

# Andromeda : Advanced PSA modeling

*A PSA management tool*

EDF R&D - Edgemind

October 6, 2017

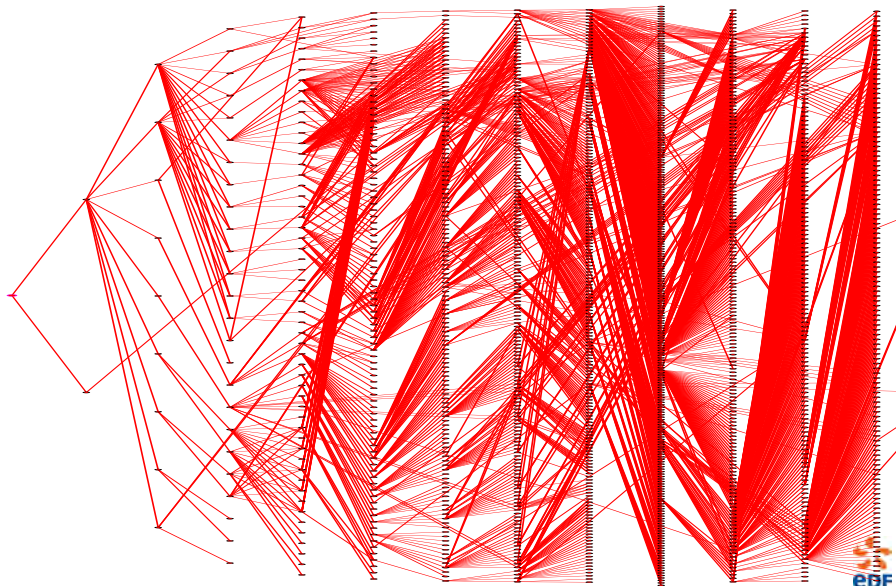
UK's 8th Risk Forum Next Generation Risk Analysis

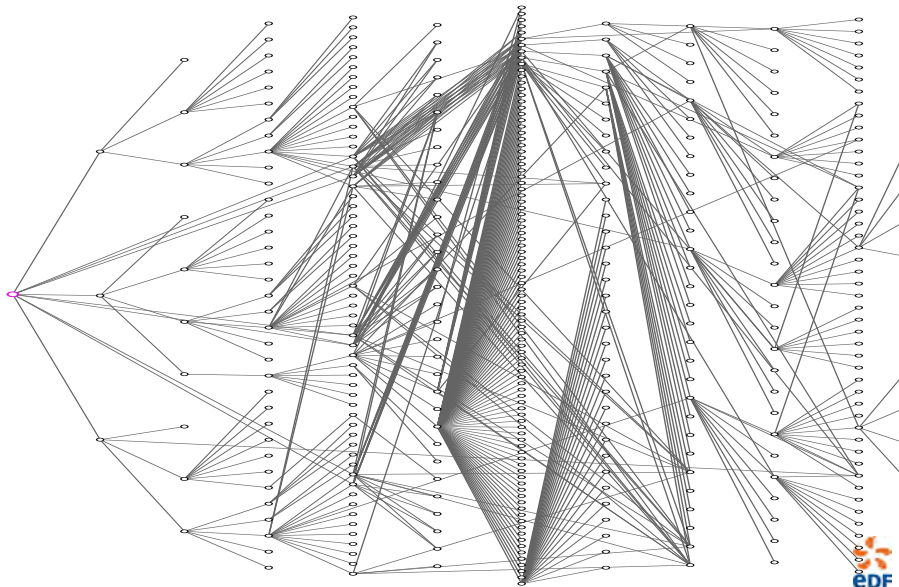


Me starting to use PSA models for the first time

Me starting to use PSA models for the first time







## *Difficulties*

- **Size** of the models **beyond the capacity** of the reference tools
- Increasing **Computational complexity** and running times no more appropriate for industrial use
- The models become more and more **obscur for neophytes**
- **Model maintenance** difficulties
- The development of the models become more tense (**work in serie**)

## *Difficulties*

- **Size** of the models **beyond the capacity** of the reference tools
- Increasing **Computational complexity** and running times no more appropriate for industrial use
- The models become more and more **obscur for neophytes**
- **Model maintenance** difficulties
- The development of the models become more tense (**work in serie**)

## *Scientific and technologic obstacles*

- We are at the **frontier** of untractable problems (NP-hard)
- Need to explore **new concepts**
- Get out from the **black box** to a **wide open world**
- Make a **bridge** to **complexity science**
- Allow more flexibility for model exchange and benchmarking



*Open PSA initiative*



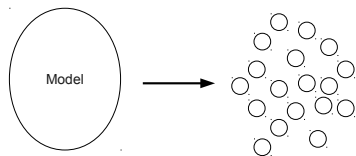
Antoine Rauzy



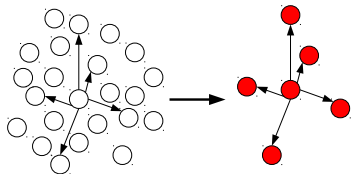
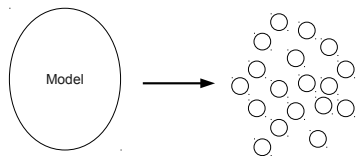
Woody Epstein

*NPSAG workshop Transparency And  
User Friendly PSAs & Lamda Mu*

*NPSAG workshop Transparency And  
User Friendly PSAs & Lamda Mu*

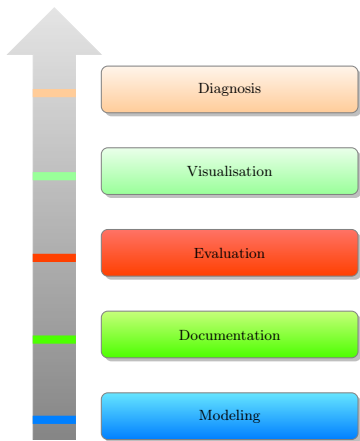


*NPSAG workshop Transparency And  
User Friendly PSAs & Lamda Mu*

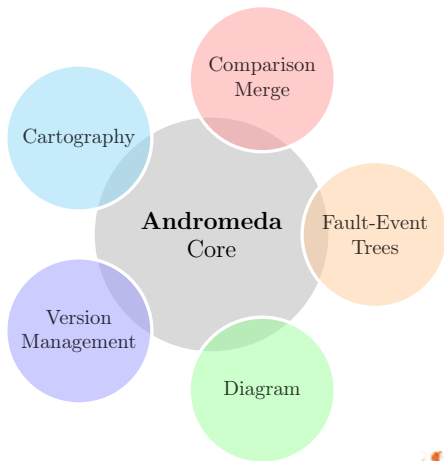
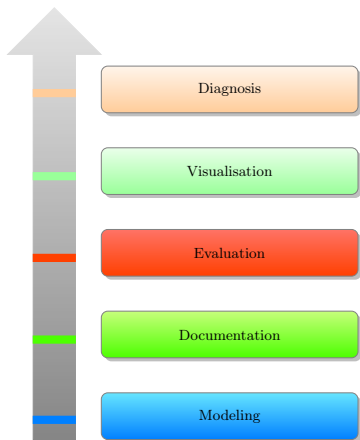


*Thesis : Thomas Friedlhuber (Rauzy & Hibti)*

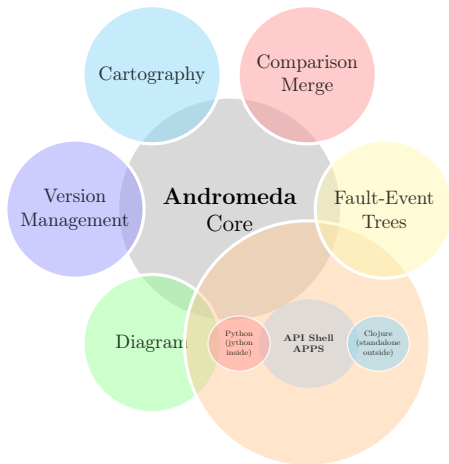
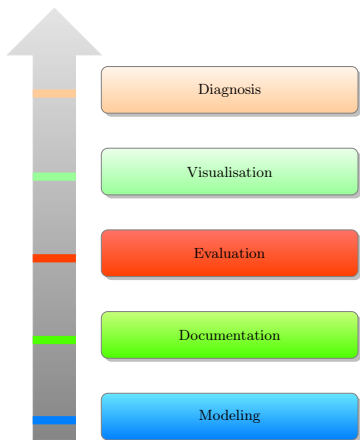
Thesis : Thomas Friedlhuber (Rauzy & Hibti)



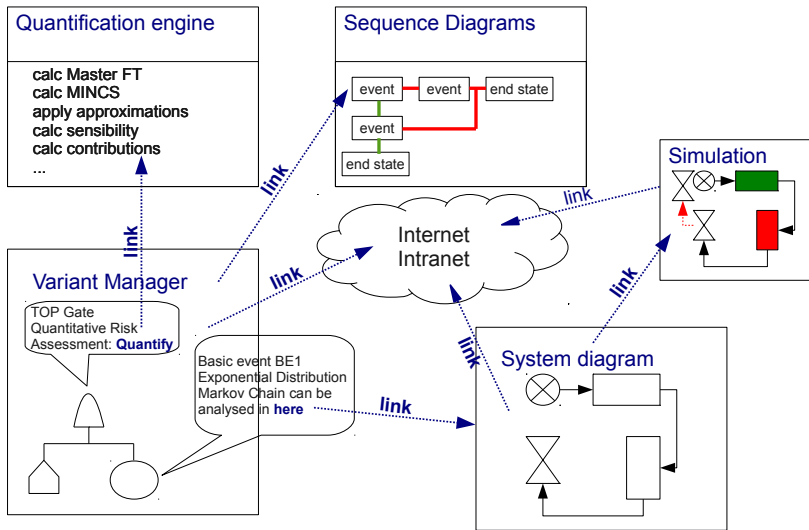
Thesis : Thomas Friedlhuber (Rauzy & Hibti)



# *Andromeda : a set of modeling and management tools*









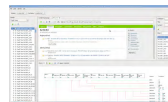
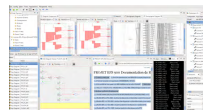
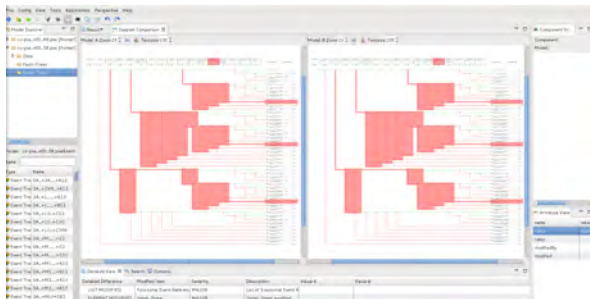
The screenshot displays a complex software interface with several key components:

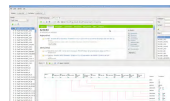
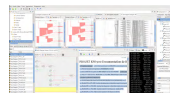
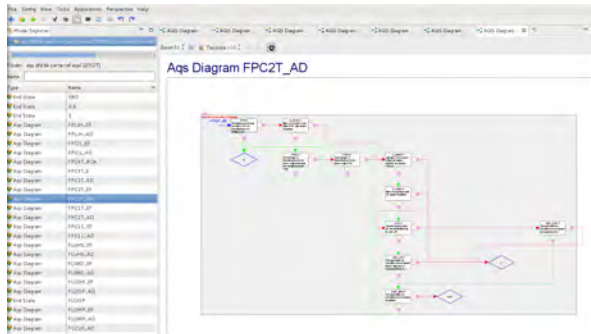
- Model Explorer (Top Left):** A tree view showing project structure with categories like Function Events, Consequences, Analysis, Rules, Noted, and Fault-Trees.
- Diagram Comparison (Top Middle):** Three side-by-side windows showing different zoom levels of a diagram (Model A, Model B, Zoom 21).
- Cartography Diagram (Top Right):** A detailed diagram showing a grid of elements and their relationships.
- Central Document Viewer (Bottom Middle):** A window titled "PROJET EPS 900 Documentation de R" displaying a document with sections such as "1.2 Pour les fonctions correspondant à l'analyse de R", "3. Analyse qualitative de séquences", and "3.1 Méthode EPS pour VDI-REX".
- Component View (Right):** A hierarchical tree of components and events, including "Regroupement FRX", "Event FRX", "Success FRX", and "Failure FRX".
- Bottom Left:** A list of application diagrams (App Diagram) with names like "FFC1C\_AD", "FFC1C\_EF", "FFC1T\_AD", etc.

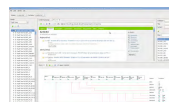
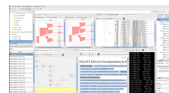
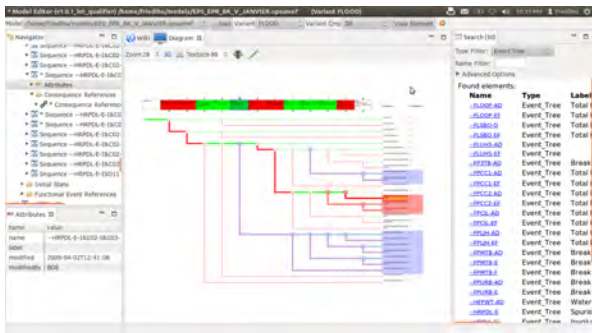
The screenshot shows the NetLogo environment with a 'wiki' tab selected. The interface includes a 'Home' menu, a search bar, and a list of 'Fault Tree' items on the left. The main content area displays a page titled 'Activité' with a sub-section 'Apprentissage'. Below this, there is a date '23/01/2012' and a paragraph of text. At the bottom, a complex fault tree diagram is visible, showing various components and their interconnections. The right side of the interface features a 'Category' dropdown and a 'List' of items.

This screenshot displays a multi-view software interface. It features several overlapping windows, including a table with columns and rows, a chart with red and white squares, and a text-based window. The interface appears to be a data analysis or management tool, possibly related to the fault tree analysis shown in the adjacent screenshot.

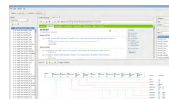
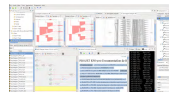
# Complex model comparison : event trees, fault tree and event sequence diagrams







```
dict = {" " : "_", ">": "S", "<": "I", "}" : "M", "\"": "Sec"} # Incomplete list
def correct_id(model):
    list_ids = model.get_global_elements();
    pattern_reference = re.compile(".*Reference")
    for element in list_ids:
        name = element.get_name()
        for key, value in dict.iteritems():
            if key not in name:
                continue
            else:
                new_char = dict[key]
                new_name = name.replace(key, new_char)
                mtype = element.get_type()
                print "dealing with " + name
                if len(new_name) > 20 \
                    and mtype is not "Sequence" \
                    and mtype is not "Analysis" \
                    and not pattern_reference.match(mtype):
                    print "new_name " + new_name + " Has more than 20 characters"
                    print "You have to modify your dictionary accordingly"
                    sys.exit()
                element.set_name(new_name)
                print name + " modified" + "(character " + key + " replaced by " +
                    new_char + ")"
```







Tesnim Abdellatif





Tesnim Abdellatif



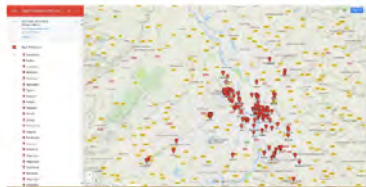
Google Maps



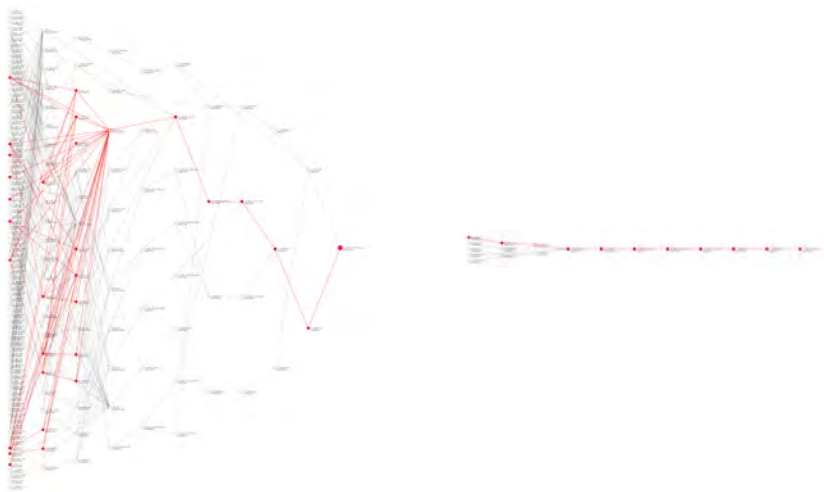
Transportation  
service



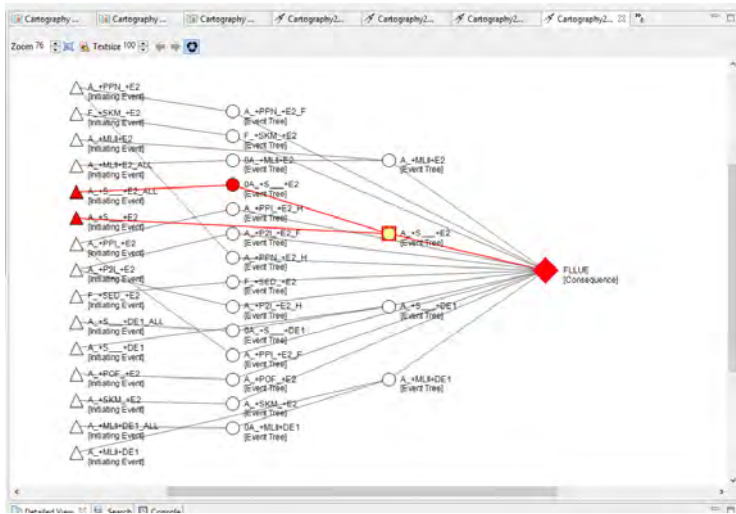
Gaming



- From parameters to consequences
- Search and reach dependencies for validation processes
- Understand dependencies for diagnosis purposes
- Use cartography to break computational complexity
  - split analysis cases
  - use modularity
  - use network metrics and specialisation



# Networks for automatic parallel analysis specifications



Generation of all CEI  
Networks for  
Co\_PSA\_vOO\_58:  
**64 Networks**

Consequence: F  
Dependencies : 777  
Metric : 6798

Dependency 2:  
Initator: B\_+SLI\_AB\_ALL  
10 possible ways  
Way 1 and Metric: 5

Configuration Board

Dependancy Direction Summary  
Source: Menu Summary: Metric(3)  
Target: Menu Summary:  
Way Point: Menu Summary

Sort Level: Dependancy

Network	Source Type	Source Name	Target Type	Target Name	Metric	Direction
2 Network	CEI				112	BACKWARD
3 Network	CEI				19	BACKWARD
10 Network	CEI				6798	BACKWARD
1. Dependancy	Consequence	F	Initiating Event	H5+FB8+C1	3	BACKWARD
2. Dependancy	Consequence	F	Initiating Event	E_+SLI_+AB_ALL	11	BACKWARD
3. Way					5	BACKWARD
3. Way					5	BACKWARD
4. Way					3	BACKWARD
5. Way					5	BACKWARD
6. Way					4	BACKWARD
7. Way					6	BACKWARD
8. Way					4	BACKWARD
9. Way					5	BACKWARD
10. Way					5	BACKWARD
2. Dependancy	Consequence	F	Initiating Event	F_+LFE_+GBE1	7	BACKWARD
4. Dependancy	Consequence	F	Initiating Event	H_+LRI_+CBBE	12	BACKWARD
5. Dependancy	Consequence	F	Initiating Event	A_+SO_+C139	3	BACKWARD
6. Dependancy	Consequence	F	Initiating Event	C_+I2_+A1_1	3	BACKWARD
7. Dependancy	Consequence	F	Initiating Event	C_+M_+A12_3	4	BACKWARD
8. Dependancy	Consequence	F	Initiating Event	A_+E_+C3AB	2	BACKWARD
9. Dependancy	Consequence	F	Initiating Event	H_+LFE_+AB	6	BACKWARD
10. Dependancy	Consequence	F	Initiating Event	A_+P2_+E2	7	BACKWARD
11. Dependancy	Consequence	F	Initiating Event	C_+L4FE_+A1_3	3	BACKWARD
11. Association	Consequence	F	Initiating Event	H_+L4FE_+B	16	BACKWARD

Detailed View: Search Console

Way	Type	Name	Label
1. Way	Event		CDI - DESCRIPTION TBD
Point	Consequence	F	
Point	Event Tree	A_+P2_+A13	RPT - P2R Safety Valve LOCA (States A1 to A3)
Point	Event Tree	E_+SLI_+AB	RPT - Large SLB (7.36-25.7) inside core (A1-A3)
Point	Event Tree	DE_+SLI_+AB	DISPATCHING - Large SLB (7.36-25.7) inside...
Point	Initiating Event	E_+SLI_+AB_ALL	Large SLB/C (A-B)



Cartography Dependencies

Dependency:  Direction:  Summary:

Source:  Name:  Summary:

Target:  Name:  Summary:

Way Point:  Name:  Summary:

Sort Level:

Simple subdivision computation based on the network metric

Network	Source Type	Source Name	Target Type	Target Name	Metrics	Direction
10. Network	CEI				6798	
1. Dependency	Consequence	F	Initiating Event	HX=F&BL=C1	3	BACKWARD
2. Dependency	Consequence	F	Initiating Event	R_=_SLI_=_AB_ALL	11	BACKWARD
3. Dependency	Consequence	F	Initiating Event	F_=_LHSE_=_DBE1	3	BACKWARD
4. Dependency	Consequence	F	Initiating Event	H_=_LPL_=_C3BE	12	BACKWARD
5. Dependency	Consequence	F	Initiating Event	A_=_SO_=_C13P	3	BACKWARD
6. Dependency	Consequence	F	Initiating Event	C_=_I1Z_=_A12_1	3	BACKWARD
7. Dependency	Consequence	F	Initiating Event	C_=_MI_=_A12_3	4	BACKWARD
8. Dependency	Consequence	F	Initiating Event	A_=_S_=_C3AB	3	BACKWARD
9. Dependency	Consequence	F	Initiating Event	H_=_LPS_=_B2	6	BACKWARD
10. Dependency	Consequence					BACKWARD
11. Dependency	Consequence					BACKWARD
12. Dependency	Consequence					BACKWARD
13. Dependency	Consequence					BACKWARD
14. Dependency	Consequence					BACKWARD
15. Dependency	Consequence					BACKWARD
16. Dependency	Consequence					BACKWARD
17. Dependency	Consequence	F	Initiating Event	F_=_PPN_=_DBE1	3	BACKWARD
18. Dependency	Consequence	F	Initiating Event	V_=_D13_=_A12	21	BACKWARD
19. Dependency	Consequence	F	Initiating Event	H_=_LHJ_=_C12	11	BACKWARD
20. Dependency	Consequence	F	Initiating Event	HX=F&BM=C2	3	BACKWARD
21. Dependency	Consequence	F	Initiating Event	F_=_LHSL_=_F	3	BACKWARD
22. Dependency	Consequence	F	Initiating Event	H_=_LHC_=_C12	11	BACKWARD
1. Way					4	BACKWARD
2. Way					4	BACKWARD

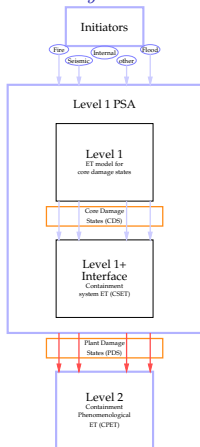
Split Cartography

Max number of dependencies:

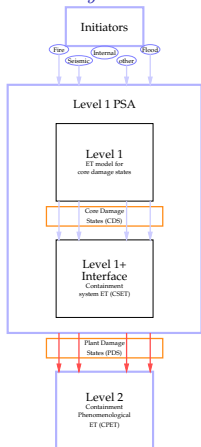
Cancel Done



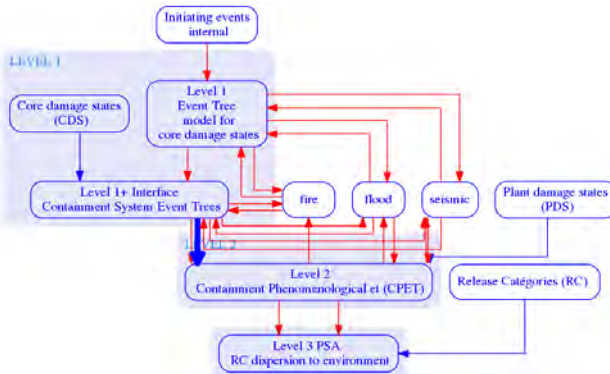


*In theory*

*In theory*



*In the real life*



## *New boundaries for a version-controlled PSA model*

- Include **LOG** files (logbook)
- Include peripheric **documentation** (assumptions, links ...)
- Include **Diagrams** for qualitative sequence analysis
- Include **scripts** if massive modifications were applied
- Include **any material that served** for some version

## *Characteristics of a reproducible PSA*

- The possibility to **keep track** of all the **history** of the model and its genesis
- Guarantee a better **quality assurance**
- Enhance **awareness** of the modeling, assumptions, theoretical arguments,
- Better modeling principles

## *A decentralized model*

- Need to Work in parallel in a **decentralized** manner
- Need to **share** information between developpers [and users]
- Need to work on a **regularly** updated basis

## *A decentralized model*

- Need to Work in parallel in a **decentralized** manner
- Need to **share** information between developers [and users]
- Need to work on a **regularly** updated basis

## *A decentralized model*

- Quality assurance : **State of the art** of Best Software Quality Assurance
- Model **documentation** and progressive **logbook**
- Be **informed** of the **relevant updates**
- **Logs** and **history** trackers
- Working on **integrated** or **splited** models

File Config View Tools Applications Perspective Help

Model Explorer

Model Explorer: / - Changements - An Search Console

https://forge-pleiade.der.edf.fr/projects/andromeda/repository/models/changes?rev=master

Accueil Projets Aide

Portail Méthodes et Outils MRI - Plate-forme Outils SdF - Andromeda

Apports Actifs Mécanisme Commandes Recherche Ressources VIE DASH

Télécharger la révision: master

Statistiques | Brancher: master | Révisions:

models @ master

#	Date	Auteur	Commentaire
a1862df1	11/04/2017 11:05	Mohamed Hébb	modif workshop juste du texte
06490d0	10/04/2017 16:36	Mohamed Hébb	Suppression de quelques lignes dans un fichier LOGBOOK
822a4539	29/03/2017 12:28	Mohamed Hébb	introduction readme
2e6b790	29/03/2017 12:27	Mohamed Hébb	Introduction de scripts
9f5806b1	29/03/2017 12:13	Mohamed Hébb	Revert "Installation de hool, je ne suis pas sûr que ça marche" This revert comment 5bb66c71ae45ab7170eb19710aa29b480f96ed8d.
5bb66c7	29/03/2017 11:42	Mohamed Hébb	Installation de hool, je ne suis pas sûr que ça marche
63a05f1b	28/03/2017 19:23	Mohamed Hébb	tests pour modification historique
264040c	28/03/2017 19:14	Mohamed Hébb	Merge branch 'master' of https://git.forge-pleiade.edf.fr/git/andromeda-2.git Conflicts: LOGBOOK (codage)
30a876a2	28/03/2017 18:45	Mohamed Hébb	Merge branch 'master' of https://git.forge-pleiade.edf.fr/git/andromeda-2.git Conflicts: LOGBOOK (codage)
5d0abfd	28/03/2017 08:25	Vincent ROLLAND	G56845-2_Prevision ajoutées a remarques et LOGBOOK
f0f46520	27/03/2017 16:40	Mohamed Hébb	recup des problemes de place
2b443024	27/03/2017 16:34	Mohamed Hébb	Modifications d'emplacement des basic events inondations créées par script
7b0996ad	27/03/2017 15:55	Vincent ROLLAND	G56845-1-2
5d72589c	23/03/2017 15:40	Vincent ROLLAND	modif de tau: de defailanos
1f70143b	21/03/2017 16:31	Mohamed Hébb	Test GTR
66b46d17	21/03/2017 15:45	Mohamed Hébb	test gr
ba03a3d	21/03/2017 12:21	Mohamed Hébb	Merge branch 'master' of https://git.forge-pleiade.edf.fr/git/andromeda-2.git
Saad0934	21/03/2017 12:01	Sébastien VERMUSE	Modif SEB - création d'un BE bache - suppression d'une mission
88370045	21/03/2017 11:30	Mohamed Hébb	remarques modifs
e0999584	18/03/2017 09:55	Mohamed Hébb	introduction de fichiers Remarques
72107808	17/03/2017 14:56	Mohamed Hébb	ajout des nouveaux basic events à DATA/basic-events
a99ce38c	17/03/2017 14:41	Mohamed Hébb	modifications avec unsrsort
11264632	17/03/2017 14:35	Mohamed Hébb	Save the model in splitted forme
15324154	17/03/2017 11:47	Mohamed Hébb	Initiacion de l'esperimentation 1300
161c2844	03/03/2017 18:12	Mohamed Hébb	Initiacion de l'esperimentation

Voir les différences

Model Explorer: cpyvd3rex20160211.psa/Fault-Trees

Type	Name	Label
Fault Tree	=SIG_AAR_13_ID	Echec AAR sur Flux C
Fault Tree	=SIG_AAR_14_ID	Echec AAR sur Disq
Fault Tree	=SIG_AAR_15_ID	Echec AAR sur HPP
Fault Tree	=SIG_AAR_18_ID	Echec AAR sur BD b
Fault Tree	=SIG_AAR_19_ID	Echec AAR sur var r
Fault Tree	=SIG_AAR_20_ID	Echec AAR sur HD 2
Fault Tree	=SIG_AAR_21_ID	Echec AAR sur Delta
Fault Tree	=SIG_AAR_80_ID	Echec AAR sur flux é
Fault Tree	=SIG_MAT_55_ID	Non basc. RCV sur j
Fault Tree	=SIG_MAT_56_ID	Non isol. décharge s
Fault Tree	=SIG_MAT_57_ID	Non isol. décharge s
Fault Tree	=SIG_MAT_66_ID	Echec signal. blocage
Fault Tree	=SIG_MAT_67_ID	Echec du basic. RRV5
Fault Tree	=SIG_MAT_68_ID	Echec du basic. RRV5
Fault Tree	=SIG_MAT_71_ID	Echec de l'appoint a,
Fault Tree	=SIG_MAT_72_ID	Echec verrouillage co
Fault Tree	=SIG_MAT_74_ID	Non appoint RA BRV

30 / 1

The screenshot displays the Antrondra 1.8.0 application interface. On the left, a 'Project' tree shows the file structure, with 'EXPACTACTOR' selected. The main area features a 'Version Tree' diagram with nodes representing different versions of files. Each node includes details such as the file name, author, date, and a brief description of changes. On the right, a 'Log' window displays a detailed list of commit messages, including file additions, modifications, and deletions, along with the author and date of each commit.

**Version Tree Details:**

- File: `Adm\Manuel.rtf`, Date: 2017-03-29 11:42:43, Author: Manuel H&Atilde;
  - Branches added: rtf,manuel,manuel
  - Log: Initial commit of rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 12:05:19, Author: Manuel H&Atilde;
  - Branches added: rtf,manuel,manuel
  - Log: ajout manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 13:04:34, Author: Manuel H&Atilde;
  - Log: Suppression rtf,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 13:30:43, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:03:41, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:30:52, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:43:03, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:45:03, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:47:03, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 14:50:26, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel
- File: `Adm\Manuel.rtf`, Date: 2017-03-29 15:07:20, Author: Manuel H&Atilde;
  - Log: rtf,manuel,manuel



The screenshot shows the Ansys Workbench interface with the 'Merge Editor' active. The main workspace is divided into four panels, each displaying a content tree for a different model:

- Model 1:** Shows a 'Fault Tree' folder containing a 'Content' folder. The 'Content' folder includes a 'Fault Tree -4044' folder with sub-items like 'label', 'modified', 'modelBy', and 'state'. Below this is a 'Data Reference @4044-2' and an 'Inplace\_Event\_Reference\_2\_3030M'.
- Model 2:** Similar structure to Model 1, but with a 'Data Reference @4044-2' and an 'Inplace\_Event\_Reference @ANIS\_4030P'.
- Base Model:** Shows a 'Fault Tree -4044' folder with sub-items like 'label', 'modified', 'modelBy', and 'state'. Below this is a 'Data Reference @4044-2' and an 'Inplace\_Event\_Reference @4044-2'.
- Merge Model:** Shows a 'Fault Tree -4044' folder with sub-items like 'label', 'modified', 'modelBy', and 'state'. Below this is a 'Data Reference @4044-2' and an 'Inplace\_Event\_Reference @4044-2'.

The interface includes a top menu bar with 'Applications', 'Performance', 'Perspective', and 'Help'. A left sidebar shows a 'Merge Editor' panel with a 'Merge Result' section. The bottom status bar indicates 'Powered By EDF - Copyright 2007'.



## *More advanced computation parallelisation*

- Now the fractionning is up to the analyst using **intuitive heuristics**
- A priori computation of **complexity metrics** for model pieces
- **Clustering** and web-based computation

## *Results Analysis and understanding*

- Tools for **smart representation** of results and insights (**CRA : Communicating PSA results to non experts** Open PSA workshop 2016)
- **Diagnosis tools** for a **better understanding** of accident scenarios

*"The more you refine your model  
the more you lower your risk"*

Antoine Rauzy — Yesterday

*"The more you refine your model  
the more you lower your risk"*

Antoine Rauzy — Yesterday



*Figure:* LOCA example

## *Excentric components*

- Some components are excentric in the sense that they are linked to many other following the same direction
- Many main components of the support systems fall in this category

