



thinknexus

Overview on NGI

access

opportunities from

EU and US (1st iteration)

Deliverable 2.1



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Executive Summary

Even though the United States of America (US) and the European Union (EU) have a long-standing cooperation history in the field of research and innovation, within the framework of specific Scientific and Technological Cooperation Agreements, it has only been until very recently where the two regions decided to make the first steps towards jointly tackling the Next Generation Internet concept. Building upon the EU-US collaboration in previous joint initiatives in the area of research experimentation and the need of reinforcing cooperation and strategic partnerships in the area of Next Generation Internet for establishing a continuous dialogue among the key actors in the US and European programmes and for implement focused projects for joint developments, led to the definition of the first joint NGI programmes and initiatives.

The EU-US Collaboration on NGI (ICT-31-2018-2019) topic¹ and the US-EU Internet Core & Edge Technologies (ICE-T)² programme, paved the way for establishing a solid communication channel between the two regions.

This current document is a guide which aims to provide an overview of the present funding environment for opportunities for EU or US researchers and innovators who want to join projects or initiatives on the other side of the ocean. The document does not intent to duplicate or re-produce that is already available in other guides, therefore it provides a brief overview of the funding ecosystem of both regions, while emphasizes in available “open” funding opportunities on specific NGI related topics which are on the heart of the Think NEXUS project. Last not least, the current document can be considered as a live document which will be frequently updated and released whenever new relevant information is available.

¹ <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ict-31-2018-2019>

² <https://www.nsf.gov/pubs/2018/nsf18535/nsf18535.htm>

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**CHAPTER 1 -
Introduction &
Purpose**

Introduction

On 17 October 2016³, the European Commission and the US Government signed an agreement which aimed to facilitate the cooperation between US organisations and Horizon 2020 participants. Such agreement enables US teams to cooperate with Horizon 2020 projects outside the framework of the grant agreement, and to increase cooperation in research projects.

With the objective to keep reinforcing a mutual agenda on the Digital Economy and its impact in the Society, the European Commission's Directorate-General for Communications Networks, Content and Technology (DG CONNECT) and the US National Science Foundation⁴ (NSF) established a joint EU-US committee in June 2017⁵. The mission of such committee was oriented to identify and underline common priorities on research- focused networking testbeds, as well as research opportunities on the Next Generation of the Internet⁶. One of the key takeaways of such committee was in the form of a recommendation, proposing the development of such strategic collaboration following three time-scales:

- In the **short run**, the focus of collaboration should be on the exchanges of students, platform design and operation engineers, and faculty members;
- In the **medium time scale**, the collaboration should include joint projects with lightweight management focusing on specific targets and objectives with the main goal of encouraging development of common advanced wireless platform environments as well as collaborative research projects on NGI;
- In the **long run**, collaboration should include joint development of control/management frameworks as well as joint development of large experimental wireless and NGI platforms (whether collocated or as a multiple deployments) and architectures.

Within its Next Generation Internet (NGI) vision in the ICT Work Programme 2018-2020⁷, the European Commission is aiming for strengthening such common agenda through the actions included in H2020-ICT-31-2018-2019: EU-US collaboration on NGI. One of those topics is the

³ Implementing arrangement between the European Commission and the government of the United States of America for cooperation between researchers. 17 October 2016. http://ec.europa.eu/research/iscp/pdf/policy/eu-usa_implementing_arrangement_2016.pdf

⁴ National Science Foundation. <https://www.nsf.gov/>

⁵ EU/US Future Networks Workshop. June 26-28, 2017

⁶ EU/US Future Networks Workshop. June 26-28, 2017

⁷ Horizon 2020 Work Programme 2018-2020, 5.i. Information and Communication Technologies. http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-leit-ict_en.pdf

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Research and Innovation Action “*Common experiments by EU/US teams on emerging topics for the Next Generation Internet / Tomorrow's Internet programmes on top of EU/US experimental platforms*”.

Contents of this Deliverable

The current deliverable is an overview of public funding opportunities provided by the EU or the US, open to researchers from both regions, in NGI related topics and themes. Some other key initiatives fostering collaboration in NGI between the two regions are also presented. Information has been collected through desk research plus consultations with Think NEXUS experts.

It is obvious, especially for European funded programmes, that the current document covers only what is currently “open and accessible” until the end of 2019 and provides preliminary information about calls and opportunities that will be available later this year and will close in 2020. This happens mainly because the Horizon 2020 work programme for 2020 has not been officially launched and deadlines have not been officially announced. For the later, additional information will be made available towards the end of 2019 and will be taken into account for the next iteration of this deliverable.

This document, includes information addressed both to EU and US researchers and research oriented organisations, willing to jointly collaborate on NGI related topics, while emphasis has been also given to other supportive actions (i.e. projects and other initiatives) who enhance the nature of collaboration in the NGI field, between EU and US organisations. The list of opportunities is not exhaustive and mainly covers opportunities on a federal or EU wide level, as national related initiatives (if any) are not part of this study.

Adding to the above, generic information about the research funding ecosystem of each region is presented, however not in a detailed way as this work has been already done and presented through other EU funded initiatives, such as PICASSO project⁸, BILAT 4.0⁹ and others.

⁸ <http://www.picasso-project.eu/>

⁹ <https://www.euussciencetechnology.eu/>



**CHAPTER 2 -
Opportunities
for US
researchers**

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Overview

The current section provides an overview, dedicated to US researchers and innovators, of the European research framework related to NGI topics of interest, who are open to US participants until the end of 2019. NGI topics presented below are only the ones which consist the main focus of Think NEXUS project, however these topics are subject for validation by the Think NEXUS expert groups.

Funding Mechanisms and Opportunities

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market.

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is important. This approach makes sure new projects get off the ground quickly – and achieve results faster.

The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation.

More information about H2020 can be found in the official portal:

<https://ec.europa.eu/programmes/horizon2020/en>

US Participation Conditions¹⁰

General openness is one of the main objectives of the European Commission when describing the Horizon 2020, the European Union's research and innovation program, with over €80 billion of funding available over 7 years (2014 to 2020), dedicated to foster excellent science, industrial leadership, and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation, and makes it easier for the public and private sectors to work together in delivering innovation. **Currently there are over 1000 projects funded by H2020, which include US partners in the consortium¹¹.**

International cooperation, as a cross-cutting topic, lies in the core of the Horizon 2020 program, addressed within its 3 pillars providing a range of opportunities to collaborate with non-EU Member States and Associated countries (Third Countries) in research, technology, and innovation (RTI). International cooperation is not only crucial to tackle global challenges, but also to strengthen Europe's excellence in science, increase its attractiveness towards becoming a global leader in innovation, and support the European Union's external policies through science diplomacy. In line with multiannual roadmaps to foster cooperation with key partner countries/regions of Europe, **Horizon 2020 specifically encourages international cooperation through various instruments**. Such instruments can be **joint/coordinated calls, targeted calls for collaborative research and innovation projects with recommended or obligatory participation of Third Countries**, and **other specific horizontal activities** called Coordination and Support Actions dedicated to promoting international cooperation specific horizontal activities in the H2020 Societal Challenge 6 'inclusive, innovative and reflective societies'.

Automatic funding for international partners, partners not located in EU Member States and Associated countries (Third Countries), on the other hand, is limited to those from developing, enlargement and neighbourhood countries. In order to improve international participation in H2020, the EC has introduced various measures in cooperation with their counterparts in third countries, as described below:

- **Participation in a H2020 Project as full partner with EU Funding**

¹⁰ ETNA 2020: <https://www.transport-ncps.net/how-can-u-s-entities-participate-in-h2020-projects-brief-terms-and-conditions/>

¹¹

[https://cordis.europa.eu/search/en?q=contenttype%3D%27project%27%20AND%20\(programme%2Fcode%3D%27H2020%27\)%20AND%20relatedRegion%2Fregion%2Fcode%3D%27US%27&p=1&num=10&srt=contentUpdateDate:decreasing](https://cordis.europa.eu/search/en?q=contenttype%3D%27project%27%20AND%20(programme%2Fcode%3D%27H2020%27)%20AND%20relatedRegion%2Fregion%2Fcode%3D%27US%27&p=1&num=10&srt=contentUpdateDate:decreasing)

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All U.S. entities and researchers can participate in all areas of H2020 together with researchers from the 28 EU Member States and Associated Countries, U.S. entities and researchers may be eligible to receive funding in the following cases:

- participation is foreseen/requested specifically in the relevant Work Programme or Call,
 - participation is decisive or essential for carrying out the project and for ensuring project success. Additionally, under societal challenge, in the area of Health, as a result of a bilateral agreement between the European Commission and the National Institute of Health (NIH), U.S. partners participating in an H2020 project are eligible to receive EU funding
- **Participation in a H2020 Project as full partner without EU funding: EU- U.S. Implementing Arrangement**

On October 17, 2016, the U.S. Ambassador to the European Union, Anthony Gardner and the European Commissioner for Research and Innovation, Carlos Moedas, signed an **Implementing Arrangement between the Government of the United States of America and the European Commission to enhance transatlantic cooperation on science, technology, and innovation**. According to this arrangement, **U.S. researchers and/or entities with their own sources of funding are allowed to collaborate with a Horizon 2020 research project consortium without having to sign the Horizon 2020 Grant Agreement**. This is a major step for those U.S. entities who cannot sign the H2020 Grant Agreements for legal reasons.

This implementing arrangement is especially useful for those U.S. researchers/entities that do not request European funding but wish to work together with European partners on a topic of their interest. The framework for a successful project implementation is set in the Consortium Agreement which is outlining the rights and obligations and signed by the beneficiaries, all having the same rights and obligations.

- **Participation in a H2020 Project as Implementing Certain Action Tasks without EU funding- Article 14a**

U.S. entities may be linked to a H2020 Project not as full research partner but as partner responsible for implementation of some activities within the Project. In this case, they do not get EU funding, neither directly nor indirectly. The cost of their participation are estimated but not included in the grant amount calculations by the Coordinator and not covered by the Grant. In this case, the U.S. entity is considered as Third Party (rather than a beneficiary or a research partner) and a designated beneficiary from the consortium will be responsible for the Third Party's activities.

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The U.S. entity performs tasks directly (under the supervision of a beneficiary) without signing the Grant Agreement. The beneficiary remains responsible towards the Commission/Agency for the tasks performed by its U.S. entity. No cost reporting is required. In line with the periodic reporting the explanation of the work carried out as well as an overview of the progress shall be reported to the linked beneficiary.

For more information about how to participate in H2020 proposals can be found in <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/how-to-participate>

Strategic Framework

The first ICT-Leadership in Enabling and Industrial Technologies (LEIT) Work Programme under H2020 provides a balanced response to the main challenges faced by Europe in the field: firstly, the need to maintain a strong expertise in key technology value chains; secondly, the necessity to move quicker from research excellence to the market.

It combines a strong support to industrial roadmaps with new mechanisms to encourage disruptive innovation. The former will reinforce medium to long term commitment to industrial strategies and provide continuity and stability. The latter will offer flexibility and openness and will help develop dynamic eco-systems in which innovators can operate. Both strands will require the involvement of new actors, on one hand to exploit and leverage new technologies and on the other to initiate and drive change.

Activities

Six main activity lines have been identified in the ICT-LEIT part of the Work Programme¹²:

- A new generation of components and systems
- Advanced Computing
- Future Internet
- Content technologies and information management
- Robotics
- Micro- and nano-electronic technologies, Photonics

¹² <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/information-and-communication-technologies>

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In addition, the Work Programme features several cross-cutting topics addressing cybersecurity, Internet of Things and research on a Human-centric Digital Age. All activities are complemented with support to innovation and take-up, international cooperation and a dedicated action for SMEs to propose bottom-up innovative ideas, using the SME instrument.

Especially for the 2020 Work Programme, the areas of Artificial Intelligence (AI), key technologies for digital transformation from photonics to software, advanced and smart connectivity with the emerging 5G, and Next Generation Internet including distributed ledger technologies and Blockchain are prioritised¹³. The actions foreseen in this work programme are strategic stepping stones in the direction of the next framework and will support Europe to take a bold lead in digital technologies by 2030. They also build ground for wide-spread deployment of digital technologies and thus provide means to respond to the challenge of digital transformation in line with the objectives of the proposed Digital Europe programme.

Funding Opportunities related to NGI topics

As already mentioned above, a number of NGI related topics are already open or will open in the following months. The categorization below has been made according to the strategic priorities already defined by the Think NEXUS project in deliverables **D1.2 Think tank strategic outline (initial)** and **D1.1 Think NEXUS think tank operational guidelines**. The later can be found in <https://thinknexus.ngi.eu/repository/project-deliverables/>.

AI and Autonomous Machines

Opportunity Number	Opportunity Title	Deadline	Budget
SESAR-ER4-03-2019	Complexity and Data Science for ATM Performance	29 August 2019	29 M€
FETPROACT-EIC-05-2019	FET Proactive: emerging paradigms and communities	03 September 2019 postponed to 8 October 2019	Between 35.4 M€ and 52.4 M€ million
FETPROACT-EIC-06-2019	EIC Transition to Innovation Activities	03 September 2019 postponed to 8 October 2019	Between 10 M€ and 13 M€
SU-FCT03-2018-2019-2020	Information and data stream management to fight against	22 August 2019	8 M€

¹³ https://ec.europa.eu/programmes/horizon2020/sites/horizon2020/files/h2020-leit-ict-2018-2020_pre_publication.pdf

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	(cyber)crime and terrorism		
SU-INFRA01-2018-2019-2020	Prevention, detection, response and mitigation of combined physical and cyber threats to critical infrastructure in Europe	22 August 2019	22 M€
ICT-48-2020	Towards a vibrant European network of AI excellence centres	13 November 2019 (draft)	50 M€ ¹⁴
ICT-49-2020	Artificial Intelligence on demand platform	22 April 2020 (draft)	20 M€ ¹⁴
ICT-38-2020	Artificial intelligence for manufacturing	16 January 2020 (draft)	48 M€ ¹⁴
ICT-50-2020	Software Technologies	16 January 2020 (draft)	30 M€ ¹⁴

Blockchains & Distributed Ledgers

Opportunity Number	Opportunity Title	Deadline	Budget
LC-SC3-EC-1-2018-2019-2020	The role of consumers in changing the market through informed decision and collective actions	03 September 2019	7,5 M€
Blockchain-EICPrize-2019	EIC Horizon Prize for 'Blockchains for Social Good'	03 September 2019	5 M€
JTI-CS2-2019-CfP10-LPA-01-72	Development of a distributed CFD platform for collaborative design	03 September 2019	0,6 M€
ICT-54-2020	Blockchain for the Next Generation Internet	16 January 2020 (draft)	20 M€ ¹⁴

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Big Data

Opportunity Number	Opportunity Title	Deadline	Budget
<u>SU-INFRA02-2019</u>	Security for smart and safe cities, including for public spaces SU-INFRA02-2019	29 August 2019	16 M€
<u>LC-SC3-EE-13-2018-2019-2020</u>	Enabling next-generation of smart energy services valorising energy efficiency and flexibility at demand-side as energy resource	03 September 2019	8 M€
<u>SESAR-ER4-03-2019</u>	Complexity and Data Science for ATM Performance	29 August 2019	29 M€
<u>SU-FCT03-2018-2019-2020</u>	Information and data stream management to fight against (cyber)crime and terrorism	22 August 2019	8 M€
<u>SU-INFRA01-2018-2019-2020</u>	Prevention, detection, response and mitigation of combined physical and cyber threats to critical infrastructure in Europe	22 August 2019	22 M€
<u>ICT-51-2020</u>	Big Data technologies and extreme-scale analytics	16 January 2020 (draft)	31,5 M€ ¹⁴
<u>DT-ICT-05-2020</u>	Big Data Innovation Hubs	13 Nov 2019	30,5 M€ ¹⁴

Internet of Things (IoT)

Opportunity Number	Opportunity Title	Deadline	Budget
<u>LC-SC3-EE-4-2019-2020</u>	Upgrading smartness of existing buildings through innovations for legacy equipment	03 September 2019	10 M€
<u>LC-SC3-EE-13-2018-2019-2020</u>	Enabling next-generation of smart energy services valorising energy efficiency and flexibility at demand-side as energy resource	03 September 2019	8 M€
<u>LC-SC3-EC-1-2018-2019-2020</u>	The role of consumers in changing the market through informed decision and collective actions	03 September 2019	7,5 M€
<u>ICT-51-2020</u>	Big Data technologies and extreme-scale analytics	16 January 2020 (draft)	31,5 M€ ¹⁴
<u>ICT-56-2020</u>	Next Generation Internet of Things	16 January 2020 (draft)	48,5 M€ ¹⁴

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Open Data

Opportunity Number	Opportunity Title	Deadline	Budget
BBI-2019-SO4-S3	Shaping the bio-based economy through a participatory approach	04 September 2019	Indicative Budget for the whole call is 135 M€
LC-SC3-CC-3-2019	Support for the opening of low-carbon energy research databases in Europe	27 August 2019	2 M€
Epidemics-EICPrize-2020	EIC Horizon Prize for 'Early Warning for Epidemics'	01 September 2020	5 M€

Cloud /Edge Computing

Opportunity Number	Opportunity Title	Deadline	Budget
ICT-40-2020	Cloud Computing: towards a smart cloud computing continuum	22 April 2020 (draft)	20 M€ ¹⁴

Future Architectures

Opportunity Number	Opportunity Title	Deadline	Budget
ICT-51-2020	Big Data technologies and extreme-scale analytics	16 January 2020 (draft)	31,5 M€ ¹⁴
ICT-50-2020	Software Technologies	16 January 2020 (draft)	30 M€ ¹⁴

Other NGI Related Calls

Opportunity Number	Opportunity Title	Deadline	Budget
ICT-57-2020	An empowering, inclusive Next Generation Internet	22 April 2020 (draft)	7 M€ ¹⁴
ICT-44-2020	Next Generation Media	16 January 2020 (draft)	17,5 M€ ¹⁴

¹⁴ The final budget will be indicated when the official call is published

The background features abstract geometric shapes in dark blue and red. A large blue shape is in the top-left, and a red shape is in the bottom-left, both pointing towards the center. The text is positioned to the right of these shapes.

**CHAPTER 3 -
Opportunities
for EU
researchers
and innovators**

Overview

The current section provides an overview, dedicated to EU researchers and innovators, of the USA research framework related to NGI topics of interest, who are open to EU participants until the end of 2019. NGI topics presented below are only the ones which consist the main focus of Think NEXUS project.

Funding Mechanisms and Opportunities¹⁵

In US, Research and Innovation is mostly financed by Federal research programmes (run through research agencies **ANNEX A: List of United States research and development agencies**), which reflect directly the President's priorities and interests. Research funding is also available at the State level, but normally reflects local-specific needs, and are mostly normally open only to local applicants – meaning that neither entity from other US States nor foreign entities have access to these resources.

Federal research and development (R&D) priorities are decided based on three main sources of input: the yearly Memorandum drafted by the Office of Science and Technology Policy (OSTP) of the White House – which provides policy advice and coordinate STI policies; the Congress input; the State's Departments and relative funding agencies. Priorities and their corresponding allocated budget are then yearly detailed by the Office of Science and Technology Policy of the President in the Multi-Agency Science and Technology Priorities for the Fiscal Year Budget¹⁶.

Apart from specific areas, such as Security or Defence, which require a confidential approach, at the level of individual funding agencies' policy, foreign participation and international partnerships are often allowed and valued, as perceived as a benefit and a positive asset to strengthen credibility to research projects. However, funding is not always foreseen, and foreign participants and organisations are expected to cover their part of effort.

According to the research conducted by the project BILAT 2.0. “nearly one-quarter of individual organisations' policy measures provide funds to other countries as long as the leading organisation is a U.S.-based university or other research institution. About 40% of the measures do not provide funding to non-U.S. institutions. The remaining 40% have specific pre-requisites for allowing receipt of U.S. funds by third countries”¹⁷.

¹⁵ PICASSO Project: D1.2: Overview on ICT-related access opportunities in EU and US

¹⁶ www.whitehouse.gov/sites/default/files/omb/memoranda/2015/m-15-16.pdf

¹⁷ Deliverable D3.1, *Report on the EU and US innovation policy framework and relevant initiatives*, in <http://www.eusscienceandtechnology.eu/documents-and-publications>

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To our knowledge, no specific calls are published for foreigners' participation, and normally international partnerships result more from existing and previous personal research collaborations than from a manifest encouragement in the call announcements.

EU Participation Conditions

Eligibility criteria are provided in the Announcement of Federal Funding Opportunity (FFO) and are specific to each announcement. Some opportunities are limited to entities located in the United States or its territories, but others are opened to foreign public entities, foreign governments, organisations under the jurisdiction of foreign governments; international organisations.

Other announcements, in presence of limitations linked to majority domestic ownership or control of applicants, may specify that "organisations that are ineligible to apply because they are majority foreign-owned or foreign-controlled may be included in a team or consortium as an unfunded collaborator, provided that they are organized and operated in the United States.

However, a European partner has to follow the following rules¹⁸:

- The authorizing legislation and agency policies will determine whether a foreign individual or organization may apply for the grant. Foreign applicants need to complete the same registration process as domestic applicants, but there are additional steps to this registration process.
- Depending on the intended usage of the grant applied for, you may need to file filing a U.S. tax return which requires a Taxpayer Identification Number (TIN), also referred to as an employer Identification Number (EIN) may be required. If a non-resident alien is awarded funding to perform activities outside the United States, then this likely does not constitute U.S. source income and a TIN/EIN is not necessary. Examples of such funding include scholarships, fellowship grants, targeted grants, and achievement awards.
- Before applying, foreign applicants should thoroughly review the IRS website and search for their most recent guidance for Aliens and International Taxpayers.

¹⁸ <https://www.grants.gov/learn-grants/grant-eligibility.html>

Strategic Framework

The Networking and Information Technology Research and Development (NITRD)¹⁹ Program is the Nation's primary source of federally funded research and development (R&D) in advanced information technologies (IT) in computing, networking, and software. NITRD is among the oldest and largest of formal Federal programs that coordinate the activities of multiple agencies to tackle multidisciplinary, multitechnology, and multisector R&D needs. The 21 NITRD member agencies now invest approximately \$5 billion annually in R&D programs that identify, develop, and transition to practical use the advanced networking and IT capabilities needed by the Federal Government and the Nation.

The NITRD PCAs are major subject areas for Federal IT R&D. PCAs are intended to facilitate budgetary comparisons from year to year in each area. The PCA set evolves over time, reflecting changes in IT R&D activities at Federal agencies and IT R&D priorities of the Administration. NITRD's FY2019 PCAs, with their definitions. NITRD's FY2020 PCAs are:

- AI - Artificial Intelligence
- CHuman - Computing-Enabled Human Interaction, Communication, and Augmentation
- CNPS - Computing-Enabled Networked Physical Systems
- CSP - Cyber Security and Privacy
- EdW - Education and Workforce
- EHCS - Enabling-R&D for High-Capability Computing Systems
- HCIA - High-Capability Computing Infrastructure and Applications
- IRAS - Intelligent Robotics and Autonomous Systems
- LSDMA - Large-Scale Data Management and Analysis
- LSN - Large-Scale Networking
- SPSQ - Software Productivity, Sustainability, and Quality

¹⁹ <https://www.nitrd.gov/about/index.aspx>

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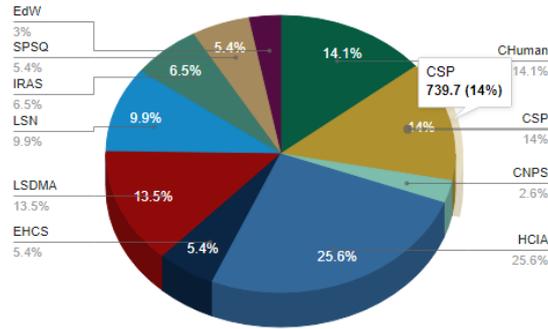


Figure 1 - NITRD FY2019 Budget (\$ in Millions)

It is obvious from the information above that a number of ICT priorities directly related to NGI receive significant federal funding, such as AU, CNPS (which include IoT), IRAS etc.

Funding Opportunities related to NGI topics

AI and Autonomous Machines

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
HR001119S0032	Strategic Technologies	DOD-DARPA-STO	02/28/2020	N/A
FA9550-19-S-0003	Research Interests of the Air Force Office of Scientific Research	DOD-AFOSR	Posted until superseded	\$1,200,000

Blockchains & Distributed Ledgers

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
RFA-DA-20-012	Blockchain Technology to Improve SUD Care (R43/R44 - Clinical Trial Optional)	HHS-NIH11	07/31/2019	\$225,000 for Phase I or \$1,500,000 for Phase II for specific topics
RFA-DA-20-011	Blockchain Technology to Improve SUD Care (R41/R42 - Clinical Trial Optional)	HHS-NIH11	07/31/2019	\$225,000 for Phase I or \$1,500,000 for Phase II for specific topics
SFOP0005762	Using Technology to Promote Transparent and Accountable Asset Return	DOS-INL	06/14/2019	Maximum Federal Grant Award: \$850,000 Minimum Federal Grant Award: \$500,000
W911NF-17-S-0002	Army Research Office Broad Agency	DOD-AMC	03/31/2022	N/A

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	Announcement for Fundamental Research			
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Big Data

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
W911NF-18-S-0005	U.S. Army Research Institute for the Behavioral and Social Sciences Broad Agency Announcement for Basic, Applied, and Advanced Research (Fiscal Years 2018-2023)	DOD-AMC	04/29/2023	N/A
2019-NIST-MSE-01	Measurement Science and Engineering (MSE) Research Grant Programs	DOC-NIST	04/30/2020	\$12,000,000
W911NF-17-S-0003	Army Research Laboratory Broad Agency Announcement for Basic and Applied Scientific Research	DOD-AMC	03/31/2022	N/A
W911NF-17-S-0002	Army Research Office Broad Agency Announcement for Fundamental Research	DOD-AMC	03/31/2022	N/A
W81XWH18SBAA1	DoD USAMRMC FY18-FY22 Broad Agency Announcement for Extramural Medical Research	DOD-AMRAA	09/30/2022	N/A
PD-19-1631	Civil Infrastructure Systems	NSF	Proposals accepted anytime	N/A
PAR-18-764	Harnessing Big Data to Halt HIV (R01 Clinical Trial Optional)	HHS-NIH11	05/07/2021	N/A

Internet of Things (IoT)

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
18-528	Expeditions in Computing	NSF	04/23/2020	\$30,000,000
2019-NIST-TPO-IOT-01	Economic Research and Analysis of the National Need for Technology Infrastructure to Support the Internet of Things (IoT)	DOC-NIST	07/24/2019	\$400,000

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

19-553 ²⁰	Cyber-Physical Systems	NSF	09/26/2019	\$7,000,000
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Open Data

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
18-591 ²¹	Collaborative Research in Computational Neuroscience	NSF	11/25/2019	\$20,000,000
19-501	Accelerating Research through International Network-to-Network Collaborations	NSF	01/31/2020	\$6,000,000

Cloud /Edge Computing

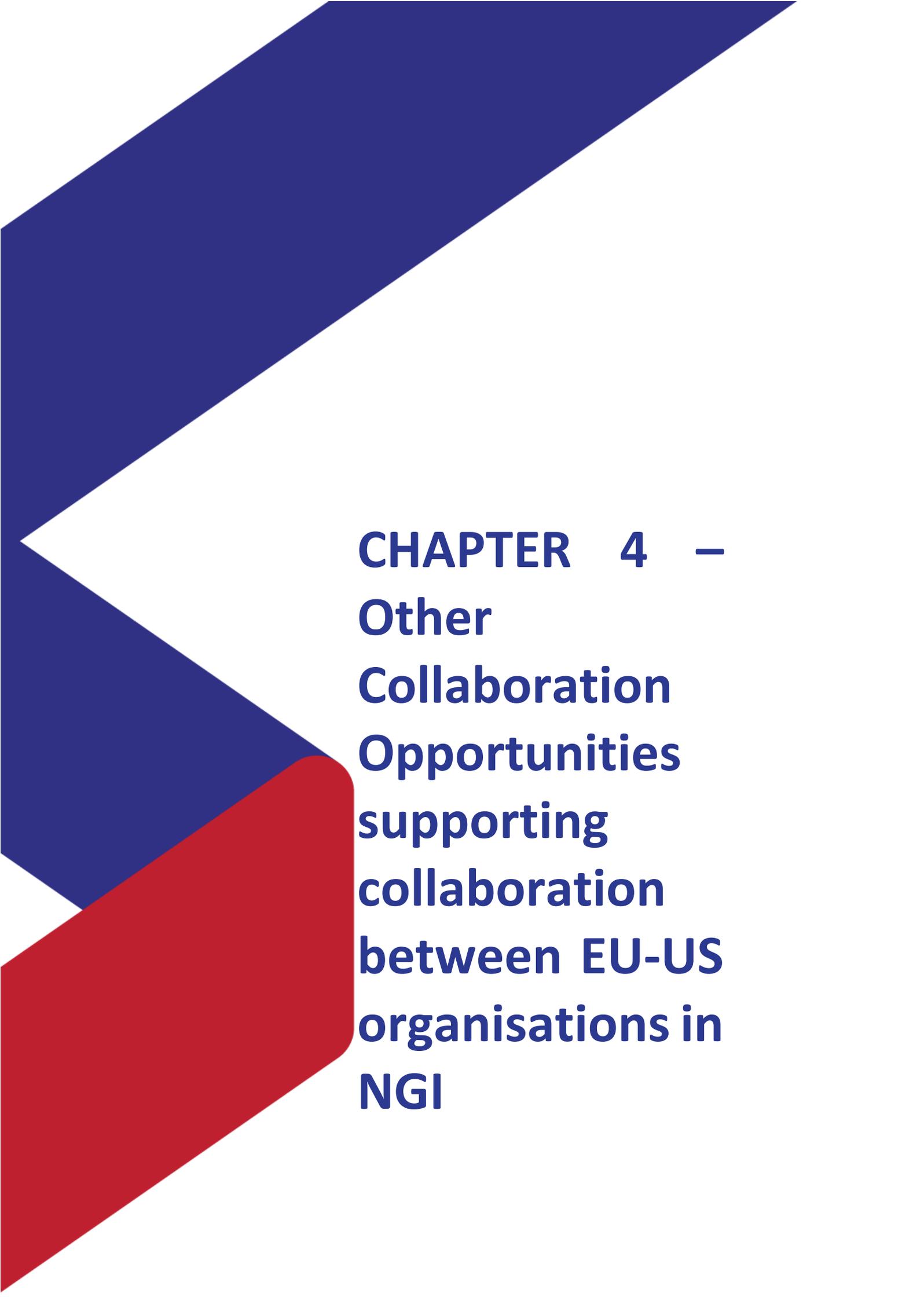
Opportunity Number	Opportunity Title	Agency	Deadline	Budget
NAP-AX-18-003	Leading Edge Acceleration Projects (LEAP) in Health Information Technology	HHS-OS-ONC	09/30/2023	\$1,000,000

Future Architectures

Opportunity Number	Opportunity Title	Agency	Deadline	Budget
W911NF-17-S-0002	Army Research Office Broad Agency Announcement for Fundamental Research	DOD-AMC	03/31/2022	N/A

²⁰ Open only to EU participants from Germany

²¹ Open only to EU participants from Germany, France, Spain and Israel and Japan

The page features a decorative graphic on the left side consisting of overlapping geometric shapes in dark blue and red. The top part is a dark blue triangle pointing downwards. Below it is another dark blue shape, and at the bottom is a red shape with a rounded top-right corner. The text is positioned to the right of these shapes.

**CHAPTER 4 –
Other
Collaboration
Opportunities
supporting
collaboration
between EU-US
organisations in
NGI**

Overview

A number of EU funded initiatives, funded by H2020, have been launched that aim on supporting innovation in the NGI sector, which are open to US participants as well. In some US participants can be funded or join as supported organisations.

H2020 NGI_Trust²²

NGI TRUST supports the development of a human-centric Internet by developing a stronger European ecosystem of researchers, innovators and technology developers in the field of privacy and trust enhancing technologies.

Three types of third-party projects will be awarded funding:

- Type 1 (viability): up to € 100,000 from NGI_Trust, no matching funds required. The objective is to explore and assess the technical feasibility and/or commercial potential of a breakthrough innovation that aims at enhancing privacy and trust for the NGI. Activities can include conceptual development, risk assessment, market study or intellectual property management of a new technology or service, or a new application of existing technologies.
- Type 2 (execution): up to €180,000 from NGI_Trust and matching funds of up to €90,000 (2/3 – 1/3 model). The objective is to fund R&D or technology development projects underpinned by a strategic plan and feasibility assessment (which can be, but need not be, developed through a Type 1 project funded by NGI_Trust).
- Type 3 (transition to commercialisation): up to €200,000 from NGI_Trust and the equivalent in matching funds (50/50). These projects should pursue the commercialisation of a privacy and trust enhancing innovation for the NGI (which can be, but need not be, developed through a Type 2 project funded by NGI_Trust).

Funding: US participants cannot be funded by this initiative, however they can join EU consortiums.

H2020 NGI Zero

NGI Zero is a idea-driven coalition of not-for-profit organisations from across Europe. It was set up to provide the Next Generation Internet initiative with an agile, effective and low-threshold funding mechanism. With funding from the European Commission, NGI Zero provides grants to

²² https://www.ngi.eu/opencalls/ngi_trust-open-call

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

individual researchers and developers as well as small teams to work on important new ideas and technologies that contribute to the establishment of the Next Generation Internet.

NGI Zero will launch two different calls:

- NGI Zero PET23: Funding available: project proposals between 5.000 and 50.000 EUR – with the potential to scale them up if there is proven
- NGI Zero Discovery24: Funding available: project proposals between 5.000 and 50.000 EUR – with the potential to scale them up if there is proven potential.

Funding: US can be supported however priority is given to EU participants

H2020 Ledger²⁵

LEDGER, is a EU funded project, that empowers people to solve problems using decentralised technologies such as blockchain, peer to peer or distributed ledger technologies.

LEDGER offers to the selected projects:

- Up to €200.000 equity free
- A venture builder programme for up to 12 months with business mentors, camps, technological vouchers, training and demo days.
- An expert researcher in residence to support the selected teams along the full programme
- Access to market and support to raise further investment for the best projects in class

Funding: US participants cannot be funded by this initiative; however they can join EU consortiums.

H2020 NGI Explorers²⁶

The **NGI Explorers Program** sponsors immersive missions to the United States for Top European Internet researchers and innovators, providing them with the skills, the network and the resources to accelerate their ambitious ideas. The program seeks to empower these change-makers to position **Europe into the powerhouse of the Next Generation Internet.**

²³ <https://nlnet.nl/PET/>

²⁴ <https://nlnet.nl/discovery/>

²⁵ <https://www.ngi.eu/opencalls/ledger/>

²⁶ <https://explorers.ngi.eu/>

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NGI Explorers Program goal is to launch Europe's best minds into a transformative journey to catalyze the success of their ambitious ideas fuelled by disruptive technology. Activities of this program are:

- 3 or 6-month experience in an American organization partnering the program (US Exchange Node) that will integrate the Explorer in their team and will support the co-creation phase
- 1+ Million EUR to support 40+ Explorers throughout 3 years
- 100% Sponsored. Financial support for travel and subsistence will be provided through grants supported by the European Commission through the Next Generation Internet initiative
- Training sessions and mentor feedback will be available to articulate and spur the ideas in the most efficient way
- Europe's most powerful network of Internet leaders. Connect with the rest of Explorers of the program to share experiences, collaborate and even create new partnerships
- Opportunities for public and private funding schemes and business development will be supported for the most promising ideas
- Awards to the best Explorers at the end of each batch

Funding: The current program supports only EU participants.

Platforms, Programmes and Initiatives supporting Joint NGI experiments

Overview

There are already multiple research infrastructures and efforts that have been closely interacting and collaborating between Europe and the US. These efforts are expected to continue to evolve the research infrastructure in support of the new research agendas. It is critical to mention that these initiatives do not provide funding to organisations, but offer their infrastructures for testing.

H2020 FED4FIRE+²⁷

FED4FIRE+ is a project under the European union's programme horizon 2020, offering the largest federation worldwide of next generation internet (NGI) testbeds, which provide open, accessible and reliable facilities supporting a wide variety of different research and innovation communities and initiatives in Europe, including the 5G PPP projects and initiatives.

It started in January 2017 and will run for 60 months, until the end of September 2021. The FED4FIRE+ project is the successor of the FED4FIRE project which established a close cooperation with GENI.

US Ignite²⁸

US Ignite is an initiative that seeks to promote US leadership in the development and deployment of next-generation gigabit applications with the potential for significant societal impact. US Ignite aims to break this deadlock by providing incentives for imagining, prototyping, and developing gigabit applications that address national priorities, and by leveraging and extending this network testbed across US college/university campuses and cities.

Some of the US Ignite programmes include:

- Smart Gigabit Communities is a network of more than two dozen communities developing a catalogue of applications and services to address smart city and IoT challenges;
- Platforms for Advanced Wireless Research (PAWR) is creating city-scale wireless testbeds in a public-private partnership designed to sustain US leadership in the industry and boost economic competitiveness for decades to come;

²⁷ <https://www.fed4fire.eu/>

²⁸ <https://www.us-ignite.org/>

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

- Smart Cities Data Exchange, a blueprint for the secure and interoperable exchange of data beyond city operational boundaries. The programme will produce a data-sharing framework, recommended data formats and protocols, security and privacy requirements, and common APIs.

GEANT- ESnet, Internet2, Indiana University and the NASA Integrated Services Network (NISN)²⁹

There is a long-standing relationship between pan-European research and education networking and North American research networks, which has led to diverse transatlantic links being established in reciprocal arrangements between the two continents.

In this collaborative environment, GÉANT provides a 100Gbps link to New York. Links provided by GÉANT's North American partners ensure that there is abundant capacity and no single points of failure, enabling research and education traffic between the two regions to flow seamlessly.

The connections to North America are key in enabling research collaboration on intercontinental projects, and are particularly significant for the Large Hadron Collider (LHC) at CERN, a number of the data-processing centres of which are located in North America.

Where projects and researchers need to exchange large amounts of data with their project counterparts in North America or have high-performance requirements, GÉANT Plus point-to-point circuits can be provisioned to the CANARIE, Internet2 and ESnet networks.

In the USA the key national organisations are ESnet, Internet2, Indiana University and the NASA Integrated Services Network (NISN), each of which caters for a subset of the US research and education community.

OneLab³⁰

Through OneLab, it is possible to test software systems in any of the following networked communication environments: IoT networks with mobility and sensing capabilities; ad-hoc wireless and wireless broadband access networks; a global, public, fixed-line Internet; and Cloud and SDN networks. Our platforms offer both wireless and fixed-line emulated environments and reproducibility of experimentation. OneLab is a consortium consisting of five different higher education and research institutions. These institutions are devoted to making testbeds used for

²⁹ <https://www.geant.org/>

³⁰ <https://onelab.eu/>

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

network computer communications available to enterprises, scientific researchers, and educators.

CloudLab³¹

CloudLab provides researchers with control and visibility all the way down to the bare metal. Provisioning an entire cloud inside of CloudLab takes only minutes. Most CloudLab resources provide hard isolation from other users, so it can support hundreds of simultaneous "slices", with each getting an artefact-free environment suitable for scientific experimentation with new cloud architectures. Run standard cloud software stacks such as OpenStack and Hadoop. CloudLab is built from the software technologies that make up Emulab and parts of GENI, so it provides a familiar, consistent interface for researchers.

TIPOFF³²

In order to leverage, advance and strengthen its investments in mid-scale computing research infrastructure, the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) will support the work of Tomorrow's Internet Project Office (TIPOFF). Working closely with the U.S. academic and industrial computer networking research community, TIPOFF will provide leadership and administrative oversight in developing, deploying and operating innovative mid-scale computing research infrastructure to meet evolving research community needs and align with emerging national priorities.

To initiate this activity, TIPOFF will assume responsibility for the operation and future evolution of the Global Environment for Network Innovations (GENI) platform. TIPOFF will then lead the research community in developing an expanded and enriched experimental platform ("Platform") that leverages the existing GENI infrastructure to support exploration of robust new networking and distributed systems architectures, services and applications. This Platform will serve as a virtual laboratory for research and education, with the goal of advancing understanding of computing and communication systems and sustaining U.S. technology leadership and competitiveness in information technology (IT) and Internet-based services.

³¹ <https://www.cloudlab.us/>

³²

https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505384&WT.mc_id=USNSF_180&WT.mc_ev=click

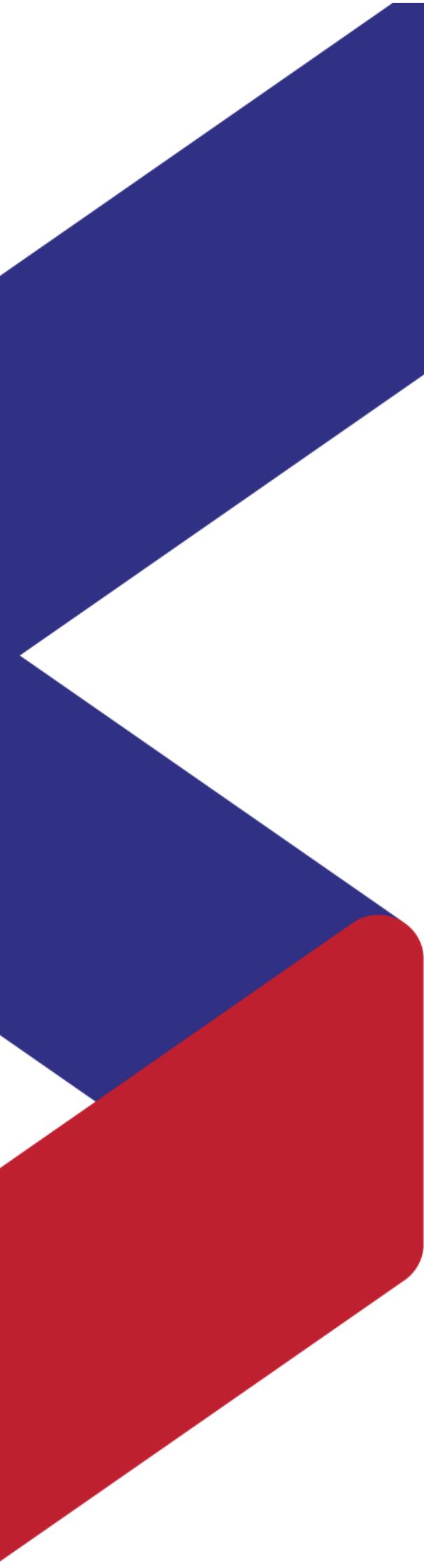
D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

PlanetLab³³

Planetlab Europe is the European arm of the global PlanetLab system, the world's largest research networking facility, which gives experimenters access to Internet-connected Linux virtual machines on over 1000 networked servers located in the United States, Europe, Asia, and elsewhere. Researchers use PLE for experiments on overlays, distributed systems, peer-to-peer systems, content distribution networks, network security, and network measurements, among many other topics.

Organisations can join PLE if they provide two physical servers at their premises, which are directly connected to the internet (no firewalls) and are put under the control of the PLE management software. Once you are a member of PLE, you can request virtual machines on any of the PLE physical servers. These virtual machines will always be directly connected to the public Internet. As an experimenter, you have full control over these virtual machines. The PlanetLab Europe Consortium has over 140 signed member institutions: mostly universities and industrial research laboratories, each of which hosts two servers that it makes available to the global system. These institutions are home to 937 experimenters. On a typical recent day, 244 were connected to ongoing experiments.

³³ <https://www.planet-lab.org/>

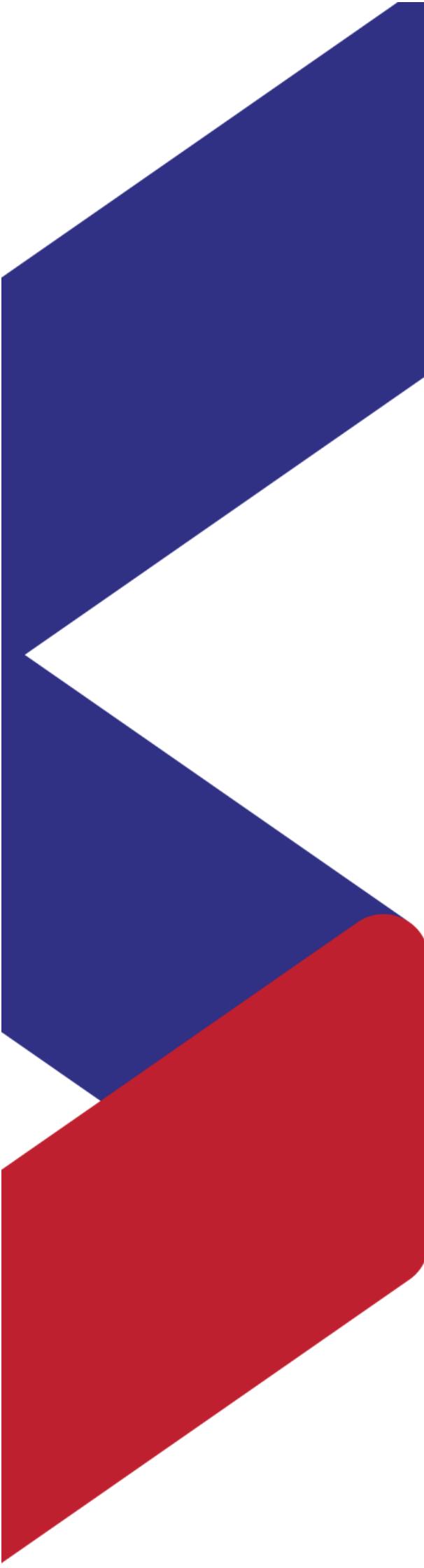


CHAPTER 5 - Conclusions

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

Information provided in this document aims at drawing a sufficiently representative panorama of what is currently being funded or opened for collaboration both in the US and the EU in the NGI priority areas that are object of Think NEXUS. However, given the fast-changing character of the funding and access opportunities panorama, the utility of this tool lies especially in its capacity to describe the higher priority-setting landscape of relevant funding institutions, and to orient the participants amongst the wide set of opportunities and initiatives that are relevant for our ICT priority areas. Information, links, and references to specific calls and initiatives shall be intended also as a gateway for future opportunities.

Any relevant updated information on upcoming opportunities or orientations will be made available through the next iterations of the current deliverable. At this purpose, the Think NEXUS team also welcomes any external contribution, suggestion or comment on the information currently available, with a view to provide a more complete photography of the present and future opportunities' landscape.



Annexes

ANNEX A: List of United States research and development agencies

Independent agencies

- [National Science Foundation](#) (NSF)
- [National Aeronautics and Space Administration](#) (NASA)
- [Environmental Protection Agency](#) Office of Research and Development
- [Intelligence Advanced Research Projects Activity](#) (IARPA)
- [Smithsonian Institution research centers and programs](#)

Department of Agriculture

- [Agricultural Research Service](#) (ARS)
- [National Institute of Food and Agriculture](#) (NIFA)
- [Economic Research Service](#) (ERS)
- [United States Forest Service Research and Development](#) (R&D)

Department of Commerce

- [National Institute of Standards and Technology](#) (NIST)
- [National Oceanic and Atmospheric Administration](#) (NOAA)

Department of Defense

- [Defense Advanced Research Projects Agency](#) (DARPA)
- [Uniformed Services University of the Health Sciences](#) (USU)

Department of the Air Force

- [Air Force Research Laboratory](#) (AFRL)
- [Air Force Life Cycle Management Center](#) (AFLCMC)
- [Air Force Nuclear Weapons Center](#) (NWC)
- [Air Force Institute of Technology](#) (AFIT)
- [Department of the Army](#)[
- [United States Army Materiel Command](#) (AMC)
- [Army Research, Development and Engineering Command](#) (RDECOM)
- [Army Research Laboratory](#) (ARL)
- [Army Armament Research, Development and Engineering Center](#) (ARDEC)
- [Engineer Research and Development Center](#) (ERDC)
- [U.S. Army Test and Evaluation Command](#) (ATEC)

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

[Army Medical Research and Materiel Command \(USAMRMC\)](#)

Department of the Navy

[Marine Corps Combat Development Command \(MCCDC\)](#)

[United States Marine Corps Warfighting Laboratory \(MCWL\)](#)

[Office of Naval Research \(ONR\)](#)

[Naval Research Laboratory \(NRL\)](#)

[Bureau of Medicine and Surgery \(BUMED\)](#)

[Naval Medical Research Center \(NMRC\)](#)

[Naval Air Warfare Center \(NASC\)](#)

[Naval Surface Warfare Center \(NSWC\)](#)

[Naval Undersea Warfare Center \(NUWC\)](#)

[Naval Command, Control and Ocean Surveillance Warfare Center \(NCCOSC\)](#)

[Naval Postgraduate School \(NPS\)](#)

[Naval Air Weapons Station China Lake \(\(NAWSCL\)\)](#)

Department of Education

[Institute of Education Sciences \(IES\)](#)

[National Institute on Disability and Rehabilitation Research \(NIDRR\)](#)

Department of Energy

[Office of Science \(DOE SC\)](#)

[Advanced Research Projects Agency-Energy \(ARPA-E\)](#)

[National Laboratories](#)

Department of Health and Human Services

[National Institutes of Health \(NIH\)](#)

[National Institute for Occupational Safety and Health \(NIOSH\)](#)

[Food and Drug Administration science and research programs](#)

[Agency for Healthcare Research and Quality \(AHRQ\)](#)

[Biomedical Advanced Research and Development Authority \(BARDA\)](#)

Department of Homeland Security

[Directorate for Science and Technology \(S&T\)](#)

[Coast Guard Research & Development Center \(CG RDC\)](#)

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

Department of the Interior

[United States Geological Survey](#) (USGS)

Department of Justice

[National Institute of Justice](#) (NIJ)

Department of Transportation

[Research and Innovative Technology Administration](#)

[Federal Aviation Administration](#) Research, Engineering, and Development

[Federal Highway Administration](#) Research and Technology

Veterans Affairs

[Veterans Health Administration Office of Research and Development](#) (ORD)

Multi-agency initiatives

[Office of Science and Technology Policy](#) (OSTP)

[U.S. Global Change Research Program](#) (USGCRP)

[Networking and Information Technology Research and Development](#) Program (NITRD)

[National Nanotechnology Initiative](#) (NNI)

ANNEX B: Funded ICE-T NGI Projects

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836870	Towards a Secure and Flexible Personal Data Platform on the Edge	Nadeem, Tamer	Virginia Commonwealth University	RI	Imperial College London, UK (H. Haddadi)	<p>The significant growth and penetration of smart and Internet of Things (IoT) devices has driven a large number of new applications and caused a surge in sensitive and personal data generation. Unfortunately, our ability to protect that information is limited, and concerns over privacy, trust, and security are becoming increasingly important to different stakeholders. Emerging IoT applications also send and receive data in various ways, and each might require different performance levels of reliability, loss, and latency. To cope with these various traffic characteristics and requirements, it is now necessary to have greater visibility and control over the traffic generated from smart and IoT devices in order to guarantee a high quality of experience to users.</p> <p>The aim of this project is to design and develop the ExtremeDataHub platform, an open, flexible, and programmable networked edge device that controls and manages access to our sensitive and personal data. This platform will integrate the European collaborators' SMILE and Databox platforms. The project will identify new services and applications that can effectively leverage the combined platform, potentially including applications in the smart home, smart healthcare, and smart cities domains. This project initiates a new research collaboration between investigators at Virginia Commonwealth University and Imperial College London, UK.</p>	September 30, 2019

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836881	Towards End-to-End Resource Optimization for Time-Critical Computing Using Reinforcement Learning and Program Analysis	Wang, Liqiang	University of Central Florida	RI	Univ. of Amsterdam, NL (Z. Zhao)	<p>Data-intensive, time-critical applications generate an enormous amount of data that needs to be analyzed quickly. Resource optimization for time-critical computing faces many challenges including high demand on programming skills, difficulty in determining suitable parallelism degree, and great complexity in making resource allocation considering multiple optimization targets. To help in designing more efficient applications, this project investigates end-to-end resource optimization for time-critical computing using reinforcement learning and program analysis techniques. The approach integrates both resource request optimization by program analysis, and resource scheduling by reinforcement learning with consideration of time-critical features. The project will enhance our understanding of the challenges involved in addressing problem demand with reinforcement learning and semantics-aware program analysis.</p> <p>This project seeks to make the following novel contributions: (1) designing a semantics-aware optimization for data-intensive applications including two stages. The offline stage uses static program analysis for analyzing big data system primitives and user-defined functions to generate a parameterized data framework and fix partial performance flaws by rule-based and cost-based models. The online stage uses dynamic program analysis that instantiates a parameterized framework based on execution metrics to repair performance problems; (2) exploring the trade-off between enlarging parallelism degree and minimizing the amount of data shuffling across computing nodes; and (3) designing a reinforcement learning based model for resource allocation.</p> <p>This project initiates a research collaboration between the University of Central Florida and the University of Amsterdam, Netherlands.</p>	September 30, 2019

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836906	A Knowledge-Defined Platform for Real-Time Management of Transmissions and Computations at Network Edge	Esposito, Flavio	Saint Louis University	RI	Univ. of Padova, IT (M. Rossi)	<p>Due to the highly dynamic nature of the communications and computations in 5th Generation (5G) cellular communications systems, new services will require real-time management to achieve extremely low latencies in communication and computation. To advance the state of the art, this project explores resource management algorithms that borrow ideas from the use of statistical learning, estimation, and data-driven techniques from high frequency financial trading systems.</p> <p>The project will design and prototype a platform based on low-cost programmable switches that will allow researchers to experiment with novel statistical learning-based algorithmic solutions for real-time management of edge networks. The platform will have two main research objectives: 1) to explore learning based solutions for real time management of virtual paths and virtual switches; and 2) to investigate real-time management of core 5G computation and network resources, and to orchestrate edge computing processing at the network edge. By leveraging learning theory, the project will define new abstractions and interfaces that will allow network operators to coordinate computation and traffic allocation decisions at the network edge. This project will develop novel approaches towards understanding the development of algorithmic aspects of prediction of network parameters and computational needs. This project will initiate a new research collaboration between investigators at Saint Louis University and the University of Padova, Italy.</p>	September 30, 2020

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836772	Accelerating NFV Service Function Chain Processing at Scale	Zhang, Zhi-Li	University of Minnesota-Twin Cities	RC	Universidad Carlos III de Madrid, ES (A. Azcorra)	<p>Network Function Virtualization (NFV), coupled with Software Defined Networking (SDN), promises to revolutionize networking. Operators can create, update or scale out/in (virtualized) network functions (vNFs) on demand, construct a sequence of vNFs to form a service function chain (SFC) and steer traffic through it to meet various policy and service requirements. In emerging 5th Generation (5G) cellular networking technologies, NFV will be a key enabling technology for support of dynamic network slicing and diverse services ranging from enhanced mobile broadband to massive machine type communications and ultra-reliable low latency communications.</p> <p>This project advances a novel distributed parallelization framework, dubbed HydraNF, for accelerating NFV service function chain processing at scale. HydraNF will be designed to simultaneously tackle the performance and auto-scaling challenges in large scale deployment of NFV by taking full advantage of a cluster of multi-core servers for dynamic and elastic scale-out. The proposed project considers the problem of scaling and accelerating NFV service chains leveraging parallelism across multi-cores on a server as well as across multiple servers in a cluster. The project is framed within the context of 5G cellular service and the intended cloud radio access network, mobile edge clouds, and packet cores that are envisioned for future 5G networks. The project team will design a framework, called HydraNF, and study 1) models for VNF behaviors and SFC specification, 2) a controller for SFC decomposition, graph construction and mapping, placement and rule generation, 3) a data plane engine, and 4) the implementation, evaluation and integration within the European collaborator's 5G testbed. This is a collaborative research project with the University of Minnesota and the Universidad Carlos III de Madrid (UC3M) and IMDEA Networks Institute in Madrid, Spain.</p>	September 30, 2021

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836889	Optimizing Internet video through support from the network edge	Rao, Sanjay	Purdue University	RC	Politecnico di Torino, IT (M. Mellia)	<p>Despite many advances in recent years, the performance of Internet video often falls below user expectations. The issues are likely to be exacerbated with the emergence of bandwidth-intensive 4K video, and more recently, interactive video such as 360-degree video which is latency sensitive as well. This project investigates new opportunities opened by recent Internet Service Provider (ISP) interest in deploying value-added services at the edge of the provider's network. Such edge-based services can aid video streaming applications through lower latencies, higher throughput, and visibility into network performance bottlenecks.</p> <p>This project will explore novel services that may be deployed at the ISP edge, which can significantly improve the performance of video streaming solutions, as well as develop new approaches to video streaming that can leverage these services. The research will systematically characterize these benefits, develop new mechanisms, and consider practical deployment concerns. Specific research contributions will include:</p> <ol style="list-style-type: none"> 1. Techniques for proactively estimating the rate at which video applications can transmit informed by explicit information collected at the network edge in real-time. The approach includes edge-based monitoring and estimation to ensure scalability, and extensive use of network data to refine and validate our algorithms. 2. Redesigning state-of-the-art available bit rate (ABR) approaches to exploit proactive rate estimation. The project team will also explore a new design point where the ABR algorithm itself is run on an edge server rather than the client. 3. Measurement-based characterization studies of interactive video streaming to investigate issues around edge support for interactive video. Specifically, the project will consider the interplay between the encoding scheme used for 360-degree video, user interactivity models, and the edge cache hit rate. This project will extend an ongoing research collaboration between Purdue University and the Politecnico di Torino, Italy. 	September 30, 2021

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836921	Multi-Domain Multi-Broker Elastic Optical Networks with Cognitive Functionalities	Yoo, S.J.Ben	University of California-Davis	RC	Universitat Politecnica de Catalunya, ES (L. Velasco), and CNIT, IT (N. Sambo)	<p>The proposed project seeks an innovative approach to the design, control and management of next generation Internet core networks. A new inter-domain networking paradigm is considered, where broker agents compete freely with each other to provide attractive inter-networking services to Autonomous Systems (ASes), while ASes also choose broker services suitable for their inter-networking needs.</p> <p>The project develops a market-driven multi-broker-assisted multi-domain framework that can coordinate -- in a distributed, incentivized manner - while providing complete autonomy and freedom to both brokers and ASes. Through market-driven incentives and competitions, the brokers and the ASes will pursue mutually beneficial services, which will in turn continuously spur innovative solutions and services. The new inter-domain networking architecture with multiple brokers will facilitate automated, Quality-of-Service aware, and impairment-responsive services. The project leverages cognitive functionalities based on machine learning to optimize end-to-end service provisioning.</p> <p>The project seeks to architect, simulate, prototype, and experiment to improve system (a) scalability, (b) end-to-end performance, (c) robustness and adaptability, and (d) manageability and coordination. The project will leverage novel and emerging cognitive techniques for dynamic traffic prediction and adaptive provisioning, quality of transmission estimation and fault detection across multiple domains. This project extends a research collaboration between the University of California, David, the Universitat Politecnica de Catalunya (UPC), Spain, and Consorzio Nazionale and Interuniversitario per le Telecomunicazioni (CNIT), Italy.</p>	September 30, 2021

D2.1 Overview on NGI access opportunities from EU and US (1st iteration)

NSF Id / URL	Name	Coordinator name	Entity	Class	EU counterpart	Abstract	End date
1836752	Horizontal Resource Management in Distributed Edge Clouds	Shenoy, Prashant	University of Massachusetts Amherst	RC	Umea University, SE (E. Elmroth)	<p>The latency, bandwidth, and mobility needs of the next-generation Internet of Things (IoT), smart wearables, and augmented reality applications and devices makes traditional cloud platforms ill-suited to their needs. Edge cloud computing, where computational and storage resources are deployed at the edge of the network and offered through a cloud model, has emerged as a promising alternative to address the needs of these emerging applications.</p> <p>This project examines network-aware horizontal resource management in edge clouds and will focus on three synergistic topics. First, the team will design network-aware orchestration algorithms for edge clouds, including new edge cloud migration technique that combines multi-path transport and virtual machine migration to provide network-transparent low-latency access in the face of user and device mobility. Second, the team will study network-aware placement in distributed edge clouds that incorporates the application's latency and bandwidth needs while being aware of interacting distributed edge and virtualized network functions. Third, the project research will address the fundamental issue of the control plane architecture for massively distributed edge clouds and will study both decentralized and hierarchical control plane architectures for future edge clouds. The project team will study the tradeoffs and benefits of both architectures through the lens of orchestration algorithms such as geo-elastic scaling algorithms as well as edge migration and network-aware placement. Our research will also involve prototype implementation and large-scale experimentation on multiple experimental research testbeds.</p> <p>This project will extend a collaboration between the University of Massachusetts, Amherst, and Umea University, Sweden.</p>	September 30, 2021

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1836725	Performance Evaluation of Advanced Wireless Network Edge Infrastructure - Network Simulation & Test Beds	Roy, Sumit	Univ. of Washington	RC	CTTC Barcelona, ES (J. Mangues)	<p>The open source network simulation (ns-3) tool is used widely by researchers to evaluate the performance of computer networks. Over the past decade, user demand for new ns-3 capabilities has centered on simulating rapidly emerging wireless networking technologies including Wireless Fidelity (WiFi) and Long Term Evolution (LTE) cellular systems. New capabilities are essential for exploration of emerging 5th Generation (5G) cellular network technologies.</p> <p>This project seeks to 1) extend the core wireless capabilities of ns-3, positioning the simulator as the research tool of choice for 5G wireless network simulations; 2) improve usability and create new educational/training materials; and 3) better align ns-3 with experiments on wireless network test-beds. The latter project goal is expected to contribute to recently announced National Science Foundation-funded Platforms for Advanced Wireless Research (PAWR) city-scale advanced wireless infrastructure testbeds. New wireless technology coexistence scenarios for heterogeneous networks as well as the ongoing challenge of scaling due to network densification are main research thrusts for this effort. In addition, a key project goal is improving usability and development of new ns-3 educational material to ease adoption of these new modules (and ns-3 broadly) by the next generation of users. The project extends an existing collaboration between investigators at the University of Washington and the Centre Technologic Telecomunicacions Catalunya (CTTC Barcelona).</p>	September 30, 2021
1836741	Multi-Element Mobile Visible Light Communication for Smart Cities	Yuksel, Murat	University of Central Florida	RI	Northumbria University, UK (F. Ghassemlooy)	<p>Prospective demands of next-generation wireless networks are ambitious and are projected to require cellular networks that support 1000 times higher data rates and 10 times lower round-trip latency. Visible light communication (VLC) is a promising technology to address the spectrum deficit problem in the legacy radio frequency bands. VLC technology can offer high speed data rates that can meet the exponential increase of wireless communications devices due to large modulation bandwidth of the Light Emitting Diodes (LEDs). Further, it can use the existing lighting infrastructure which may contain large number of LEDs for illumination, and therefore, it is cheaper than setting up new RF base stations.</p>	September 30, 2019

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1836880	Software Hardware Efficient Extensible Protocols (SHEEP)	Leeser, Miriam	Northeastern University	RI	Trinity College Dublin, IE (L. da Silva), and Maynooth Univ., IE (R. Farrell)	<p>Wireless devices have become ubiquitous. New devices are coming on line all the time, and protocols for these devices continue to evolve. This research will investigate a flexible platform that can support a variety of different devices and protocols for both high data rate wireless networking and low power, low bandwidth devices that are part of the Internet of Things (IoT). This represents a shift from the rigid networks of previous generations, towards greater versatility and adaptability. The resulting research will enable new devices to integrate with existing systems more easily, and has the potential to change the way wireless networking is supported worldwide. Essential enablers for this versatility include: more flexible radio access technologies and dynamic management of resources at the edge of wireless networks.</p> <p>This research represents a new collaboration between researchers in the US and in Ireland to pursue a common strategy to investigate physical layer wireless protocols. Prototyping of new protocols as well as developing an agile approach to support existing protocols will be investigated. The platform includes both hardware and software to enable prototyping and experimentation across a range of protocols especially at the physical layer. The base platform will use state-of-the-art hardware that can easily be upgraded as new hardware becomes available. In addition, supporting software packages will ease the use of the base hardware for researchers with wireless and communications backgrounds. Hardware/software implementations will allow the support of a range of wireless applications at different performance points. Run-time reconfiguration of hardware will enable rapidly adapting to the existing environment. Flexibility and reconfigurability will ensure that real time implementations of future protocols can be experimented with.</p> <p>Shared test-beds for wireless networking research will be developed between Ireland and the US. The test-beds will be flexible and reconfigurable and thus support novel designs in wireless protocols and edge computing. The test-beds, which include both hardware and software, will be used for both research and educational purposes. Educational materials that can be used in both the US and Ireland as well as worldwide will be developed and shared widely. Material developed in this project will be shared with European Horizon 2020</p>	September 30, 2019
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						researchers, as well as through the internet, conferences, and open source software. The resulting platform will enable flexible, adaptable and scalable wireless networking.	

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1836909	Millimeter Wave Communications and Edge Computing for Next Generation Tetherless Mobile Virtual Reality	Chakareski, Jacob	University of Alabama Tuscaloosa	RC	Aalborg University, DK (P. Popovski)	<p>Virtual and augmented reality (VR/AR) technologies hold tremendous potential to advance our society, having impact on quality of life, environmental and energy conservation, and the world economy. However, two main challenges stand in the way of realizing this vision. These applications are hyper-data-intensive and require ultra-low latency, neither of which can be met by current and upcoming conventional networking methods and systems. These presently limit VR/AR applications to an offline operation, synthetic content, high-end wired equipment, and gaming/entertainment settings. This project envision a novel system at the intersection of millimeter-wave communication (mmWave) and edge computing that aims to overcome these challenges to bring us closer to the next generation tetherless VR/AR societal applications. The project will make notable contributions to the emerging area of networked VR/AR application systems and communications, leading to advances in numerous socially relevant applications, e.g., search and rescue, and disaster response. It will also facilitate fundamental research in the general application area of high-volume high-speed/low-latency data transfer in emerging settings. Beyond the direct scientific and technology impacts and their broader effects on society, educational, outreach, international collaboration, and scientific leadership activities will be pursued as an integral part of the project.</p> <p>Overcoming the broad performance gap between present and upcoming networked systems capabilities and anticipated requirements of next generation applications will require novel holistic approaches to capture, coding, networking, and reconstruction/navigation of VR/AR data. Towards this objective, the project will investigate a futuristic 5G heterogeneous cellular network system that integrates radio frequency (RF) and millimeter wave communication, and viewport-adaptive space-time scalable VR signal tiling, for multi-path streaming of 360-degree tetherless mobile VR applications. In this setting, the project will pursue the following synergistic investigations: (1) Navigation-aware scalable VR signal tiling to enable interactive streaming of only the data truly needed by the user during navigation; (2) Deep machine learning for user navigation prediction to assist the envisioned resource allocation methods. (3) Space-time scalable rateless code construction for effective source-channel VR signal representation to protect against prospective</p>	September 30, 2021
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						transmission errors. (4) Dynamic rate-distortion optimized strategies for hybrid RF-mmWave multi-path VR streaming and analysis of the foundations of the interdependencies between the VR signal tiling design and the characteristics of the two network paths. (5) Analysis of the fundamental trade-offs between edge computing and communication that arise here and pursuit of optimization methods that will leverage them to maximize the system efficiency. (6) Graph-theoretic analysis of the problem of dynamic mmWave transmitter to VR user assignment. (7) Network slicing for parallel operation with other applications. Extensive integration and experimentation will be carried out to assess, validate, and prototype the enabled research advances in practical settings.	
1836901	Orchestration and Reconfiguration Control Architecture for Software Defined Radios	Seskar, Ivan	Rutgers University	RC	ORCA Consortium - IMEC/Ghent Univ., BE (I. Moerman)	Wireless networks have grown enormously during the past 30 years, impacting numerous industries, including telecommunications, emergency response, and entertainment. Wireless advances could radically change several industries in the near future, including manufacturing, the automotive industry, healthcare, assisted living, public events, home automation, and utilities. However, each industry has different, often opposing, wireless demands. Manufacturing often requires a low data rate, ultra-low latency closed loop communication between machines, while emerging augmented reality interactions between people have much larger large data volumes, but can tolerate higher latency. Today, applications and services are constrained to a handful of wireless technologies, such as 4G, Wi-Fi and Bluetooth, because developing and modifying new radio protocols requires many man-years. The challenge for the wireless community is to enable wireless networks the same flexibility as regular computing devices, such as laptops or phones, where the same hardware supports a near infinite variety of behaviors realized in software. Flexibility at the wireless level has lagged as radios have been implemented as fixed-function circuits, in order to minimize marginal cost, energy use, and network latency. Enabling such flexibility would open opportunities for new wireless functions in diverse application domains.	September 30, 2021

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1836802	<p>Towards Highly Reliable Low Latency Broadband (HRLB) Communications over Wireless Heterogeneous Networks</p>	<p>Walid Saad</p>	<p>Virginia Polytechnic Institute</p>	<p>RC</p>	<p>Aalborg University, DK, (P. Popovski), and University of Oulu, FI (M. Bennis)</p>	<p>Driven by the emergence of the Internet of Things (IoT), next-generation wireless networks will witness a radical departure from the rate-centric designs of yesteryear, toward an ultra-reliable low latency communication (URLLC) paradigm. While current URLLC research has been primarily guided by the need to deliver very short IoT sensor packets, the advent of new IoT applications such as the tactile Internet, is rapidly disrupting this original URLLC premise. Such emerging IoT applications can be classified as highly reliable, low latency broadband (HRLB) services as they require joint uplink and downlink transmission of variable-length packets, while guaranteeing high reliability, low latency, and broadband data rates. The goal of this research is, thus, to initiate one of the first concerted US-EU efforts focused on developing the fundamental science needed to seamlessly integrate HRLB services into tomorrow's cellular networks. In particular, the proposed research will provide novel analytical tools to facilitate the modeling, design, analysis, and optimization of wireless networks that can cater to HRLB services. This, in turn, will enable a broad range of novel wireless services with significant societal impacts, ranging from haptics to autonomous systems. The research is further coupled with an extensive US-European Union (EU) educational plan that includes new curriculum development and extensive training of US and EU students and researchers on interdisciplinary research at the boundary of wireless networking, economics, and network optimization. K-12 outreach events will be organized to involve minority students in hands-on URLLC IoT activities thus attracting them to Science, Technology, Engineering, Mathematics (STEM) and wireless careers. Broad international dissemination will be ensured via joint US-EU events such as tutorials and workshops.</p> <p>The proposed research will introduce a holistic framework for expediting the introduction of emerging HRLB services over wireless networks. Through a collaboration between the US, Denmark, and Finland, this research will yield a number of transformative outcomes that include: 1) Rigorous reliability metrics that leverage novel frameworks from statistics and economics to characterize the achievable HRLB quality-of-service, jointly over uplink and downlink, under extreme network conditions, 2) Fundamental characterization of the wireless tradeoffs governing the rate-reliability-latency performance of HRLB</p>	<p>September 30, 2021</p>
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						services, 3) Novel, dynamic orthogonal and non-orthogonal multiple access designs coupled with anticipatory HRLBB handover schemes that enable a seamlessly co-existence of heterogeneous services, 4) Disruptive online algorithms that will enable HRLBB services to optimize their rate-reliability-latency performance by leveraging fog computing functions while effectively managing, in real-time, their communications and computing resources, and 5) Validation using practical experiments.	



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