



TECHNIEK
EN MANAGEMENT



Introductie RTC-tools

Klaas-Jan van Heeringen



Deltares

Enabling Delta Life



Real-time Control

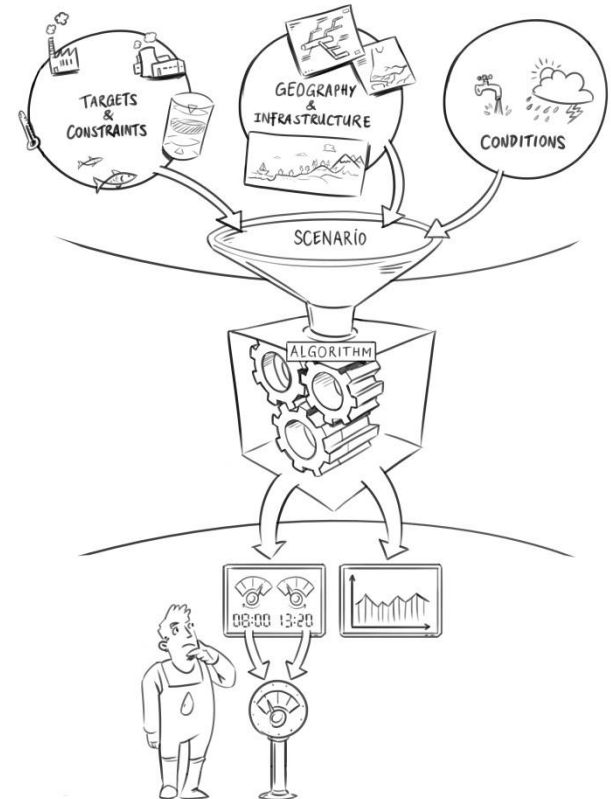
FEEDBACK CONTROL



FEEDFORWARD CONTROL

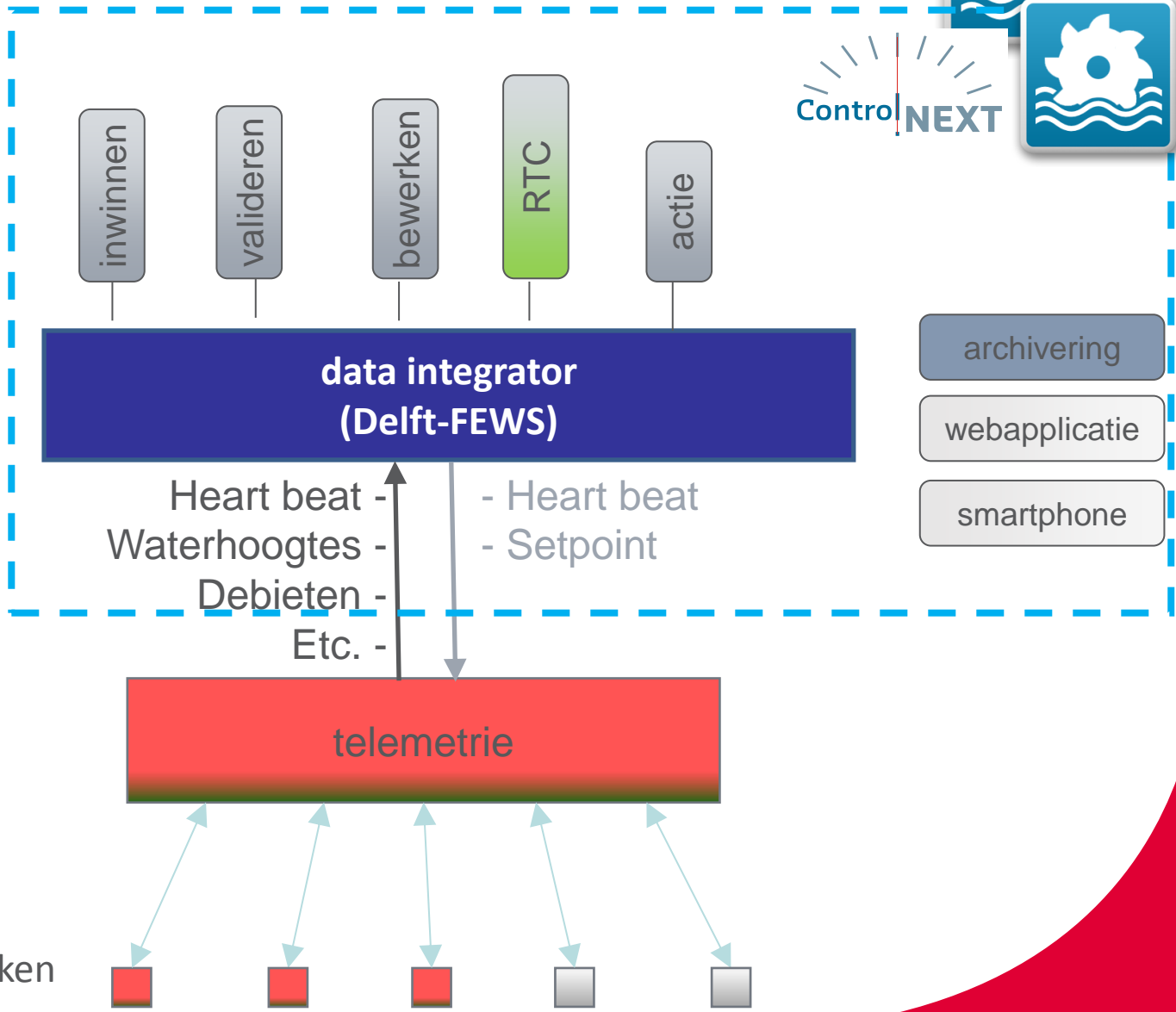


MODEL PREDICTIVE CONTROL



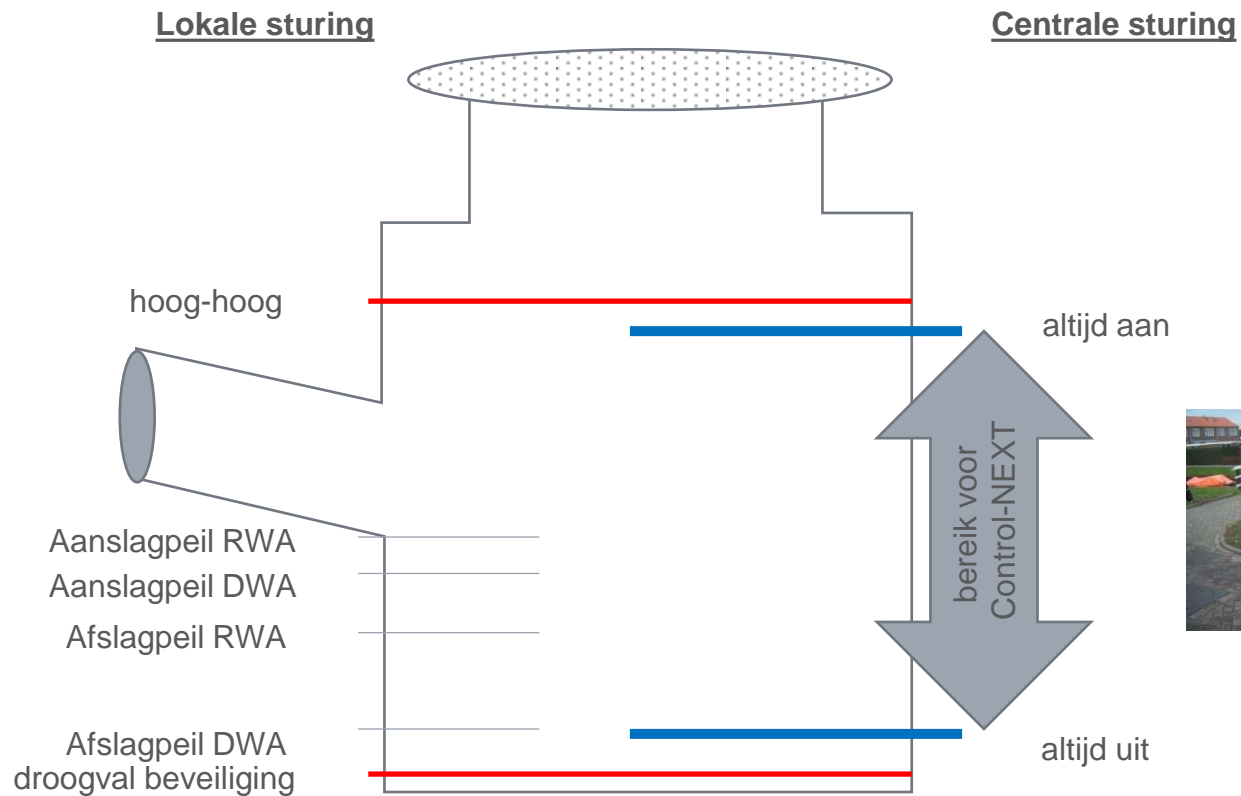
Tools

externe
Meteo



kunstwerken

Backupstrategie





RTC programmering

- In telemetrie:
 - Als-dan regels (rules)
 - Controllers (PI, interval,)

- Dus: feedback en/of feedforward

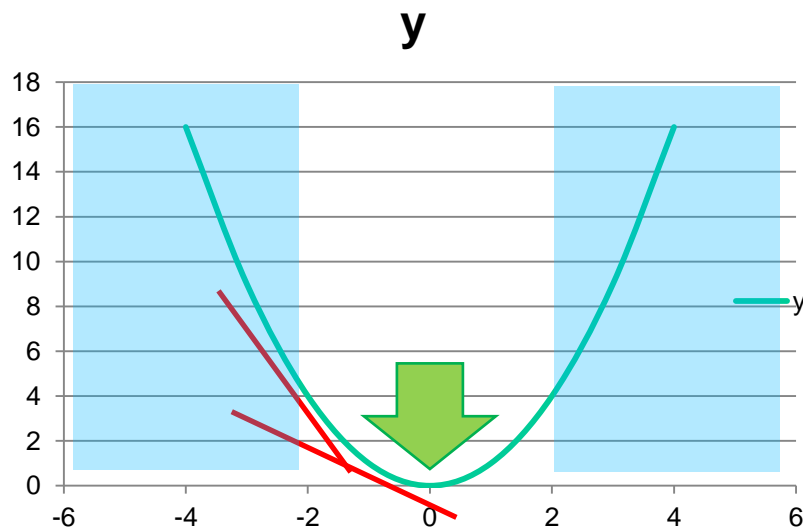
- Maar ook MPC gewenst ?
 - *wat zijn voor/nadelen van*
 - *Feed-Back*
 - *Feed-Forward*
 - *Model Predictive Control*

Doelfunctie

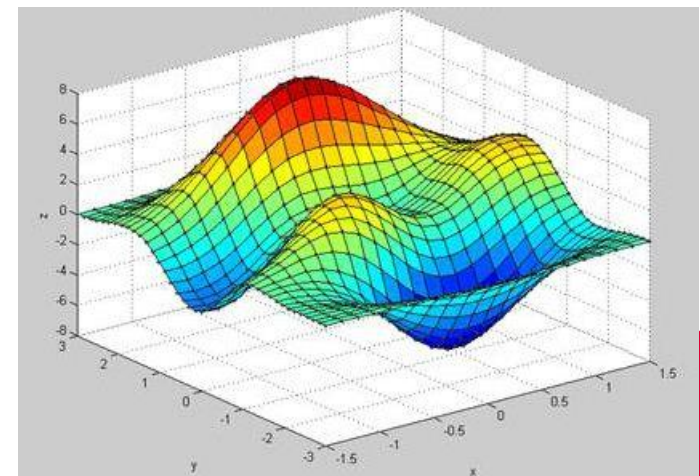
Zoek het minimum van een **objective function**

Bijv.: minimaliseer $y = x^2$

Gradient gebaseerd optimalisatie algoritme gebruik de helling

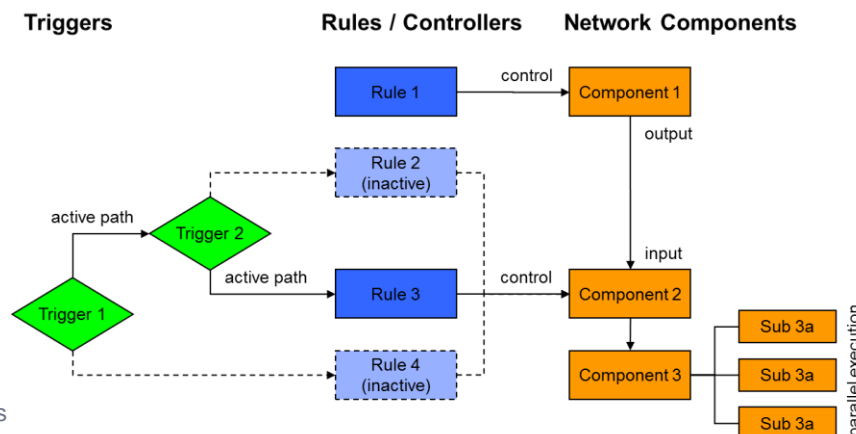


Bijv. 2 variabelen:



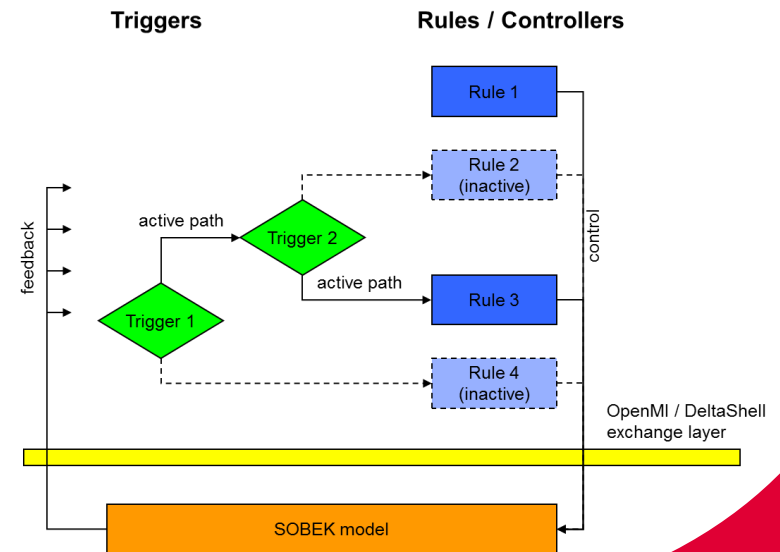
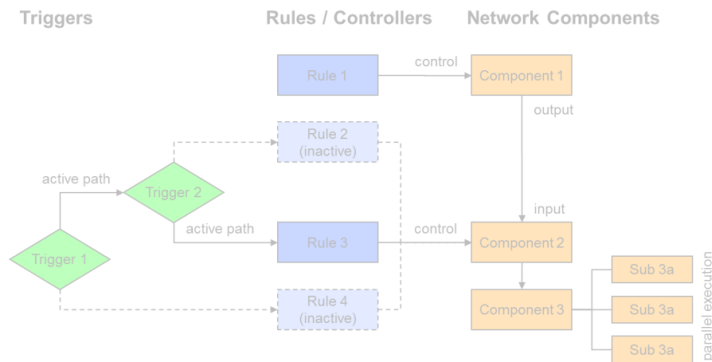
RTC-Tools: als losse module

- Rules, triggers
- MPC (optimalisatie)
- Externe koppelingen (Matlab, OpenDA, OpenMI)
- Interne modellen
 - Hydrologische (HBV, sacramento, ...)
 - Hydraulische (zoals Sobek-CF)
 - Reservoirs en stuwdammen



RTC-Tools: koppelingen

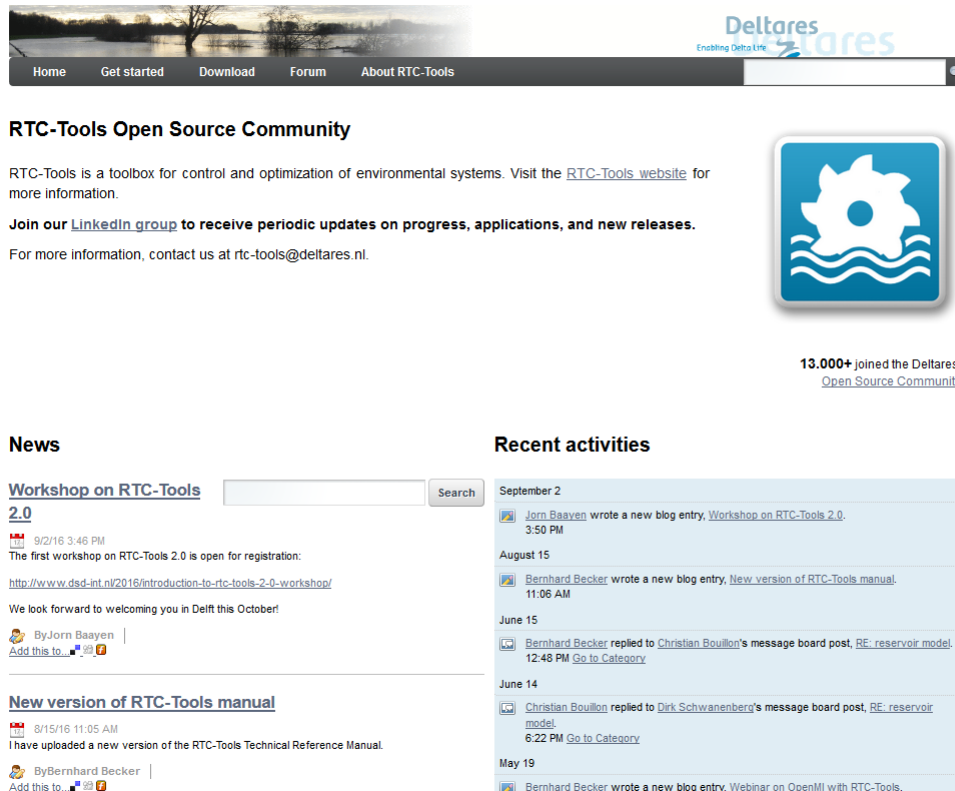
- Matlab, OpenDA, OpenMI
- RTC module van SOBEK 3.x
→ Alleen rules en triggers (FeedBack, FeedForward)





RTC-Tools community

- Open source: <http://oss.deltares.nl/web/RTC-Tools>



The screenshot shows the website for the RTC-Tools Open Source Community. At the top, there is a navigation bar with links for Home, Get started, Download, Forum, and About RTC-Tools. Below the navigation bar, the main heading is "RTC-Tools Open Source Community". The text describes RTC-Tools as a toolbox for control and optimization of environmental systems and provides a link to the website for more information. It also encourages users to join the LinkedIn group for updates and provides contact information. A large blue gear icon is prominently displayed. Below the icon, it states "13.000+ joined the Deltares Open Source Community". The page is divided into two main sections: "News" and "Recent activities".

RTC-Tools Open Source Community

RTC-Tools is a toolbox for control and optimization of environmental systems. Visit the [RTC-Tools website](#) for more information.

Join our [LinkedIn group](#) to receive periodic updates on progress, applications, and new releases.

For more information, contact us at rtc-tools@deltares.nl.

13.000+ joined the Deltares Open Source Community

News

Workshop on RTC-Tools 2.0

9/2/16 3:46 PM
The first workshop on RTC-Tools 2.0 is open for registration:
<http://www.dsd-int.nl/2016/introduction-to-rtc-tools-2-0-workshop/>
We look forward to welcoming you in Delft this October!

By [Jorn Baayen](#) |
[Add this to...](#)

New version of RTC-Tools manual

8/15/16 11:05 AM
I have uploaded a new version of the RTC-Tools Technical Reference Manual.

By [Bernhard Becker](#) |
[Add this to...](#)

Recent activities

September 2
[Jorn Baayen](#) wrote a new blog entry, [Workshop on RTC-Tools 2.0](#).
3:50 PM

August 15
[Bernhard Becker](#) wrote a new blog entry, [New version of RTC-Tools manual](#).
11:06 AM

June 15
[Bernhard Becker](#) replied to [Christian Bouillon's](#) message board post, [RE: reservoir model](#).
12:48 PM [Go to Category](#)

June 14
[Christian Bouillon](#) replied to [Dirk Schwanenberg's](#) message board post, [RE: reservoir model](#).
6:22 PM [Go to Category](#)

May 19
[Bernhard Becker](#) wrote a new blog entry, [Webinar on OpenMI with RTC-Tools](#).



RTC-Tools versie 1.x

Versie 1.4:

- Geen user interface
- Definitie in XML bestanden
- Continue optimalisatie

Versie 2.0:

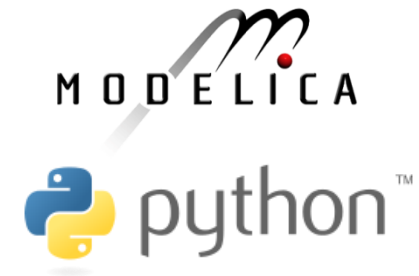
- user interface met modelica
- Definitie in python



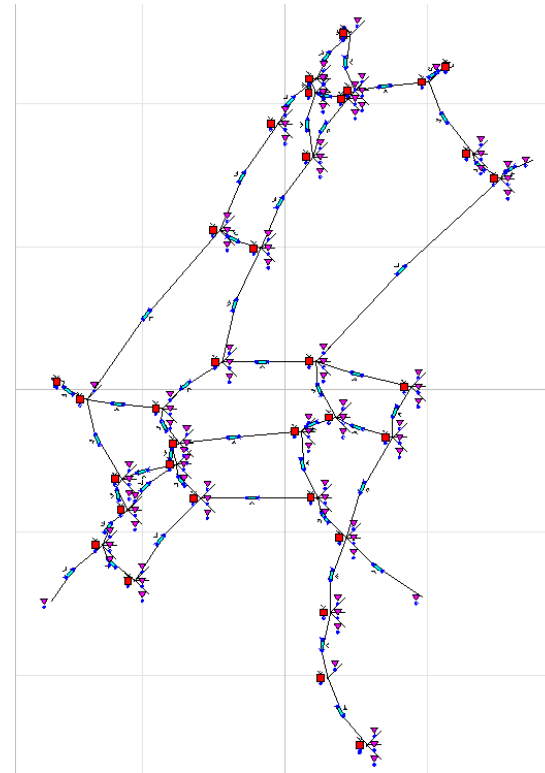
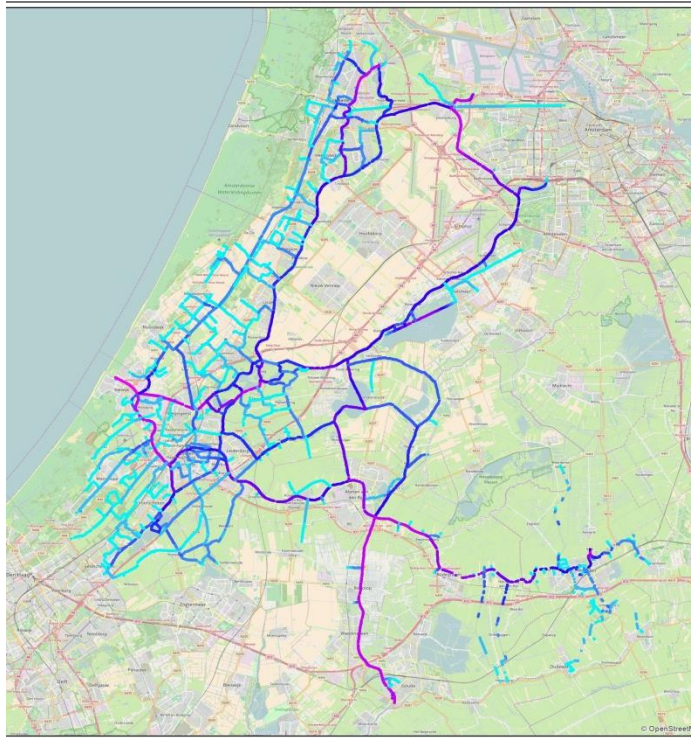
RTC-Tools versie 2.0

- ontwikkeld in kader van TKI
- user interface met modelica
- koppeling met python

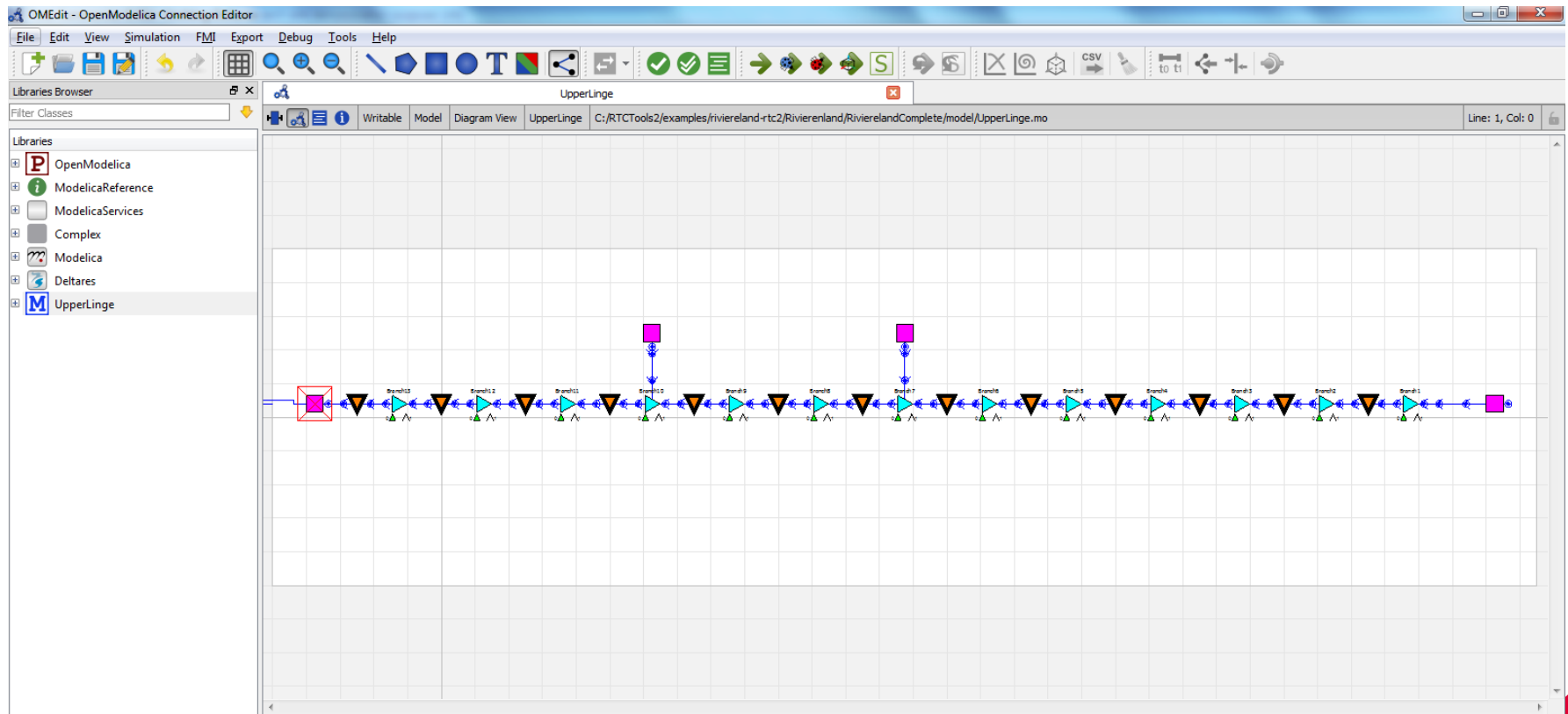
- Mogelijkheden:
 - Multi-objective functions / Goal Programming
 - Treebased optimalisatie (onzekerheden)
 - Mixed-Integer optimalisatie



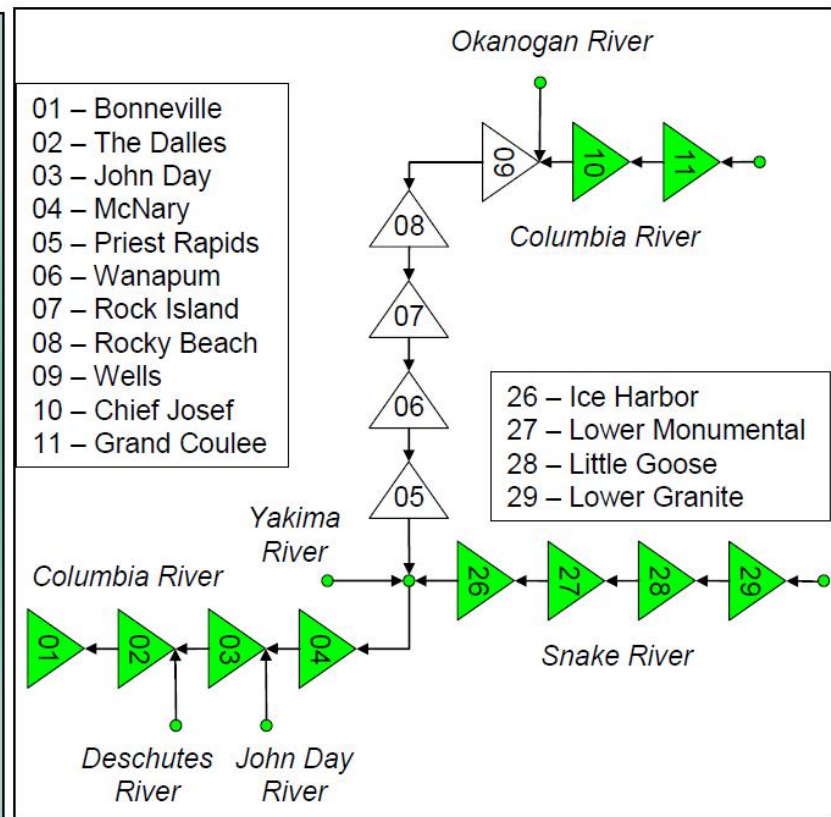
Voorbeeld Rijnland model



Voorbeeld Linge



Voorbeeld Bonneville Power Admin.



Voorbeeld Bonneville Power Admin.





Voorbeeld Bonneville Power Admin.

Afweging van:

- Berging in reservoirs
- Peilen en peilvariatie
- Elektriciteitsvraag
- Scheepvaart
- Natuur / ecologie (zalmtrek!)
- Prioritering

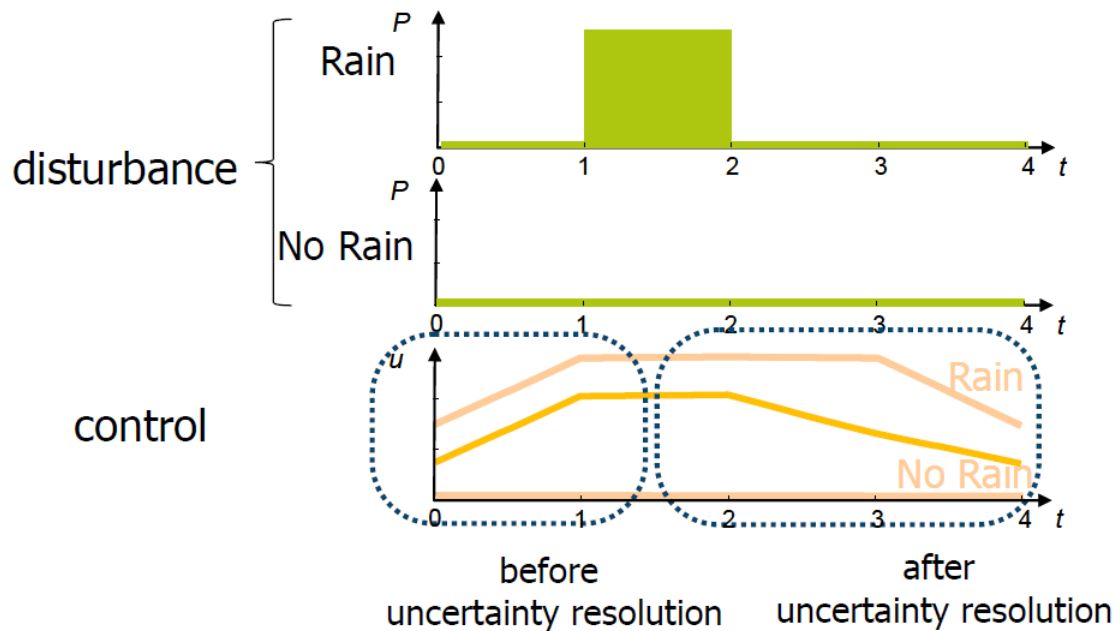


Actuele innovatieprojecten in NL

- TKI project “Multi-stage Stochastic and Robust Optimization of Flood Mitigation Measures under Forecast Uncertainty” (Dirk Schwanenberg): Fundamenteel onderzoek naar onzekerheid in voorspellen en getrapte optimalisatie
→ **bouw** RTCTools v2
- TKI project “Rekenen aan Slim Water Management” (Klaas-Jan van Heeringen): vervolg op bovenstaande, brede toepassing van korte termijn optimalisatie bij 4 waterbeheerders
→ **toepassen** RTCTools v2
- “Slim Malen” (Ivo Pothof + KJvH): optimalisatie van energieverbruik (CO₂ en kosten) in NL waterbeheer, in samenwerking met energieleveranciers

Treebased Optimization

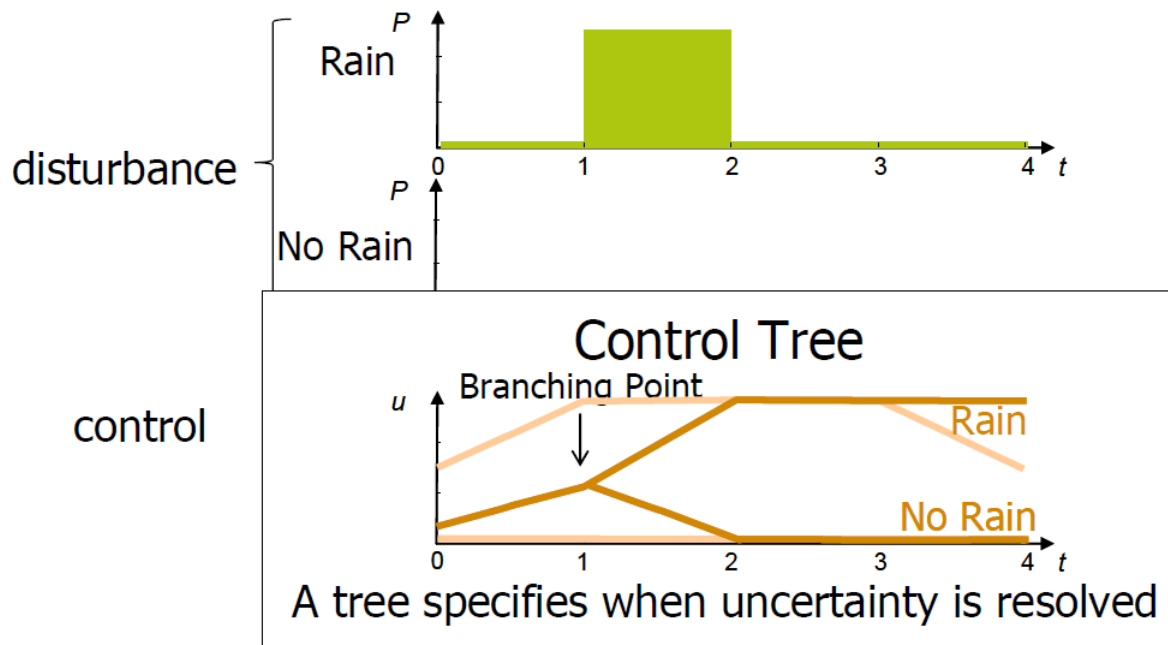
Decision Uncertainty Resolution Decision



Once uncertainty is resolved, it is possible to adopt the control strategy optimal to the remaining scenario !!!

Treebased Optimization

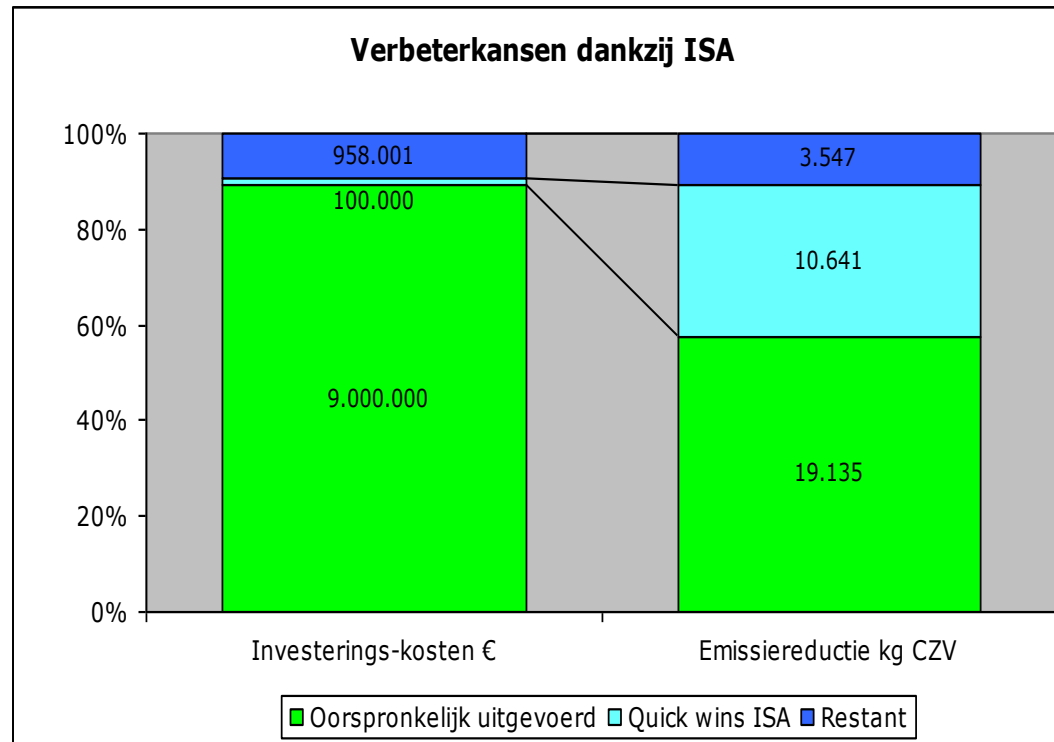
Decision Uncertainty Resolution Decision



Once uncertainty is resolved, it is possible to adopt the control strategy optimal to the remaining scenario !!!

PROJECTEN

1. Ken je watersysteem

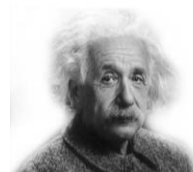




PROJECTEN

1. Ken je watersysteem
2. Heldere doelen
3. Gefaseerde aanpak
4. Backup strategie (bij centrale regeling)
 - beperk regelmacht van centrale regeling
 - buiten bereik regelmacht: lokale regeling
 - heartbeats
5. Keep it simple

**Things should be made
as simple as possible,
but not any simpler.**



Albert Einstein
German Theoretical-Physicist
(1879-1955)



Meer informatie

<http://oss.deltares.nl/web/RTC-Tools>

rtc-tools@deltares.nl