Intel India Research Fellowship Program 2023-24

intel.®

One Year Fellowship Program

Open to

- Full time **PhD/MD/MS/MTech students** in the penultimate year or final year of thesis submission
- **Post-Doctoral Research Associates** who have submitted their thesis in the preceding year, and have authored or co-authored papers

Intel® Leadership and Excellence in Academic Development (LEAD) Program

The impact of globalisation and keeping up with the fast change of pace has resulted in the need to further the research at higher education institutions in all disciplines. A robust education system and vigorous academic research lead to a healthy, innovative and dynamic economy.

Recognising this need, Intel India strives to nurture innovators through multiple platforms. We recognise that academia plays a pivotal role in nurturing high quality talent and skills, and promote research and development. From the very first days, Intel has fostered and promoted the next generation of technology innovators and leaders, and have endeavoured towards building an ecosystem that supports innovation and entrepreneurship.

The Intel® LEAD Program recognises the pivotal role that academia plays in nurturing high quality talent and skills, and promotes research and development. It is a key part of Intel India's ongoing endeavours with technical colleges and universities to promote the next generation of innovators and leaders to strengthen India's tech ecosystem.

The Intel India Research Fellowship Program, an offering of the Intel® LEAD program, focuses on developing industry-ready manpower through identifying and nurturing exceptional talent from academia for the Indian technology ecosystem, through mentorship, research and internship opportunities for students.

Intel® LEAD Program

- EXECUTIVE CONNECT
- HIGH IMPACT RESEARCH
- KNOWLEDGE AND INNOVATION EXCHANGE
- COLLABORATIVE CLASSROOMS
- TALENT FOR INDIA'S TECH ECOSYSTEM

Intel India Research Fellowship Program

The Intel India Research Fellowship Program is a prestigious and highly competitive program, that awards fellowships to exceptional PhD, Doctorate in Medicine (MD), MS or MTech students and post-doctoral research associates from premier institutes, pursuing cutting edge and high impact research in the fields of Engineering, Medicine, Communication and Technology, and Social Sciences, and the key focus areas identified by Intel Technology India Pvt Ltd.

Key Focus Areas: 2023-24 *For details of each Key Focus Area, click on its title below.*

- Digital Biology Research
- AI for High Performance Code
- AI for Chip Design
- Scientific Machine Learning (SciML): Bringing Together HPC and AI for Sciences
- Security and Privacy in Virtual Computing Environment
- AI for IoT

- Deep Learning and AI Workload Optimisation
- FPGA and Platform Architecture
- SoC Architecture and System Design for Cloud Computing
- Specialised Accelerators and Memory Systems for Future Artificial Intelligence
- Formal Verification

Program Highlights

➢ **A one year fellowship** will be awarded to exceptional students and research associates from prestigious institutions pursuing cutting edge, high impact research in key focus areas identified by Intel Technology India Pvt Ltd.

➢ **A monetary grant** of up to ₹7,50,000 will be awarded to the selected PhD/MD/MS/MTech candidates, and up to ₹11,70,000 for post-doctoral research candidates. The amount will include a monthly stipend, grants for travel within India for the candidate and the research guide, a contingency grant, and an international air fare to attend a Tier 1 conference *(see details on page 5).*

➢ **A senior Intel researcher will be assigned as a 'mentor'**, to develop a deep understanding of the technological issues facing the industry, and to stay at the forefront of solving the most complex technological problems that lie ahead. The Intel mentor, along with the Research Guide, will review the progress of the research every quarter.

➢ **Exposure to Intel's world-class research and state of the art technology**, including an **opportunity for internship** at the research and development centre at Intel India.

➢ **An opportunity to participate in Intel's annual research events**, which would help the candidate in building the right network in pursuance of the research.

Applying for the Grant

Who Can Apply

- Students in their **penultimate or final year of PhD, MD, MS or MTech**; and **Post-Doctoral Research Associates** who have completed their thesis or are in the last 6 months of thesis completion
- Pursuing **Engineering, Medicine, Communication and Technology, Social Sciences**, or other Intel key focus areas
- From **educational institutions of national importance**

Application Essentials

- Your Application should be routed through your Research Guide. **Intel will not accept direct applications from students**.
- Your Application **must include:**
  1. Application Form
  2. *Curriculum Vitae* (CV)
  3. Covering Letter
  4. Recommendation Letter from Research Guide/Head of the Department
  5. List of publications and/or papers authored/co-authored by you
- Your Application should be emailed to *india_fellowship@intel.com* and must reach us by **30th June 2023.**

Eligibility

➢ **Applications** are received by Intel once a year.

➢ **Only Indian nationals** are eligible to submit applications for participation in the Intel India Research Fellowship Program.

➢ Applicants for the Intel India Research Fellowship Program should be **PhD/MD/MS/MTech students** in the penultimate year or final year of thesis submission, or **Post-Doctoral Research Associates** who have submitted their thesis in the preceding year, and have authored/co-authored papers.

➢ **Intel employees and their families are not eligible** to apply for the fellowship.

➢ The candidate should have a **first class education career** right from Higher Secondary and Secondary School levels.

➢ The candidate must be **currently enrolled at selected universities/institutes**, with a research problem solving complex challenges in the fields of Medicine, Healthcare, Social Sciences, Communications or Intel core focus areas *(see the Appendix on page 9)*.

➢ The candidate must be **registered as a full time student** in the institute where she/he is enrolled.

➢ The **list of publications** by the candidate must be included with the application.

➢ Once selected, the candidate may not defer the fellowship.

Application Process

➢ Intel will not accept direct applications from students.

➢ Select universities/institutes will be invited to submit a limited number of student candidates for consideration.

➢ The candidate **must first be nominated by the university/institute** where she/he is enrolled, and **the application should be routed through the research guide**.

➢ The **application should be accompanied by the doctoral thesis or papers** authored/co-authored by the candidate.

➢ The candidate **must submit a *Curriculum Vitae* (CV)**, including GPAs obtained for Bachelor's, Master's, and PhD degrees, along with a covering letter with the following information:
   ▪ Is the candidate working in any of the key focus areas relevant to Intel *(refer the Appendix on page 9)*? If so, which one?
   ▪ Expected date of graduation?
   ▪ Has the candidate been funded by Intel Technology India Pvt Ltd in the past for the same or any other research work?
   ▪ Has the candidate's research guide been funded in the past, or is the research guide currently being funded, by Intel Technology India Pvt Ltd?
   ▪ Is the candidate interested in doing an internship with Intel Technology India Pvt Ltd, during or post the fellowship, if offered? If so, please share approximate dates that are suitable.

➢ The **list of publications** by the candidate should be clearly mentioned.

➢ The candidate must submit **a letter of recommendation from her/his research guide or from the Head of the Department**.

➢ The application should be sent to the India Fellowship Program Office at ***india_fellowship@intel.com***.

Timeline for the Intel India Research Fellowship Program 2023-24

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Applications Closing Date	**30th June 2023**
Announcement of Results	**August 2023**

Selection Criteria

➢ Nominations from the universities and institutes will be screened to ensure that the overall eligibility criteria are met.

➢ Selection will be based on:

- Candidate's academic excellence and credentials
- Credentials of the candidate's research guide
- Present stage of research work, and the progress till date
- Alignment of the candidate's technical interest with Intel's key focus areas
- Ability to clearly articulate the research interests and overall potential for research excellence
- Recommendation from the candidate's research guide or the Head of the Department

Terms and Conditions

- Intel Technology India Pvt Ltd reserves the right to grant any research fellowship.

- Intel Technology India Pvt Ltd reserves the right to have a discussion with the candidate, if deemed necessary.

- Prior written approval from Intel Technology India Pvt Ltd has to be taken by the candidate in case of any international travel required for the research work.

- The Intel India Research Fellowship Program is open only for Key Focus Areas mentioned in the Appendix.

- The institute will intimate Intel on the date of filing of any patent related to any invention by the fellowship recipient under this program.

- The institute is free to publish any work developed by the fellowship recipient, provided it sends Intel a written intimation, along with the work that will be published, 30 days prior to such publication.

- The Intel India Research Fellowship Program can be taken in addition to research fellowships that the candidate receives from other sources, provided there are no violations of rules.

- Intel will get the first opportunity to consider the candidate for employment opportunities, if any, within Intel.
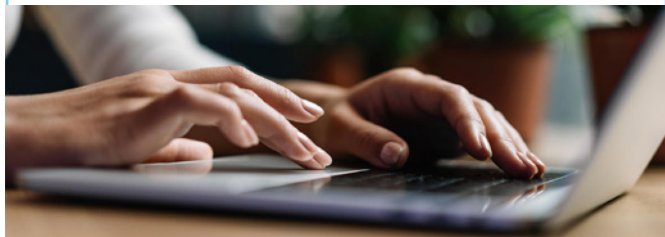
Monetary Grant: Details

All amounts in INR (₹)

Selected candidates will be awarded fellowship grants that will vary based on their respective qualifications, as follows:

Grant Eligibility	Post-Doctoral Research Candidates	PhD/MD/MS/MTech Candidates
Stipend	75,000 x 12 = 9,00,000	40,000 x 12 = 4,80,000
1 International Travel for Tier 1 conference *(subject to written approval)**	1,20,000 x 1 = 1,20,000	1,20,000 x 1 = 1,20,000
Travel Grant for Paper Presentation within India and travel to Intel Bengaluru*	50,000	50,000
Travel Grant for the Research Guide*	50,000	50,000
Contingency	50,000	50,000
TOTAL (per annum)	**11,70,000**	**7,50,000**

* Travel Grants will be disbursed against, and limited to, actual travel undertaken

Frequently Asked Questions (FAQs)

1

What is Intel India Research Fellowship Program?

The Intel India Research Fellowship Program is a one year fellowship created to recognise exceptional students pursuing cutting edge and high impact research in fields related to Intel's business and research interests. This is a highly competitive program with a limited number of fellowships awarded annually. Selected candidates in the program are recognised as being amongst the best in their areas of research.

2

What does Intel India Research Fellowship Program include?

Candidates receive fellowships which include a monetary grant (of up to ₹7,50,000 per annum for those pursuing PhD/MD/MS/MTech, and up to ₹11,20,000 per annum for post-doctoral candidates) that covers a monthly stipend, travel expenses for the candidate and the research guide, contingency amount and one international air fare based on prior approval. The candidate also gets an opportunity to network and be a part of Intel's various research events. The funds are given directly to the candidate's university or institute. Further, the candidate will be matched with an Intel research mentor who will become a valuable resource to the candidate.

The selected candidates will also receive an opportunity to intern at Intel Technology India Pvt Ltd. Intel reserves the right to select and provide internship to the candidate.

3

Who can apply for the Intel India Research Fellowship Program?

The Intel India Research Fellowship Program is only for PhD/MD/MS/MTech students in the penultimate or final year of their thesis work, and for research associates who have recently completed their thesis, from prestigious universities. The nominations can only be made by the university/institution.

4

What language should the application be in?

All the documents for the application should be submitted in English.

5

Can the fellowship be renewed or extended after the completion of one year?

Yes, the candidate may apply for an extension or renewal of the fellowship for one more year. Intel Technology India Pvt Ltd, however, reserves the right to grant the extension of the fellowship based upon the annual review.

6

What disciplines are eligible to apply for the Intel India Research Fellowship Program?

To be eligible for the fellowship, the research area must be aligned to Intel's Key Focus Areas, mentioned in the Appendix. This year, we have opened our application eligibility to include students pursuing impactful and leading edge scientific research in computer science and related domains, medicine and social sciences.

7

Are you looking at top tier schools only?

To begin with, we would focus on top tier schools or research institutes in the country. However, we do intend to expand this Program to more institutes and universities in the future.

8

Is there any fixed number of fellowships per institute that will be awarded by Intel?

No. There is no fixed number of fellowships awarded per institute. Our focus is on the quality of the research and its impact in locally relevant research problems.

9

Will there be a performance review by Intel?

Yes. Each fellowship awardee will be assigned a mentor from Intel who is an established researcher in the given domain. The fellow will be in touch with the Intel mentor on a constant

basis. At the end of each quarter, a review of the progress of the research will be done by the Intel India Research Fellowship Program Committee.

10 **Will Intel mentors be co-authors of research papers arising from the research through fellowships?**

Yes, Intel Mentors can be co-authors to research papers at their discretion. As the focus of the Program is to encourage outstanding technical research, Intel will aim to publish the research papers in renowned publications and conferences.

11 **What will happen if the selected candidate gets a better job offer and would like to discontinue the fellowship?**

It is not binding on the candidate to continue with the fellowship. The candidate can apply for discontinuation of the fellowship by providing reasons justifying the same, recommendation and support of the research guide for the discontinuation, and sufficient notice period before the fellowship can be terminated. However, the unused grant amount accounted for the remaining duration of the candidate's fellowship shall be returned to Intel India.

12 **Is there an interview for the selection?**

Intel may conduct an interview of a candidate if deemed necessary.

13 **How are the Intellectual Property rights of the research work treated under the Program?**

For Intel, it will be an Open Research platform with no interest in the IPR of the researchers/ guide. The research guide and student need to take all necessary steps to protect their IPR as per the governing rules and regulations of the institute. However, it is recommended to keep the Intel India Research Fellowship Program Committee updated on such developments. Intel's interest in this Program is to enhance quality research output in India, and our focus thus will be on quality of research and publications in world-class academic/industry conferences relating to computing sciences.

14 **Can the fellowship be taken in addition to other fellowships that the candidate is receiving?**

Yes. An Intel India Research Fellowship can be taken in addition to other fellowships, provided the institutes' rules and regulations permit it and the terms and conditions of the fellowship scheme from any other source are not violated.

Intel India Research Fellowship Program: Focus Areas

Digital Biology Research

We are in the epoch of Digital Biology. Digital Biology is fueled by the convergence of three revolutions:

1) Measurement of biological systems at high resolution resulting in massive multi-modal, multi-scale, unstructured, distributed data;
2) Novel data science (AI and data management) techniques on this data; and
3) Wide-spread cloud use enabling massive public data repositories, large collaborative projects and consortia.

Datasets and compute requirements for Digital Biology are poised to dwarf everything else on the planet, making them a leading indicator for data-centric workloads. We seeking to drive breakthroughs in Digital Biology at the intersection of biology applications (genomics, transcriptomics, proteomics, drug molecule search, etc) and computing:

1) novel AI algorithms (structure learning, learning over large graphs, causal learning, multimodal learning, anomaly detection, etc);
2) data management (data cleaning, data integration, polystore systems, etc.);
3) HPC (novel parallel algorithms, architecture aware acceleration, architecture research, etc); and
4) building an open source digital biology full stack integrating technologies to accelerate science.

AI for High Performance Code

With the rise in heterogeneous computing, even within a CPU, programming effectively for best-in-class performance while maintaining productivity is one of the grand challenges that industry is already facing, with the significant programmer shortage. Programming for high performance is a cognitively demanding task that requires extensive knowledge, experience, and a large degree of creativity—making it notoriously difficult to automate. With the advent of AI, we envision a future where correctness and high-performance software development is significantly automated disrupting the division of labour between the human and the machine.

We invite proposals that advance *MLIR mapping to underlying hardware target* automation via AI at high performance on the Intel provided access to the state-of-the-art CPU platform.

AI for Chip Design

With chip design becoming more complex due to advanced process technologies, and HW features driving complex structures in the design, maintaining design cycle time at the same levels is a huge challenge. The longer the design cycle times, the later important feature advancements in CPUs reach customers, an undesirable result for the whole industry.

Therefore, to improve productivity of chip designers, we envision a future where AI techniques predict or estimate design properties such as IR drops, routing congestion, switching activity, and parasitics. AI must also solve place-and-route problems for both large structures such as memory and standard cells. Potentially, AI may also be used to design more efficient circuits.

We invite proposals to solve these challenging problems and advance the state-of-the-art in using AI to design the next generation of chips.

Scientific Machine Learning (SciML): Bringing Together HPC and AI for Sciences

Machine learning (ML) has revolutionised a wide array of scientific disciplines and solved problems that were unsolvable before: predicting protein structure, imaging black holes, automating drug discovery, and so on. We aim to enable scientific discovery. This growing enthusiasm for SciML stems from the combined development and use of efficient data analysis algorithms; massive amounts of data available from scientific instruments, scientific computations, and other sources; and advances in high-performance computing.

We aim to collaborate with partners across the world to:

1) create novel ML methodology to discover science-based solutions that are suitable for real world adoption (e.g., synthesisable materials);
2) formulating unsolved problems in science in the ML language to advance science; and
3) explore solution to grand challenges at the intersection of multiple disciplines

Security and Privacy in Virtual Computing Environment

The virtualisation environment adopted in cloud computing offers the abstraction of platform hardware resources that could be shared between multiple agents popularly knowns as Virtual Machines (VMs) running Guest Operating System. Virtual Machine Monitor (VMM), also known as Hypervisor software, is responsible for managing the hardware resources of the underlying platform across VMs and to offer isolation between VMs.

Despite the critical role in optimising cloud services, the virtualisation environment is prone to new attacks and security challenges. For example, in the case of vulnerabilities in VM isolations, data privacy of the VMs cannot be guaranteed. Also, software vulnerabilities in VMM could compromise VM security. The potential attack scenarios may target one of the security objectives of the virtualisation environment, such as VM isolations, privileged access management and operations, host access control protection, decoupling virtual resources from underlying hardware, etc.

The objective of the proposed research proposal is to define a framework for investigating new attacks and vulnerabilities in virtualisation environments in one or more of the research topics listed below, and provide a concrete

solution or remediation strategy to enhance the security of the virtualisation technology.

1) VM to VMM attacks
2) VM to VM attacks
3) VMM to VM attacks
4) Attacks from malicious devices (underlying physical platform) targeting VM and VMM memory

As a future research goal, the key learnings from this research work could be extended to analyse the emerging threats in the context of confidential computing, such as Intel's TDX (Trust Domain Extensions).

AI for IoT

The existing research in this space using deep learning (DL) techniques depends heavily on off-line training using enormously large data sets, which normally takes a long training time (high latency), and suffers from scalability and security concerns. Thus, one of the key aspects of the research is the ability to continuously learn from the gathered data in real time and solve complex problems using edge intelligence.

The research areas include edge learning; anomaly detection; distributed machine learning, including federated learning; transfer learning; and reinforcement learning. The overall aim is to learn continuously and adaptively to enable robust self-learning systems.

The scope of this research work includes exploring algorithms for applications across Retail, Health and Industrial segments, connected compute capabilities and technology demonstrations (through simulations and system proof-of-concepts).

Another area of interest is AI/ML advancements in security and performance, to make IoT devices and services smarter and more secure in order to increase their adoption in industry, healthcare, retail and smart city infrastructure.

Deep Learning and AI Workload Optimisation

Advances in artificial intelligence (AI) and machine learning (ML) capabilities are playing important roles in our lives these days, and have been widely used in many applications. ML methods, including traditional and deep learning (DL) algorithms, achieve impressive performance in solving complex problems. Many direct applications of AI/ML capabilities could revolutionise the industrial automation and VLSI design processes.

Beyond traditional CPUs and GPUs, hardware accelerators (e.g., Habana Gaudi, Google TPU, Cerebras) targeting AI workloads have been gaining prominence. Hence, optimising AI workloads running on such accelerators is of paramount importance. Programming the AI accelerators remains a major challenge. Also, traditional compiler optimisation techniques that can enable the workloads to execute faster may need a relook. As hardware platforms evolve, workloads should take advantage of heterogeneous compute platforms (CPU, GPU, FPGA and specific IPs) through compilers, FW/SW frameworks and specific customisations.

We are interested in examining the entire gamut of technologies starting from new programming languages, novel compiler optimisations and run times, as well as performance and productivity tools that can enable the programmers of

tomorrow to exploit a myriad of AI hardware accelerators to the fullest while running complex models and frameworks.

An additional vector is workload optimisation. A key area in this field is Natural Language Processing, with a focus on improving training efficiency and generalised multilingual models. On the implementation side, it is expected that there will be a growing interest in miniaturisation of neural networks with a focus on pruning, quantisation, low rank factorisation, compact convolutional filters and knowledge distillation.

Proposals addressing novel optimisation techniques shall also be a key focus.

FPGA and Platform Architecture

With heterogeneous workloads being deployed at scale, general purpose compute architectures will need to be complemented by domain specific acceleration. FPGAs are potent, flexible acceleration architectures that are intrinsically capable of adapting to very different workloads.

Here are few areas of research that we would like to enable:

1) Multi Tenancy on FPGAs including tradeoffs between Space and Time Complexity in the context of Network and Cloud Deployments
2) Energy Management and Harvesting techniques and support in FPGAs
3) AI/ML on FPGAs — for various usages and techniques in getting inferencing engines in the data path
4) FPGAs vs ASIC — Reconfigurable Computing in the Chiplet era
5) Security in Edge Compute deployments, e.g., protection from side channel attacks

Other topics of research can be FPGAs targeted for data centre infrastructure offloading and edge compute. One such example is smartNICs going into these domains.

SoC Architecture and System Design for Cloud Computing

This topic broadly invites research into next-generation CPU architectures that are specially optimised for cloud computing—in particular, innovations in cache hierarchy, x86 processor architecture and microarchitecture, specialised memory architecture and accelerators that mitigate data centre tax for cloud-scale workloads of today. Data centre designs are transforming to disaggregated pools of General-Purpose Compute, Accelerators, and Memory/Storage.

This topic also invites research on workload orchestration, security, telemetry, data movement optimisations, and micro services performance optimisations for the disaggregated data centre paradigm.

Specialised Accelerators and Memory Systems for Future Artificial Intelligence

We invite research into accelerator-based subsystems for emerging AI workloads that can be integrated into mainstream CPUs and GPUs as part of a seamlessly programmed heterogeneous architecture for efficient AI.

Also of interest are specialised memory architectures for future AI workloads spanning heterogeneous memory systems, compute-in-memory architectures and hardware-software co-designs that mitigate memory access and data movement.

Formal Verification

Formal Verification (FV) uses mathematical techniques to prove that a design conforms to its specification. Hardware designs are complex and are optimised to keep up with the competitive market while meeting the mounting time to market demands and ensuring the quality of the product.

In the semiconductor industry, because of fine and subtle interactions between components, testing the wide set of possibilities by traditional simulation is not realistic. FV has been accepted as the new dawn of verification by the industry and vendors.

Our aim is to demystify the various facets of formal techniques —algorithm checking, formal property verification (FPV), etc —and drive FV through awareness across multiple groups. We are interested in research topics related to DV to FV testbench automation, new paradigms of formal verification applied to the areas of security, deploying AI in formally verifying designs, etc. We are looking for hard working and self-motivated individuals who would join hands in this vision.
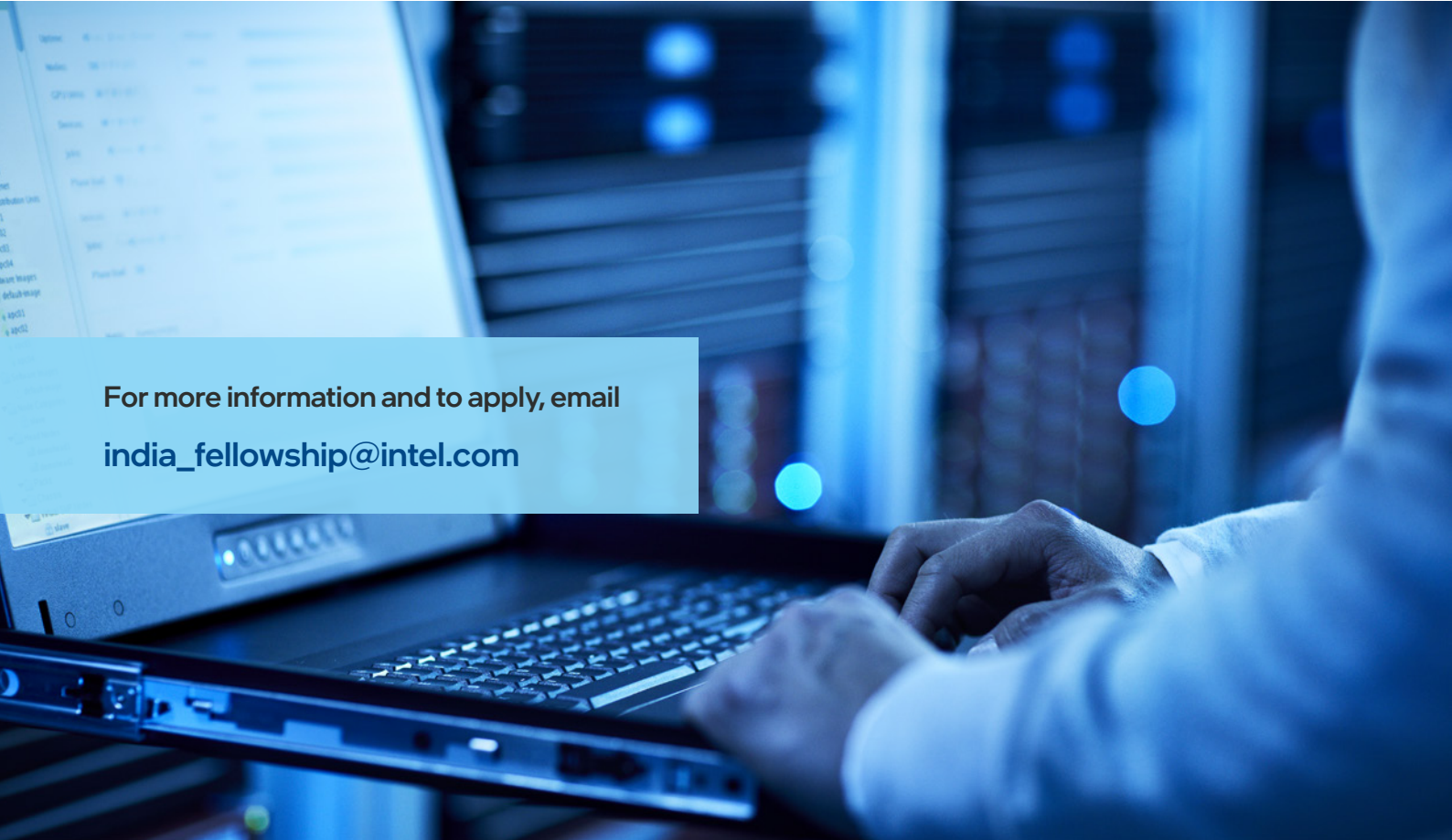
For more information and to apply, email

india_fellowship@intel.com

intel.