

Quels outils pour gérer et valider de "gros" projets sous LabVIEW ?

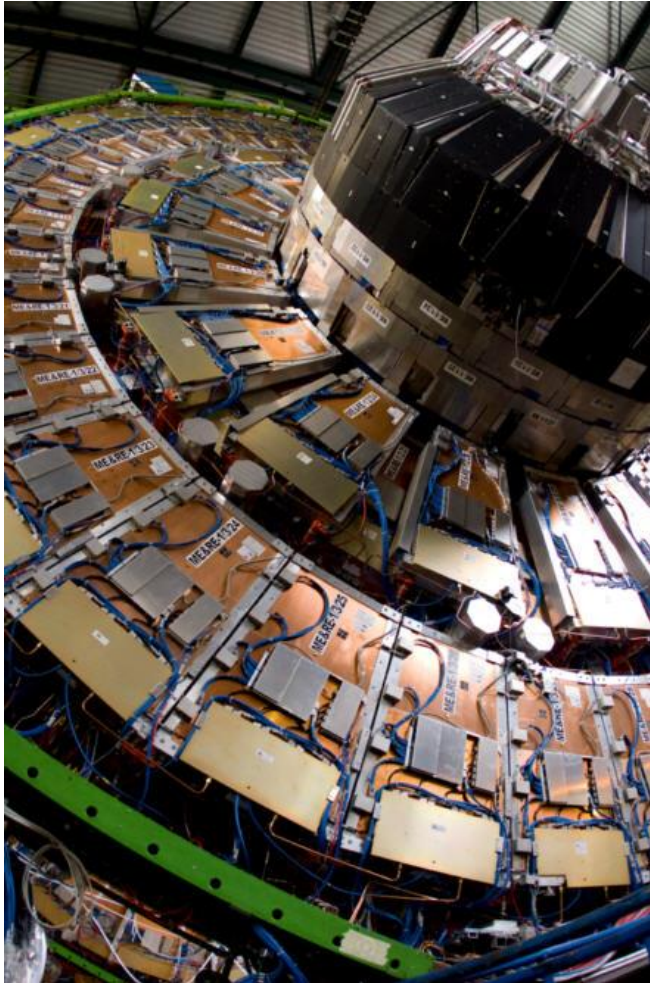
Laurent VAYLET

Ingénieur Produits pour l'Enseignement et la Recherche

Sommaire

- Enjeux liés aux applications critiques et/ou volumineuses
- Outils disponibles sous LabVIEW
 - Contrôle de code source
 - Traçabilité des exigences
 - Architecture
 - Développement et documentation
 - Analyse, débogage et validation
 - Déploiement
- Formations, certifications

LabVIEW au CERN - Large Hadron Collider



- Anneau de 27 km
- 200 châssis PXI + FPGA
- 600 moteurs pas-à-pas
- $dT = 1 \text{ ms}$

Application critique

- Implique beaucoup d'argent
- Peut occasionner de sérieux dommages aux personnes
- Peut ternir la réputation de la société

- Évalué
- Validé
- Documenté



« Et LabVIEW, il est certifié ? »

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CERTIFICATE

Certificate Number: 540312.000

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Headquarters: 4031 Debrecen
11500 N. Mopac Expressway 1/A Hatar Str
Austin, TX 78759 Hungary
United States

Including its implementation, meets the requirements of the standard:

ISO 14001:2004

Scope:
Manufacturing Operations for Software and Hardware Products for Personal Computers and Workstations that are used for Measurement and Automation.

This Certificate is valid until: July 12, 2010
This Certificate is valid as of: July 12, 2007
Certified for the first time: July 12, 2004

H. Pierre Salé
H. Pierre Salé
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4377 County Line Road
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Ph: (215)997-4519
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CERTIFICATE

Certificate Number: 510312.000

The Quality System of:

National Instruments
Headquarters: 4031 Debrecen
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United States

Including its implementation, meets the requirements of the standard:

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Scope – Austin, TX:
Marketing, Design, Development, Manufacturing, Sales, Support for Software and Hardware Products for Personal Computers and Workstations that are used for Measurement and Automation.

Scope – Debrecen, Hungary:
Production & distribution of software and hardware products for personal computers and workstations that are used for measurement and automation

This Certificate is valid until: August 31, 2010
This Certificate is valid as of: August 31, 2007
Certified for the first time: August 25, 1995

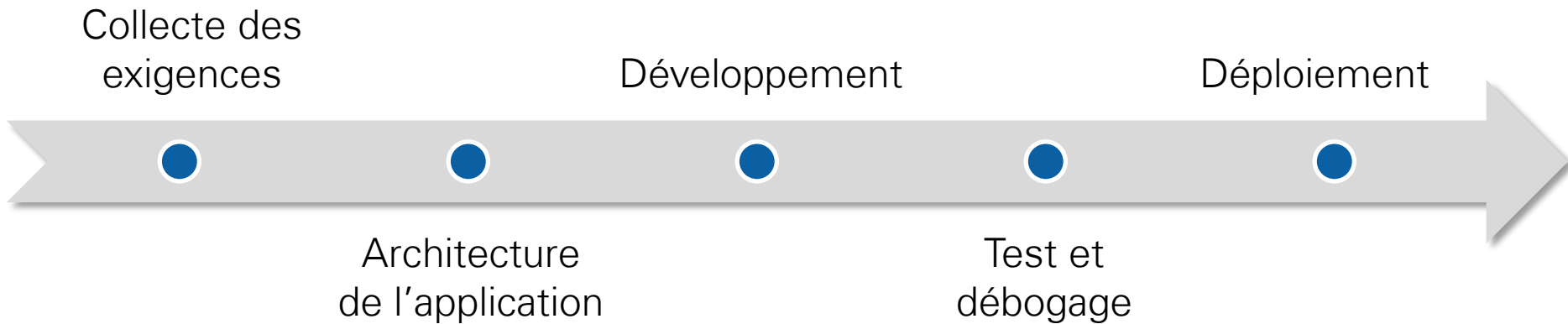
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Le processus de génie logiciel



Prouver le bon fonctionnement

Améliorer la qualité. Réduire le risque. Gagner du temps.

Collecte des
exigences

Développement

Déploiement

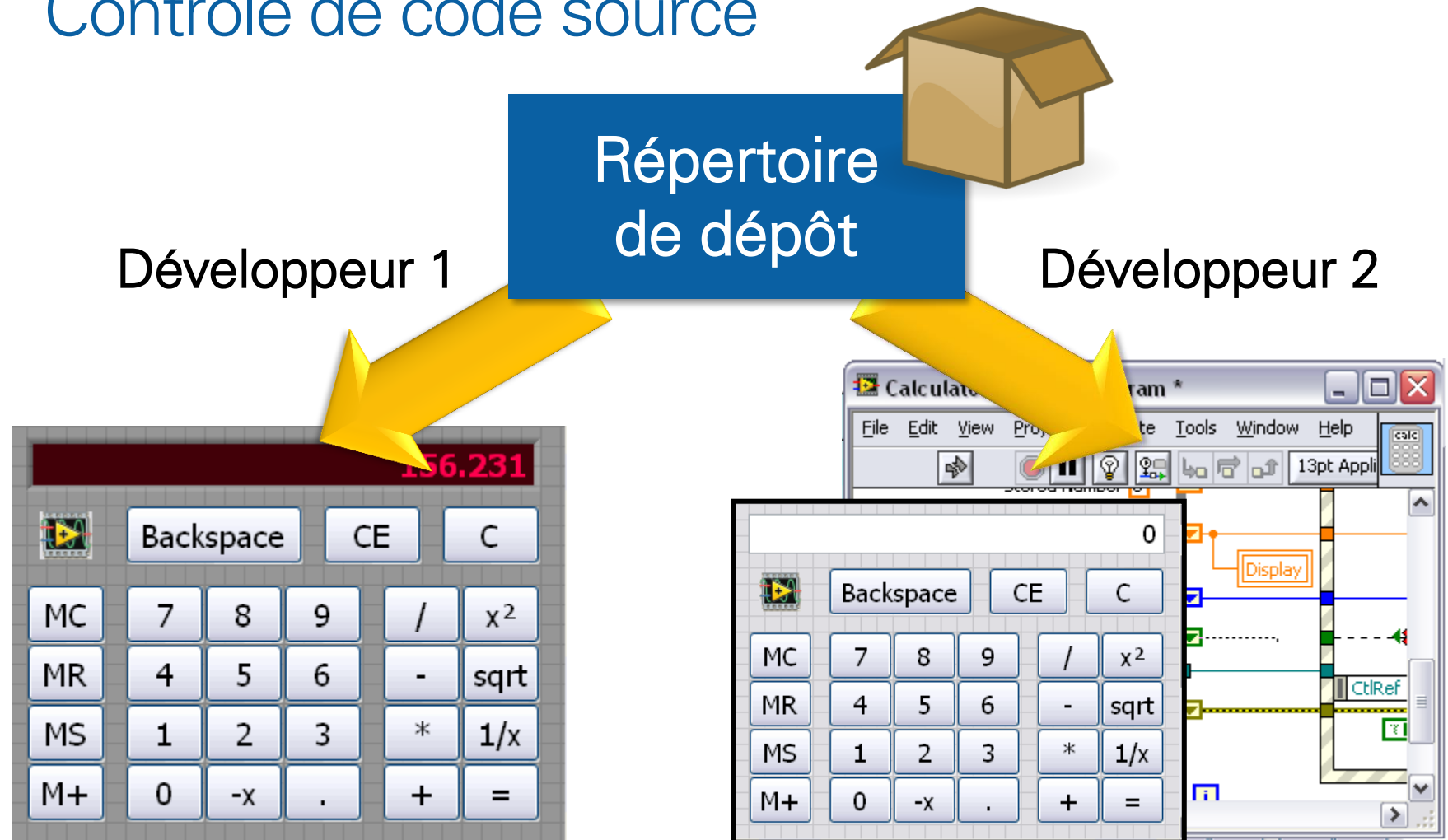


Architecture
de l'application

Test et
débogage

Outils pour le travail collaboratif

Contrôle de code source

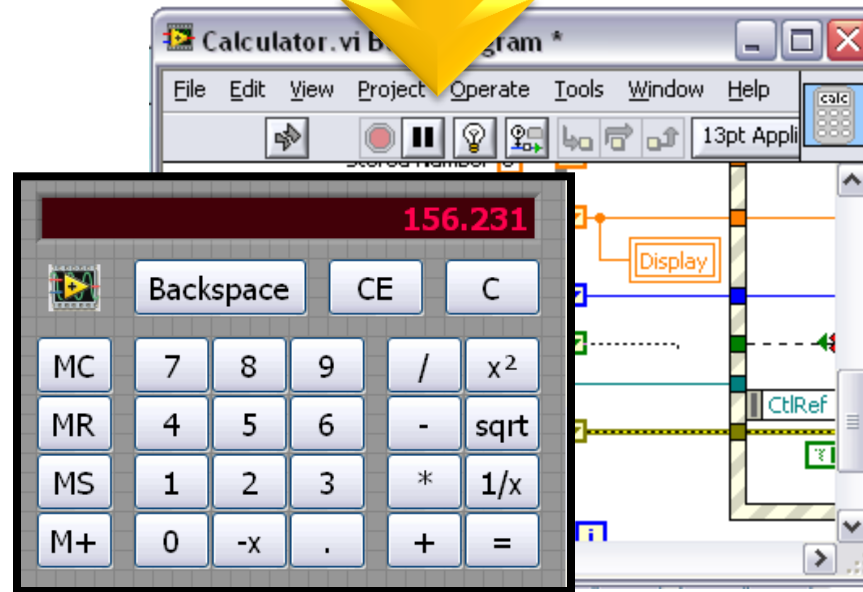
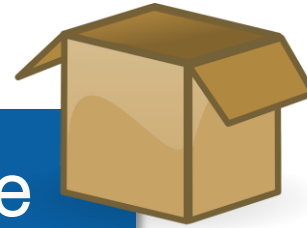


Changement de couleur de la Face Avant

Changement de comportement dans le diagramme

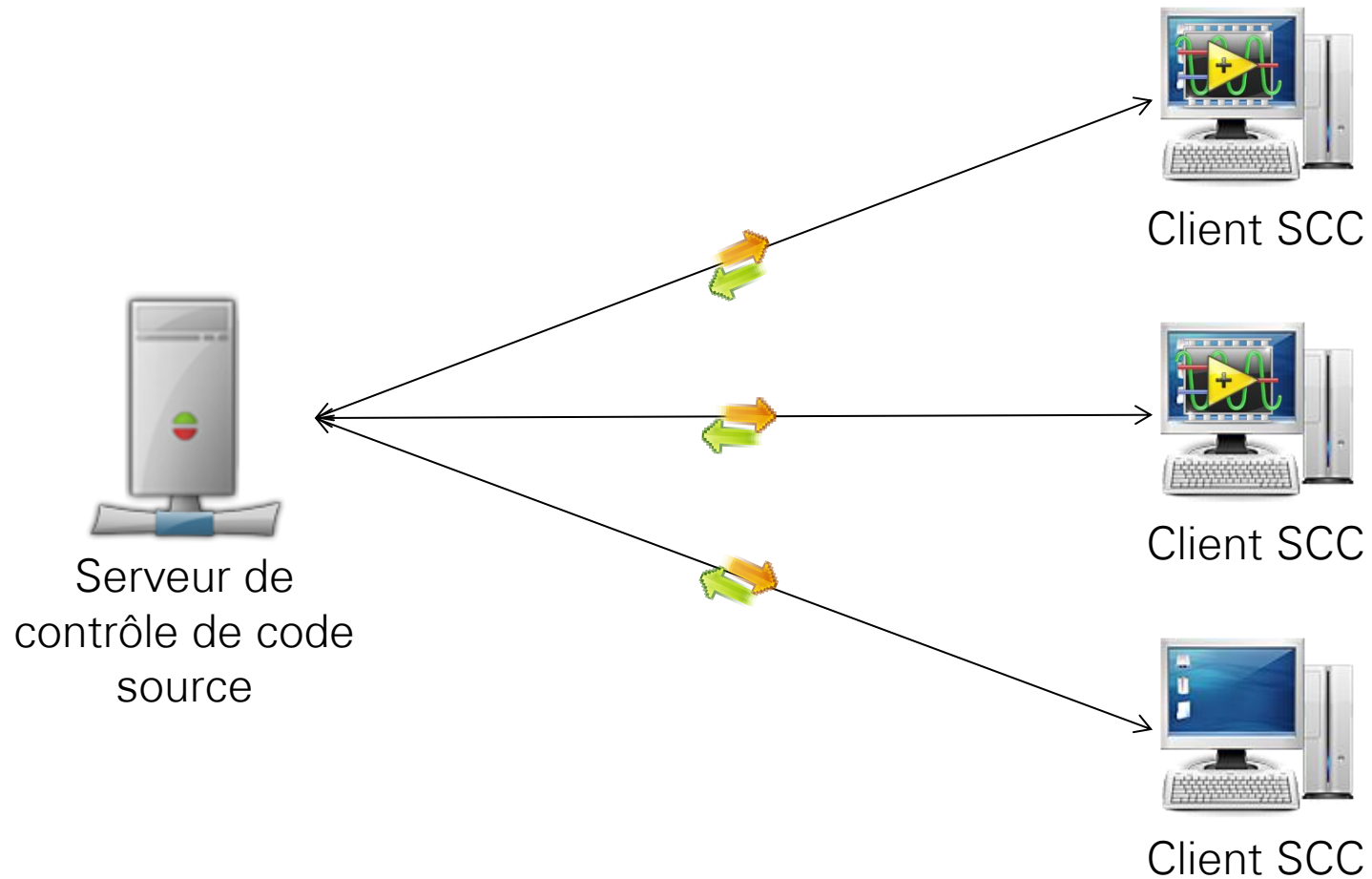
Contrôle de code source

Répertoire
de dépôt



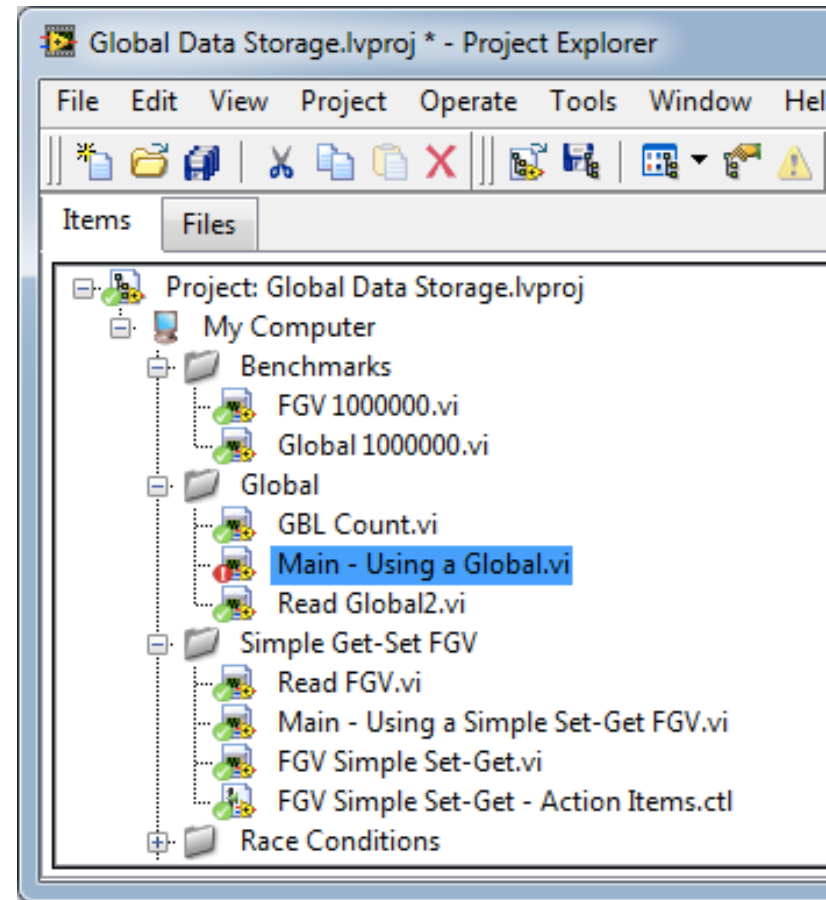
La version finale tient compte des deux modifications

LabVIEW et les SCC (Source Code Control)



Quels sont les serveurs accessibles ?

- Intégration avec :
 - Subversion
 - Microsoft Visual SourceSafe
 - Microsoft Team System
 - Perforce
 - Rational ClearCase
 - PCVS (Serena) Version Manager
 - MKS Source Integrity
 - Seapine Surround SCM
 - Borland StarTeam
 - Telelogic Synergy
 - ionForge Evolution
- Accès aux outils SCC depuis le projet LabVIEW

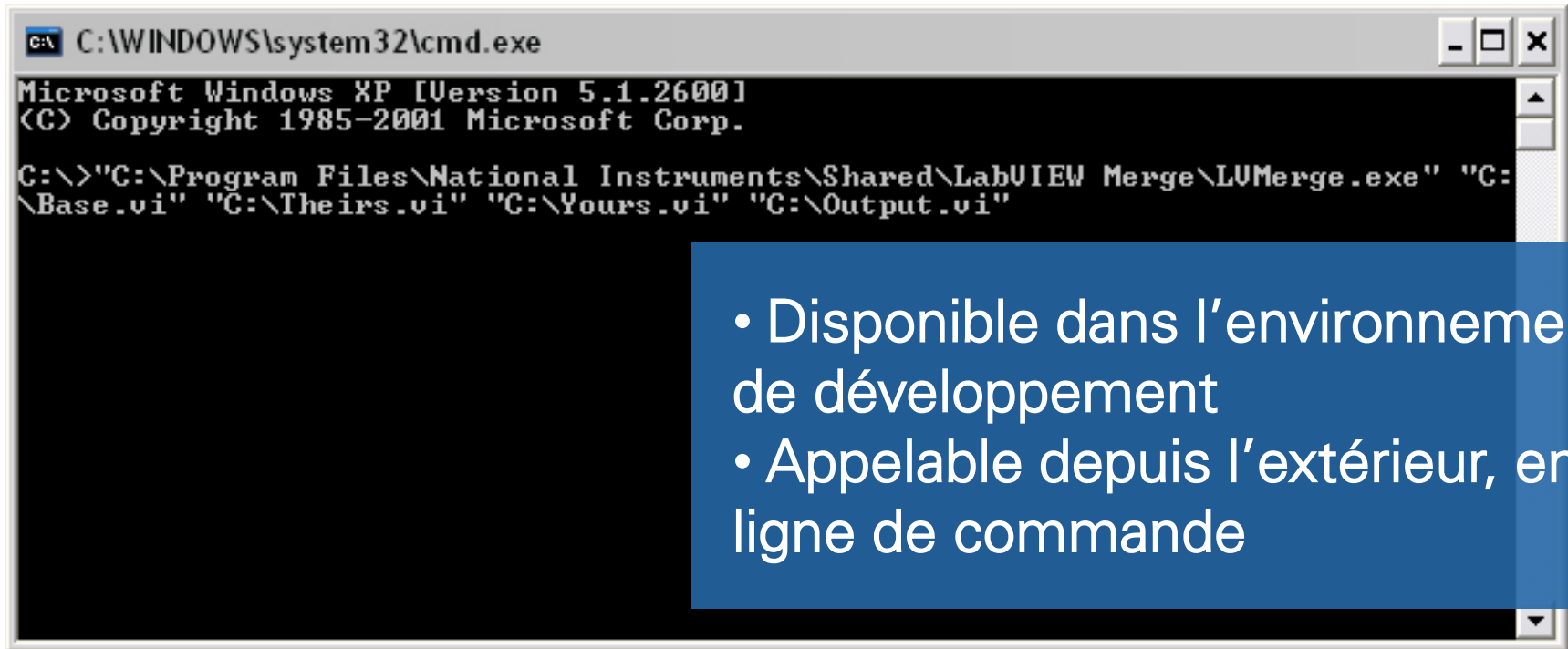


Outils » Comparer » Comparer des VIs

- Compare un VI à une version précédente du SCC
- Fournit une liste des modifications
- Disponible par ligne de commande

Résoudre les collisions de code

- Fusion manuelle
- VI Merge (depuis LabVIEW 8.5)

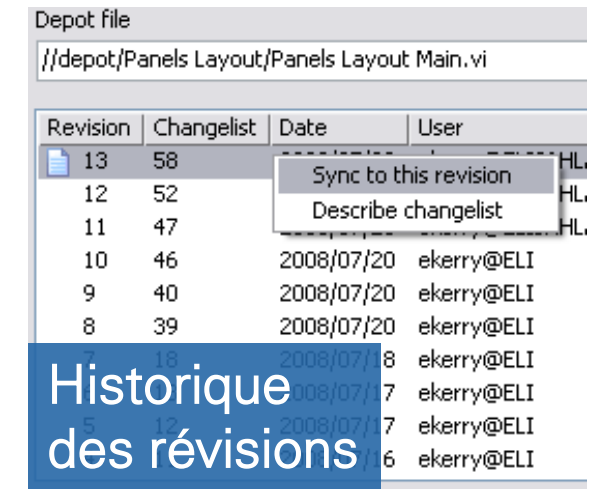
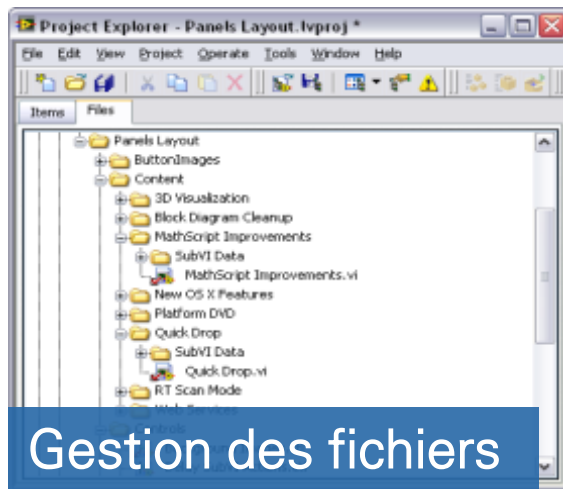
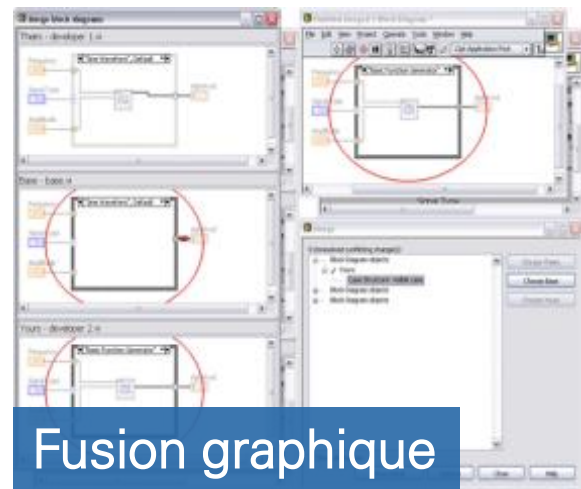
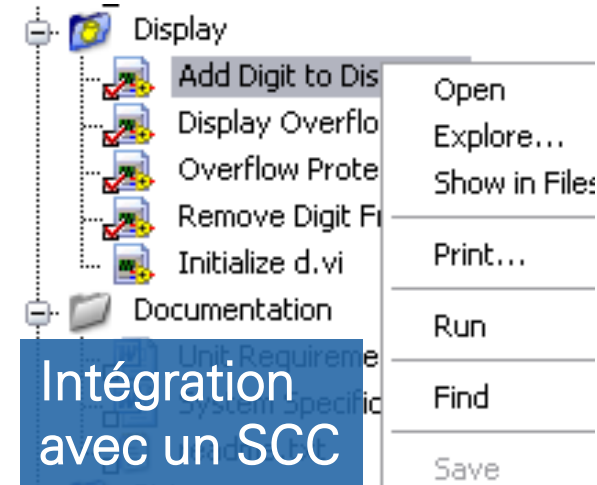
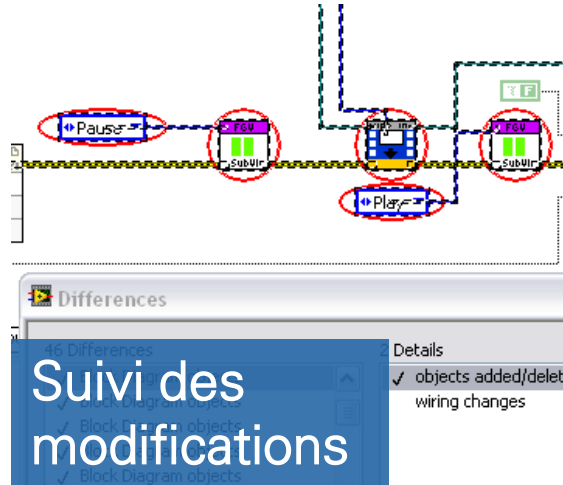
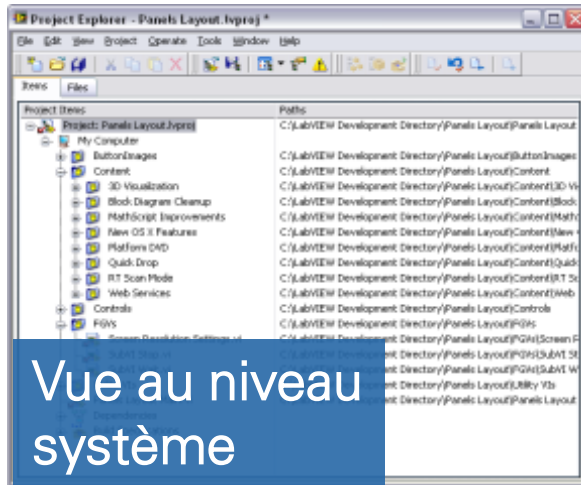


```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\>"C:\Program Files\National Instruments\Shared\LabVIEW Merge\LUMerge.exe" "C:\
\Base.vi" "C:\Theirs.vi" "C:\Yours.vi" "C:\Output.vi"
```

- Disponible dans l'environnement de développement
- Appelable depuis l'extérieur, en ligne de commande

Gestion de configuration logicielle pour LabVIEW



Collecte des
exigences

Développement

Déploiement



Architecture
de l'application

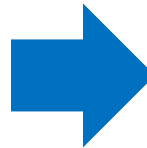
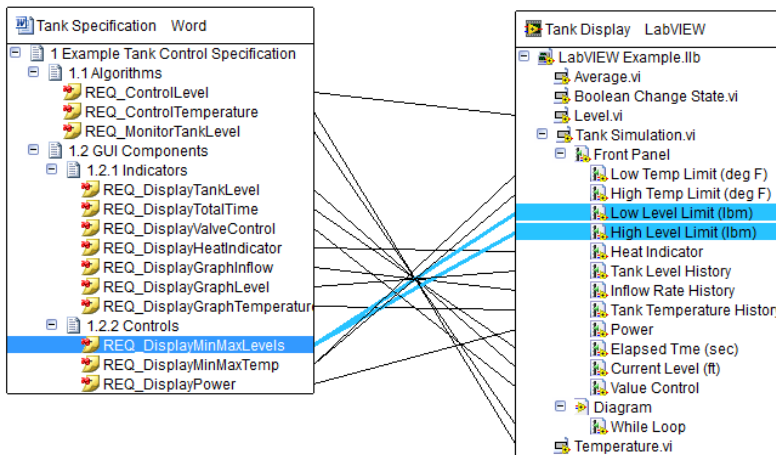
Test et
débogage

Outils pour le processus de génie logiciel



Architecture de l'application

Test et débogage

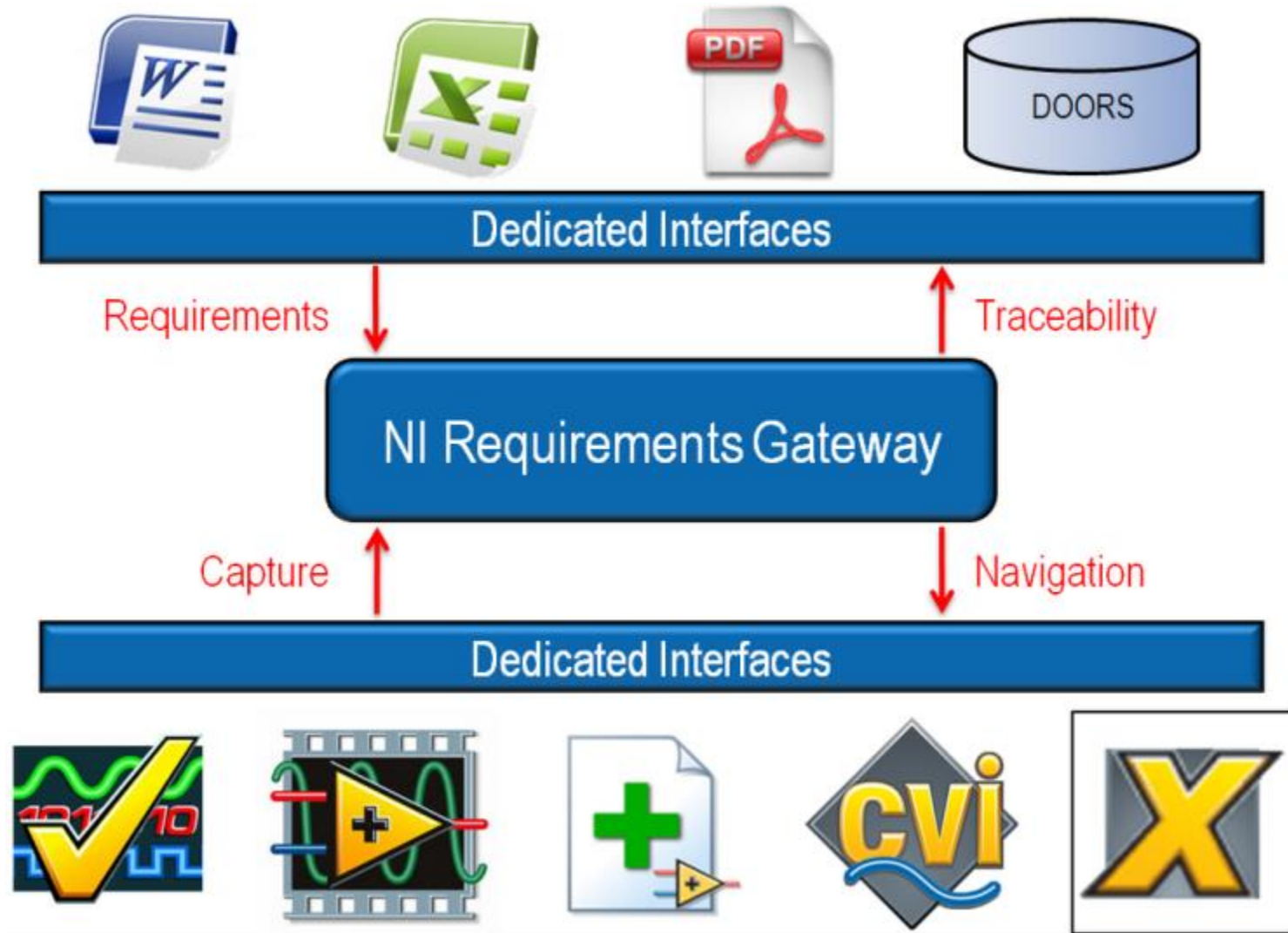


Upstream	Text	Downstream
REQ_ControlLevel	The application must maintain a separate control algorithm for controlling tank levels.	Level.vi
REQ_ControlTemperature	The application must maintain a separate control algorithm for controlling temperature.	Temperature.vi
REQ_DisplayGraphInflow	The display must display a graph indicating the inflow rate.	Inflow Rate History
REQ_DisplayGraphLevel	The display must contains a graph indicating the tank level.	Tank History
REQ_DisplayGraphTemperature	The display must contains a graph indicating the tank temperature.	Tank Temperature History
REQ_DisplayHeatIndicator	The display must show whether furnace is on or off.	Heat Indicator
REQ_DisplayMinMaxLevels	The display must allow the operator to control the minimum and maximum levels for the tank.	Low Level Limit (lbm)
REQ_DisplayMinMaxLevels	The display must allow the operator to control the minimum and maximum levels for the tank.	High Level Limit (lbm)
REQ_DisplayMinMaxTemp	The display must allow the operator to control the minimum and maximum levels for the tank temperature.	Low Temp Limit (deg F)

Couverture des exigences et suivi du projet

Traçabilité et génération de la documentation

NI Requirements Gateway



Collecte des
exigences

Développement

Déploiement



Architecture
de l'application

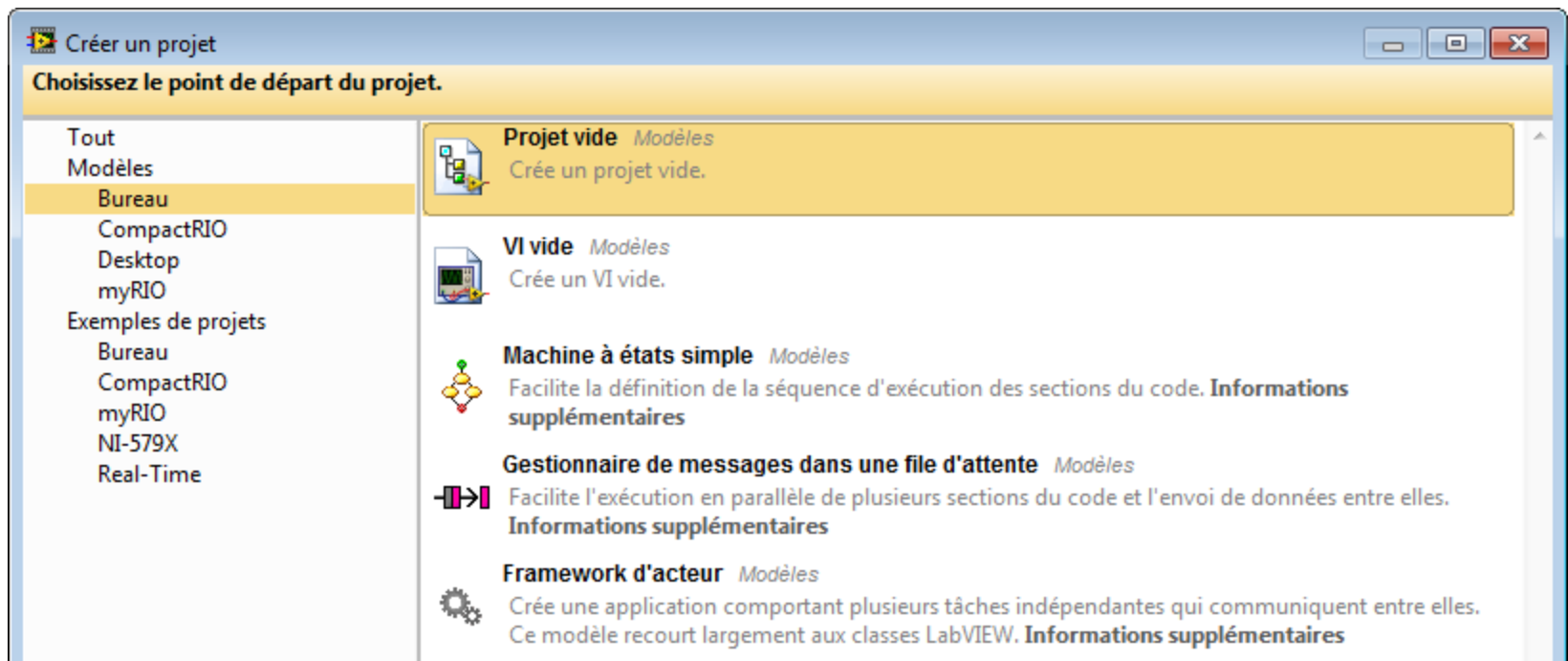
Test et
débogage

Buts

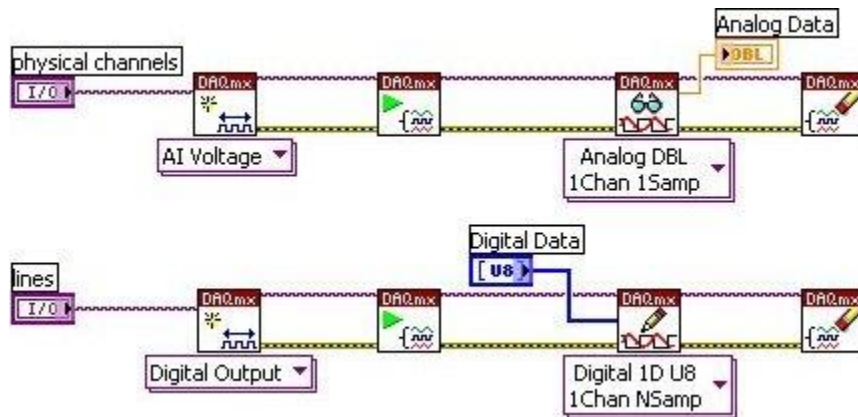
- Déterminer comment le code sera réparti sur l'équipe
- Vérifier que les codes sont lisibles et maintenables
- Maximiser la réutilisation et tirer avantage des structures ou fonctionnalités existantes

Les modèles de conception LabVIEW

- Squelettes standards, faciles à reconnaître
- Améliorent la lisibilité du code
- Évitent de réinventer la roue
- Tirent avantage de plus de 20 années d'expérience en LabVIEW



Autres outils dédiés à l'architecture

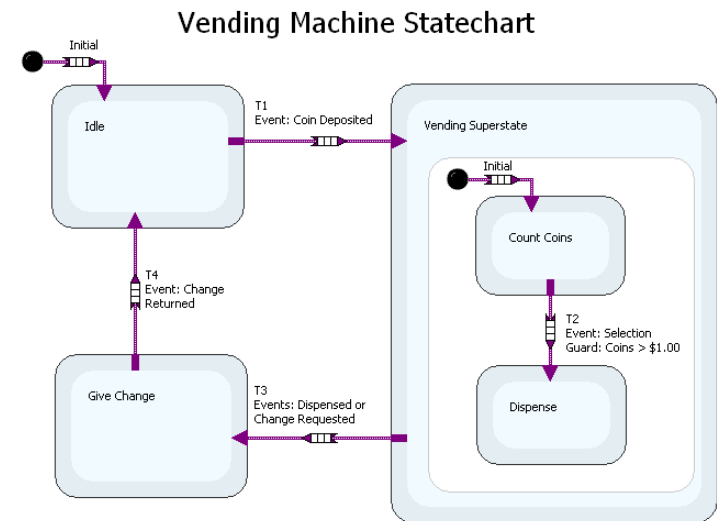


Multicoeur



Creating a child class object, calling parent method and closing the child object

Programmation Orientée Objet (POO)



LabVIEW Statechart

Collecte des
exigences

Développement

Déploiement



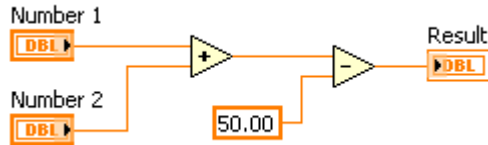
Architecture
de l'application

Test et
débogage

Buts

- Implémenter l'application en relation directe avec les spécifications
- Se conformer aux directives du modèle
- Effectuer des revues du code à chaque étape
- **Documenter, documenter, documenter**

Plusieurs approches possibles

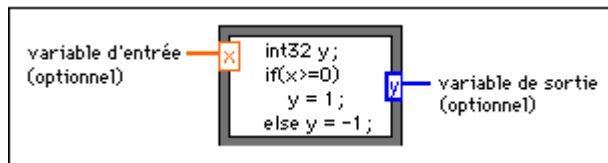


Flux de données

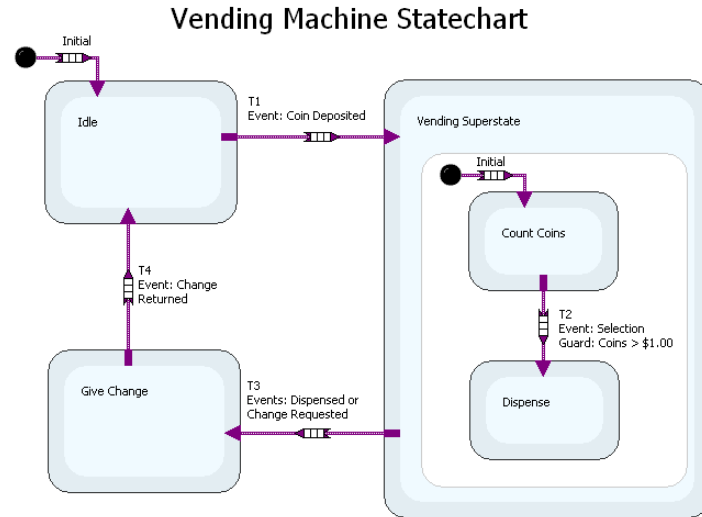
```

1 c = 0.285 + 0.013i;
2 [X Y] = meshgrid(x, y);
3 z = X + i*Y;
4 for k=1:30
5   z = z.^2 + c;
6 end
    
```

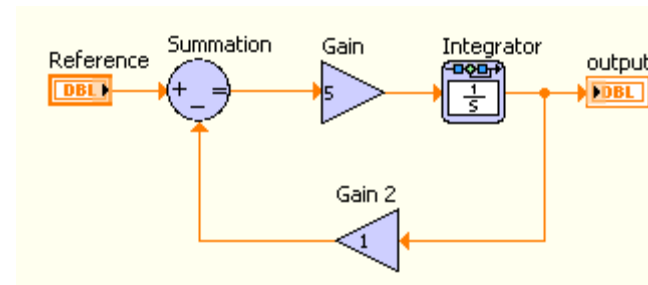
Mathématiques textuelles



Code C, VHDL



Machine à états



Simulation

Documentation

- Étiqueter les objets
- Commentaires en ligne
- Distinguer les icônes
- Description et astuces
- Impressions HTML
- Couverture des exigences

The image shows two overlapping windows from the LabVIEW software. The top window is titled 'Context Help' and displays the documentation for a VI named 'Remove Digit From Display.vi'. The documentation includes a block diagram showing a 'Backspace' function block with inputs for 'Decimal Count In' and 'Display In', and outputs for 'Decimal Count Out', 'Display Out', and 'error out'. Below the diagram, there is a text description: 'This VI handles the backspacing of a decimal number. The way it works is as follows: The display is multiplied by 10 raised to however many decimals it has to make it a whole number (ex: $12.34 * 10^2 = 1234$). Next, we Mod 10 the display (ex: $1234 = 123$). Finally, we divide the display by the 10 raised to the number of decimals it had minus one (ex: $123 / 10^1 = 12.3$)'. The bottom window is titled 'VI Properties' and has a 'Category' dropdown set to 'Documentation'. It contains a 'VI description' field with the following text: 'This VI reads an unlimited number of parameters corresponding to project files to build. To build projects programmatically, enter the following text in the command line window to run this VI: <LabVIEW directory>\labview.exe "<this VI>" -- "<project file 1>.lvproj" "<project file 2>.lvproj" ... "<project file n>.lvproj"'. Below the description is a 'Help tag' field. A diagram is overlaid on the bottom window, showing a logic flow: an input line goes to a comparison block '>=0'. The output of this block goes to a '1' block, which then goes to a '>' comparison block. The output of the '>' block goes to a 'p' block. A yellow box highlights the text: 'Enter decimal mode.' and 'If we are already in decimal mode (>0), keep the decimal count.'

Documentation générée par LabVIEW

Page 1

Calculate Blood Pressure.vi
 C:\Documents and Settings\Developer\My Documents\LabVIEW Development Directory\Software Validation Demo\Main Demo\Calculate Blood Pressure.vi
 Last modified on 7/8/2009 at 7:15 PM
 Printed on 7/8/2009 at 7:23 PM

Page 2

Calculate Blood Pressure.vi
 C:\Documents and Settings\Developer\My Documents\LabVIEW Development Directory\Software Validation Demo\Main Demo\Calculate Blood Pressure.vi
 Last modified on 7/8/2009 at 7:15 PM
 Printed on 7/8/2009 at 7:24 PM

Page 3

Calculate Blood Pressure.vi
 C:\Documents and Settings\Developer\My Documents\LabVIEW Development Directory\Software Validation Demo\Main Demo\Calculate Blood Pressure.vi
 Last modified on 7/8/2009 at 7:15 PM
 Printed on 7/8/2009 at 7:24 PM

Page 4

Calculate Blood Pressure.vi
 C:\Documents and Settings\Developer\My Documents\LabVIEW Development Directory\Software Validation Demo\Main Demo\Calculate Blood Pressure.vi
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 Printed on 7/8/2009 at 7:24 PM

Page 5

Calculate Blood Pressure.vi
 C:\Documents and Settings\Developer\My Documents\LabVIEW Development Directory\Software Validation Demo\Main Demo\Calculate Blood Pressure.vi
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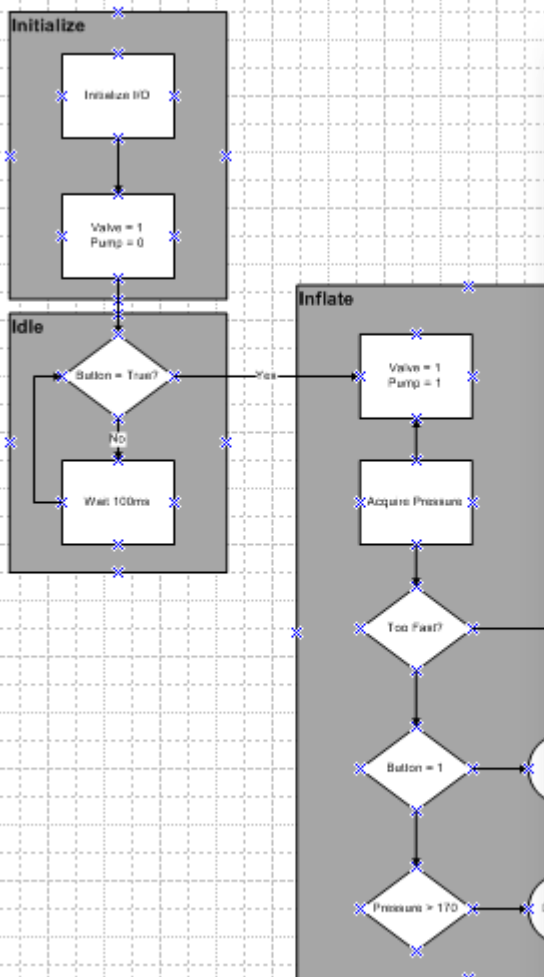
Legend:

- status**: -status is TRUE (X) if an error occurred or FALSE (checkboxmark) to indicate a warning or that no error occurred.
 Right-click the -error in control on the front panel and select -Explain Error or -Explain Warning from the shortcut menu for more information about the error.
- code**: -code is the error or warning code.
 Right-click the -error in control on the front panel and select -Explain Error or -Explain Warning from the shortcut menu for more information about the error.
- source**: -source describes the origin of the error or warning.
 Right-click the -error in control on the front panel and select -Explain Error or -Explain Warning from the shortcut menu for more information about the error.
- warn**: -warn is the mean, or average, of the values in the input sequence -X.
- Systolic**: Systolic

Sub-VI List:

- Compare results.vi
- Calculate Blood Pressure.vi
- Update constants.vi
- Process Heartbeat Waveforms.vi

Documentation générée par LabVIEW



HOME NON-INVASIVE BLOOD PRESSURE MONITOR SYSTEM LEVEL REQUIREMENTS

INTRODUCTION

This document contains the system level requirements for the home non-invasive blood pressure monitor.

GENERAL SYSTEM REQUIREMENTS

REQ1: MEASURES BLOOD PRESSURE

The device should be able to measure blood pressure to within 3 mmHg.

Priority: High

REQ2: MEASURES HEART RATE

The device should be able to measure heart rate to within 5 beats per minute.

Priority: Medium

REQ3: HOME USE

This device should be able to be operated by a patient to administer the test themselves and without the need for a healthcare professional.

Priority: High

MEASUREMENT REQUIREMENTS

REQ4: RESOLUTION OF BLOOD PRESSURE

The device should be able to detect a change in blood pressure of 1 mmHg over the entire range of the device.

Priority: High

REQ5: RESOLUTION OF HEART RATE

The device should be able to detect a change in heart rate of 5 beats per minute over the entire range of the device.

HOME NON-INVASIVE BLOOD PRESSURE (NIBP) MONITOR

VISION AND SCOPE

INTRODUCTION

This document contains the scope and vision associated with the blood pressure monitor.

VISION

Monitoring your blood pressure at home offers several benefits. It can:

- **Help track treatment.** Self-monitoring provides vital information between visits to the doctor.
- **Encourage better control.** Taking your own blood pressure measurements has been shown to result in better blood pressure control and greater success meeting blood pressure targets.
- **Cut health care costs.** Home monitoring should cut down on the number of doctor visits.
- **Guard against white-coat hypertension.** Monitoring blood pressure at home or work can help determine if you have true high blood pressure or anxiety about the doctor.

SCOPE

This device will provide a safe, affordable, and accurate means for a patient to monitor his/her own blood pressure and heart rate using an arm cuff and the oscillometric measurement method. Measurements will be targeted at less than a minute (on average) and the device must be simple enough for a patient to administer themselves without formal training. This device will be targeted at adults without irregular heartbeats.

Collecte des
exigences

Développement

Déploiement

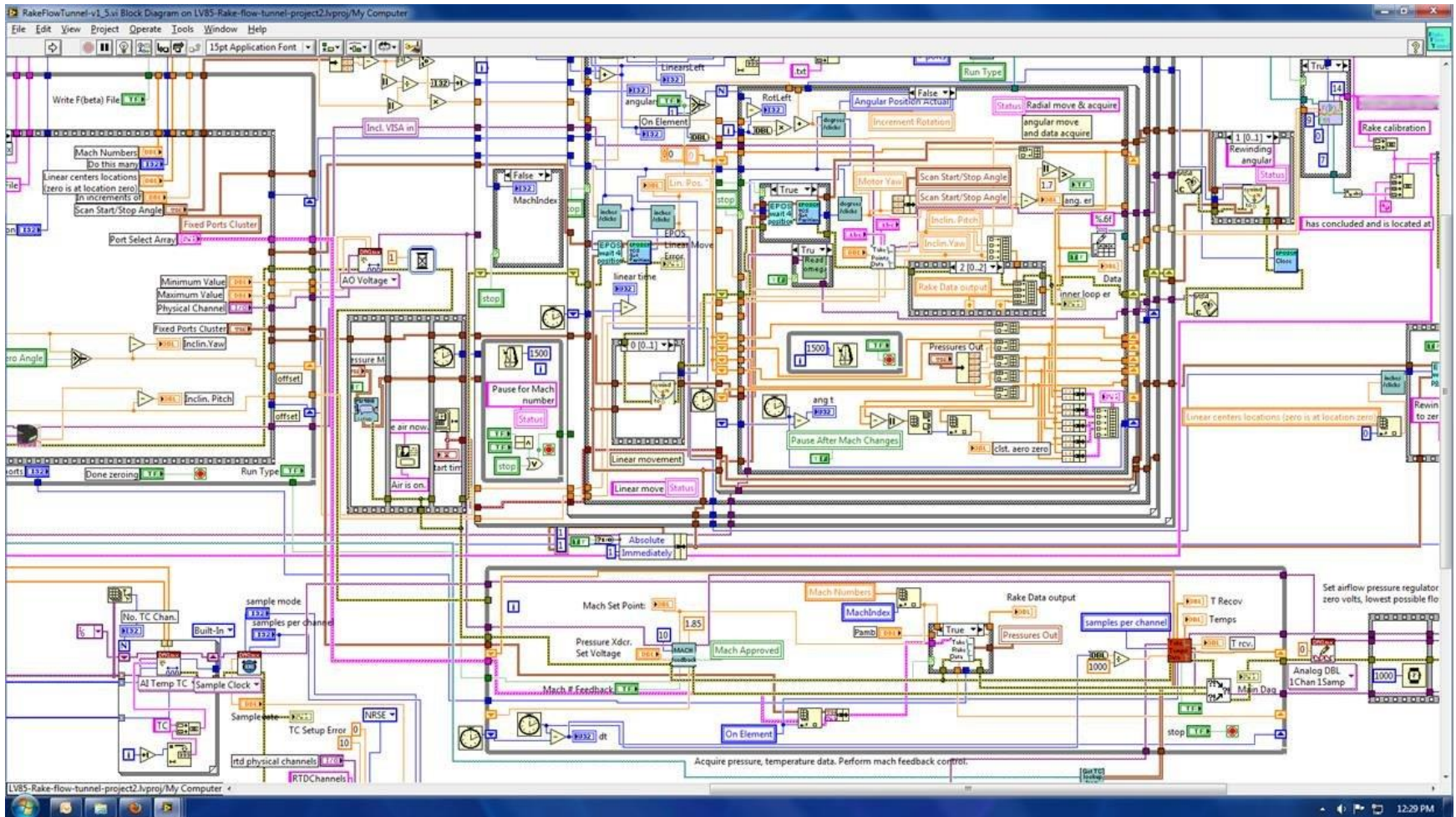


Architecture
de l'application

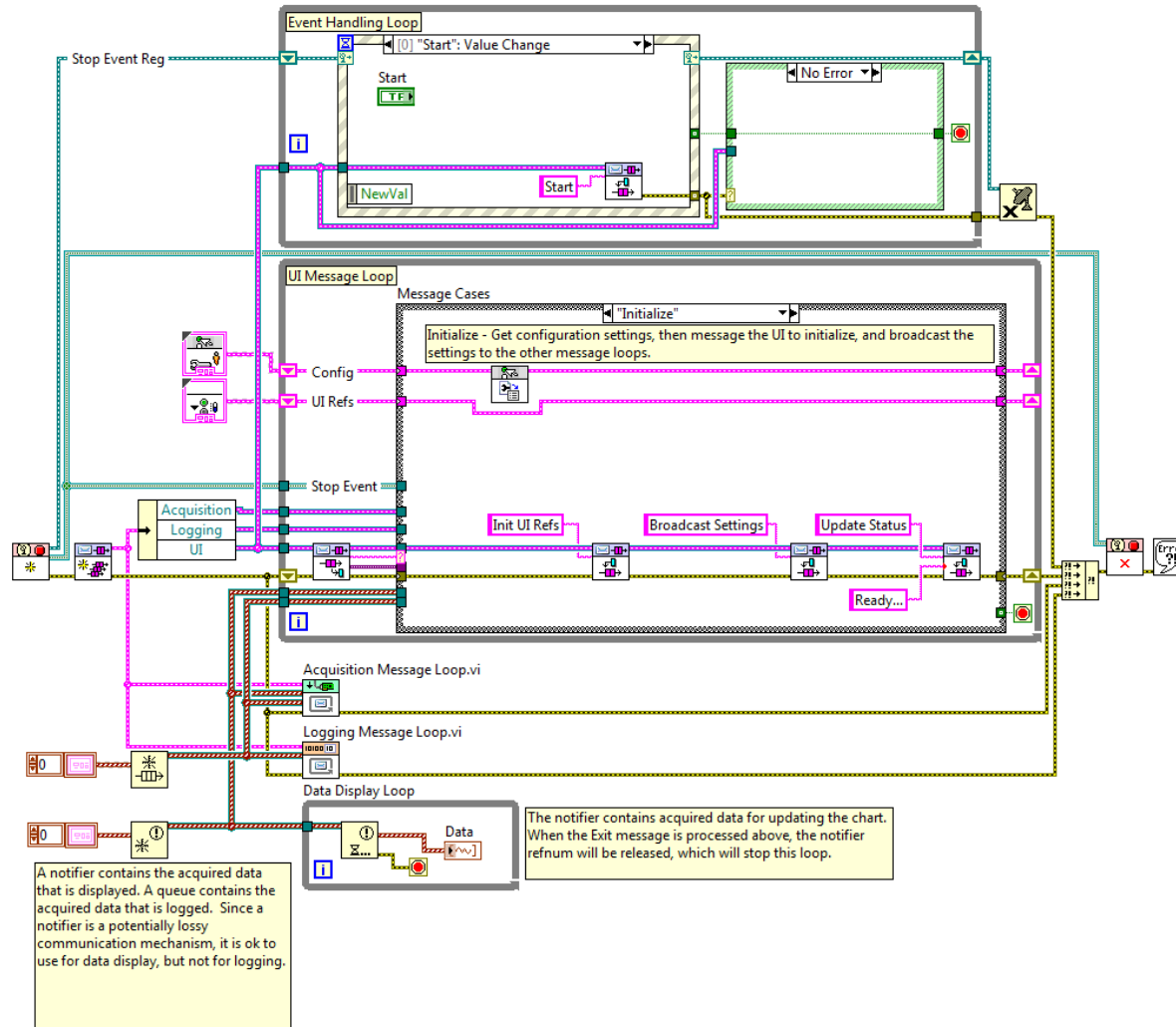
Test et
débogage

Outils d'analyse, de débogage et de validation du code

Comment reconnaissez-vous un bon codage ?



Comment reconnaissez-vous un bon codage ?



Collecte des
exigences

Développement

Déploiement



Architecture
de l'application

Test et
débogage

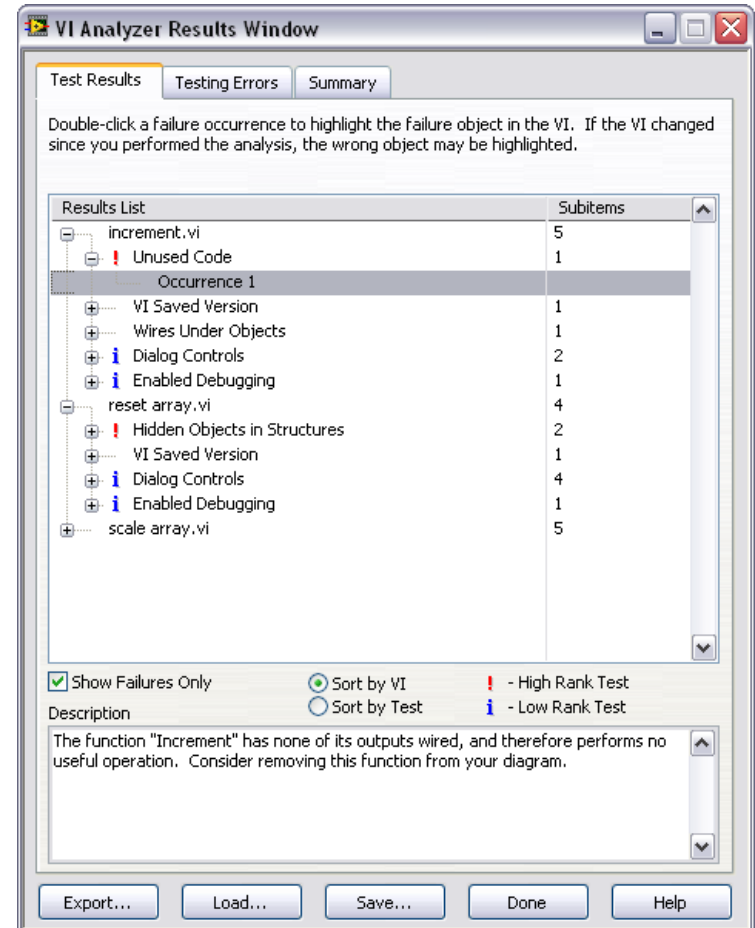
Outils directement intégré dans LabVIEW

- Compilation en arrière-plan
- Exécution pas-à-pas
- Gestionnaire de points d'arrêt
- Gestion d'erreurs automatique
- Nettoyage du diagramme
- Analyseur de VI
- Points de coercition (optimisation mémoire)
- Structures à désactivation conditionnelles

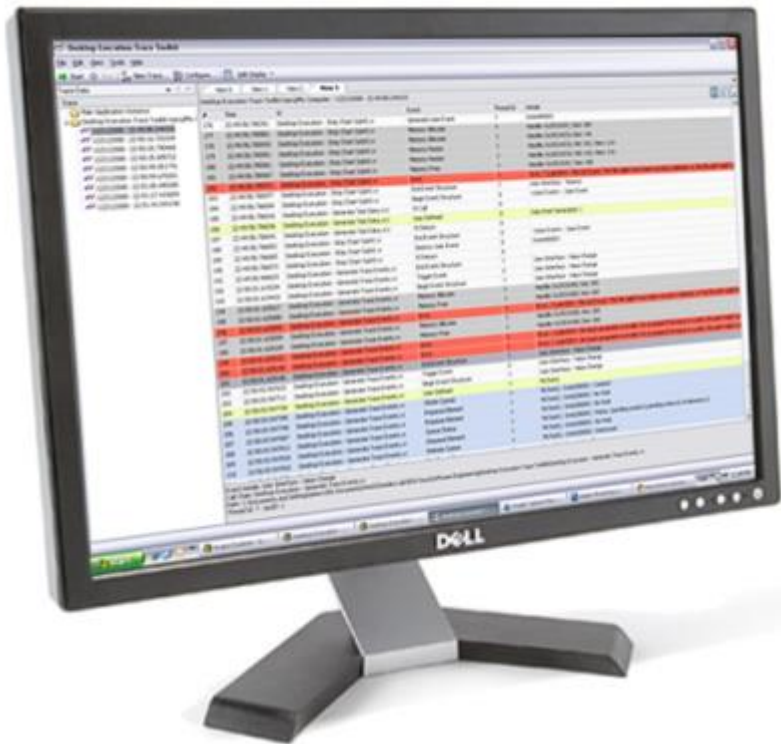


Outils » Analyseur de VI

- Automatiser l'analyse du code avec plus de 60 tests configurables
 - Performances
 - Style
- Inspecter interactivement les améliorations possibles
- Générer des rapports personnalisés
- Mesurer la complexité cyclomatique du code



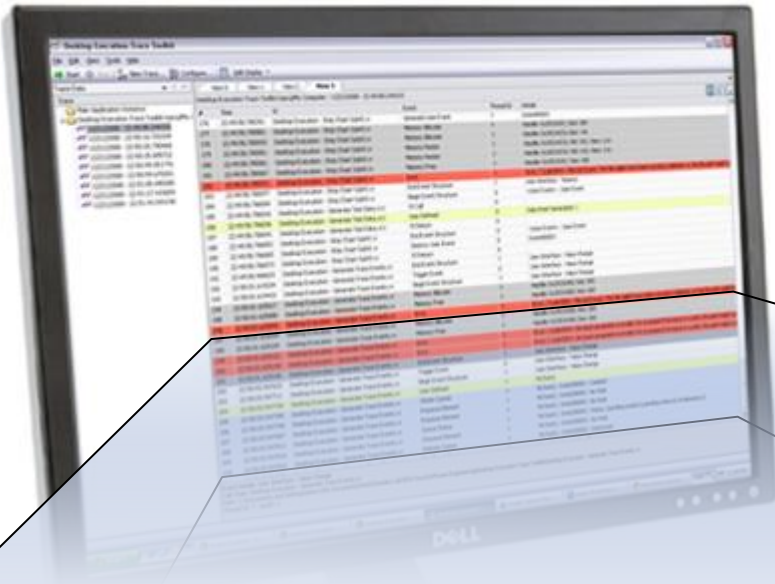
Toolkit Desktop Execution Trace



- Structures Événements
- Allocations mémoire
- Files/Notificateurs
- Pertes de références
- Identification des threads
- Erreurs non gérées
- Sous-VIs dynamiques et statiques
- Chaînes d'événements définies par l'utilisateur

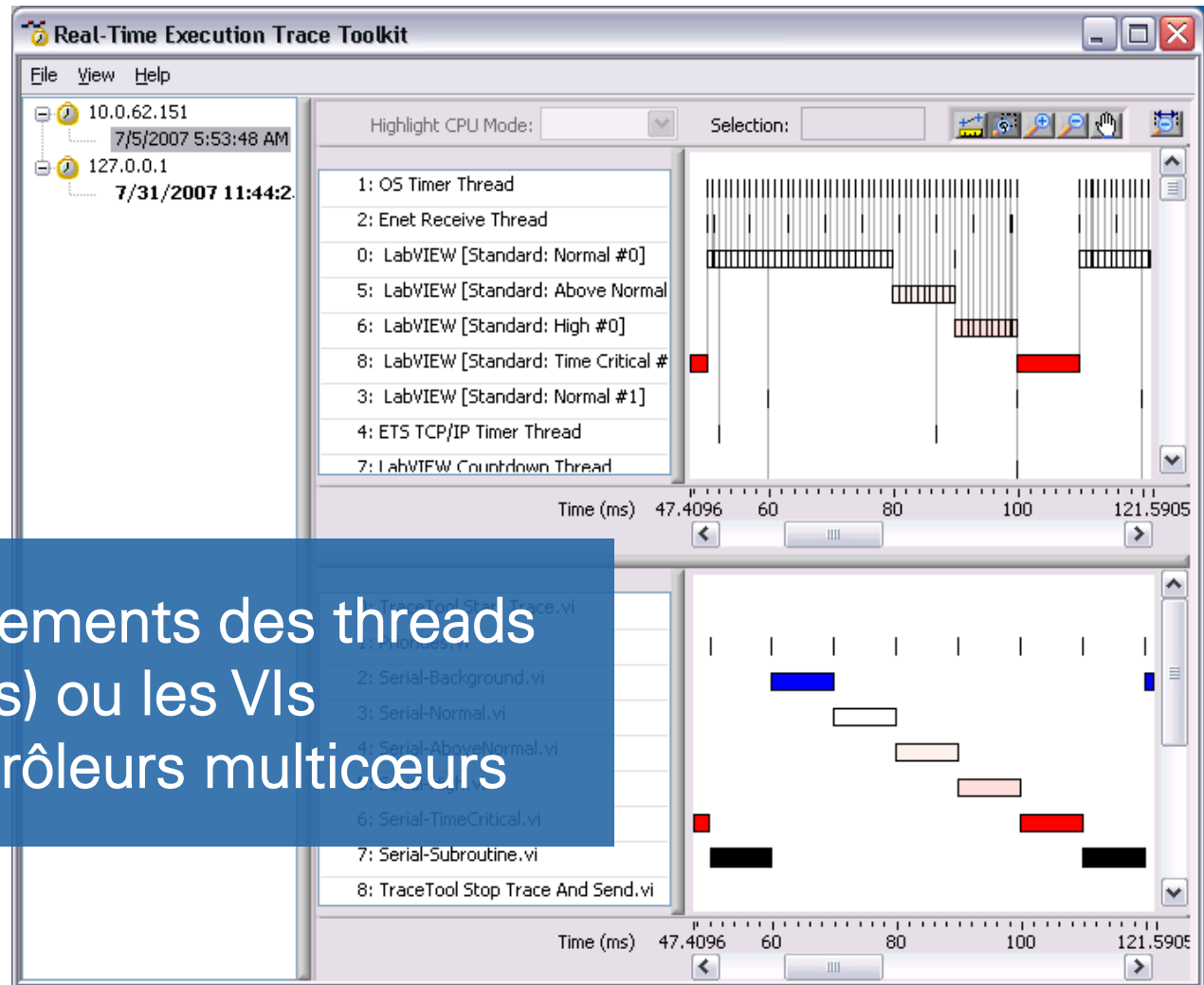
Toolkit Desktop Execution Trace

- Structures Événements
- Allocations mémoire
- Files/Notificateurs
- Pertes de références
- Identification des threads
- Erreurs non gérées
- Sous-VIs dynamiques et



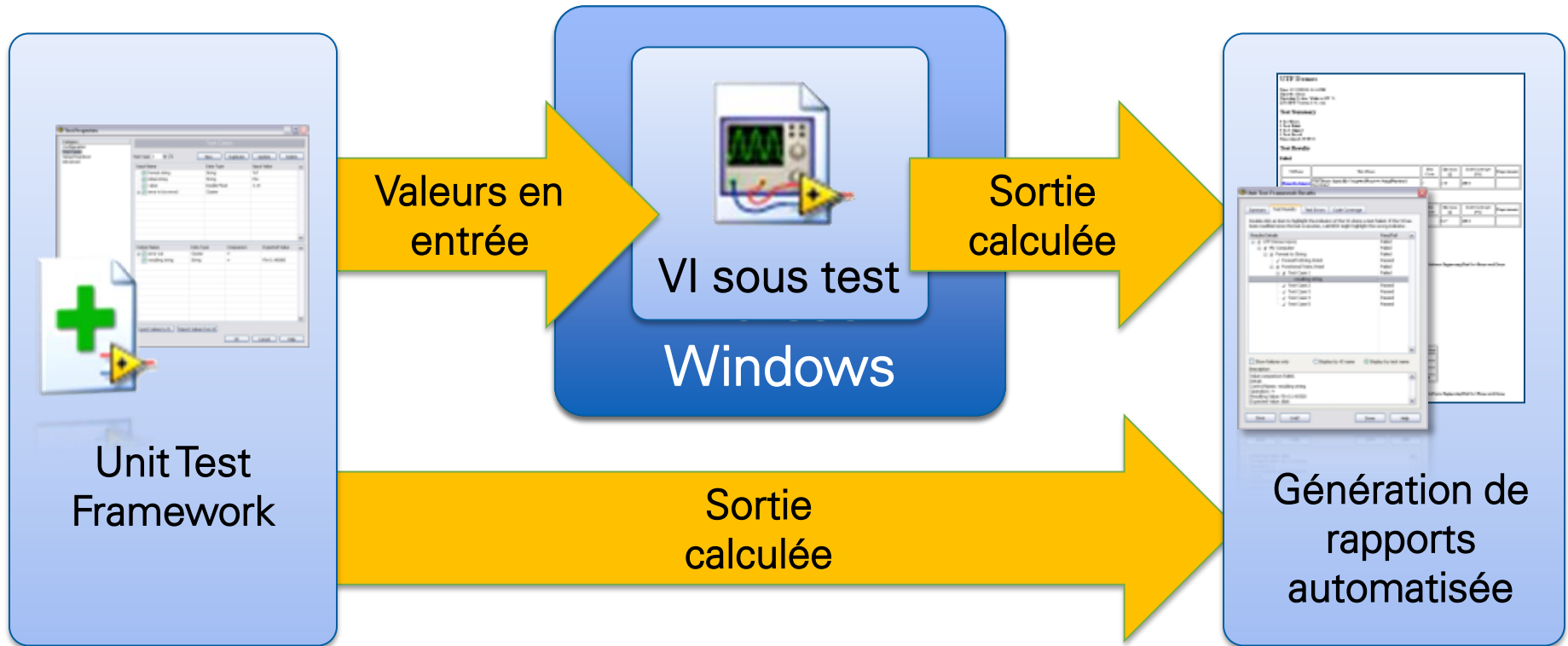
Strip Chart SubVI.vi	Memory Resize	7	Handle: 0x25CA3C8; Old: 142; New: 118
Strip Chart SubVI.vi	Memory Allocate	7	Handle: 0x25CA3C8; Size: 142
Strip Chart SubVI.vi	Memory Resize	7	Handle: 0x25CA3C8; Old: 142; New: 118
Strip Chart SubVI.vi	Error	7	Error: 7 (LabVIEW: File not found. The file might have
Generate Trace Events.vi	User Defined	7	MyTestQ
Generate Trace Events.vi	Obtain Queue	7	MyTestQ - 0x66200002 : Created
Generate Trace Events.vi	Enqueue Element	7	MyTestQ - 0x66200002 : No Wait

Toolkit Real-Time Execution Trace



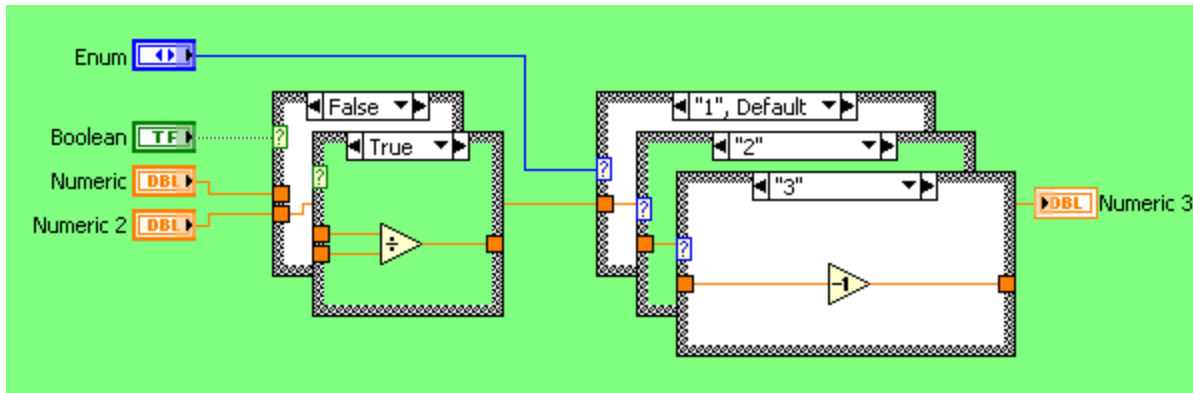
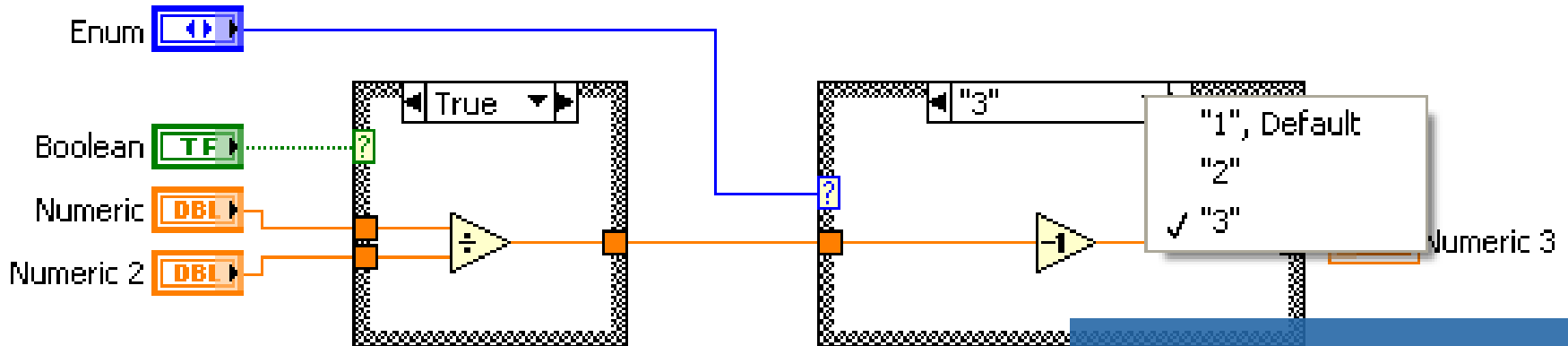
- Vérifie les cadencements des threads (boucles cadencées) ou les VIs
- Supporte les contrôleurs multicœurs

LabVIEW Unit Test Framework



Vecteur de test = valeur(s) d'entrée + sortie(s) attendue(s)

Rapport de couverture du code



6 diagrammes possibles,
3 diagrammes exécutés
=> 50% de couverture du code

Collecte des
exigences

Développement

Déploiement



Architecture
de l'application

Test et
débogage

Outils de déploiement

Collecte des exigences

Développement

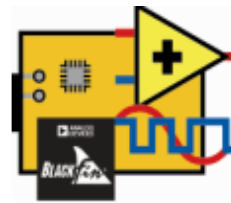
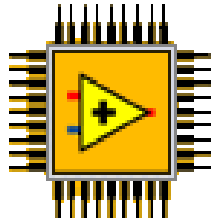
Déploiement



Architecture de l'application

Test et débogage

Déployer du logiciel sur des cibles matérielles embarquées



Construire des applications professionnelles pour PC de bureau

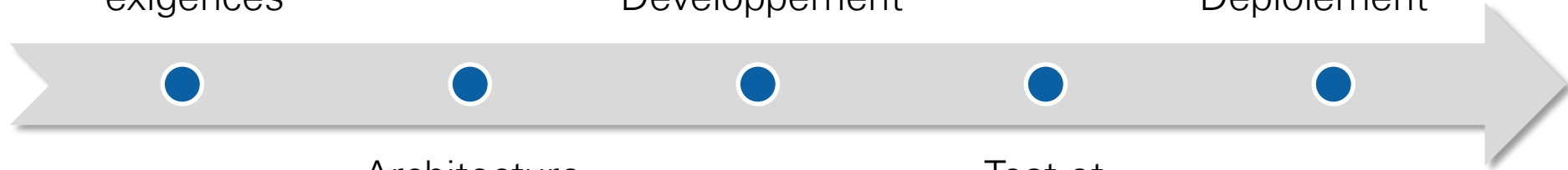


Le processus de génie logiciel

Collecte des exigences

Développement

Déploiement



Architecture de l'application

Test et débogage

NI Requirements Gateway

Modèles de conception
Orienté objet
Multicœur

Flux de données
MathScript
Statechart
Simulation
Express

VI Analyzer
Real Time Execution Trace
Desktop Execution Trace
Unit Test Framework

Application Builder
Real-Time
FPGA
Embarqué

Formation et certifications

- Formations au catalogue, chez nous ou sur site
 - [LabVIEW Core 3](#)
 - [Object-Oriented Design and Programming in LabVIEW](#)
 - [Managing Software Engineering in LabVIEW](#)
 - [Advanced Architectures in LabVIEW](#)
- Certifications
 - **Certified LabVIEW Associate Developer (CLAD)** : connaît et maîtrise les bases de LabVIEW
 - **Certified LabVIEW Developer (CLD)** : familier avec l'usage des modèles de programmation
 - **Certified LabVIEW Architect (CLA)** : capable d'architecturer un code et de coordonner une importante équipe de développement



Advanced Application Development with LabVIEW



LabVIEW is used to build some of the largest and most complex applications in the world. Graphical dataflow, or G, is a complete programming language, requiring the same software engineering practices and disciplines as traditional text-based approaches. This site is dedicated to providing best practices for the application of software engineering tools and principles when developing in G in order to ensure quality and reliability.

- Best Practices
- Case Studies**
- Training
- Community



"Through the use of advanced software architecture and NI hardware, G Systems was able to provide Lockheed Martin Aeronautics with a highly-configurable, expandable system to meet current and future requirements of the F-35 VSIF."

- Michael Fortenberry - G Systems, Inc.

[» Read the full case study](#)

Case Studies and User Solutions

CERN - Spanning more than 27 km, the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (also known as CERN) is one of the largest and most complex machines on earth. To redirect any potentially dangerous stray particles, CERN selected LabVIEW and PXI from NI to control the motion inside 108 collimators with an accuracy of 20 microns. The final system uses more than 100 PXI systems, which are synchronized within 1 ms of each other.

[» Read More](#)

Ventura Aerospace - Ventura developed an intelligent fire monitoring and suppression control system for FedEx Express using NI LabVIEW software and NI Single-Board RIO hardware to prevent catastrophic fires within freight aircraft and keep pilots, packages, and planes safe from fires that may start in the shipping containers.

[» Read More](#)

Download Exercises

Download a tutorial and example code for how to setup tools and practices

[» Get Started Now](#)

NI Software Products

Find out more about LabVIEW add-ons for advanced development to improve the quality and reliability of systems.

[NI Requirements Gateway](#)

[VI Analyzer Toolkit](#)

[Desktop Execution Trace Toolkit](#)

[Unit Test Framework](#)

Partner Products

Learn more about third-party products for software engineering with LabVIEW

[VI Package Manager](#)

[TortoiseSVN Tool for LabVIEW](#)

[LTK LabVIEW Localization Toolkit](#)

[Reference-Based Classes](#)

