



Uni.lu HPC School 2019

PS12b: Machine / Deep learning II Distributed DL with Horovod

Uni.lu High Performance Computing (HPC) Team
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<http://hpc.uni.lu>



Latest versions available on Github:



UL HPC tutorials:

<https://github.com/ULHPC/tutorials>

UL HPC School:

<http://hpc.uni.lu/hpc-school/>

PS12b tutorial sources:

ulhpc-tutorials.rtfd.io/en/latest/deep_learning/horovod/



Summary

1 Introduction

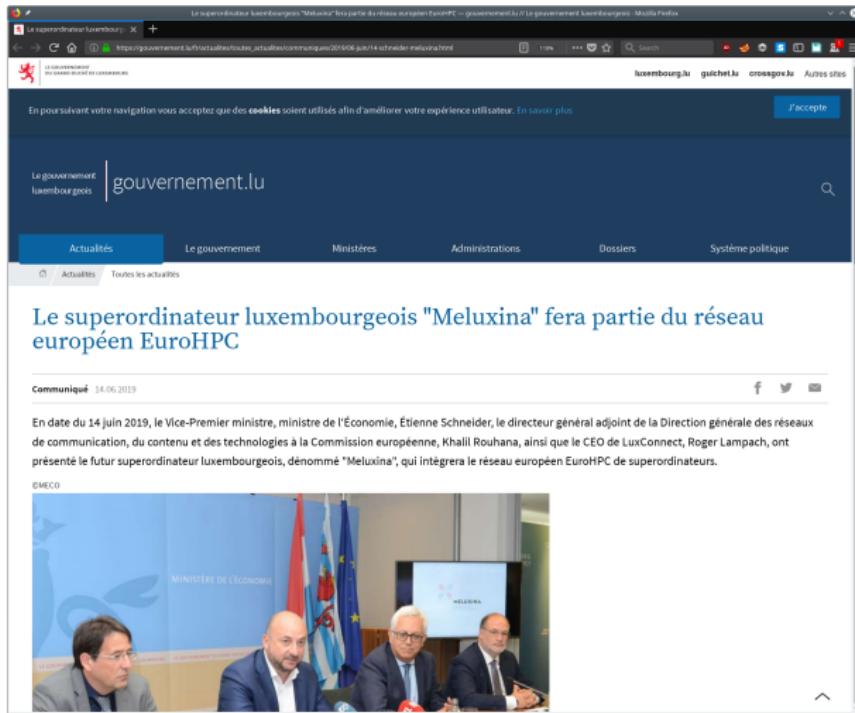
2 Scalable Deep Learning with Horovod

Foreword

So we have some news...

Introduction

Foreword



The screenshot shows a news article from the Luxembourgish Government website. The headline reads: "Le superordinateur luxembourgeois "Meluxina" fera partie du réseau européen EuroHPC". The article was published on 14.06.2019. It mentions the Vice-Premier minister, minister of the Economy, Etienne Schneider, and other officials. A photo shows four men seated at a table during a press conference.

Le superordinateur luxembourgeois "Meluxina" fera partie du réseau européen EuroHPC

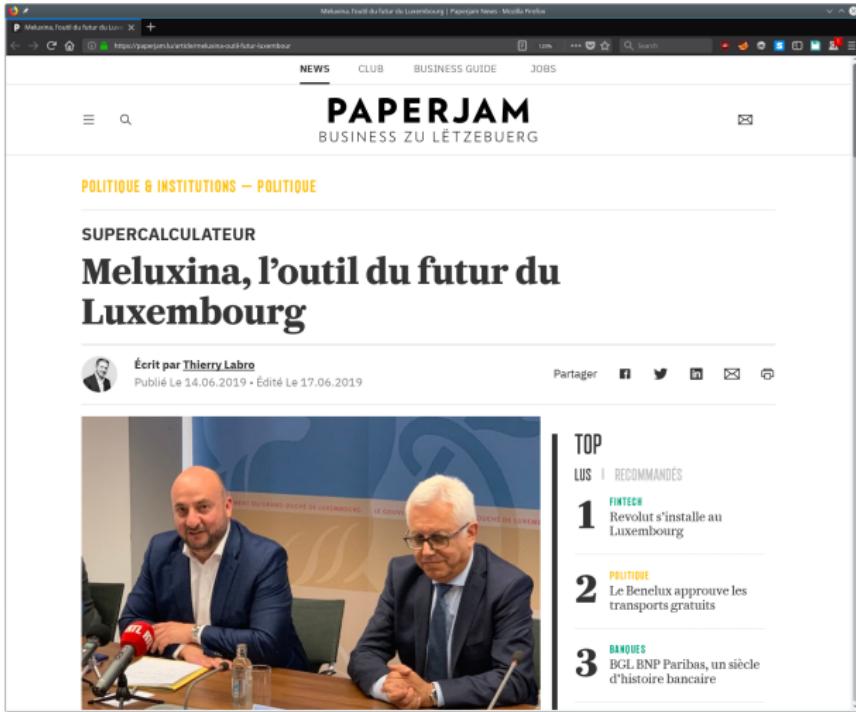
Communiqué 14.06.2019

En date du 14 juin 2019, le Vice-Premier ministre, ministre de l'Économie, Étienne Schneider, le directeur général adjoint de la Direction générale des réseaux de communication, du contenu et des technologies à la Commission européenne, Khalil Rouhana, ainsi que le CEO de LuxConnect, Roger Lampach, ont présenté le futur superordinateur luxembourgeois, dénommé "Meluxina", qui intégrera le réseau européen EuroHPC de superordinateurs.

©EMECO



Foreword



Meluxina, l'outil du futur du Luxembourg | Papierjam News - Mozilla Firefox

NEWS CLUB BUSINESS GUIDE JOBS

PAPERJAM

BUSINESS ZU LËTZEBUERG

POLITIQUE & INSTITUTIONS – POLITIQUE

SUPERCALCULATEUR

Meluxina, l'outil du futur du Luxembourg

Écrit par Thierry Labre

Publié Le 14.06.2019 • Édité Le 17.06.2019

Partager

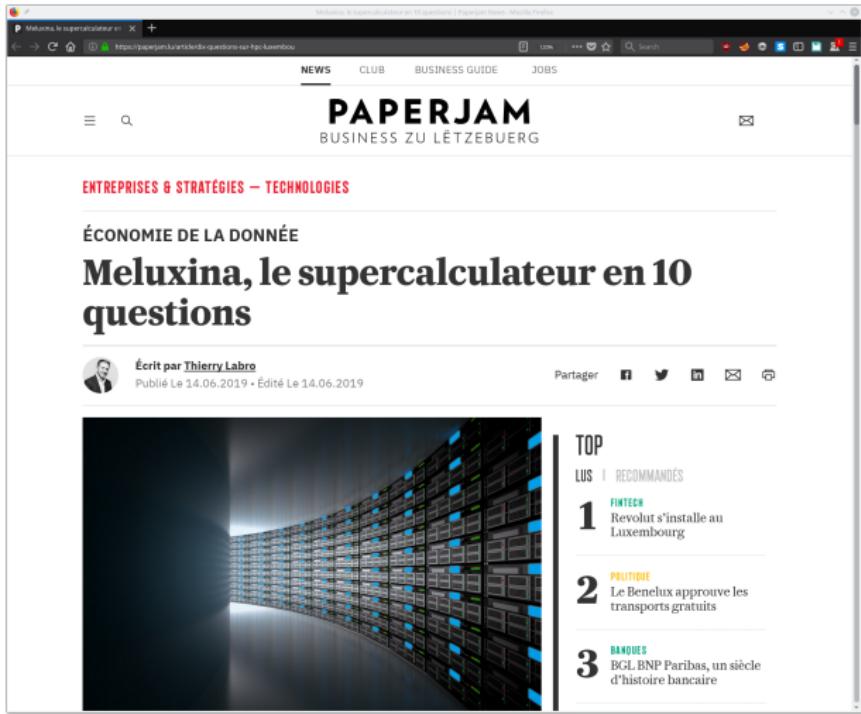


TOP

LUS | RECOMMANDÉS

- 1** FINTECH Revolut s'installe au Luxembourg
- 2** POLITIQUE Le Benelux approuve les transports gratuits
- 3** BANQUES BCL BNP Paribas, un siècle d'histoire bancaire

Foreword



The screenshot shows a web browser displaying an article from **PAPERJAM BUSINESS ZU LËTZEBUERG**. The article is titled **Meluxina, le supercalculateur en 10 questions**, categorized under **ENTREPRISES & STRATÉGIES – TECHNOLOGIES** and **ÉCONOMIE DE LA DONNÉE**. It was written by **Thierry Labre** on June 14, 2019, and edited on the same day. The article features a large image of server racks. To the right, there is a sidebar with a top news section and a recommended articles section.

TOP

LUS | RECOMMANDÉS

1 FINTECH
Revolut s'installe au Luxembourg

2 POLITIQUE
Le Benelux approuve les transports gratuits

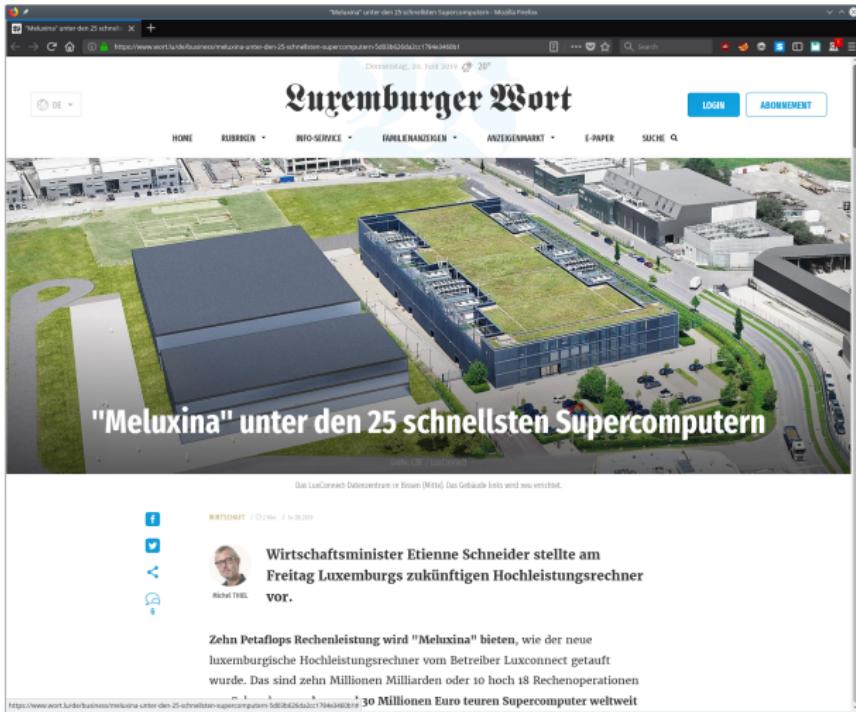
3 BANQUES
BCL BNP Paribas, un siècle d'histoire bancaire

Foreword



The Luxembourg Space Agency website features a prominent banner headline: "THE LUXEMBOURG SUPERCOMPUTER "MELUXINA" TO BE PART OF THE EUROPEAN EUROHPC NETWORK". Below the headline is a photograph of four men seated at a conference table during a press conference. The men are dressed in professional attire, and the background includes flags and logos, including the Luxembourg Ministry of Economy and the Meluxina supercomputer logo.

Foreword



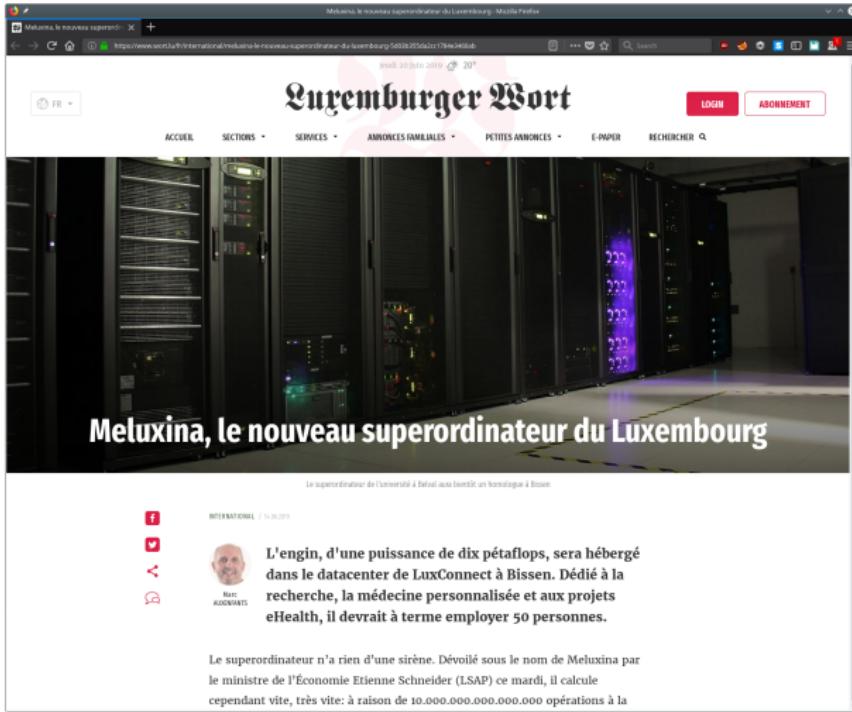
The screenshot shows a news article from the Luxemburger Wort website. The headline reads: "Meluxina" unter den 25 schnellsten Supercomputern. The article discusses the new supercomputer Meluxina, which is ranked among the world's top 25 fastest supercomputers. It is located at the LuxConnect data center in Esch-sur-Alzette. The article is dated Wednesday, 16 July 2014, at 20:00. It includes a photo of the building and a quote from Etienne Schneider, Minister of Economy, about the importance of such a machine for Luxembourg's future.

"Meluxina" unter den 25 schnellsten Supercomputern

Wirtschaftsminister Etienne Schneider stellte am Freitag Luxemburgs zukünftigen Hochleistungsrechner vor.

Zehn Petaflops Rechenleistung wird "Meluxina" bieten, wie der neue luxemburgische Hochleistungsrechner vom Betreiber Luxconnect getauft wurde. Das sind zehn Millionen Milliarden oder 10 hoch 18 Rechenoperationen pro Sekunde. Ein 30 Millionen Euro teuren Supercomputer weltweit

Foreword



Meluxina, le nouveau superordinateur du Luxembourg - Mozilla Firefox

jeudi 20 juillet 2017 20°

Luxemburger Wort

LOGIN ABOURNEMENT

ACCUEIL SECTION SERVICES ANNONCES FAMILIALES PETITES ANNONCES E-PAPER RECHERCHER

Meluxina, le nouveau superordinateur du Luxembourg

Le superordinateur de l'université à Differdange vient d'inaugurer un homologue à Bissen.

INTERNATIONAL / 16.07.2017

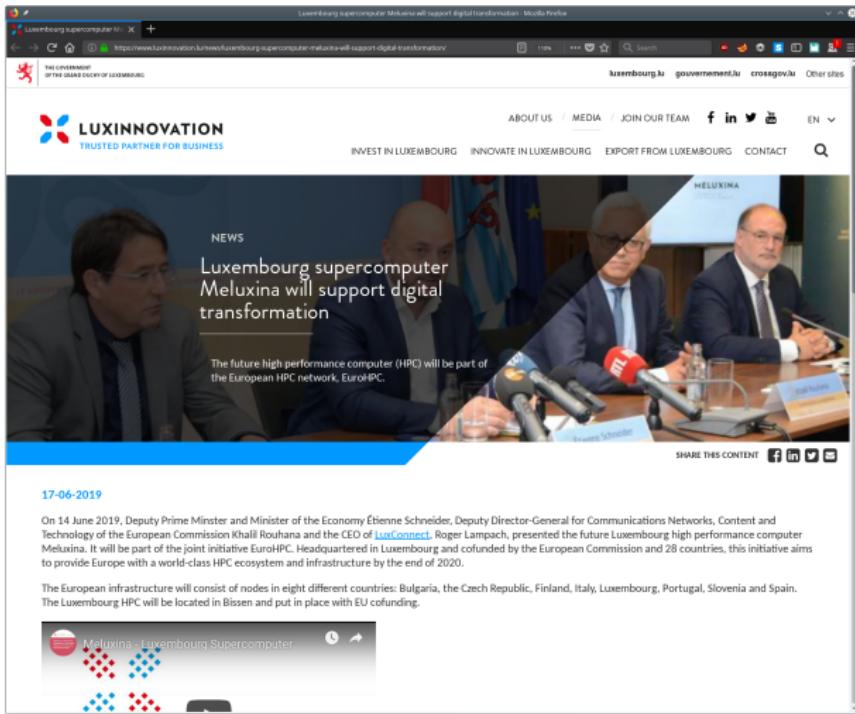
 **Etienne Schneider**

L'engin, d'une puissance de dix pétaflops, sera hébergé dans le datacenter de LuxConnect à Bissen. Dédié à la recherche, la médecine personnalisée et aux projets eHealth, il devrait à terme employer 50 personnes.

Le superordinateur n'a rien d'une sirène. Dévoilé sous le nom de Meluxina par le ministre de l'Économie Etienne Schneider (LSAP) ce mardi, il calcule cependant vite, très vite: à raison de 10.000.000.000.000.000 opérations à la

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Luxembourg supercomputer Meluxina will support digital transformation - Mozilla Firefox

THE GOVERNMENT OF THE STATE OF LUXEMBOURG

LUXINNOVATION
TRUSTED PARTNER FOR BUSINESS

ABOUT US / MEDIA / JOIN OUR TEAM f in tw EN ▾
INVEST IN LUXEMBOURG INNOVATE IN LUXEMBOURG EXPORT FROM LUXEMBOURG CONTACT

NEWS

Luxembourg supercomputer Meluxina will support digital transformation

The future high performance computer (HPC) will be part of the European HPC network, EuroHPC.

Etienne Schneider, Khalil Rouhana, Roger Lampach

SHARE THIS CONTENT

17-06-2019

On 14 June 2019, Deputy Prime Minister and Minister of the Economy Etienne Schneider, Deputy Director-General for Communications Networks, Content and Technology of the European Commission Khalil Rouhana and the CEO of LuxConnect, Roger Lampach, presented the future Luxembourg high performance computer Meluxina. It will be part of the joint initiative EuroHPC. Headquartered in Luxembourg and cofounded by the European Commission and 28 countries, this initiative aims to provide Europe with a world-class HPC ecosystem and infrastructure by the end of 2020.

The European infrastructure will consist of nodes in eight different countries: Bulgaria, the Czech Republic, Finland, Italy, Luxembourg, Portugal, Slovenia and Spain. The Luxembourg HPC will be located in Bissen and put in place with EU cofunding.

Meluxina Luxembourg Supercomputer

Introduction

Foreword

Screenshot of a news article from L'essentiel Luxembourg 22° website.

The article is titled: «Meluxina» soll Lücke zu China und USA schließen

Text: BISSEN – Der Supercomputer, der bis Ende 2020 installiert wird, soll einer der 20 schnellsten Rechner der Welt werden. Das teilte Wirtschaftsminister Schneider am Freitag mit.

Image: A photograph of four men seated at a long table during a press conference. From left to right: Mario Grutz, Etienne Schneider, Khalid Rouhana, and Roger Lampech. They are all wearing dark suits and are positioned behind microphones and nameplates.

Caption: Mario Grutz, Etienne Schneider, Khalid Rouhana und Roger Lampech (v.l.) haben am Freitag den Supercomputer vorgestellt. (Bild: L'essentiel)

Other news snippets visible on the page include:

- TIERISCHE FRACHT** Cargolux liefert die Beluga-Wale wohlbehalten ab
- LUXEMBURG** – In einer Bucht bei Island entsteht ein Wasserpark für Wale und Delfine – als Alternative zu Freizeitparks. Zwei Beluga-Wale wurden nun aus China eingeflogen.
- CHAMBER-PRÄSIDENT** Etgen zieht nach dem ersten Halbjahr Bilanz
- LUXEMBURG** – Vor einem halben Jahr hat Fernand Etgen das Amt des Parlamentspräsidenten übernommen. Zeit für eine Zwischenbilanz.
- RADARE IN LUXEMBURG** Am Donnerstag heißt es wieder aufpassen!
- LUXEMBURG** – Die Police Grand-Ducale zeigt keine Gnade für Raser. Am Donnerstag hat sie sich diesbezüglich im Großherzogtum auf die Lauer gelegt.

Introduction

Foreword

The screenshot shows a news article from Chronicle.lu. The main headline reads: "Luxembourg Meluxina Supercomputer to Join European EuroHPC Network". The article is dated Friday, 14 Jun 2019, 17:11, by ID. It features a photo of several men at a conference table. Below the article is a summary: "The EuroHPC Joint Undertaking, headquartered in the Grand Duchy, is an initiative co-financed by the European Commission and 28 countries, including Luxembourg, which aims to provide Europe with an ecosystem and a computing infrastructure. By June 2019, following a call for projects, EuroHPC selected eight sites in different Member States to host supercomputers. The Luxembourg project to install the petascale supercomputer Meluxina at LuxConnect in Biel/Bienne has been selected." To the right of the main content is a "TRENDING NEWS" sidebar with links to other articles.

Chronicle.lu

Thursday, 20 Jun 2019

NEWS FEATURES EVENTS OPINION CLASSIFIEDS PROMOTIONS ABOUT LUXEMBOURG EMERGENCY

HOME NEWS ECONOMICS / LUXEMBOURG MELUXINA SUPERCOMPUTER TO JOIN EUROPEAN EUROHPC NETWORK

Luxembourg Meluxina Supercomputer to Join European EuroHPC Network

Published on Friday, 14 Jun 2019 17:11 by ID

SHARE THIS ARTICLE: f t i g+ w

RATE THIS ITEM: ★★★★★

On Friday 14 June 2019, Luxembourg's Deputy Prime Minister for Economic Affairs, the Minister of the Economy, Etienne Schneider, together with the Deputy Director General of the Directorate General of Communication Networks, Content and Technologies (DG CNECT) at the European Commission, Khalil Rouhana, as well as LuxConnect CEO, Roger Lampach, presented the future Luxembourg supercomputer, named "Meluxina", which will join the European network of EuroHPC supercomputers.

The EuroHPC Joint Undertaking, headquartered in the Grand Duchy, is an initiative co-financed by the European Commission and 28 countries, including Luxembourg, which aims to provide Europe with an ecosystem and a computing infrastructure. By June 2019, following a call for projects, EuroHPC selected eight sites in different Member States to host supercomputers. The Luxembourg project to install the petascale supercomputer Meluxina at LuxConnect in Biel/Bienne has been selected.

TRENDING NEWS

Jean Asselborn Advocates Defence of Human Rights, Support for Jordan at EU Foreign Affairs Council

Minister Grimaux Reveals 60 Companies Established in Grand Duchy re Brexit

Nordic Chamber (Nobulus & Swebulus)

Nicolas Grässle Formally Appointed Honorary Consul General of India In Luxembourg

Embassies & Consulates

Luxembourg-UK Agreement Guarantees Citizens' Voting Rights Post-Brexit

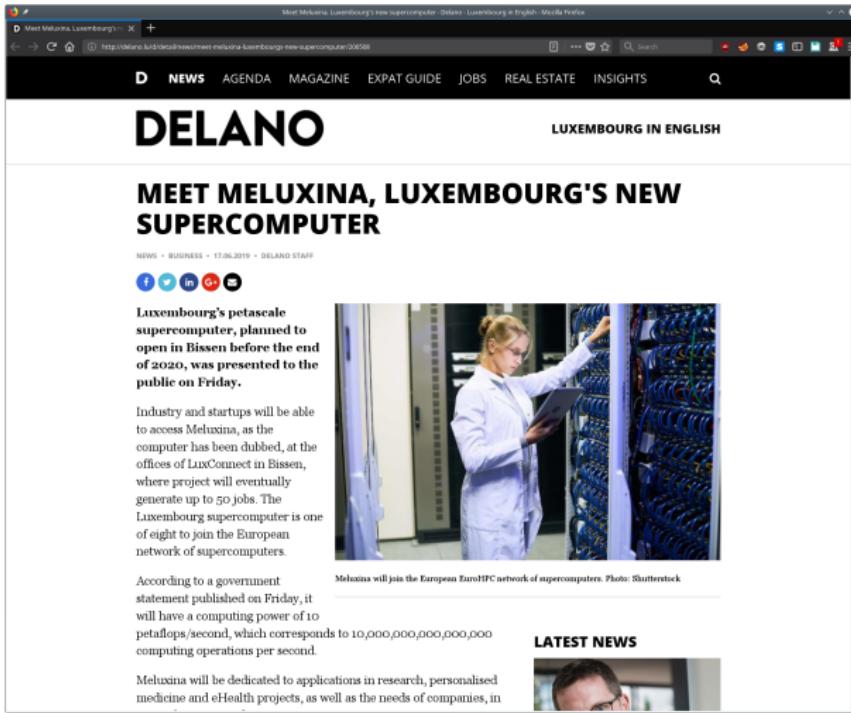
Politics

Grosbusch Introduces 100% Recyclable, Biodegradable Packaging

Environment

Luxembourg, LU

Foreword



The screenshot shows a news article from the DELANO website. The header features the DELANO logo and "LUXEMBOURG IN ENGLISH". The main title is "MEET MELUXINA, LUXEMBOURG'S NEW SUPERCOMPUTER". Below the title, it says "NEWS • BUSINESS • 17.06.2019 • DELANO STAFF". There are social media sharing icons for Facebook, Twitter, LinkedIn, Google+, and Email. The text discusses the Meluxina supercomputer's petascale capacity, its planned opening in Bissen, and its potential impact on industry and startups. It also mentions its role in the EuroHPC network. A photograph of a woman in a lab coat working on server racks is included. A caption below the photo states: "Meluxina will join the European EuroHPC network of supercomputers. Photo: Shutterstock". A "LATEST NEWS" section is visible at the bottom right.

DELANO LUXEMBOURG IN ENGLISH

MEET MELUXINA, LUXEMBOURG'S NEW SUPERCOMPUTER

NEWS • BUSINESS • 17.06.2019 • DELANO STAFF



Luxembourg's petascale supercomputer, planned to open in Bissen before the end of 2020, was presented to the public on Friday.

Industry and startups will be able to access Meluxina, as the computer has been dubbed, at the offices of LuxConnect in Bissen, where project will eventually generate up to 50 jobs. The Luxembourg supercomputer is one of eight to join the European network of supercomputers.

According to a government statement published on Friday, it will have a computing power of 10 petaflops/second, which corresponds to 10,000,000,000,000,000 computing operations per second.

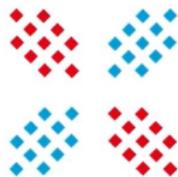
Meluxina will be dedicated to applications in research, personalised medicine and eHealth projects, as well as the needs of companies, in

Meluxina will join the European EuroHPC network of supercomputers. Photo: Shutterstock

LATEST NEWS



Foreword



MELUXINA

HIGH PERFORMANCE
COMPUTING IN LUXEMBOURG

MeluXina National Supercomputer

MeluXina - coming in 2020

- 10 PetaFlop supercomputer
- Modular architecture covering a wide variety of needs
- High performance network & storage for HPC, BigData & AI

MeluXina National Supercomputer

MeluXina - coming in 2020

- 10 PetaFlop supercomputer
- Modular architecture covering a wide variety of needs
- High performance network & storage for HPC, BigData & AI

What this means for you

- Algorithms and applications must be run **at scale**
- **Code development** will play a large role
- Need to use different computing elements and memory hierarchy
 - will play a critical role in your **application performance**

Session Objectives

- Practice with the (excellent) SC18 Tutorial: Deep Learning At Scale
 - ↪ ... on the UL Iris cluster
 - ↪ ... with our latest software environment
 - ↪ ... with and without GPU accelerators

<https://github.com/NERSC/sc18-dl-tutorial>

- For Horovod details also highly recommending the talk
Horovod: Distributed Deep Learning in 5 Lines of Python
 - ↪ from Uber Open Summit 2018

<https://www.youtube.com/watch?v=4y0TDK3KoCA>

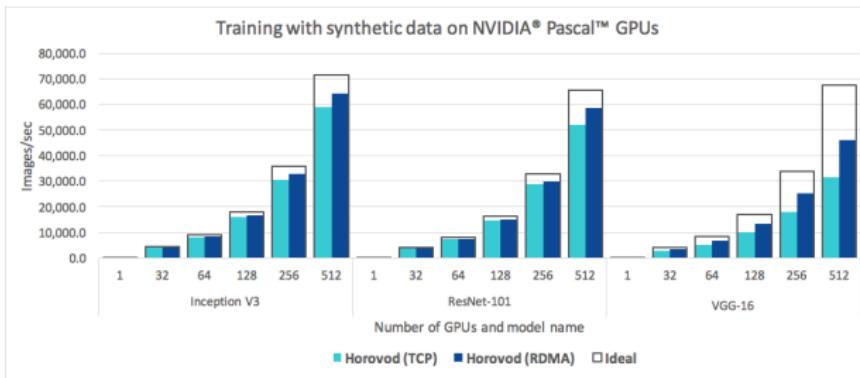
Summary

1 Introduction

2 Scalable Deep Learning with Horovod

Horovod in brief

- Distributed training framework for
 - ↪ TensorFlow
 - ↪ Keras
 - ↪ PyTorch
 - ↪ MXNet
- Goal: make distributed Deep Learning fast & easy to use



<https://github.com/horovod/horovod>



Horovod on Iris

```
$> module load swenv/default-env/devel
```

only needed during HPC School, part of 2019 software env. soon

- Horovod and TensorFlow **without GPU support**

```
module load lib/TensorFlow/1.13.1-foss-2019a-Python-3.7.2
module load tools/Horovod/0.16.3-foss-2019a-Python-3.7.2
```

- Horovod and TensorFlow **with GPU support**

- ↪ **highly recommended**
- ↪ using cuDNN for GPU-accelerated DNN primitives
- ↪ using NCCL for multi-GPU communication

```
module load lib/TensorFlow/1.13.1-fosscuda-2019a-Python-3.7.2
module load tools/Horovod/0.16.3-fosscuda-2019a-Python-3.7.2
```

Multi-GPU Multi-Node Horovod + TF

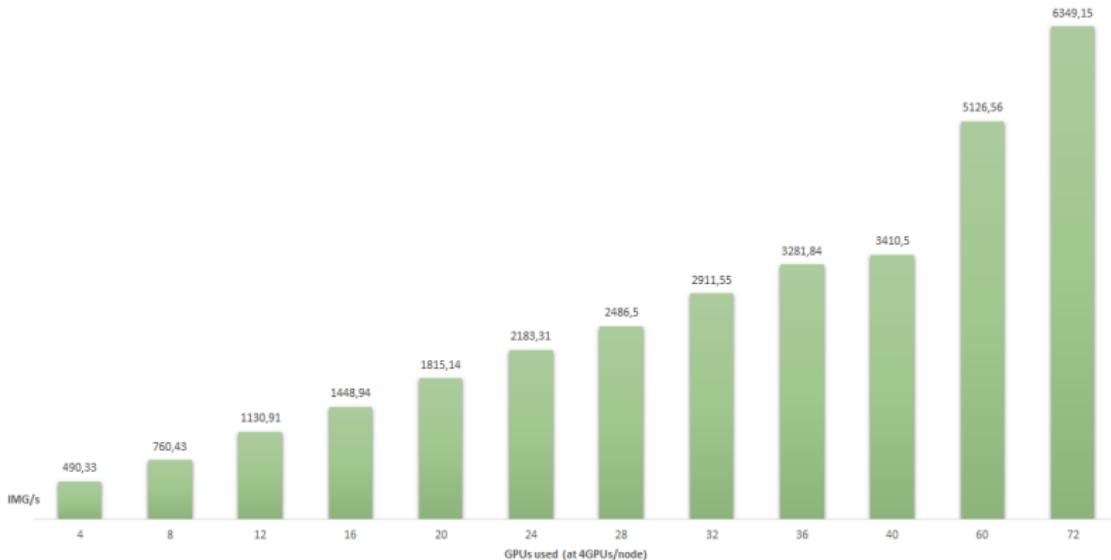
```
#!/bin/bash -l
#SBATCH -J HorovodTFGPU
#SBATCH -o %x_%j.out
#SBATCH -N 1
#SBATCH -n 4
#SBATCH --gres=gpu:4
#SBATCH -t 1:0:0
#SBATCH -p gpu

module load swenv/default-env/devel
module load lib/TensorFlow/1.13.1-fosscuda-2019a-Python-3.7.2
module load tools/Horovod/0.16.3-fosscuda-2019a-Python-3.7.2

mkdir ~/tests-horovod && cd ~/tests-horovod
git clone https://github.com/tensorflow/benchmarks

horovodrun -np $SLURM_NTASKS \
    python scripts/tf_cnn_benchmarks/tf_cnn_benchmarks.py \
        --model resnet101 --batch_size 64 --variable_update horovod
```

Some scaling benchmarks on Iris



Questions?

<http://hpc.uni.lu>

High Performance Computing @ uni.lu

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