We believe that a key component to realizing the NEC 2030VISION in a VUCA* world, that is both complex and difficult to predict, is the idea of “seizing the future together,” multiplied by “technology.” To this end, it is important to implement technology in society, which requires a scheme for market intelligence, development of technology, development of business, and acceptance within society. Therefore, NEC is working toward R&D co-creation, expanding open innovation, and venturing into intelligence, development of technology, development of business, and acceptance within society.

To this end, it is important to implement technology in society, which requires a scheme for market

Approach to R&D Investment

We allocate approximately 4% of revenue to R&D in order to maintain and improve our R&D capabilities over the medium to long term, independent of any external trends.

<table>
<thead>
<tr>
<th>Year</th>
<th>R&amp;D Expenses (Billion of yen)</th>
<th>Ratio of R&amp;D expenses to Revenue (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2021</td>
<td>114.6</td>
<td>3.8%</td>
</tr>
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<td>FY2022</td>
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<td>4.2%</td>
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<td>FY2023</td>
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* Acronym for volatile, uncertain, complex, and ambiguous

Human Resource Acquisition and Cultivation to Boost Innovation

- Provides researchers with compensation according to their market value, with no upper limit
- Launched program in fiscal 2020 in Japan and extended it to applicable new graduates during recruitment activities in the U.S.
- Total number of researchers acquired: 22

- Have engaged in recruitment activities at India’s prestigious Indian Institutes of Technology (IIT) since 2012
- Part of our continued efforts to keep acquiring top talent from around the world

- Implemented system to accelerate integration of R&D and Business Development divisions
- Aimed at developing human resources who are highly skilled in both technology and business

- High-risk, high-return system providing highly skilled business development professionals with benefits based on their market value
- Established the new position of Executive Analytics Consultant Lead for data-driven AI-related businesses in fiscal 2022, in addition to AI drug professionals

In Search of Social Value Creation—The NEC Technology Vision

Digital Twins for Co-creation and Trials of the Future

Providing a foundation to support the convergence of the real and cyber worlds

AI that Works with People and Permeates Society

AI that people can trust, AI that people can accept

Platform to Support Environmental Friendliness, High Reliability, and High Efficiency

Integrated apps / IT / network, security, and secure data platforms

Innovation: R&D and Business Development

NEC’s research laboratories are responsible for research and development that is geared toward strengthening the technological competence of the NEC Group. These laboratories adopt a global perspective, working with locations and other research laboratories around the world to conduct R&D that can create new social value and open up possibilities for the future.

Approach to R&D Investment

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Ratio of R&D Expenses to Revenue

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**High Technological Competitiveness on the Global Stage**

<table>
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<tr>
<th>Machine learning</th>
<th>Number of papers accepted by leading journals</th>
<th>8th in the world</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial Intelligence</td>
<td>Video and image processing</td>
<td>Number of papers accepted by leading international academic conferences as of December 2021</td>
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**Communication** and Security*<sup>1</sup>

- Cryptography 2019, the leading international academic conference on cyber security
- Best Paper Award

**Optical communication**
- Acceptance of papers by leading international academic conferences

**Patents**
- Top 100 Global Innovators*<sup>2</sup> global survey of patent activities
- Number of international patent applications
  - 11 consecutive years

**Biometric authentication, video analytics, AI**
- Number of international patent applications
  - No. 1 in the world

*<sup>1</sup>*NIST testing results do not constitute an endorsement by the U.S. government of any particular system, product, service, or company.

**World’s No. 1 Biometric Authentication Technology**

- Beyond facial recognition, NEC boasts world-class biometric technology for key biometrics such as iris and fingerprint recognition.

**AI and Human Rights Principles**

NEC has formulated the NEC Group AI and Human Rights Principles (hereinafter referred to as the “Companywide principles”) to guide our employees to recognize respect for privacy and human rights as the highest priority in our business operations regarding social implementation of AI and utilization of biometric and other data (hereinafter referred to as “AI utilization”). In addition to facilitating compliance with relevant laws and regulations around the globe, the Companywide principles will guide our employees to recognize respect for human rights as the highest priority in each and every stage of our business operations regarding AI utilization and enable them to take action accordingly.

For more details, please refer to the “AI and Human Rights” section on page 64 of Sustainability Report 2022.

**Intellectual Property Policy**

- NEC leverages its intellectual property to create innovative businesses, create new opportunities, and enhance corporate value.
- NEC focuses its intellectual resources toward growth businesses and areas that will serve as pillars of growth in the future. We are working to build an intellectual property network linked to NEC’s technological strengths and utilize it extensively.
- NEC utilizes its intellectual property to support co-creation of new businesses and technologies with stakeholders.

For more details, please refer to the “Innovation Management” section on page 77 of Sustainability Report 2022.

**Examples of Initiatives Based on the NEC Technology Vision**

- **Digital Twins for Co-creation and Trials of the Future**
  - Realization of a Safe and Secure Society through Visualization
  - Multi-satellite image analysis to detect all kinds of changes in the earth’s surface

Conventional methods can detect changes only in specific locations every two weeks. This technology, which can seamlessly integrate observed images from multiple SAR satellites and optical satellites, can detect changes in the ground surface at any point with higher frequency (within an hour to a day), regardless of the time of day, storms, or other bad weather conditions.

- **Support for Society via Mission-critical Infrastructure**
  - Invariant analysis and model-free analysis of time-series data
  - Development of the manned spacecraft Orion, part of NASA’s manned lunar exploration project Artemis

This technology generates a model for normal operations by finding 22 billion relationships from 150,000 sensors on the spacecraft within several hours, enabling anomaly detection for the design, development, manufacture, and testing stages of spacecraft.

**AI That Works with People and permeates Society**

- **Making Society Efficient and Green through Optimal Prescriptions**
  - NEC is developing various types of proprietary technologies in the field of optimization. In addition to quantum computing, these technologies include intention learning, in which AI learns the intentions that underlie the decisions made by experts, and online optimization, which facilitates interactive optimization, even amid uncertain conditions.

These technologies will significantly reduce the amount of labour and increase the speed of operations that require choosing the optimal decision from a massive number of options, such as dynamic pricing, shift scheduling, delivery planning, personalized advertising, and optimized recommendations.

**Platform to Support Environmental Friendliness, High Reliability, and High Efficiency**

- **Integrating AI x Communications x Computing**
  - Satellite Constellation / HFAPS*<sup>3</sup>
    - Provides a telecommunications environment that can be accessed anywhere in the world
  - Optical Core Networks
    - All Photonics Network (Non-linear distortion compensation / Photonics chips)
    - Wavelength conversion technology targeting <1/100 low latency and power
    - All Photonics Network (Wavelength conversion)
  - Communication Prediction and Optimized Bandwidth Allocation (Open RAN Resource Optimization)
    - Dynamic pricing
  - 5G Access Networks
    - Distributed MIMO*<sup>4</sup>
    - Open RAN Resource Optimization
    - Submarine Optical Communication

NEC’s Business Model

Innovation: R&D and Business Development
**NEC’s Business Model**

**Innovation: R&D and Business Development**

**Venturing into New Business Areas**

At NEC, we expect innovation to spur business development in areas where both potential customers and value are yet to be discovered, and we are working on open innovation to develop innovative new businesses that would be difficult for NEC to pursue on its own. We aim to create new social value on the global stage by creating new combinations of diverse knowledge that shatter the boundaries of preconceived notions.

**Direction for New Business Development**

**Proactively Use External Resources**

- **BIRD INITIATIVE—A First-of-Its-Kind R&D Business from Japan Centered on Co-Creation**

  In September 2020, NEC became one of six companies to form BIRD INITIATIVE, Inc., a consortium incorporating business, finance, and academia with the goal of using R&D rooted in co-creation to speed up the creation of new businesses.

  BIRD INITIATIVE’s activities include R&D, commissioned research, consulting, and investment related to digital technologies and academia with the goal of using R&D rooted in co-creation to speed up the creation of new businesses. With NEC’s human resources and technology at its core, NEC X will promote commercialization through open innovation and create new social value.

**Strengthen partnering**

(with major companies, universities, and start-ups)

**Proactively Use External Resources**

- **NEC’s Business Model**

  NEC has built a business model that combines the strengths of its business units and non-business units to create new business opportunities. This model includes R&D businesses, business units that focus on creating new business opportunities, and non-business units that focus on creating value in various social domains.

  - **R&D Businesses**
    - AI
    - Network Security
  - **Business units / Non-business units**
    - Creation of business opportunities
  - **Space / Canvas for co-creation**
    - Based on real-life use cases
  - **Spin-offs**

**Development of New Businesses Globally**

**Carve-outs planned for fiscal 2023**

- **2 projects**

  - **assimee**
    - Aiming for a world where digital twins are the natural order
    - Analysis of assimee’s services showed a threefold improvement in investment efficiency at a major semiconductor manufacturer
  - **Automated Negotiation Plus Drones**
    - Aimed at establishing smartlogistics and smart factories
    - First three domestic tests completed in Waikanae, Hokkaido

**NEC X—Working with the Silicon Valley Start-up Ecosystem**

**Ecosystems Rooted in Cutting-edge Technology**

NEC-established NEC X, Inc. in California to work with Silicon Valley’s start-up ecosystem and capitalize on the technology coming from research laboratories in order to accelerate the creation of new businesses. With NEC’s human resources and technology at its core, NEC X will promote commercialization through open innovation and create new social value.

**AI Drug Development**

- **1) Personalized cancer immunotherapy using cutting-edge AI**
  - **Technological progress**
    - Personalized vaccine design utilizing AI
  - **Graph-based associative learning**
    - Multivaccine vaccine design technology
  - **Paradigm shift toward drug development processes**
    - Optimized for each patient
  - **2025 business value: 300 billion yen***

- **2) Development of a next-generation coronavirus vaccine**
  - **NEC’s AI technology makes the next generation of coronavirus vaccines a possibility**
    - One vaccine for over 100 betacoronaviruses
    - Resistant to virus mutations and expected to help maintain long-term immunity
  - **Helping realize a safe and secure world**
    - First Japanese corporate group to partner with the Coalition for Epidemic Preparedness Innovations (CEPI)
    - Project launched to develop a next-generation vaccine using AI technology put forth by NEC

**Strengthen Partnering**

- **CEPI’s call to action**
  - Public-private partnerships to accelerate vaccine development

**Investment focused on six areas**

- **Smart cities**
- **Digital government**
- **Digital finance**
- **Healthcare and life science**
- **DX**
- **Carbon neutrality**

**Establishment of the NEC Orchestrating Future Fund**

This NEC-anchored fund raises capital from external sources, which is then invested in early stage and late-stage start-ups in order to develop co-creation ecosystems.