PROGRAMMABLE ANALOG INTEGRATED CIRCUIT FOR USE IN REMOTELY OPERATED LABORATORIES

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Outline

- Background & Motivation
- System Architecture
- Programmable Analog Circuits
- PAnIC Architecture
- Future work

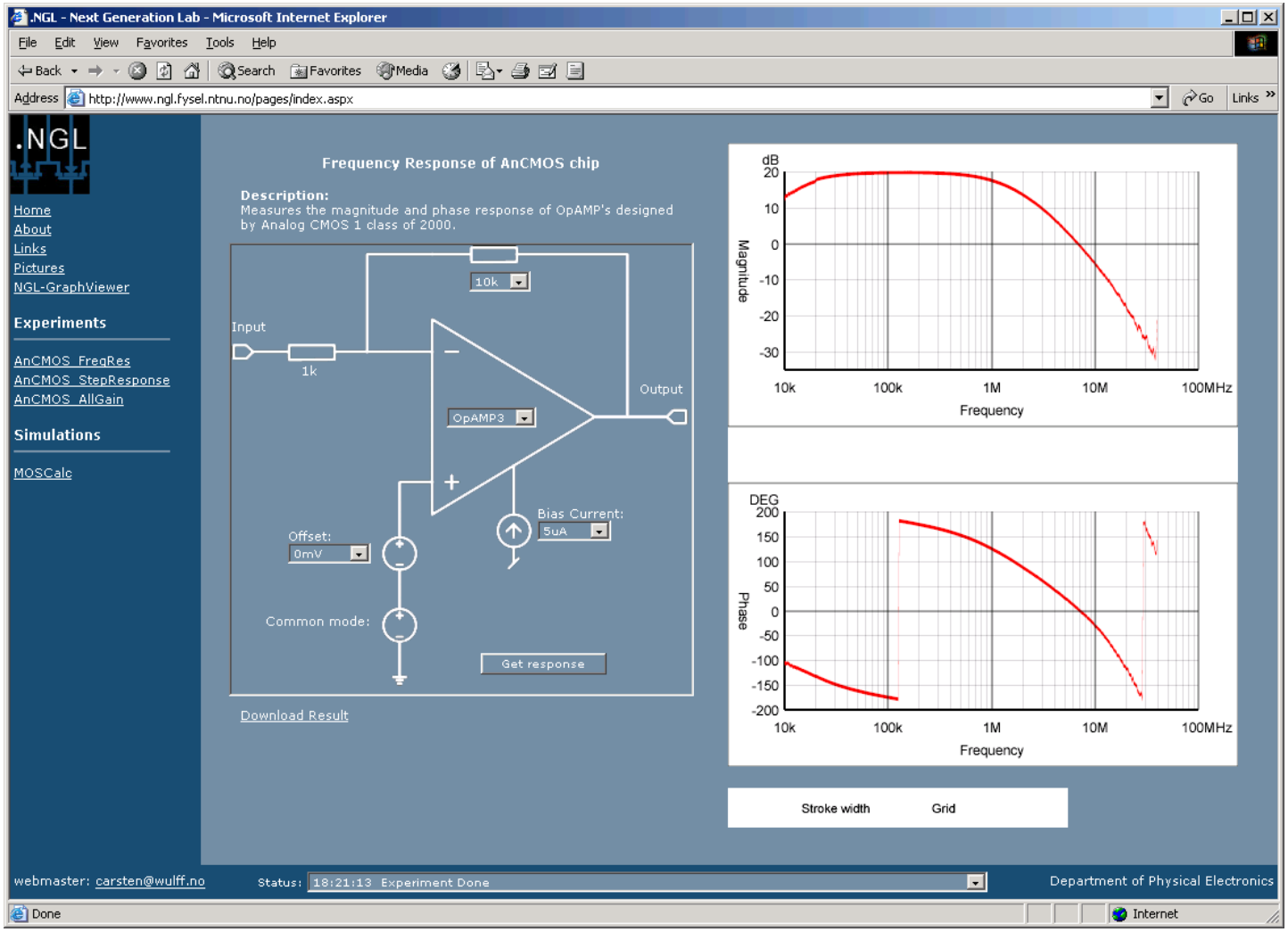
Background & Motivation

Background & Motivation

- Based on work done in the field of remote laboratories at Norwegian University of Science and Technology and Rensselaer Polytechnic Institute (NY)
- Project at NTNU summer of 2001:
  - To create a remote laboratory for education in design of analog integrated circuits at our department.
  - To create a platform for circuit experiments.
- Result: Next Generation Laboratory (NGL).
  - Frequency response measurement on 9 operational amplifiers with ability to control bias current, closed loop gain and common mode offset

Next Generation Lab

http://www.ngl.fysel.ntnu.no



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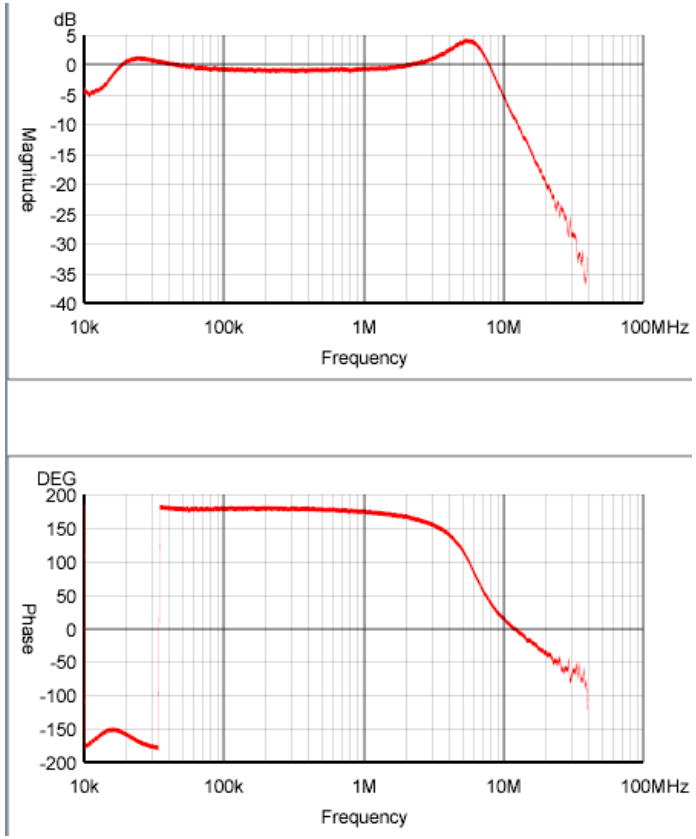
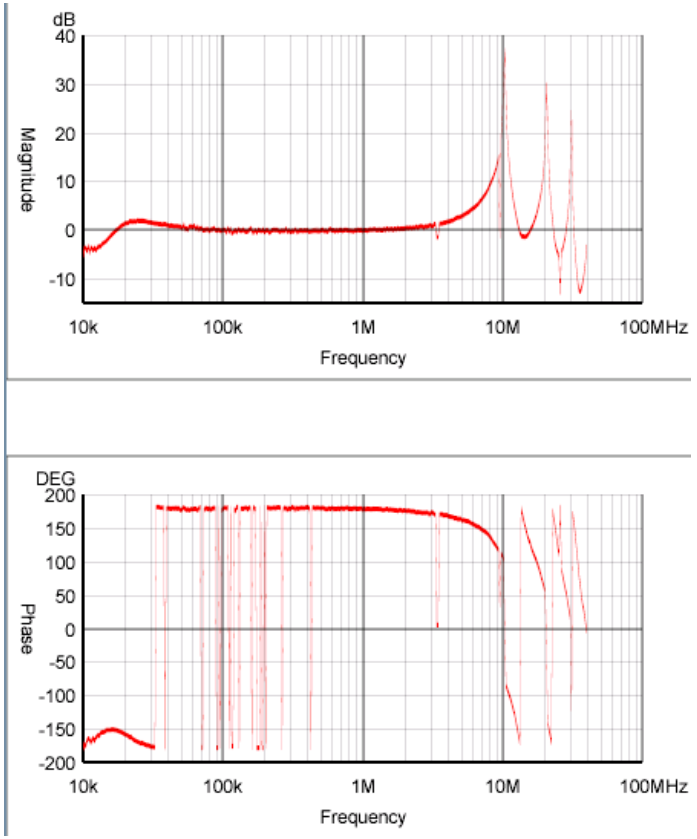
Programmable Analog Integrated Circuit (PAnIC)

Example from NGL



Opamp=1, Bias=**5uA**, Gain=0dB



Opamp=1, Bias=**25uA**, Gain=0dB

Why PAnIC?

- Provide students with more circuits to choose from without using expensive switching matrices
- Provide students with circuit programmability

System Architecture

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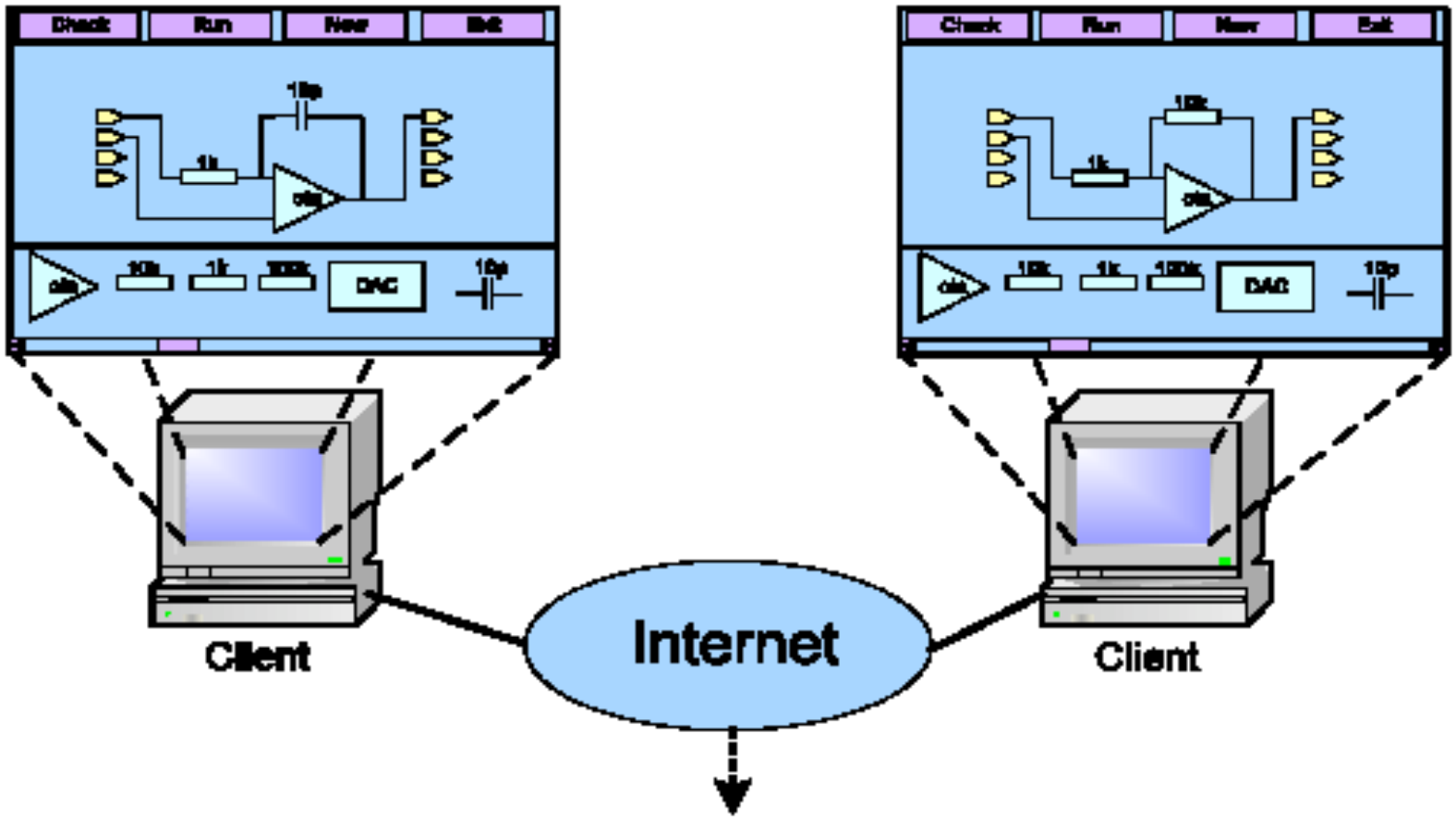
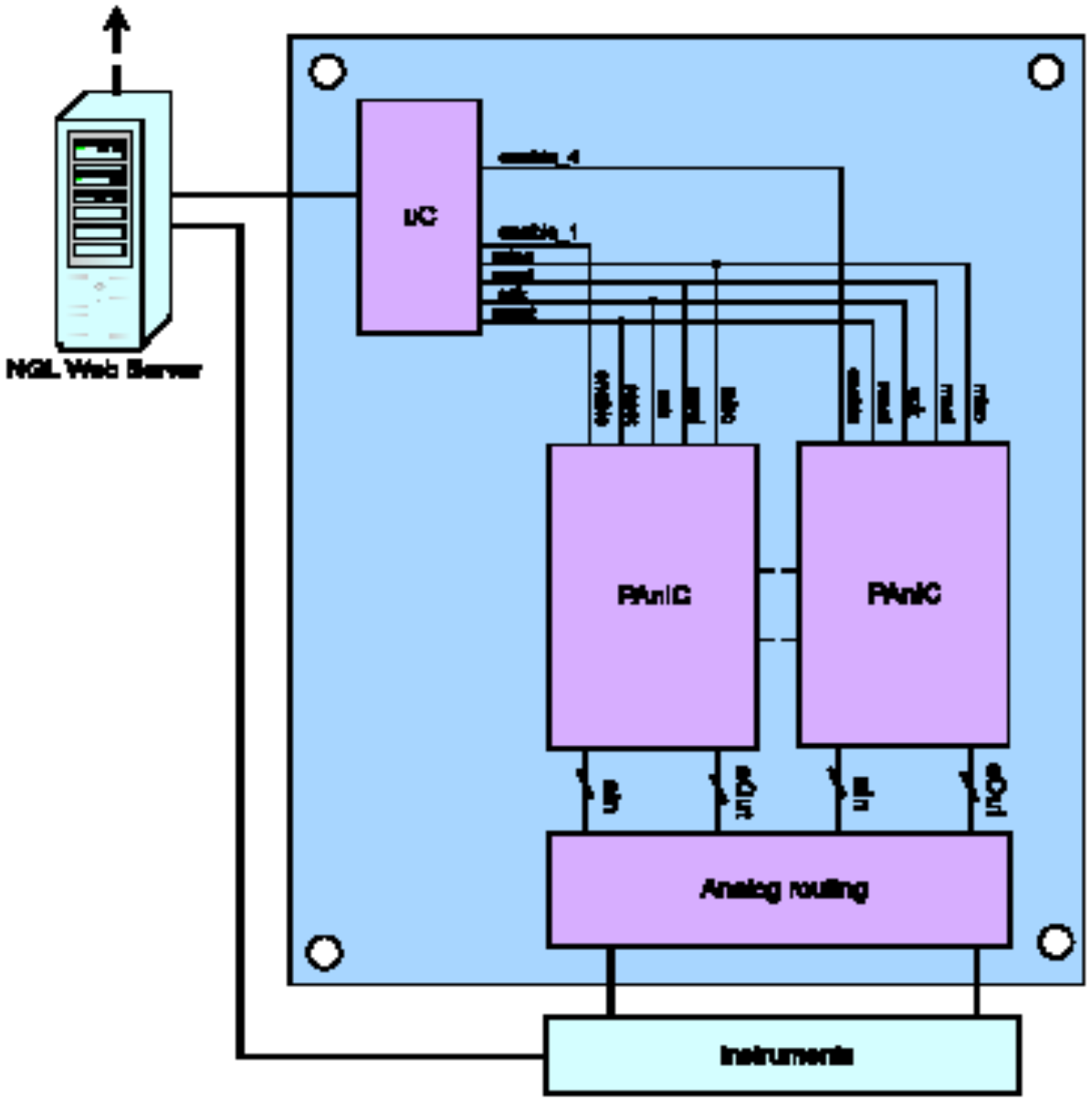
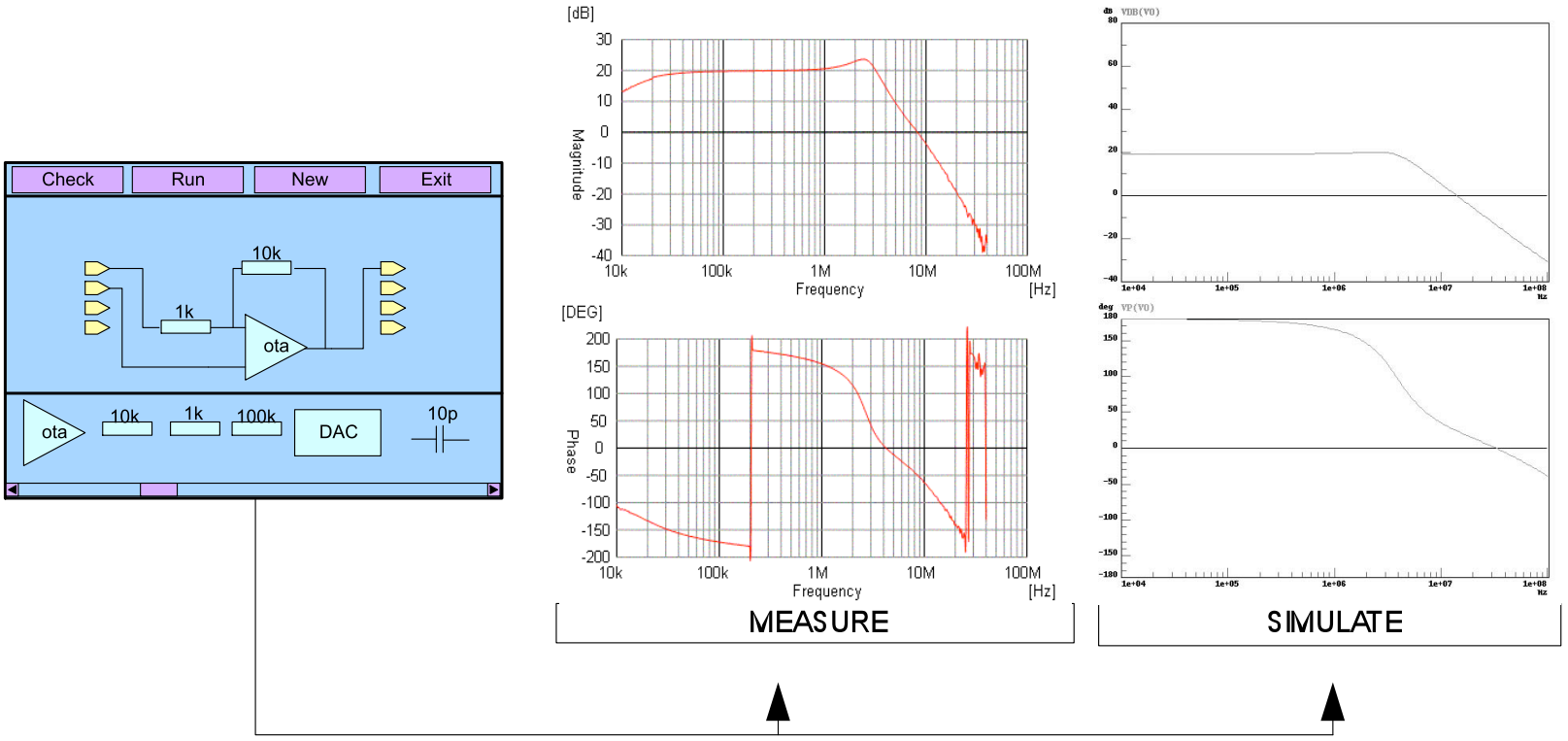
Client side



Server side



Possibilities



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Making it possible

- What is needed to make this work:
  - Circuit measurement through web
  - Circuit simulation on web
  - Circuit drawing on web
  - Programmable Analog Integrated Circuit

Technologies

- NGL:
  - Microsoft .NET platform
  - C#
  - C++
- Circuit simulation (AIM-SPICE.NET):
  - Microsoft .NET platform
  - C#
  - COM
- Circuit drawing:
  - Java

Programmable analog circuits

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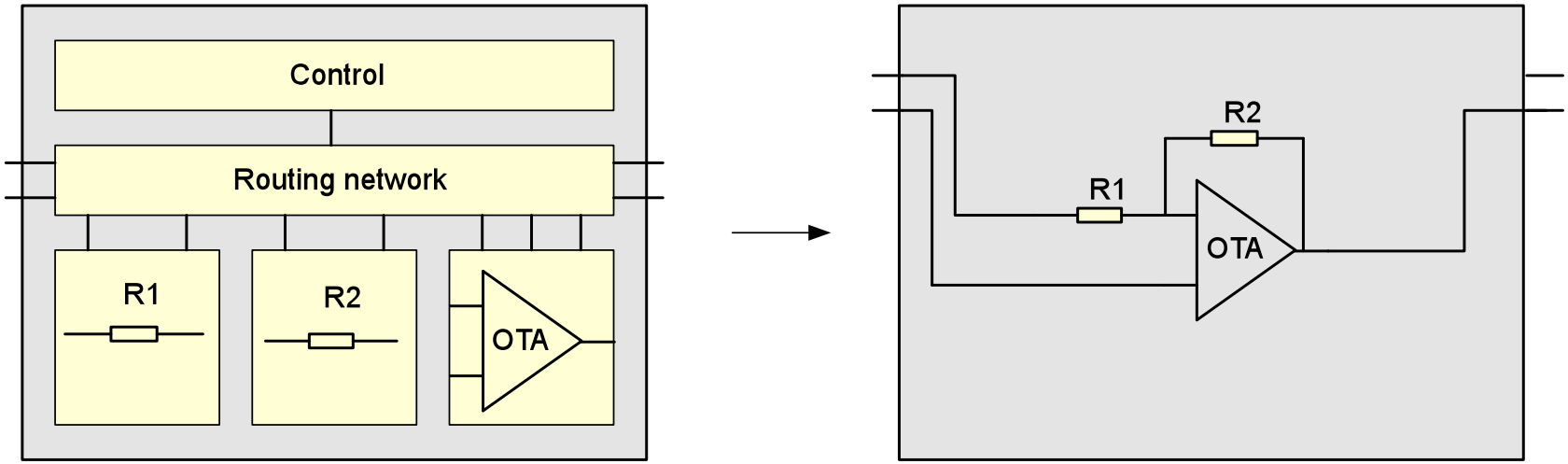
Programmable Analog Circuits (1)

- "Building" analog circuits programmatically
- I.e amplifier with gain A= -R2/R1

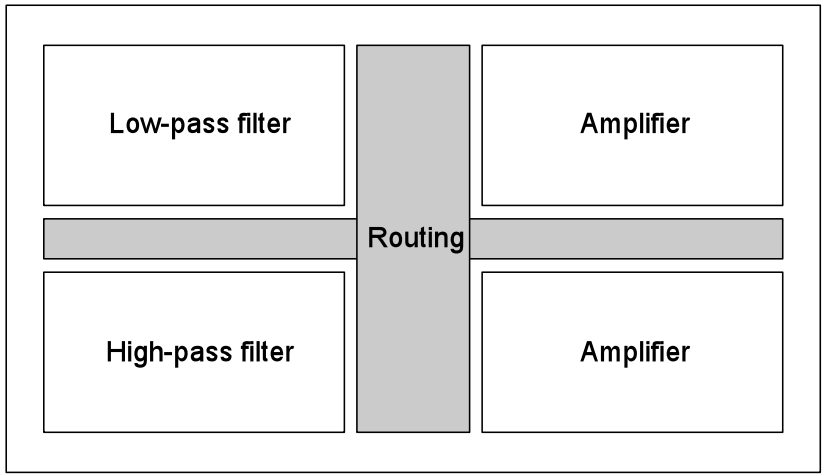


Programmable Analog Circuits (2)

- Reported for more than a decade.
- Several firms have manufactured such circuits, among them are Motorola, IMP Inc, Lattice Semiconductor and Anadigm.
- Types:
  - Field programmable analog arrays
  - Expert cells
- Not had the same breakthrough as Field Programmable Gate Arrays (FPGA)

Expert Cells

- Each cell is designed to work under all programmable conditions
- Each cell can have tuneable parameters i.e. cut-off frequency for the filters and gain for the amplifier



Programmable Analog Integrated Circuit (PAnIC)

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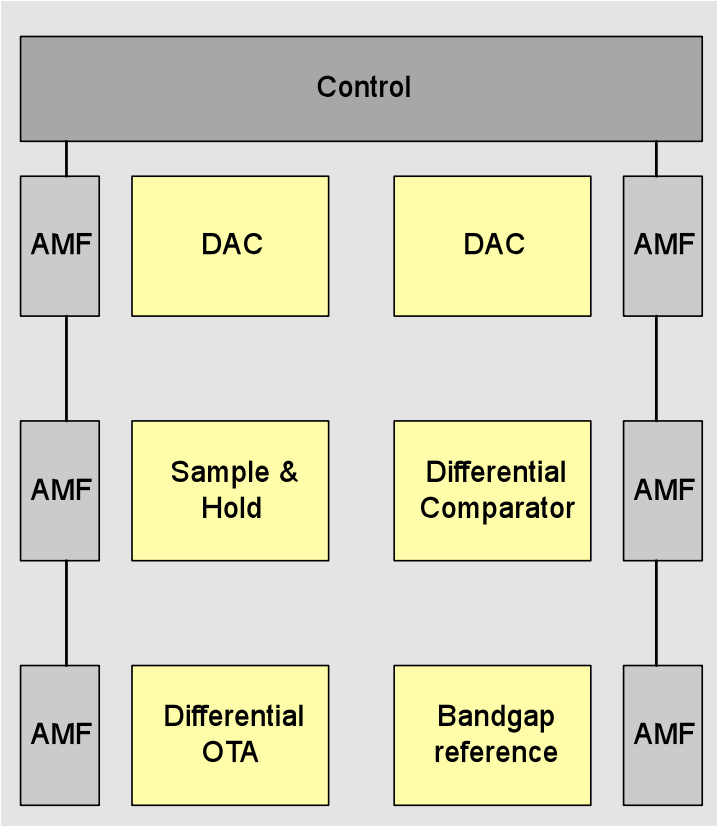
Programmable Analog Integrated Circuit (PAnIC)

PAnIC Architecture (1)

- Features:
  - Based on an ”expert cell” design
  - Serial Peripheral Interface and 3 digital pins for control of the PAnIC
  - Asynchronous design
  - ReadBack.
  - Table of Content
  - 4 analog inputs, 4 analog outputs
  - Chip area of 2x3mm in AMS 0.6u

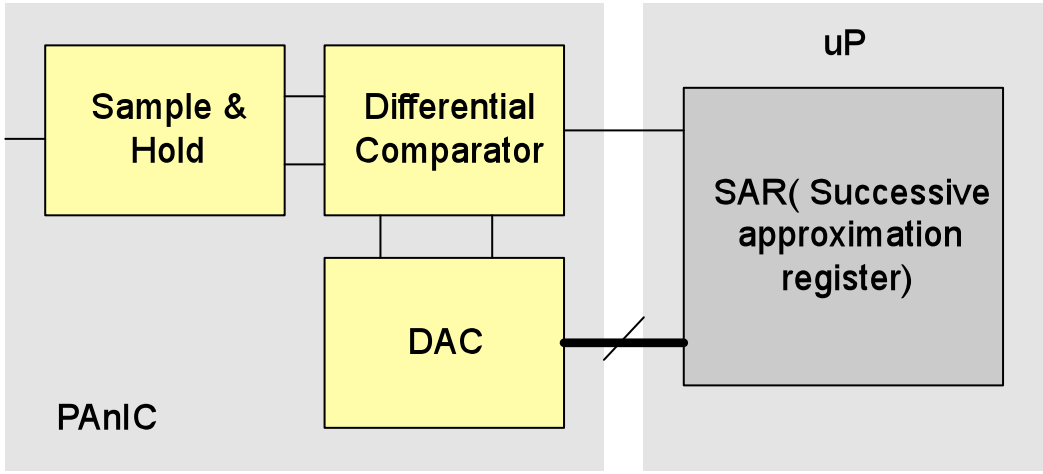
PAnIC Architecture (2)

- Control logic
- 6 analog cells, 2 DAC's, Sample & Hold, Differential Comparator, Differential OTA, Bandgap Reference.
- Analog module Framework: Registers, transmission gates, buffers etc.



Example Top-Level circuit

- 8 bits Analog-Digital Converter based on a successive approximation architecture.



Future work & use of PAnIC

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- Future work:
  - Prototype production: Fall 2002
  - Prototype of NGL using PAnIC: Spring 2003

- Use of NGL with PAnIC:
  - Remote laboratory for Analog CMOS design courses at NTNU
  - Student exercise on characterization of operational amplifiers, bandgap voltage reference, digital to analog converter, analog to digital converters.