



25<sup>o</sup>

Workshop  
RNP

*Onde o futuro  
se encontra.*

# “Testbets”

The art of gambling with public fundings to get science, technology, and Innovation done.

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INSTITUTO  
FEDERAL  
Espírito Santo



Sisfóton  
SISTEMA NACIONAL DE LABORATÓRIOS DE FOTÔNICA  
— NCTI



LABTEL  
LABORATÓRIO DE TELECOMUNICAÇÕES

# Outline

## Part I

Timeline of UFES' involvement with testbeds

Contemporary history of testbeds activities

RARE/FreeRtr with PolKA

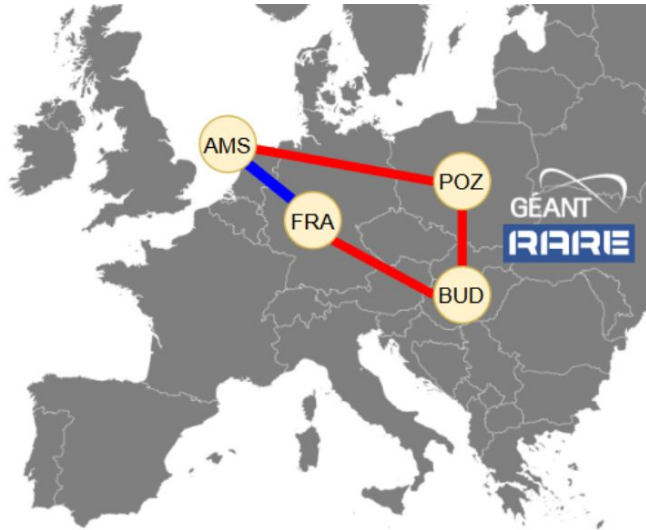
Fabric Testbed and Data-Intensive Science

## Part II

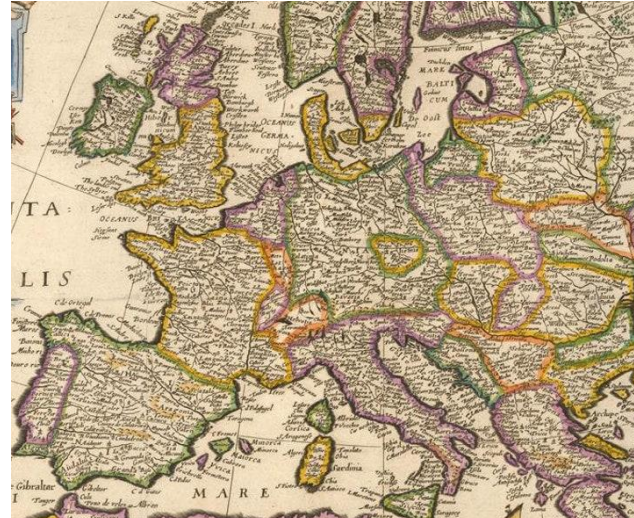
What the past can teach us about testbeds

Three Issues for Discussion

Our history begins in 2020 with GÉANT-RARE, but once upon 1659 the concept of “testbeds” was born in Europe...



Part I



Part II

# “Prehistory”

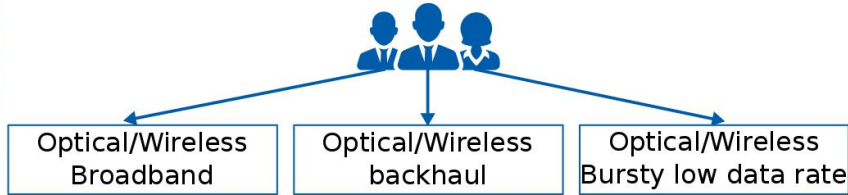
# Federated Union of Telecommunications Research Facilities for an EU-Brazil Open Laboratory (FUTEBOL)

GIGA  
(2003)

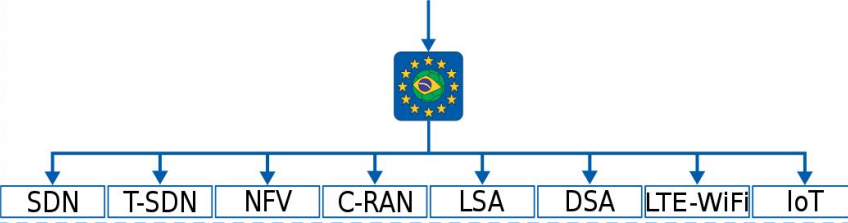
FIBRE  
(2010)

FUTEBOL  
(2016)

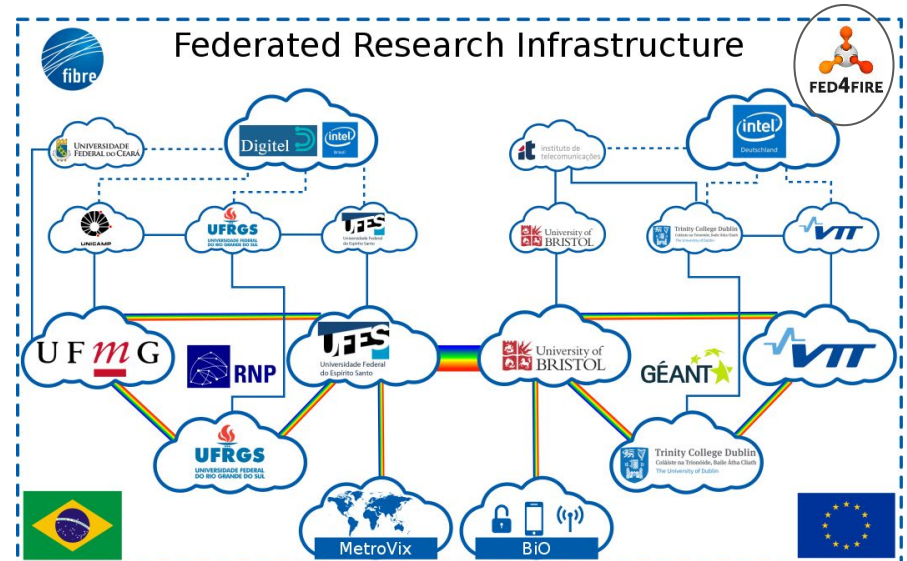
## Advancement of Telecommunications



## Control Framework

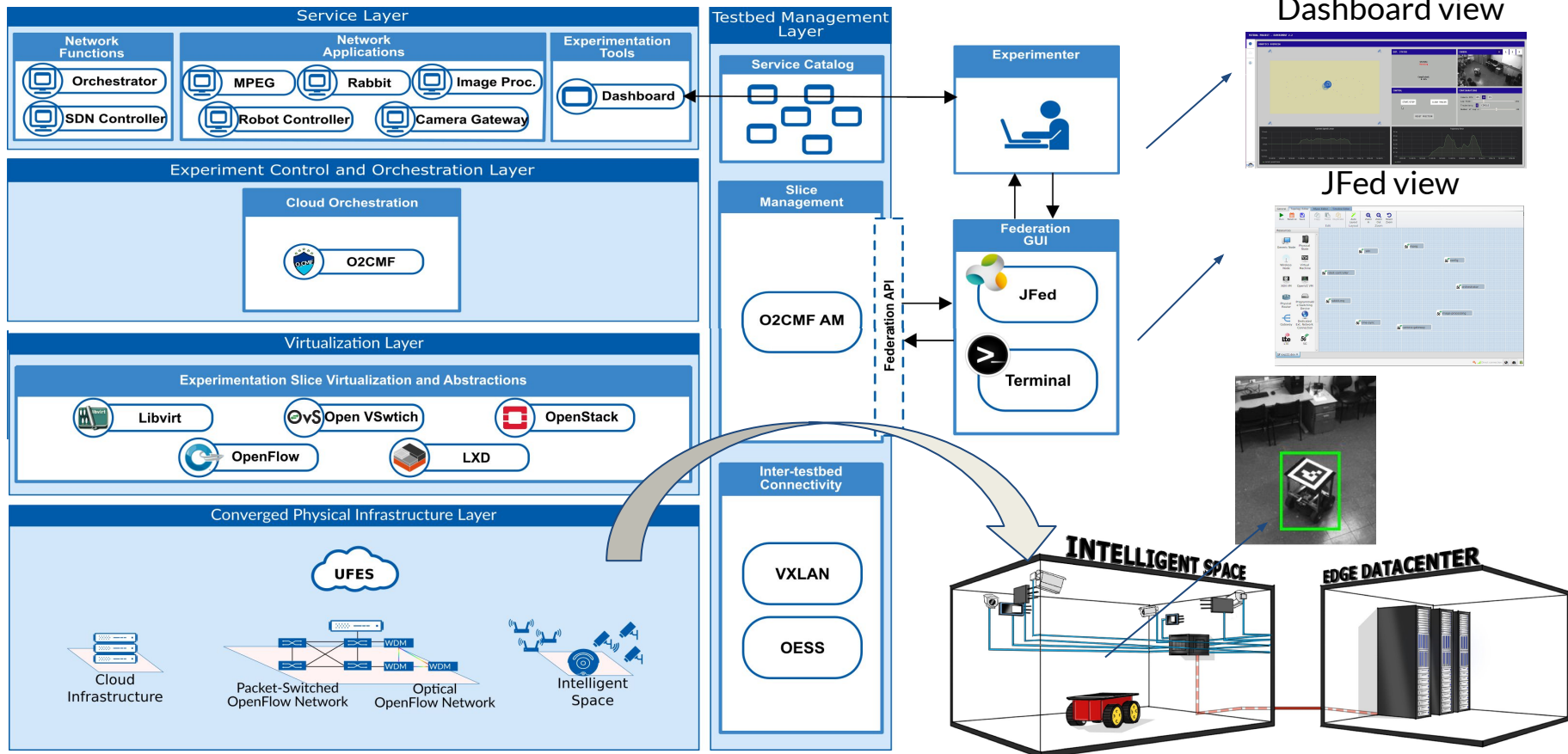


## Federated Research Infrastructure



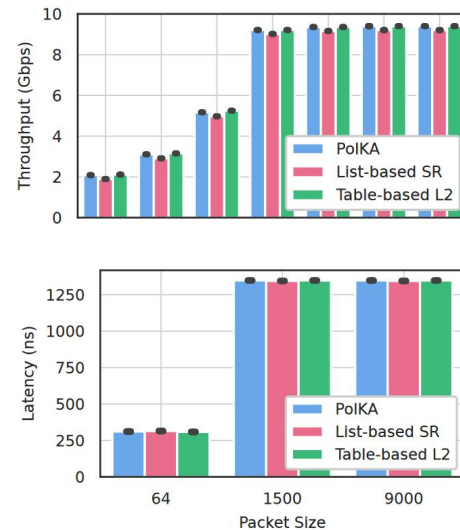
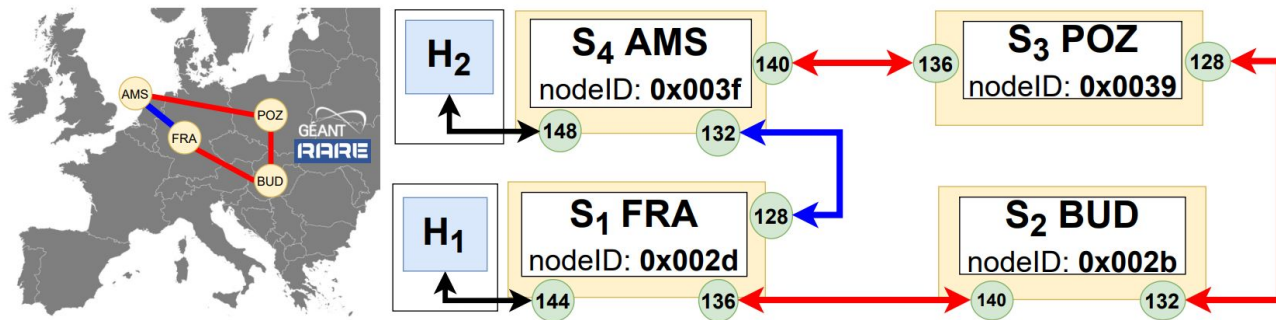
# UFES' Testbed connected to Fed4FIRE\*

\*Full Demo <https://www.youtube.com/watch?v=qMbszZBYnVY>



I. de A. Ceravolo, et.al, "O2CMF: Experiment-as-a-Service for Agile Fed4Fire Deployment of Programmable NFV," in *Optical Fiber Communication Conference 2018*, paper Tu3D.13.

# Then, our “contemporary history” begins in 2020\* PoIKA in RARE/GÉANT P4 Lab European Testbed



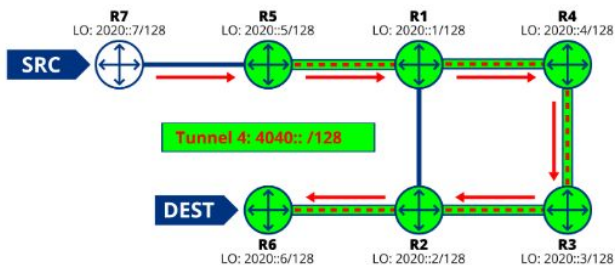
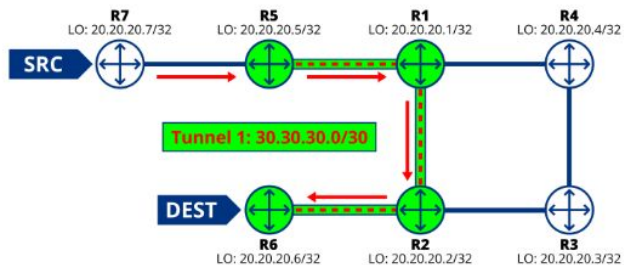
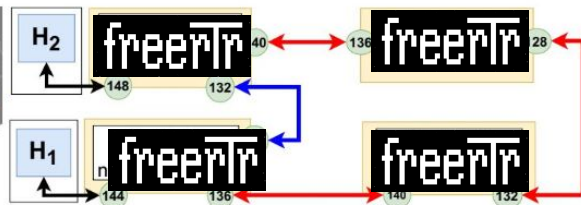
C. Dominicini et al., "Deploying PoIKA Source Routing in P4 Switches : (Invited Paper)," 2021 International Conference on Optical Network Design and Modeling (ONDM), Gothenburg, Sweden, 2021,

\*RARE's Call: Application filled with a former partner from FUTEBOL

<https://connect.geant.org/2020/01/17/rare-project-bringing-back-the-network-innovation-within-research-and-education-community>



# From prototyping to deployment at Géant Lab with RARE/FreeRtr"



route	180	polka
route	181	vlan polka
route	182	mpolka core
route	183	mpolka vlan core
route	184	mpolka edge
route	185	mpolka vlan edge

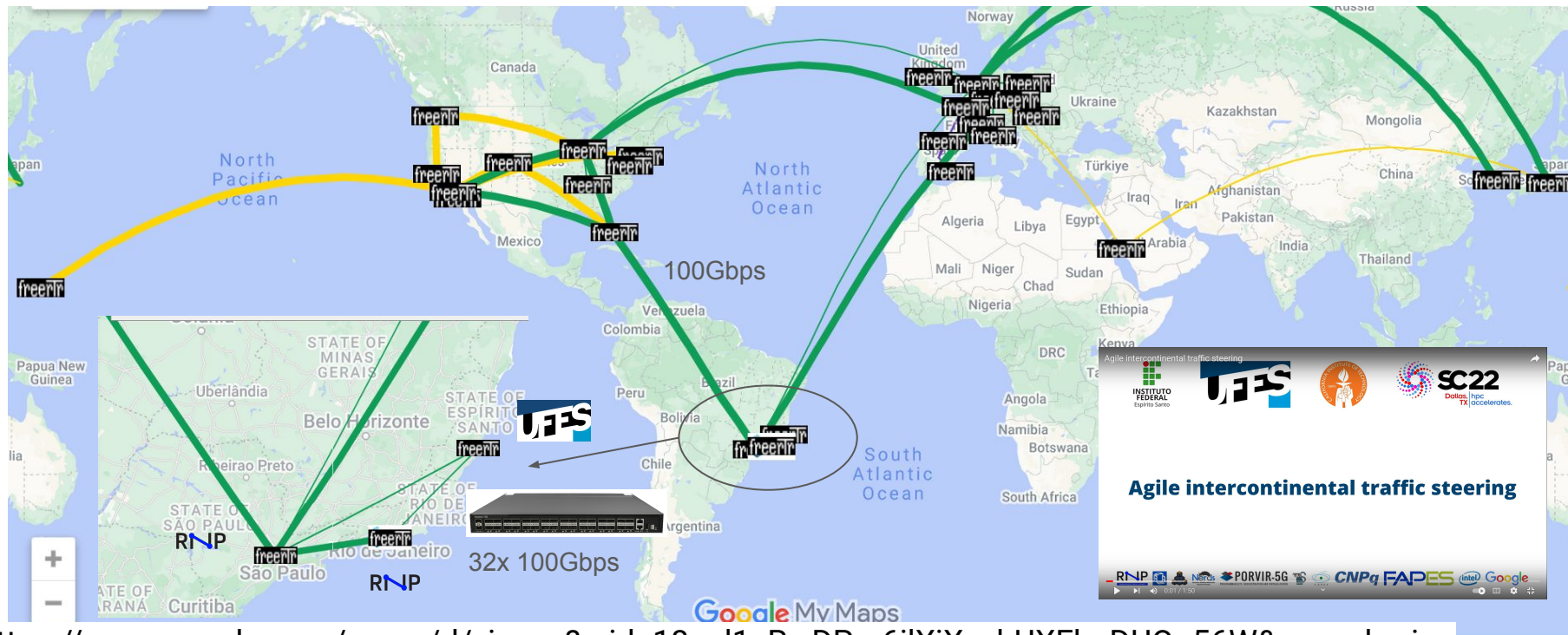
<https://wiki.geant.org/display/RARE/Home>



E. Borges *et al.*" A lifecycle experience of PolKA: From prototyping to deployment at Géant Lab with RARE/FreeRtr", in *Anais do XIII Workshop de Pesquisa Experimental da Internet do Futuro*, Fortaleza, 2022,



# From RARE/FreeRtr to P4 - Persistent Multi-Resource Infrastructure

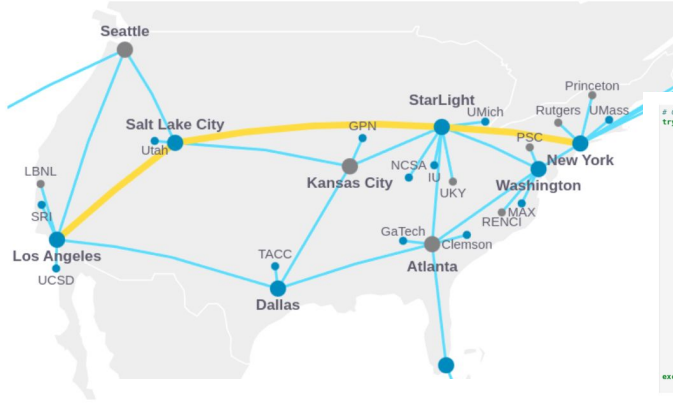


<https://www.google.com/maps/d/viewer?mid=18na1cRwDPm6jIXjXuyhUXFhpDUOo56W&usp=sharing>

<https://opennetworking.org/news-and-events/blog/applications-open-for-the-next-round-of-the-icrps-fast-forward-initiative-ffi-22/>



# From Europe to the new world: FABRIC Testbed



```
slice_name = 'OSPF_Routing_Topology'
try:
    slice = fablib.new_slice(name= slice_name)

    nodes, nics = [], []

    for i, name in enumerate(sites):
        nodes.insert(i, slice.add_node(name=f'r{i+1}', site=name, image='default_debian_10'))

    for node in nodes:
        nics.insert(i, node.add_component(model='NIC_Basic', name='nic1').get_interfaces()[0])
        nics.insert(i+1, node.add_component(model='NIC_Basic', name='nic2').get_interfaces()[0])

    net1 = slice.add_l2network(name='net1', interfaces=[nics[0], nics[3]])
    net2 = slice.add_l2network(name='net2', interfaces=[nics[2], nics[5]])
    net3 = slice.add_l2network(name='net3', interfaces=[nics[4], nics[1]])

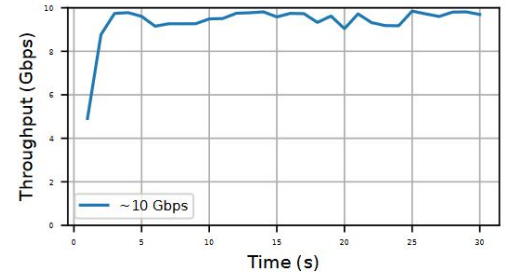
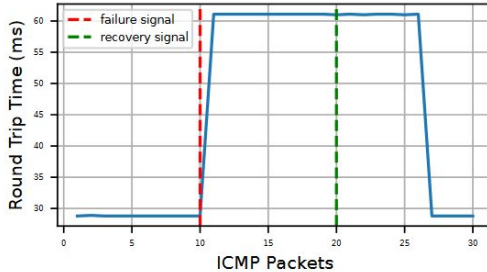
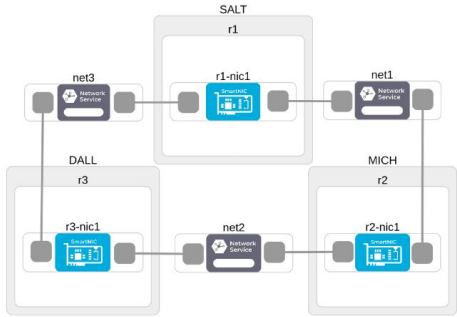
    slice.submit()
except Exception as e:
    print(f"Exception: {e}")
```

```
# Configure FRrouting on each node
try:
    slice_name = 'Triangle_Topology'
    slice = fablib.get_slice(name=slice_name)

    node_threads = []
    subnets = ['net1', 'net3'], ['net2', 'net1'], ['net3', 'net2']
    router_ids = ['1:1.1.1.1', '2:2.2.2.2', '3:3.3.3.3']
    nodes = slice.get_nodes()

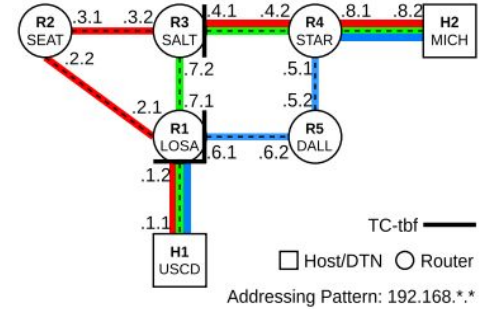
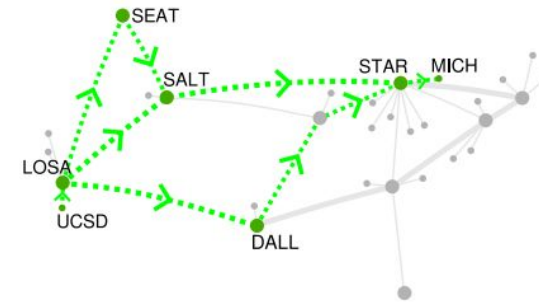
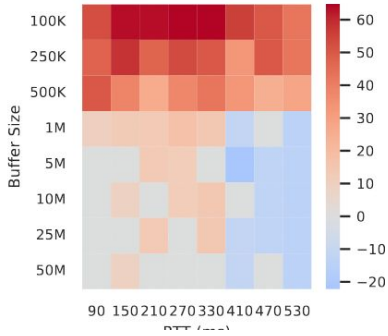
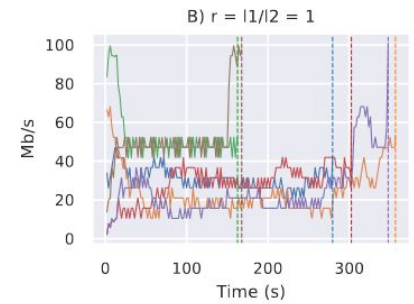
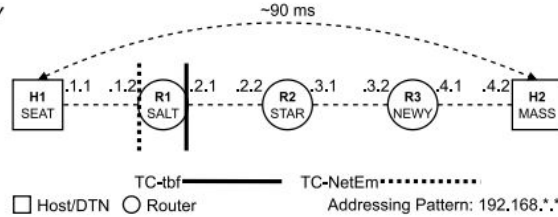
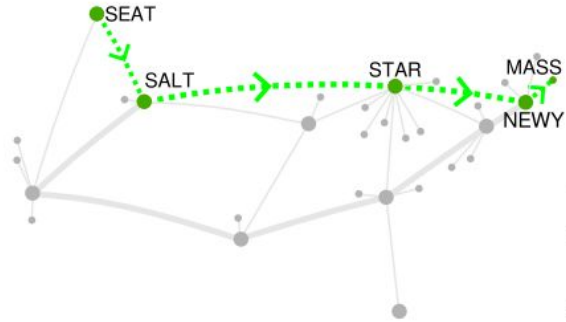
    for i, node in enumerate(nodes):
        print(f"Config Router {i+1}")
        node.upload_files(['frr_config_rocky.sh', 'frr_config_rocky.sh'])
        node_ifacel = node.get_interface(network_name=subnets[i][0])
        node_ifacel2 = node.get_interface(network_name=subnets[i][1])
        node_config_thread = node.execute_thread(f'chmod +x frr_config_rocky.sh && sudo ./frr_config_rocky.sh
            {node_ifacel.get_os_interface()} {route_link_addr[i][0]},
            {node_ifacel2.get_os_interface()} {route_link_addr[i][1]},
            192.168.0.0 {router_ids[i]}'
            )
        node_threads.append(node_config_thread)

    print(f"Joining Threads")
    for i, thread in enumerate(node_threads):
        stdout, stderr = thread.result()
        print(f"Router {i+1}: ", stdout, stderr)
except Exception as e:
    print(f"Exception: {e}")
```

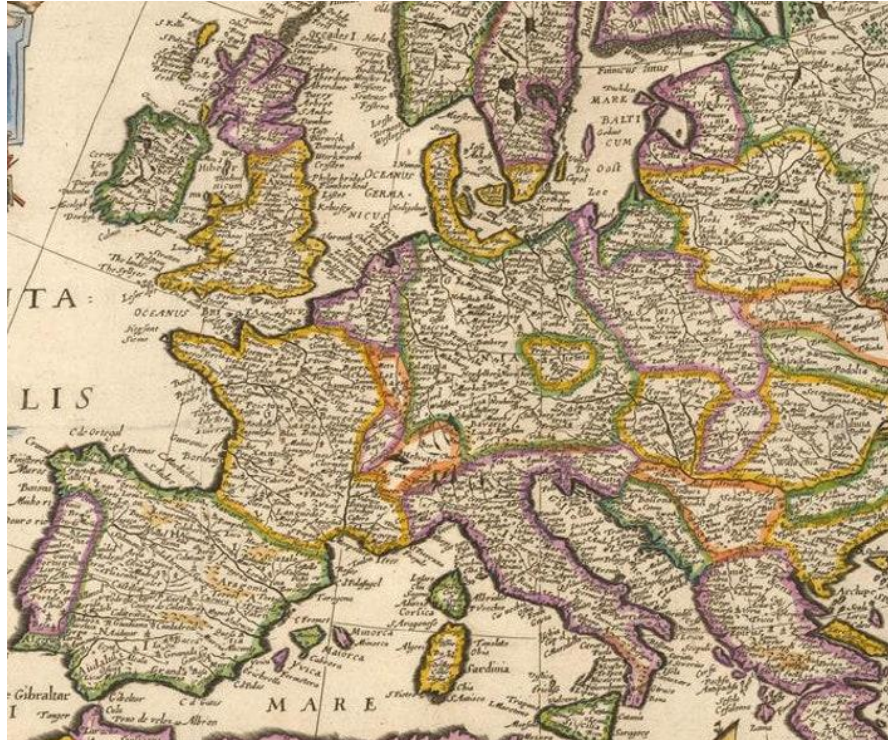


E. Pontes *et al.* "FABRIC Testbed from the Eyes of a Network Researcher", in *Anais do II Workshop de Testbeds*, João Pessoa/PB, 2023, pp. 38-49,

# New Worlds: Data-Intensive Sciences on FABRIC's Slices



## Part II: What the past can teach us about testbeds in 1659



“History is not just a collection of facts, but a way of thinking about and seeing the world.

# An Experiment on a Bird in the Air Pump



The National Gallery. Joseph Wright of Derby: An Experiment on a Bird in the Air Pump, 1768

# Why does one do experiments in order to arrive at scientific truth?

## Hobbes vs. Boyle on the air-pump experiments in 1659

### Knowledge via precise abstractions (Geometry, Logic)

Hobbes challenged both the validity of Boyle's experiment and the philosophical foundations of this new approach to science.



### Knowledge via evidences, experiments generating the “matter of fact”

Boyle's air-pump, a complicated and expensive device, became an emblem of the new experimental science that was promoted by the Royal Society.

Shapin, Steven; Schaffer, Simon (2011). Leviathan and the air-pump : Hobbes, Boyle, and the experimental life : with a new introduction by the authors. Princeton, N.J.: Princeton University Press.



# An Experiment on a Bird in the Air Pump in 1659

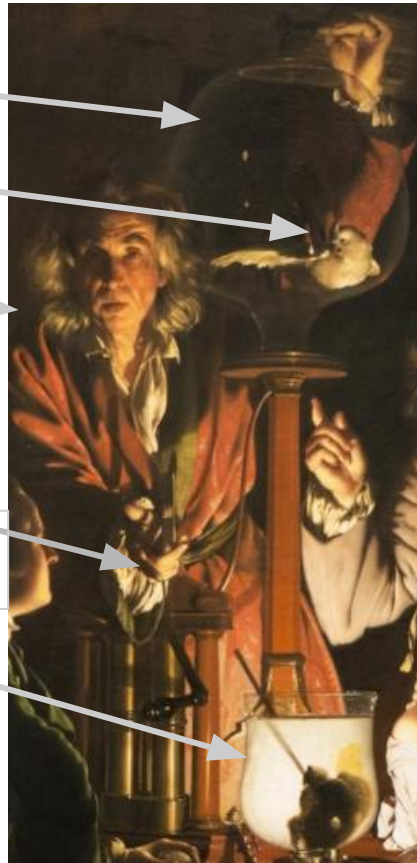
(An impossible\*) Vacuum Chamber

The (asphyxiated) Bird

“Natural Philosopher”

The Air Pump

An Specimen of (perhaps) lungs



Research Questions:

-What is respiration for?

-What is the role of air in keeping flames alive?

This “Testbed” was conceived to establish the “matter of fact” through witnessed and well documented (and thus reproducible) experiments.

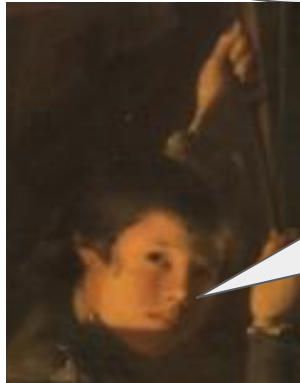
“Void is nothing and nothing cannot rightly be said to exist, because existence refer to “things” and not to “nothings” - Plato



# Issue #1 Cost: Scalability and Sustainability



This is just a very expensive and silly way of killing birds...Not scalable, not sustainable to be funded.

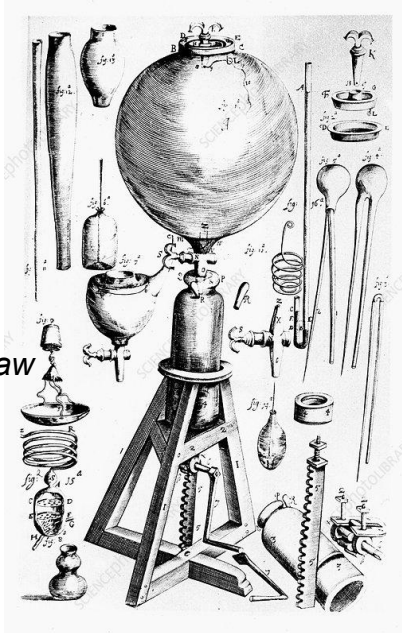


Some skills are only learned by doing things!

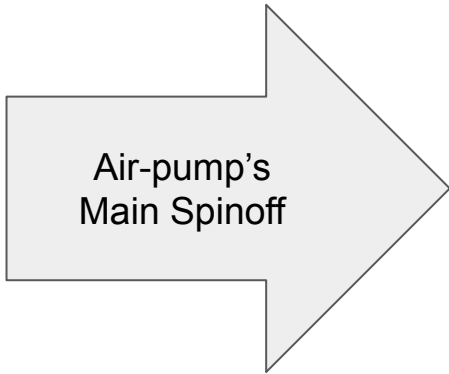
The National Gallery. Joseph Wright of Derby: An Experiment on a Bird in the Air Pump, 1768

# Doing Things: Testbeds as hotbeds for science and innovation

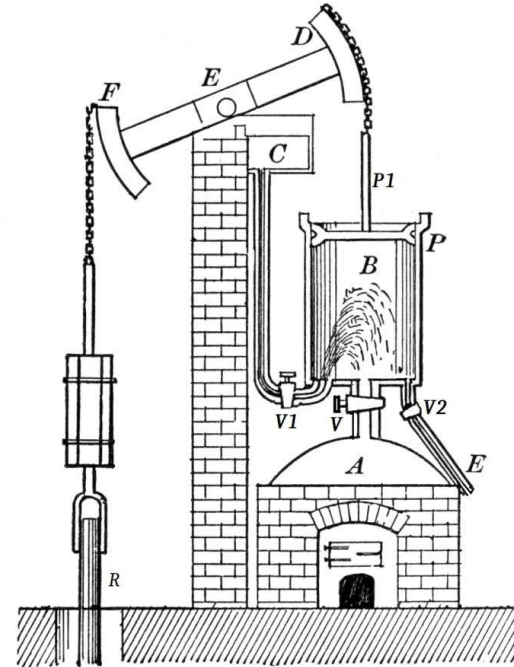
Air pump built for Robert Boyle by his research assistant **Robert Hooke**, 1660.



Hooke's law  
 $F_s = kx$   
1676



Newcomen "Fire Engines,"



Water pump by Thomas Savery in 1698, then 1715 Thomas Newcomen, and John Calley, for coal mines. Later improved by James Watt in 1769 (then called steam engines)

## Issue #2 Usability: Learning Curve and Community Support

Dear PhD student,  
look, I do want you  
to use this  
interesting testbed!

Hold on, what is  
missing for  
fostering a testbed  
community?



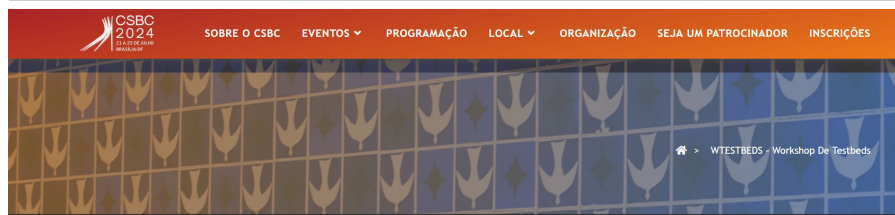
Oh no, no proper  
community, awkward  
APIs..., I'll not get  
results for my PhD  
Thesis in time...

The National Gallery. Joseph Wright of Derby: An Experiment on a Bird in the Air Pump, 1768

# WTESTBEDS: Fostering Communities at CSBC



Cool, but a lot of  
work for little  
impact on my CV.



**WTESTBEDS** - 3º Workshop de Testbeds

<https://csbc.sbc.org.br/2024/wtestbeds/>

# Issue #3 Industry-Academy Gap: Validation Cycles

Forget about testbeds, we've NS3, OMNeT++ and Mininet..., fancy a cup of tea, dear?

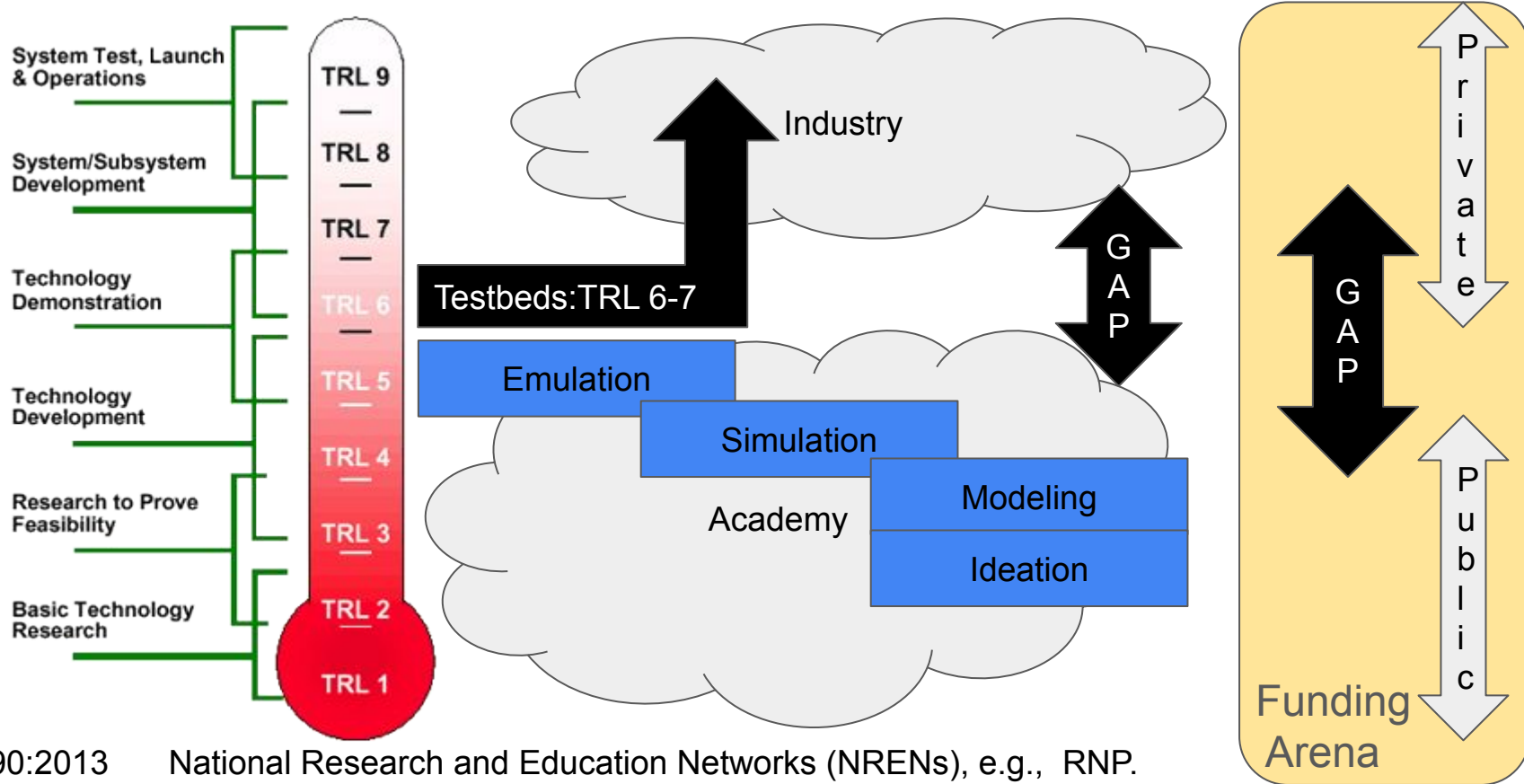


Silly billie, be prepared! We've the industrial revolution coming and also the new women's roles in society.

“Mind the gap...”

The National Gallery. Joseph Wright of Derby: An Experiment on a Bird in the Air Pump, 1768

# NRENs bridging gaps: Technology Readiness Level (TRL\*)



“Ou nós comemos a tecnologia moderna ou seremos  
recolonizados”

Darcy Ribeiro





25<sup>o</sup>

Workshop  
RNP

Obrigado!

Contato: [moises.ribeiro@ufes.br](mailto:moises.ribeiro@ufes.br)