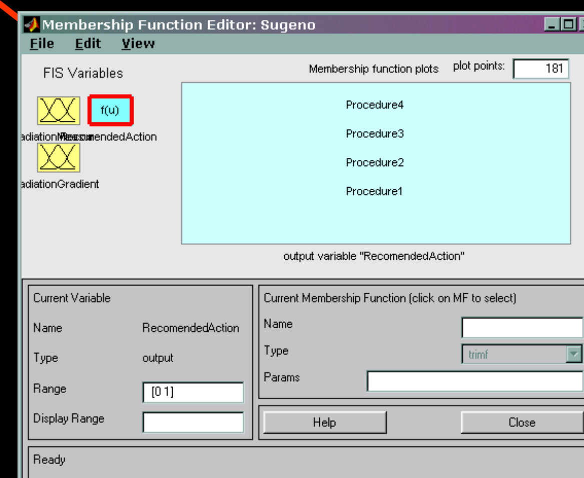
Fuzzy Inference System



Rules Editor

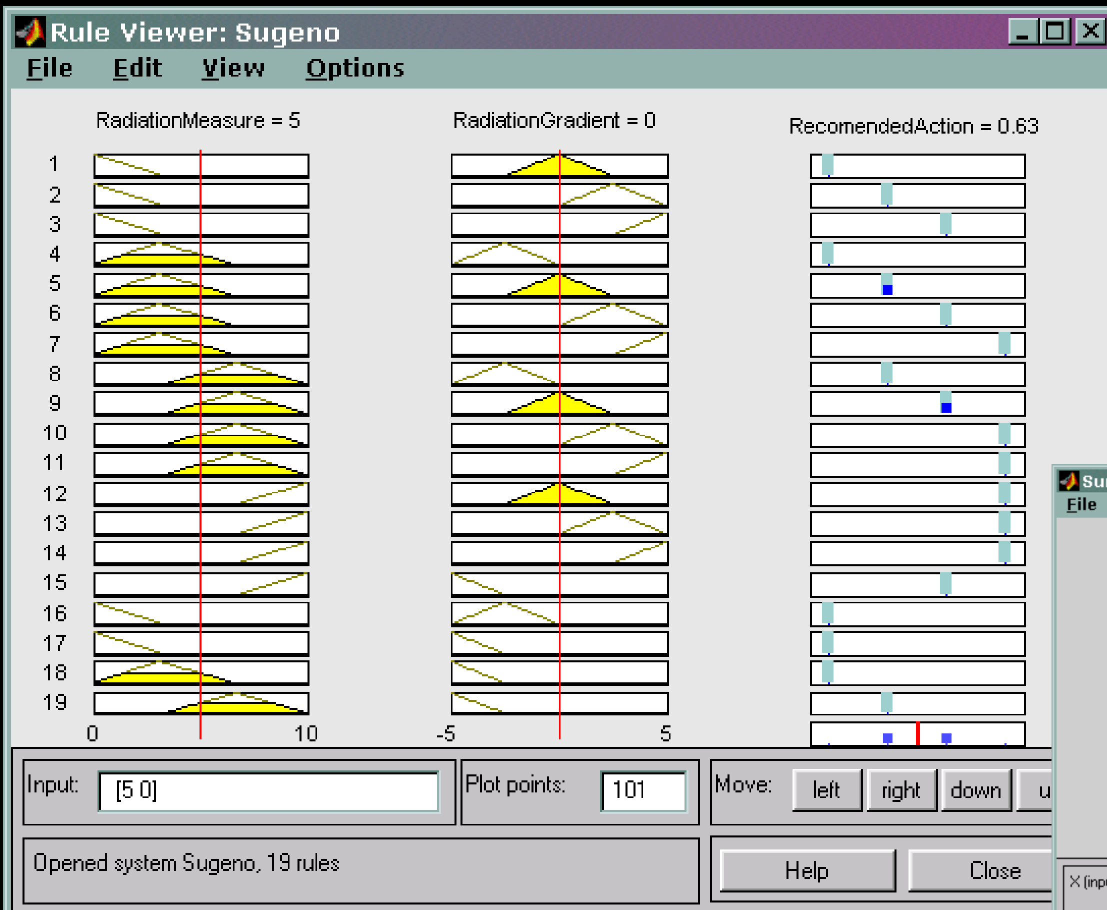


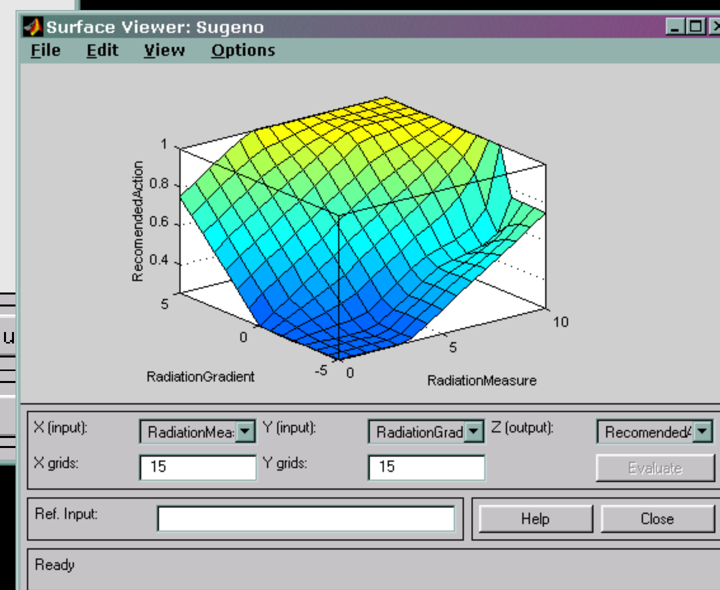
Input 2: Predicted Radiation



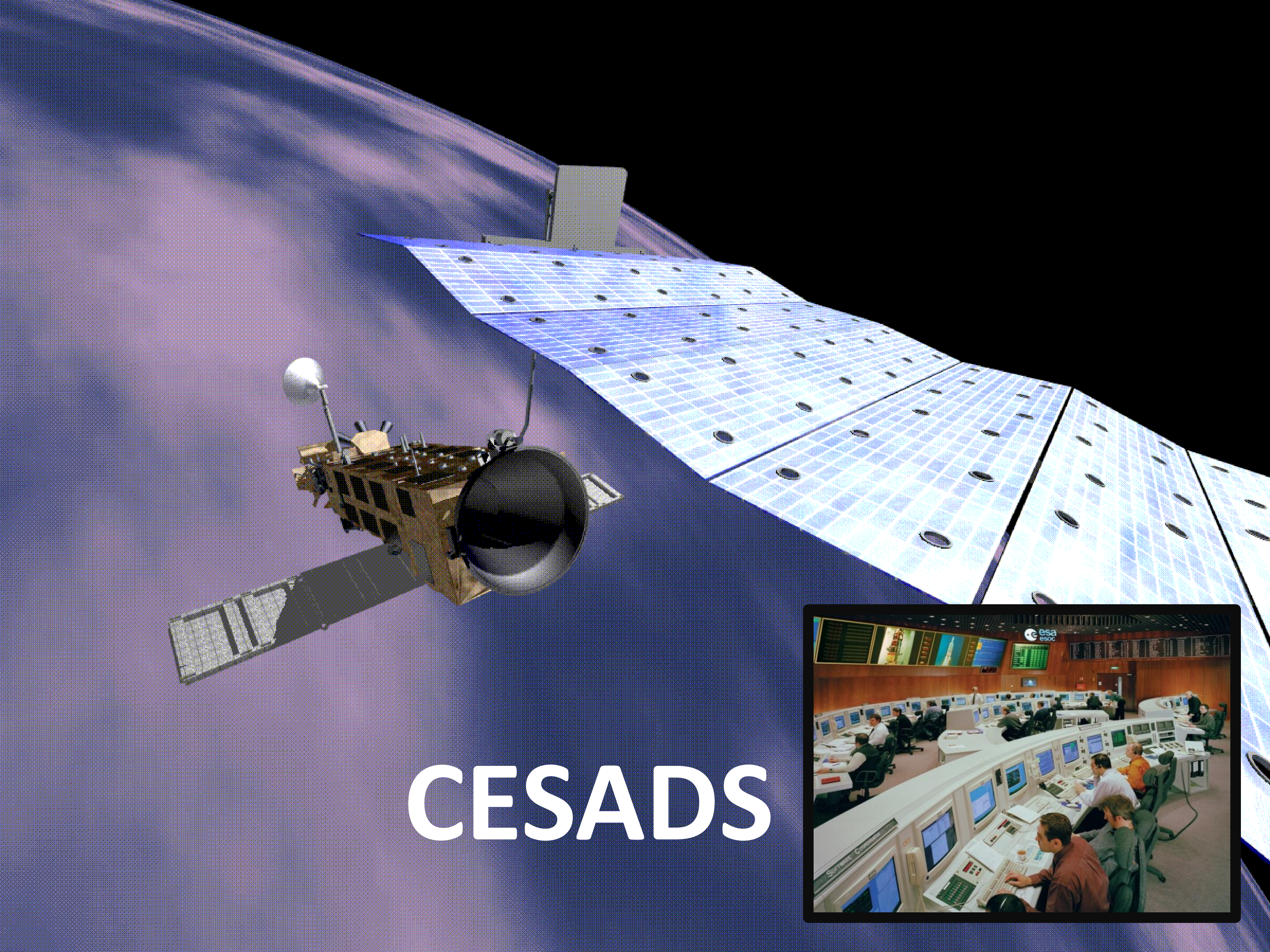
Output: Recommended Action

FIS: Surface viewer

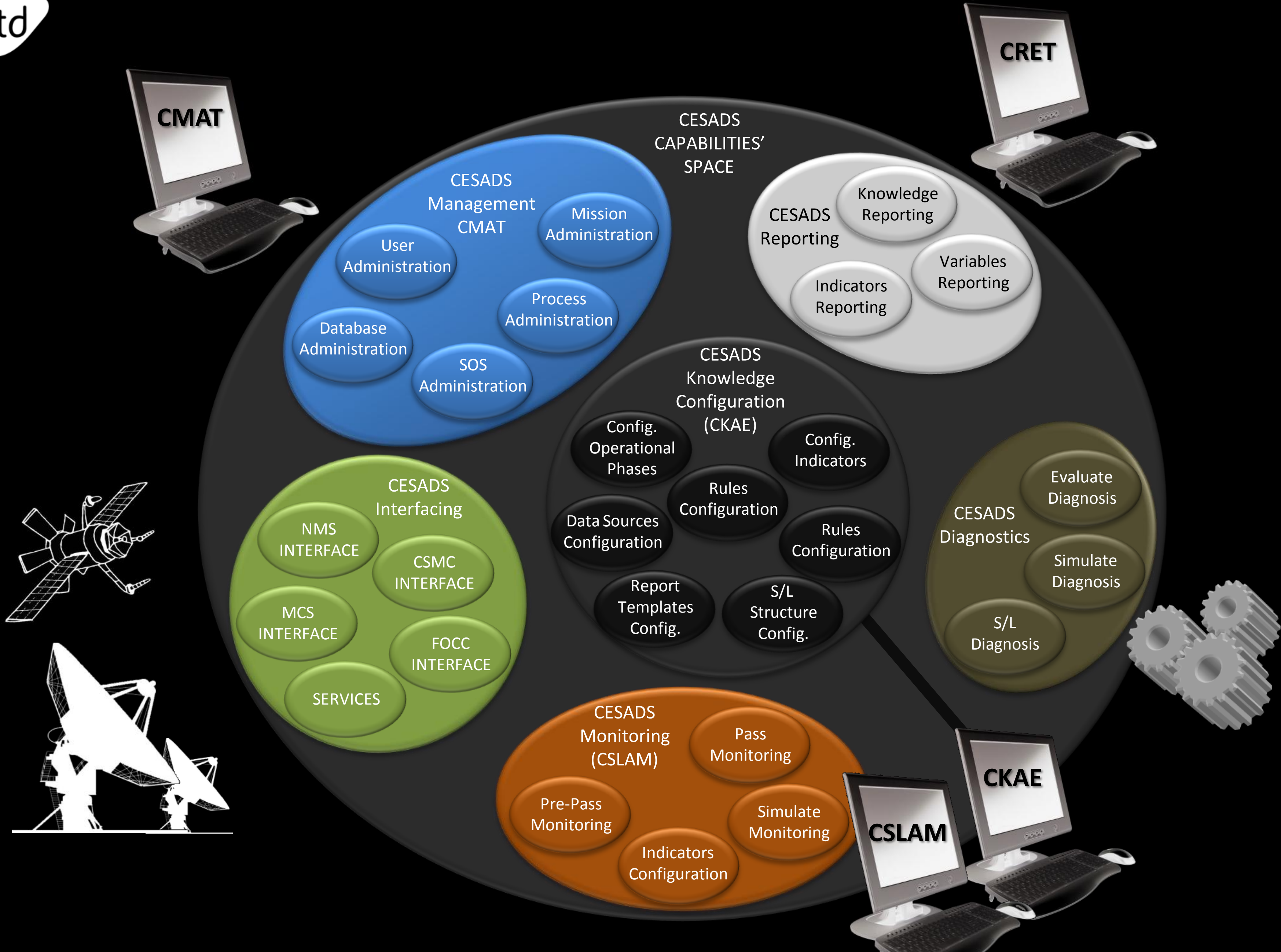


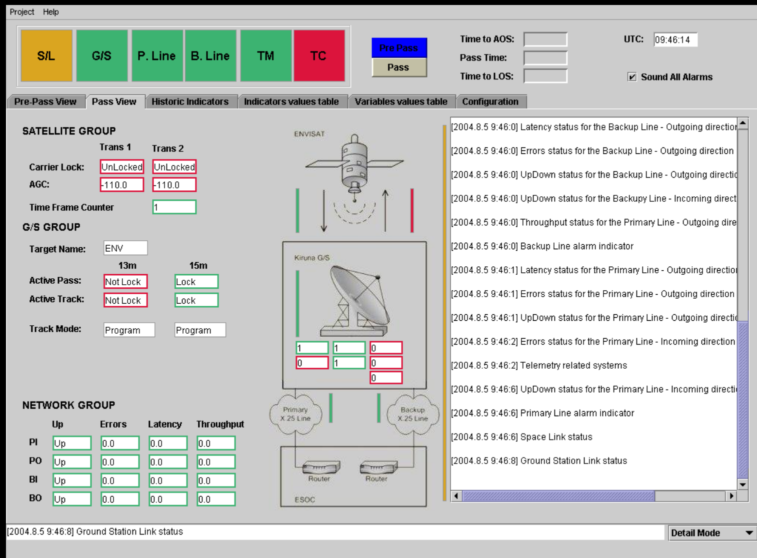


FIS: Rules result viewer


CESADS

http://www.esa.int/SPECIALS/ESOC/index.html

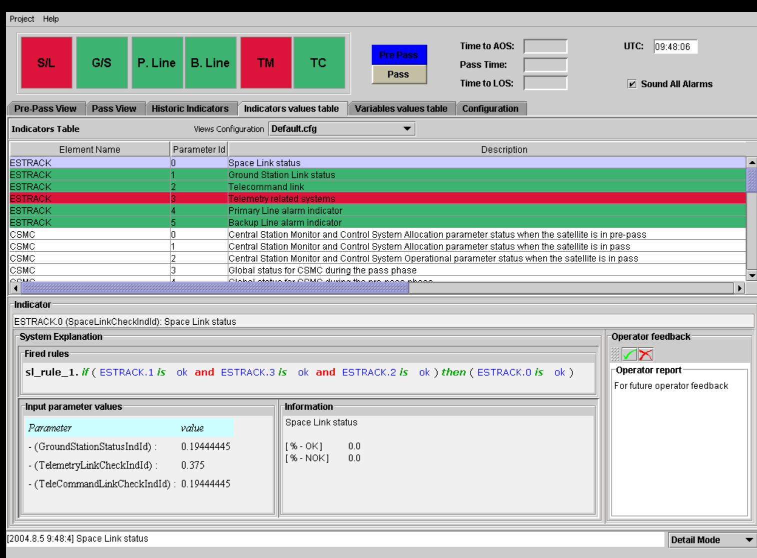

CMAT
CRET
CKAE
CSLAM
CESADS CAPABILITIES' SPACE
CESADS Management CMAT
User Administration
Mission Administration
Process Administration
Database Administration
SOS Administration
CESADS Reporting
Knowledge Reporting
Variables Reporting
Indicators Reporting
CESADS Knowledge Configuration (CKAE)
Config. Operational Phases
Config. Indicators
Rules Configuration
Data Sources Configuration
Rules Configuration
Report Templates Config.
S/L Structure Config.
CESADS Interfacing
NMS INTERFACE
CSMC INTERFACE
MCS INTERFACE
FOCC INTERFACE
SERVICES
CESADS Diagnostics
Evaluate Diagnosis
Simulate Diagnosis
S/L Diagnosis
CESADS Monitoring (CSLAM)
Pass Monitoring
Pre-Pass Monitoring
Simulate Monitoring
Indicators Configuration



Conjunto de indicadores de alto nivel
(Por debajo existe una jerarquía de indicadores detallados)

La herramienta mantiene las informaciones esenciales de adquisición y perdida de Señal (AOS y LOS).

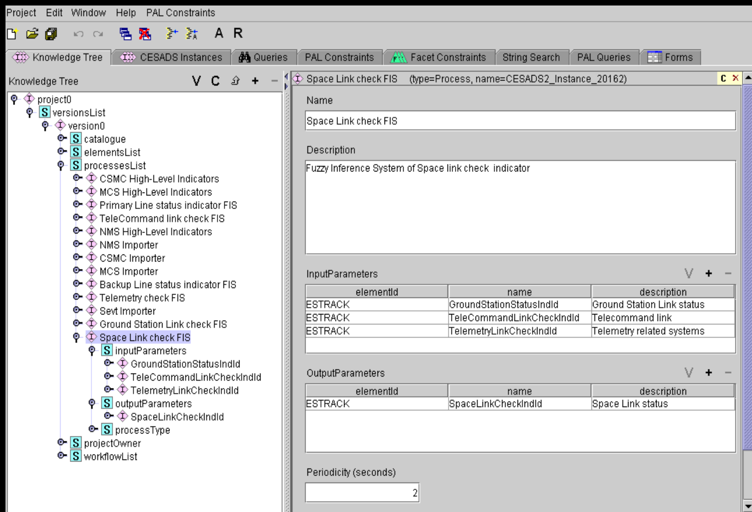
La herramienta mantiene registros de eventos
(Son los elementos convencionales que enlazan con la visión más tradicional)

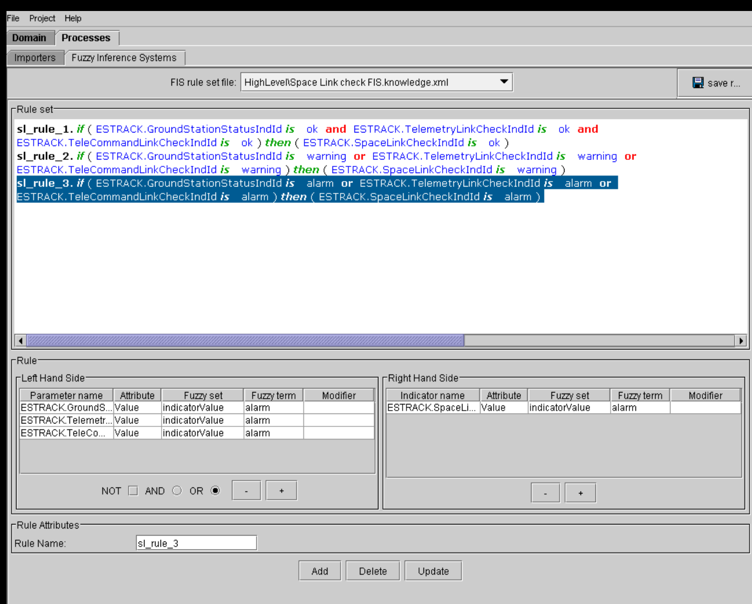


Conjunto completo de indicadores generados por el sistema
(comienzan las diferencias: los indicadores responden a la activación de reglas Fuzzy)

Referencia a las reglas Fuzzy activadas y mecanismos para navegar la activación

Herramienta para la captura formal del feedback del operador conforme a términos específicos de la ontología del sistema





Definición de la ontológica del sistema, con referencia explícita a los procesos del sistema:

- 7 procesos de importación de datos
- 6 procesos de inferencia fuzzy

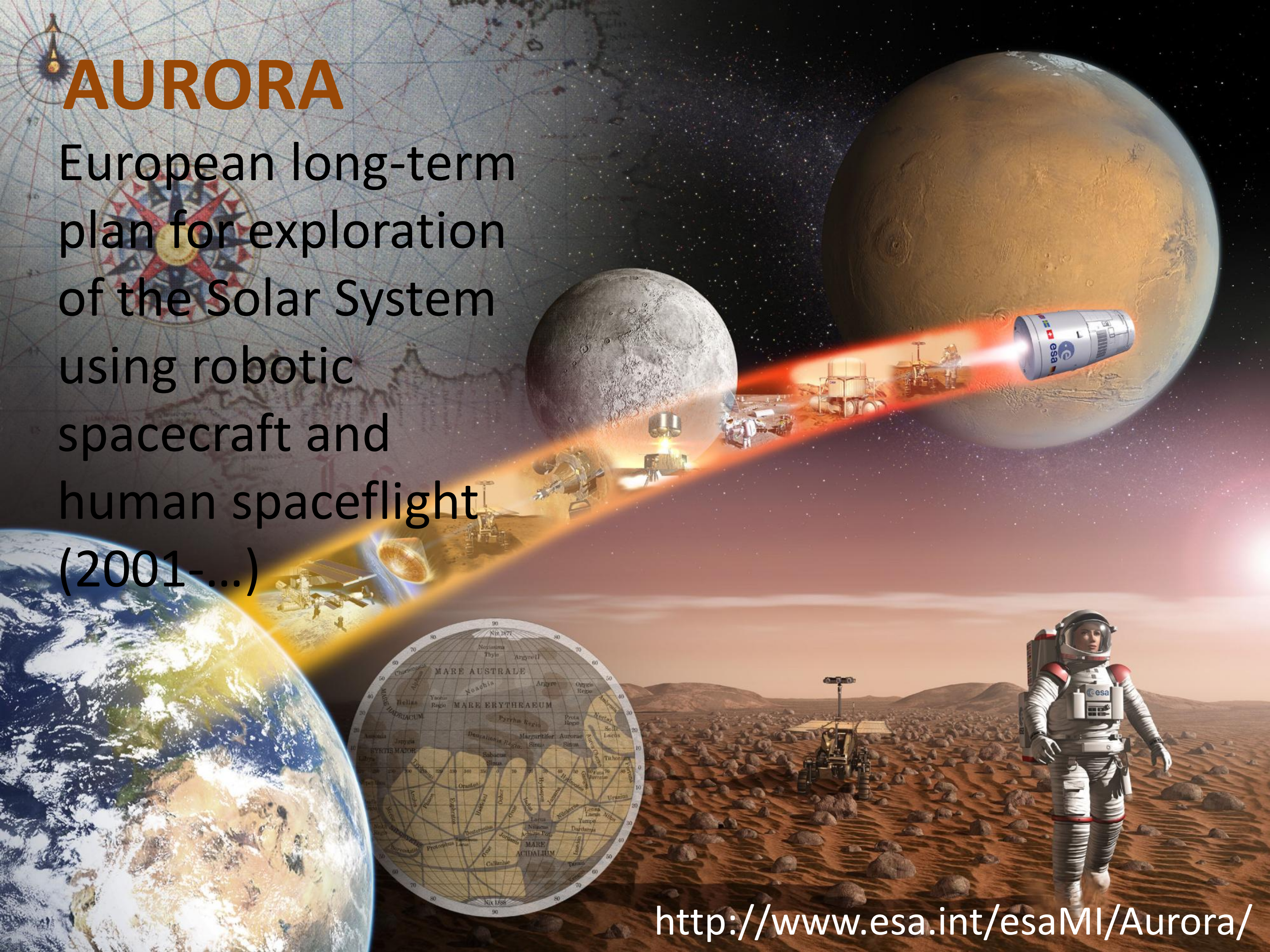
… a workflows especializados para la fases previas al paso del satélite y durante el paso del satélite

Editor de reglas fuzzy, con todos los términos semánticos construidos dentro de la ontología del sistema.

http://icalepcs2005.web.cern.ch/Icalepcs2005/

AURORA

European long-term plan for exploration of the Solar System using robotic spacecraft and human spaceflight (2001-…)



http://www.esa.int/esaMI/Aurora/

In order to represent complexity, to be able to work with different types of knowledges and to create a dynamic system of datas, our researches pushed us in many directions, from semantic to fuzzy logic, from game protocol to game theory.

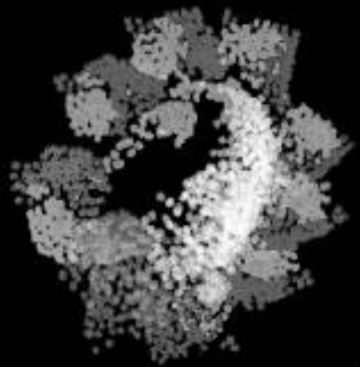
But the idea of making **a holistic interface, that would be more than the sum of its parts,** emerged.

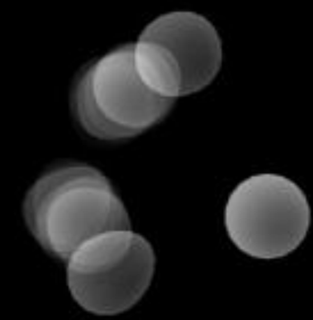
It was obviously linked to the different approaches that induces in sciences holism, instead of reductionnism, but not only.

To create an holistic interface means to find modes of representations that would be neither too litteral nor too abstract; a matrix where the behaviors of elements will make sense by themselves. The way that we found went through **physical forces and movements.**

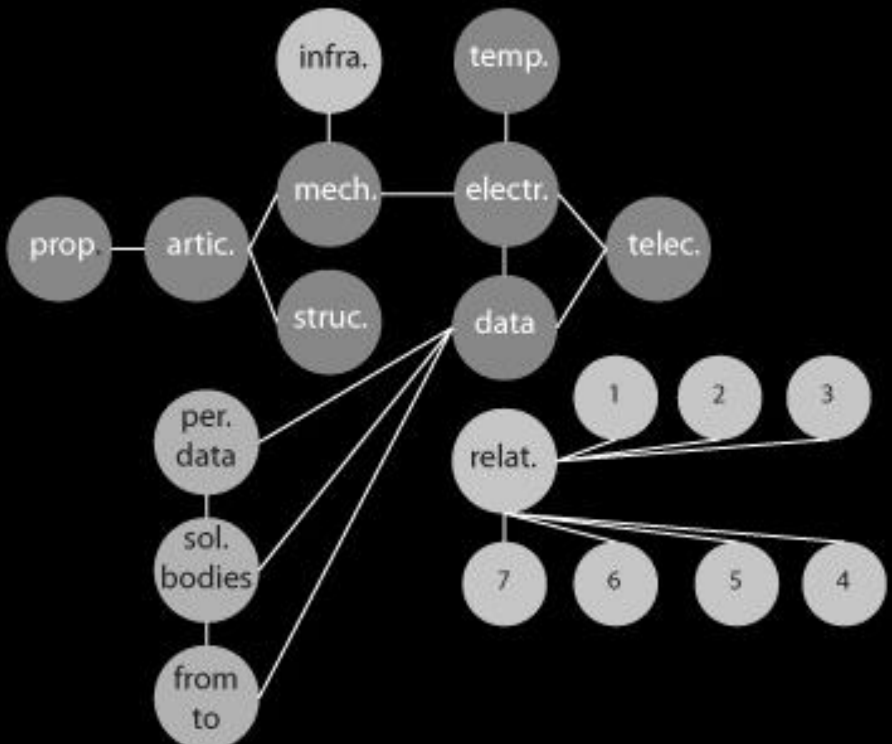
HOLISTIC

CHEMICAL SIGNAL





The second main idea was to imitate the way chemical signals are making their path in through cells. Why? Because chemical signals are at the same time subject to physical forces and morphogenesis. The article of Alan Turing, **The Chemical Basis of Morphogenesis**, published in 1952 has been decisive. In this article he took the example of the hydra: chemical signals are running through the cells of the animal to end by stabilizing as spots. Those spots determine where the tentacles will grow. The stabilization of patterns is the results of two elements working together: inhibitors and activators. Trying to introduce inhibitors and activators in our project was a way to define a world, shapes that will never be totally **stabilized but that will tend to.** If inhibitors were the operative knowledge, the elements and behaviors determined and expected before the launching, the activators would be the unexpected, the ones coming to disturb this perfect organization. **The opposition between activators and inhibitors was introducing the idea of tension as a productive force.**



ORGANISATION of KNOWLEDGE

The hierarchy that we proposed, SYS-SUB-ASSEMBLIES supposed certain types of **relationship** between the elements. The predefined knowledge giving them their position at the beginning of the simulation, and the "learning knowledge" coming after to modify those positions.

Those initial positions define **degrees of proximities and connectivities** that affect SUB's behaviors during the simulation of the mock-up.

DISONANCIAS

http://www.disonancias.com/es/
http://the8thpassenger.blogspot.com/

Inteligencia Artificial en Aplicaciones Aeroespaciales

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