Please provide the following information to get access to the SDN testbed at Caltech and send it to hep-wheel@caltech.edu.

1. Project description:
    - In a few sentences, please describe your project.

PolKA is a novel Source Routing approach that exploits the Residue Number System (RNS) and Chinese Remainder Theorem (CRT) by performing the forwarding through an arithmetic operation: the remainder of division. PolKA encodes an explicit path in a routeID using the RNS in contrast to the conventional list-based representation. Then, PolKA core nodes use this encoded route label to discover the output ports, while fixed function production switch routers in the path simply pass the packets through transparently.

PolKA eliminates the need for tables or for ASIC support in the network, and runs at wire speed across multidomain networks by exploiting the CRC hardware already present in switch-routers. As a result, PolKA has afforded a new level of controllability and software-based performance. From the application's point of view, PolKA full deployment is a promising approach towards meeting the extreme traffic engineering demands of data-intensive sciences, offering a new range of network functionalities such as: multipath routing, in-network telemetry and proof-of-transit with path attributes to support higher level stateful traffic engineering decisions.

2. Project funding:
    - Please list all ongoing project funding supporting your research.

UFES - Federal University of Espírito Santo, **IFES** - Federal Institute of Espírito Santo,

CALTECH - California Institute of Technology,

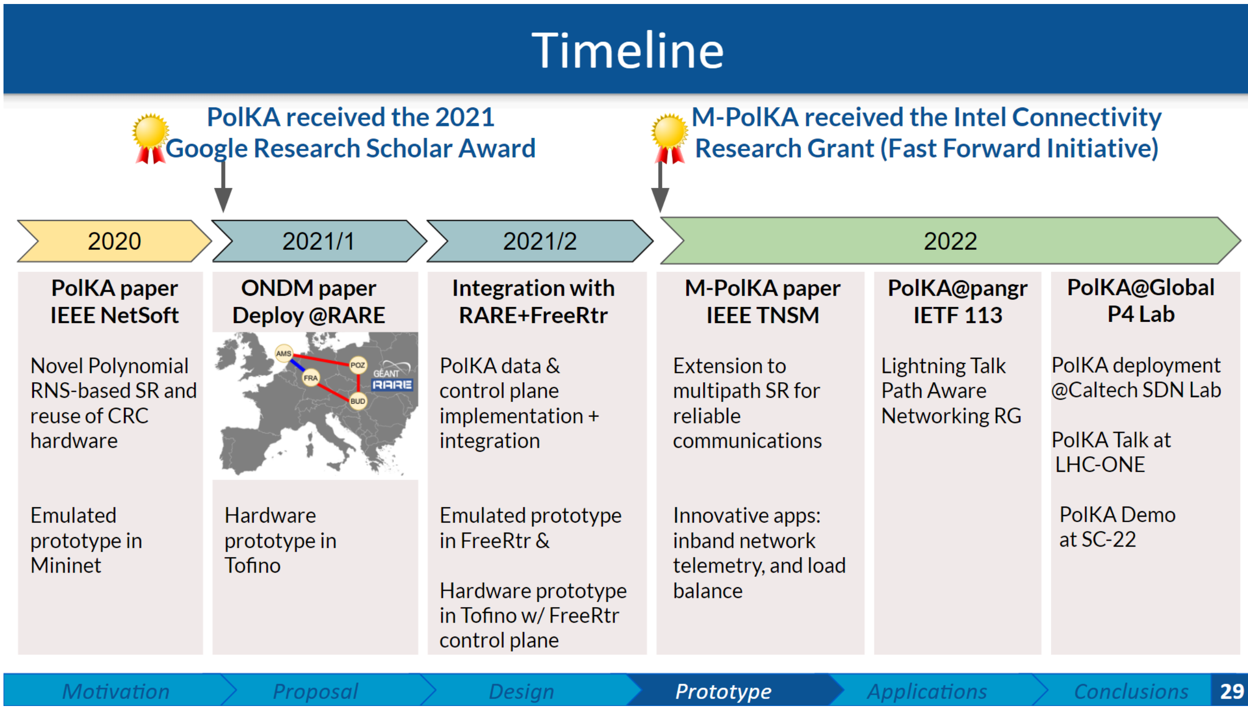
This work received the 2021 Google Research Scholar Award, and the 2022 Intel Connectivity Research Grant (Fast Forward Initiative). It is also supported in part by the following Brazilian agencies: CNPq, RNP, CAPES, FAPESP/MCTI/CGI.br (PORVIR-5G \#20/05182-3, SAWI \#20/05174-0, and SFI, \#18/23097-3), FAPES (\#94/2017, \#281/2019, \#515/2021, and \#284/2021). CNPq fellows Dr. Martinello \#306225/2020-4 and Dr. Ribeiro \#315463/2020-1.

3. Project PIs: Prof. Magnos Martinello (UFES)
    - Please list all PIs in your project.

PolKA team: Everson Scherrer Bordges, Rafael Silva Guimarães and Cristina Klippel Dominicini and Moises Ribeiro

RNP and RARE/freert team: Marcos Schwarz, Frederic Loui, Csaba Mate.

4. Project timeline:
    ○ Project approval dates (based on Funding)



    ○ How long will you need access to Caltech SDN Testbed to run tests?

We would like to have access to the Caltech testbed for 12 months (aiming to get new results for a demo at the Supercomputing 2023).

5. Project Goals and Success metrics:
    ○ What are the project goals and success metrics in terms of using Caltech SDN Resources?

To illustrate the success metrics, the SC22 live demonstrations by the PolKA team achieved several goals:

1. Design and execution of emulated experiments based on GNA-G topologies within the freeRtr environment to compare PolKA and Segment Routing functionalities.

2. Implementation of emulated topologies and traffic scenarios on the RARE/freeRtr testbed with the Tofino-based P4 switches to select representative proof-of-principle use cases.

3. Creating a PolKA overlay by integrating existing resources and services from the GNA-G AutoGOLE/SENSE working group in the context of the Caltech P4 lab and the Global P4 Lab testbeds, to provide a foundation for the simu-ltaneous execution and comparison of PolKA with Segment Routing.

4. Validating a proof-of-principle of the PolKA mechanism on the GNA-G AutoGOLE/SENSE international testbeds, to demonstrate support to: (i) data-intensive transfers over 10G and 100G+, and (ii) traffic engineering capabilities for avoiding link congestion and improving quality of service.

PolKA was deployed and operated in a system-based set of video-recorded live ongoing demonstrations at the Caltech booth (SDN resources) throughout SC22. The results and outcomes have shown that PolKA can be deployed in high-performance programmable network switch-routers, and perform advanced traffic engineering at 100G wire speed by use of the CRC hardware.

PolKA's agility in steering traffic across network paths configured at the edge, using its source routing with stateless core nodes, was demonstrated across national and intercontinental SENSE/AutoGOLE overlay circuits within the Global P4 Lab testbed. The demonstrations included the definition of explicit paths (i.e. a specific RNS-encoded route label) at the edge with intercontinental traffic migration from one path to another triggered by setting a single update at the edge.

For the control plane, PolKA is fully integrated in the freeRtr platform, offering an easy and high-level way to configure PolKA tunnels. This feature facilitates the use of PolKA by network operators that may set up the underlay tunnels that explore, not only a shortest path, but any explicit path in the network, allowing one to specify policies and traffic engineering at the edge.

Moreover, PolKA deployment in the Caltech P4 lab testbed demonstrated its performance, achieving 100 Gbps transfer rate with multiple aggregated TCP flows. This validation of data-intensive transfers proved that PolKA mechanism can deliver line rate throughput on 100G+ Tofino 1 switches. (Preliminary tests on Tofino 2 switches were also conducted thanks to the cutting-edge equipment in the Caltech booth). In addition, a comparison with SR was carried out, resulting in equivalent throughput. This comparison with SR was a significant step towards PolKA consolidation, since PolKA's agility on configuring paths and traffic controllability at the edge can provide important advantages relative to the SR approach.

The new goals are: i) to validate the PolKA routing approach in terms of scalability in steering data-intensive science traffic at 200, or 400 Gbps; ii) to investigate the control plane capabilities towards optimizing network resources in an agile manner using PolKA; iii) Perform a test using polka tunneling passing Arista, Dell and SONiC, in order to validate possible incompatibilities found during the sc2022 experiments.

6. Project Requirements in terms of Hardware:
    - Can your application run inside a Kubernetes container? OR
    - Do you need a dedicated server?

The polka approach runs in the freertr NOS, and we need access to the Tofino running freertr. Furthermore, we need access to two DTNs for generating traffic, and we would like access to Sandie-7 and Sandie-10 for performance tests. Yes, for tuning the servers and generating traffic, we need dedicated access during the test executions, which can be scheduled with the team. In summary, we need access to two DTNs and the Tofinos (BUR0001, BUR0002, BUR0051, BUR0061).

7. Project Requirements in terms of Software, tools, and System tuning:
    - Is there any known Software needed (besides outside connectivity and Kubernetes)?

Iperf3, pktgen-DPDK, trex

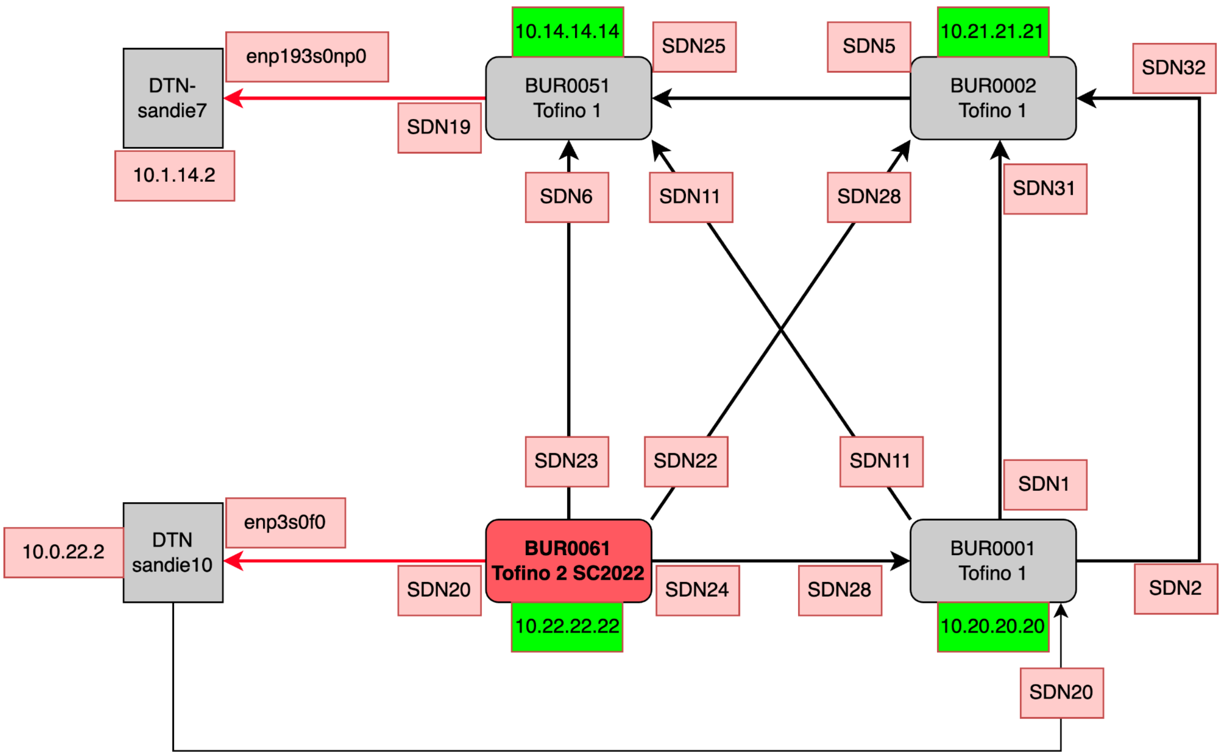
- Is there any known System tuning needed?

Yes, there are requirements in terms of tuning the NIC cards to sent traffic at the 100Gbps scale, such as:

- To set default Linux use the ‘performance’ CPU governor.
- To specify which core handles the NIC interrupts, you need to disable irqbalance and then bind the interrupts to a specific CPU socket.
- To assign the IRQs explicitly using ethtool to configure receive network flow classification rules.

8. Project Requirements in terms of Networking and Network connections - LAN/WAN:
    - Any specific LAN Requirements? Dedicated links, VLANS? Private network?
    - Any specific WAN Requirements? A dedicated path between sites? QoS?
    - Do you need a public IPv4 Range? What is the minimum range required? Do you need any DNS records for those IPs?
    - Do you need a public IPv6 Range? What is the minimum range required? Do you need any DNS records for those IPs?

This diagram covers the main resources about IP and devices we need.



9. In case you do need sudo/root access - please explain why
    - Given security and repeatability - sudo/root access is limited to a few people. Please explain why you think you will need sudo/root access (if you need one, of course). Most of the things on Caltech SDN Testbed are automatically configured using Puppet - and we want to ensure in case of node loss or disk loss - we can fastly redeploy nodes and bring you back up to speed with all config. (So, we need to ensure system changes are present inside the puppet)

To configure the NIC cards pinning, we need to have access as super user (root), once the requirements cited in item 7 can only be set or can be debugged in the DTNs as super user profile (i.e. ethtool, ip, iptables and sysctl commands).

10. In case you do need to have 'configure' or console access to switches - please explain why:
    - Most of the Network Resources in Caltech SDN Testbed are controlled by SiteRM - which covers 90% of all use cases projects require. In this something special - please explain the need - so we can find the best way to achieve and accommodate it.

We need 'configure' access to the freeRtr switches to create PolKA and troubleshoot PolKA tunnels

11. Which users will need access to SDN Testbed (Whom the account should be created for):
    - Any user needing access must have a Tier2/SDN account created. Please list all users assigned to this project and who should get a Tier2/SDN account.

Everson, Marcos, Rafael <rafaelsg@gmail.com>, Domingos <domingos.paraiso@gmail.com>