Putting Bernina on the Web

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The Bernina package

- Interface to $\sum^{it}$ functions.
- Efficient computations related to differential operators.
- Bernina solves problems such as:
  - "*Darboux polynomials of lowest possible degree*"
  - "*Liouvillian solutions of second-order operators*"
- Author: Manuel Bronstein (INRIA Sophia-Antipolis, France)

Bernina internals

- $\sum^{it}$ and Bernina are written in Aldor
- Standard IO for communication (stdin, stdout, sockets)
- External format of objects: Lisp, Maple, or Latex
- No support for building (web) Aldor services
  (e.g. interfacing with OpenMath, handling SOAP messages)

How to use Bernina?

- Download Bernina locally
  - use Bernina interactively
  - communicate through files (e.g. with Maple)
- Play with the Bernina demo web site:

  `http://www-sop.inria.fr/cafe/Manuel.Bronstein/sumit/bernina_demo.html`

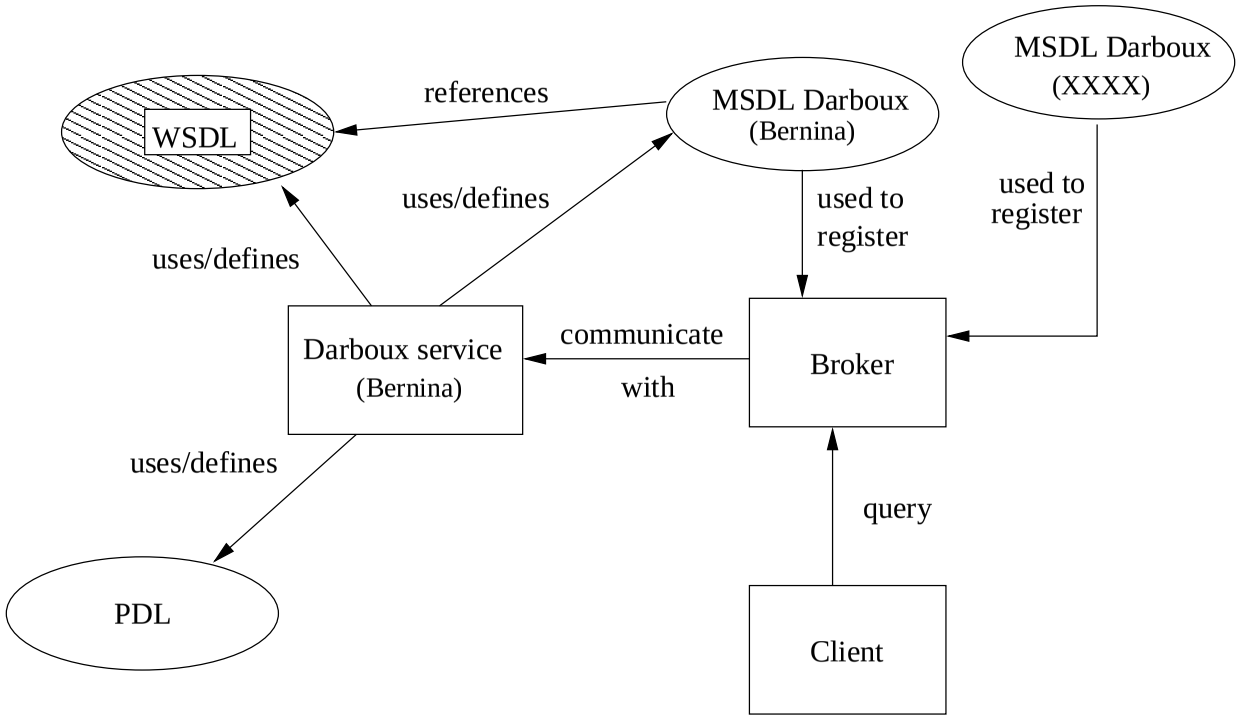
Bernina as a MONET web service

Exporting Bernina functions as (MONET) web services will increase Bernina's accessibility and visibility:

- Standard languages (MSDL, PDL, and so on)
- Discovery of Bernina through MONET brokers
- Use of a broker/planner to perform computations

Bernina in the MONET context

Example with a Darboux service:



Service description: WSDL file

```
...
   <wsdl:portType name="Bernina">
      ...
      <wsdl:operation name="darboux" parameterOrder="in0">
         <wsdl:input name="darbouxRequest"
                     message="impl:darbouxRequest"/>
         <wsdl:output name="darbouxResponse"
                      message="impl:darbouxResponse"/>
      </wsdl:operation>
      ...
   </wsdl:portType>
...
```

Problem description: PDL file

```
<pdl:definitions
    xmlns:pdl="http://monet.nag.co.uk/monet/ns"
    xmlns="http://www.openmath.org/OpenMath">

<pdl:problem name=Darboux>
  <pdl:header/>
  <pdl:body>

    <input name=L> Differential Operator Type </input>
    <output name=dReturn> Polynomial List Type </output>

  </pdl:body>
</pdl:problem>

</pdl:definitions>
```

Service description: MSDL file

```
<definitions xmlns="http://monet.nag.co.uk/monet/ns">
<service name="BerninaDarboux">
  <classifications>
    <problem-reference>
        http://www.inria.fr/diffop.pdl
    </problem-reference>
  </classifications>
  <implementation-details>
    <software>http://www.inria.fr/Bernina</software>
  </implementation-details>
  <service-interface-description
      sid-ref="http://www.inria.fr/Bernina/bernina.wsdl" />
```

```
  <service-binding>
    <map operation="darboux" problem-ref="Darboux" />
    <message-construction
        io-ref="L"
        message-name="darbouxRequest" message-part="in0" />
    <message-construction
        io-ref="dReturn"
        message-name="darbouxResponse"
        message-part="darbouxReturn" />
  </service-binding>
  <service-metadata/>
  <broker-interface/>
</service>
...
</definitions>
```

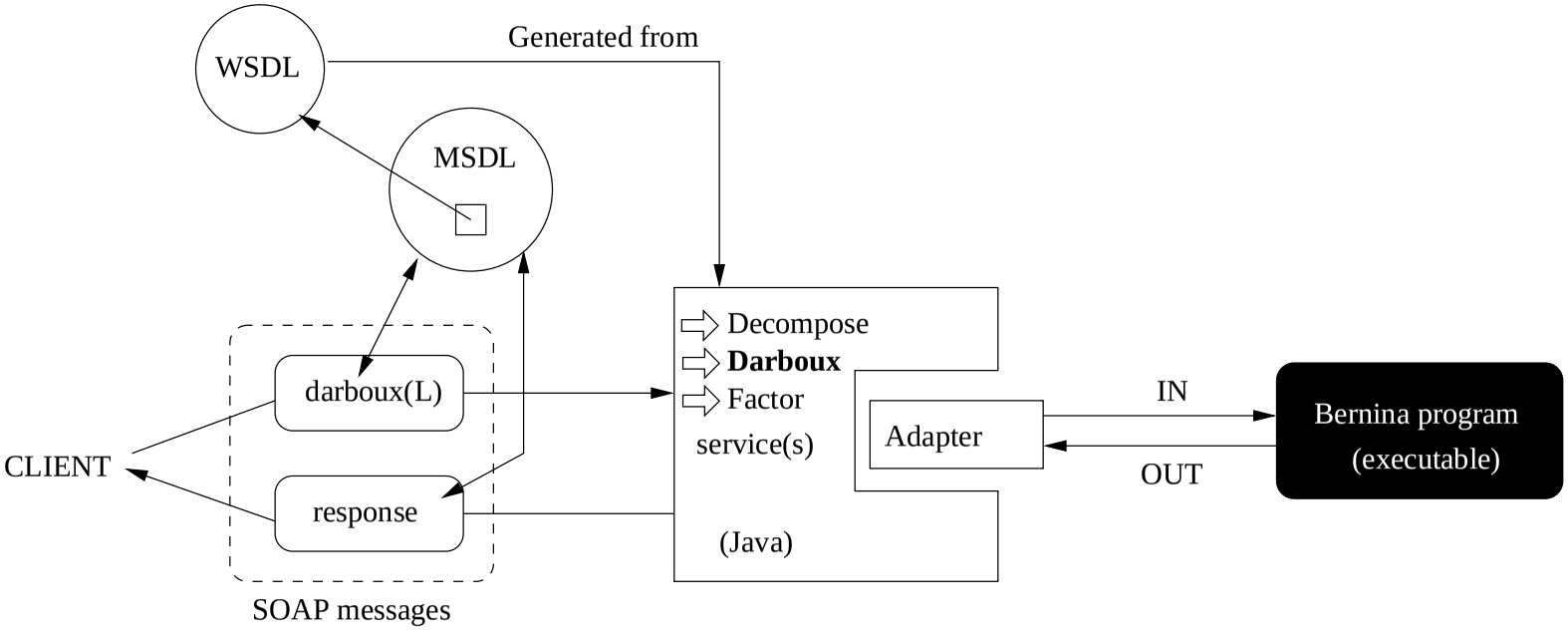
Technologies

- **Web services**: SOAP and WSDL
- **Programming languages**: Java, .NET, Perl
- **Specific environments**:
  What about Maple, Mathematica, Aldor, . . . ?
- **Web servers**: Tomcat, Apache, . . .
- **Web services layer**: Axis, Glue, . . .

Linking Bernina to MONET

- We choose Java as it is multiplatform
- Problem: how to link the Bernina back-end program to our Java Web Services-compliant front-end?
- Solution: we create an **adapter** that will fill the gap between both worlds

Implementation



Comments on this experiment

- Bernina does not have to be modified to be exposed as a web service (using a simple software adapter)
- It would be useful to have other examples such as Bernina to experiment with the MONET framework
- Currently, there is no classification for problems like the ones solved by Bernina (e.g. Darboux)
- We also need richer ontologies to describe mathematical objects (e.g. OpenMath)

Future work

- Finalize implementation and show that Bernina can be used from inside Maple
- Write a user guide to expose mathematical software as web services
- Towards registration of Bernina in a broker