



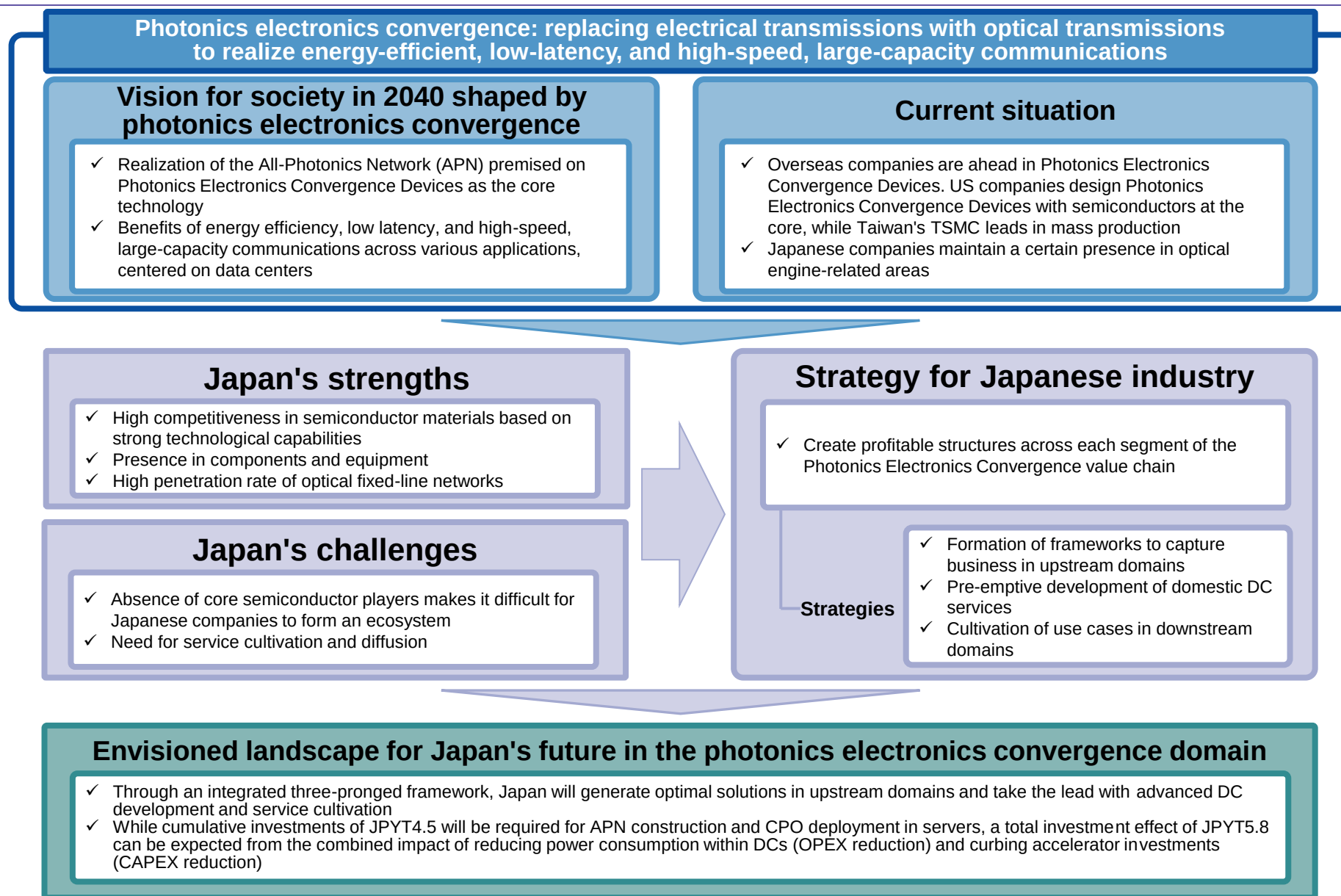
Photonics Electronics Convergence

The path to success through an integrated three-pronged approach, development of advanced data centers, and cultivation of services unique to photonics electronics convergence

March, 2026

Industry Research Department
Mizuho Bank

Envisioned landscape of the photonics electronics convergence domain in 2040



The winning strategy for photonics electronics convergence: "integrated three-pronged framework," "advanced DC development," and "service cultivation unique to photonics electronics convergence"

■ Background and Issues

- The world of Photonics Electronics Convergence is anticipated in both devices and fixed-line communications. With US and Taiwanese players leading in core technologies such as LSI design, Japan needs to formulate a strategy to remain competitive

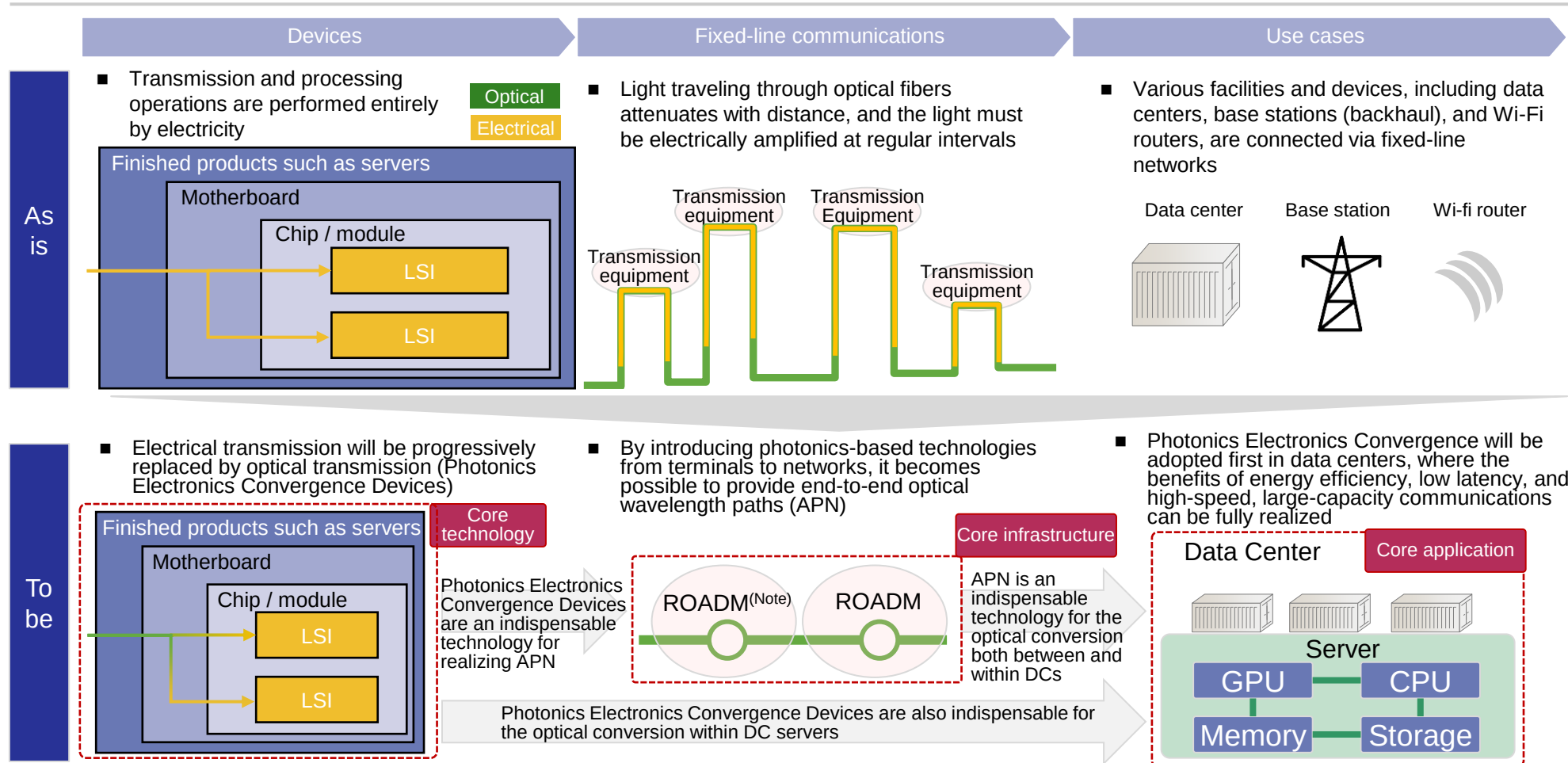
■ Summary

- In the world of Photonics Electronics Convergence, devices will be the core technology. These Photonics Electronics Convergence Devices will enable the All-Photonics Network (APN), an end-to-end optical communications network. Combined deployment of devices and APN is expected for data centers, where the benefits of energy efficiency, low latency, and high-speed, large-capacity communications can be fully realized
- Looking ahead to the world of Photonics Electronics Convergence, Japan can leverage its strengths in materials ("*suriawase*" (coordination and fine-tuning), "*tsukurikomi*" (built-in refinement), and "*omotenashi*" (quality assurance and meticulous service)), in components ("procurement," "formulation," "processing and manufacturing," and "large-client relations"), and in its existing high penetration rate of optical fixed-line networks. On the other hand, in devices, US and Taiwanese players are strong at the semiconductor, foundry, and server layers, making it difficult to form a domestic ecosystem across materials, components, and equipment. In addition, for Photonics Electronics Convergence to be widely adopted, the cultivation and diffusion of services will be necessary
- In a future where Photonics Electronics Convergence is realized, Japan needs to build a structure in which Japanese companies can leverage their strengths and in which challenges have been overcome to a certain extent. For Japan to continue to win in the world of Photonics Electronics Convergence, three strategies are considered effective: (i) becoming the partner of choice through an integrated three-pronged framework of materials, components, and equipment, including via government support; (ii) taking the lead in DC development based on Photonics Electronics Convergence technologies; and (iii) cultivating services unique to Photonics Electronics Convergence
- To realize Photonics Electronics Convergence domestically, it is necessary to consider a promotion approach that takes into account the fact that the entities making investments and conducting R&D differ from the actual beneficiaries. APN is also a technology with aspects of public-good infrastructure, making government support for its diffusion important
- The investment required to realize the world of Photonics Electronics Convergence domestically is estimated at a cumulative JPY¥4.5, comprising the investment to build APN domestically and the investment for CPO deployment in domestic DC servers. On the other hand, by connecting data centers via APN, it becomes possible to reduce power consumption within data centers (OPEX reduction) and curb accelerator investments (CAPEX reduction), with a cumulative investment effect estimated at approximately JPY¥5.8

In the world of photonics electronics convergence, devices become the core technology and APN becomes the core infrastructure

- In the world of Photonics Electronics Convergence, Photonics Electronics Convergence Devices, in which electrical transmissions are replaced by optical transmissions, will be the core technology
- Photonics Electronics Convergence Devices will enable the All-Photonics Network (APN), an end-to-end optical communications network

Overall picture of the world of photonics electronics convergence (overview of promising domains)



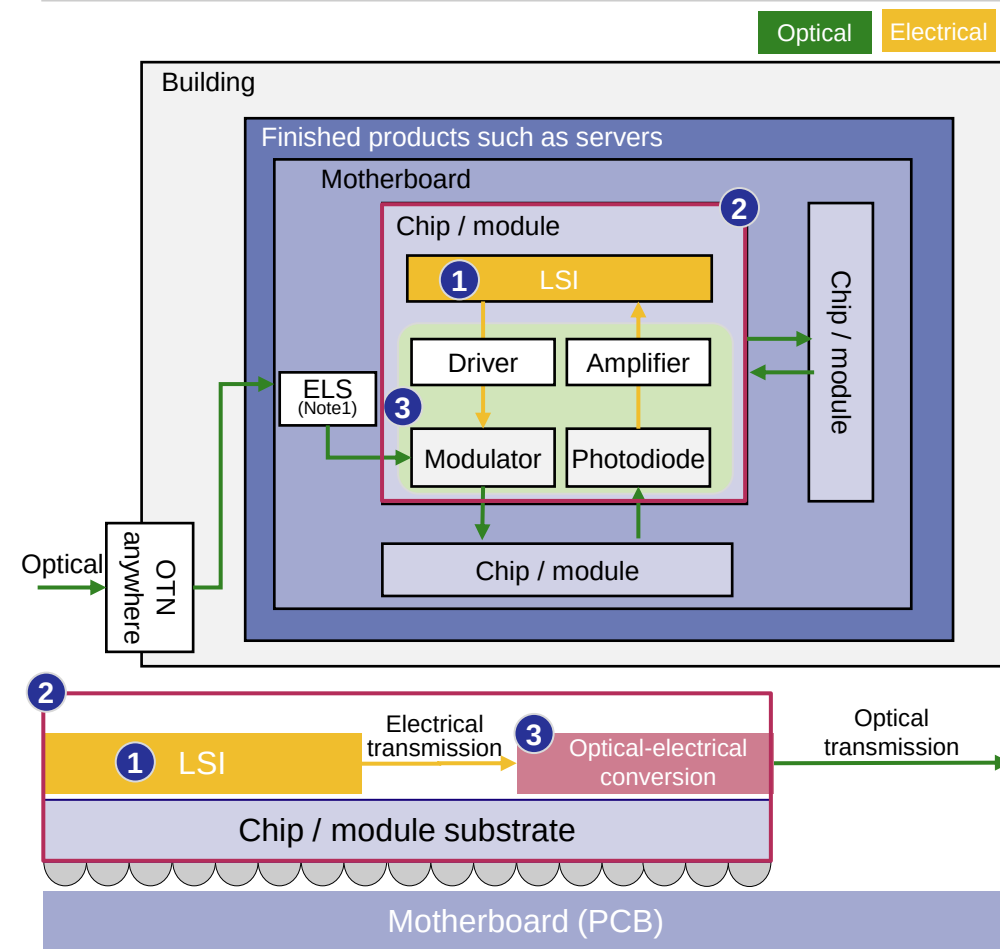
Note: ROADM: Reconfigurable Optical Add-Drop Multiplexer. Performs route control via remote operation without converting optical signals back to electrical signals

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Japanese companies have a presence in the optical engine-related areas of photonics electronics convergence devices

- US and Taiwanese players hold a strong presence in LSI design and in the manufacturing and assembly of chips and modules. On the other hand, Japanese companies maintain a presence in the optical engine-related areas (materials, components, and equipment)

Configuration of photonics electronics convergence devices



Note 1: ELS: External Laser Source

Note 2: SiPH Alliance: Silicon Photonics Industry Alliance

Source: Both figures compiled by Industry Research Department,
Mizuho Bank, Ltd.

Corporate presence in each category of photonics electronics convergence devices

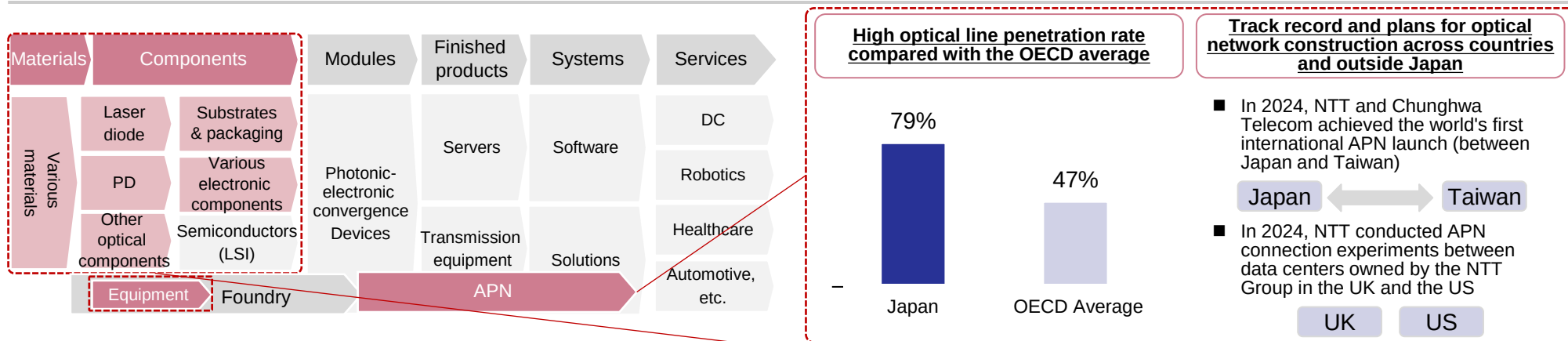
#	Category	Major companies	Trends
I	LSI	Broadcom, NVIDIA, AMD, Marvell	■ The US commands a high market share. The US is also advancing peripheral technology acquisition through inorganic measures
II	Semiconductor Chips and Modules (Manufacturing and Assembly)	TSMC, ASE	■ Taiwanese players are advancing ecosystem formation through the SiPH Alliance (Note 2)
III	Optical Engine-Related Areas (Materials, Components, and Equipment)	Mitsubishi Electric, Sumitomo Electric, Furukawa Electric, etc.	■ There exist areas where Japanese companies hold market share

Sub-category	Areas where Japanese companies hold market share (examples)
Materials	■ Compound semiconductors for laser diodes (InP / GaAs) ■ Optical fiber ■ Underfill and adhesives ■ Sealants and heat-dissipation materials
Components	■ Optical isolator ■ Lasers (laser diodes, laser modules) ■ Optical connectors / ferrules / microlenses ■ High heat-resistant substrates ■ Various electronic components (passive components, etc.)
Equipment	■ Mounting equipment

Japanese companies have strengths at the materials, components, and equipment layers, with a well-developed existing optical fixed-line network

- Japanese companies hold strengths in the upstream materials, components, and equipment of the Photonics Electronics Convergence Device value chain
- The penetration rate of optical fixed-line networks, which form the foundation for APN deployment, is also relatively high compared with the OECD average

Location of Japanese companies' strengths within the photonics electronics convergence value chain



Materials (Note)		Components and equipment (note)	
<i>Suriawase</i> Coordination and fine-tuning Customized products are completed by adjusting for manufacturing processes, taking into account the impact on and compatibility with other materials (e.g., creating recipes for each individual client, including differences not listed in physical property tables)		Relationships with existing large clients Individual companies maintain relationships with Tier 1 semiconductor manufacturers, hyperscalers, etc.	
<i>Tsukurikomi</i> Built-in refinement Development technologies and production know-how that have been built up and refined to manufacture specific products such as custom-made items (e.g., control at the PPT <one part per trillion> level)		Needs Product	
<i>Omotenashi</i> Quality assurance and meticulous service Quality assurance and meticulous after-sales follow-up to stably produce and supply products (e.g., managing the quality distribution within 3σ)		Procurement Component companies specify even the origin of raw materials, conducting procurement to maximize component performance	Formulation By internalizing the formulation of procured raw materials, performance is maximized while technologies in layers downstream of materials are kept confidential
Factors underlying the unique strengths of Japanese semiconductor materials Accumulated coordination and fine-tuning with Japanese semiconductor and equipment companies; bold R&D and investments based on technology roadmaps		Processing and manufacturing - Process technologies such as precision coating and molding, lamination, pressing, and sintering - Component companies internalize their manufacturing facilities and keep process technologies confidential - High technological capabilities of the equipment itself and the ability to provide total solutions	

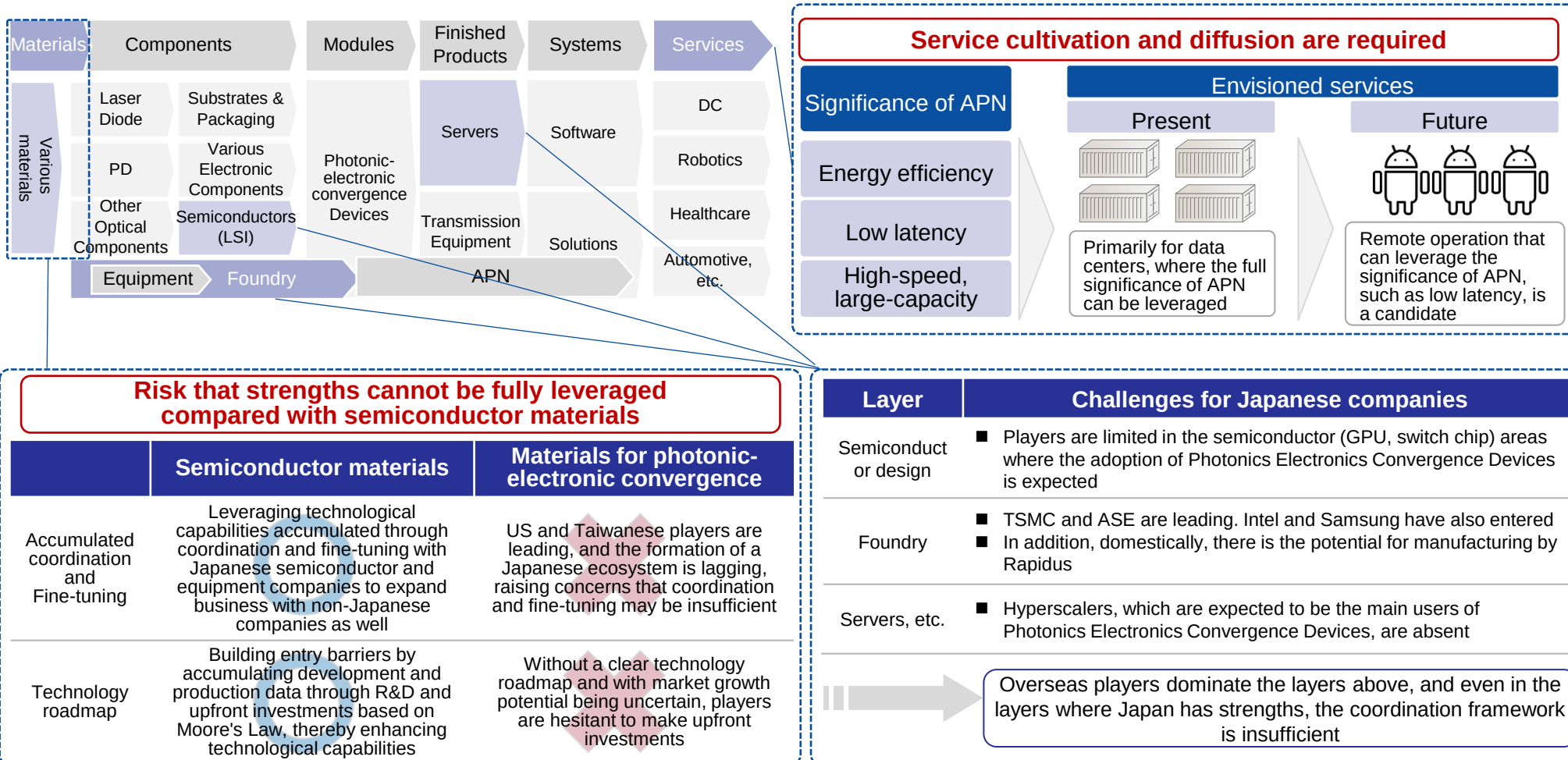
Note: This describes the factors and areas in which Japanese companies have strengths in existing semiconductors and various devices, focusing on those elements that can be leveraged in Photonics Electronics Convergence Devices

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on OECD and other sources

Overseas players dominate the semiconductor and foundry layers; risk that strengths in materials, components, and equipment cannot be fully leveraged

- On the other hand, overseas players dominate the layers of semiconductor design, foundry, and finished products (servers, etc.)
 - As a result, under the current situation, coordination is difficult even in the layers where Japan has strengths

Location of Japanese companies' challenges within the photonics electronics convergence value chain

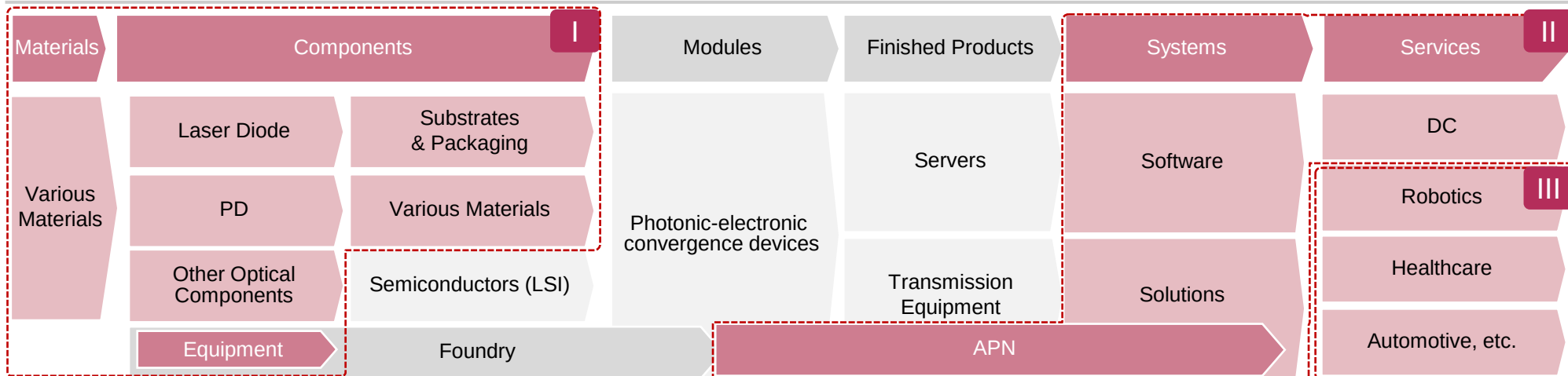


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

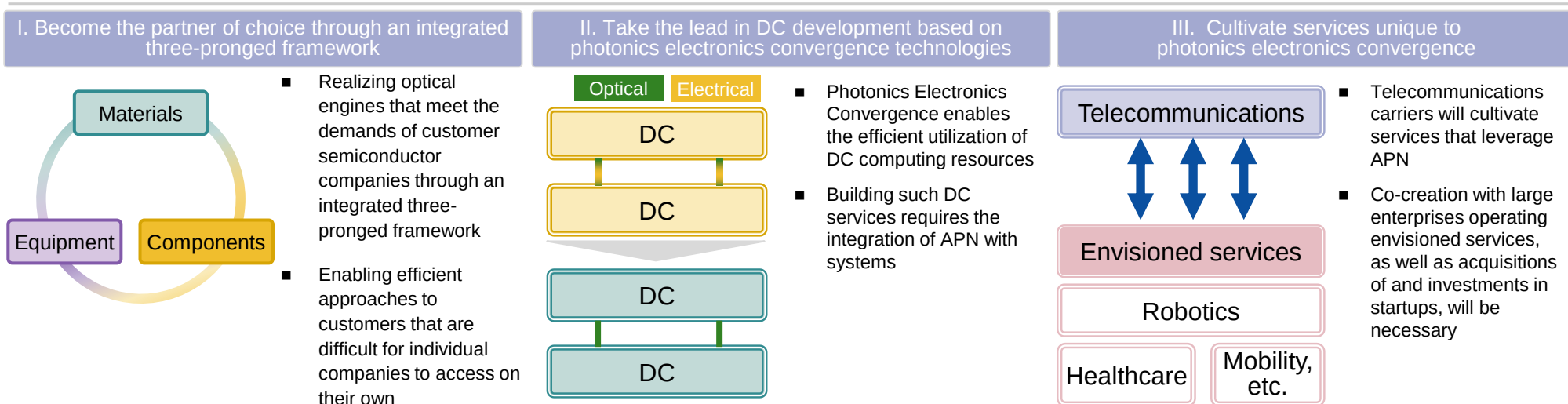
Continuous growth becomes possible by building profitable mechanisms across each segment of the photonics electronics convergence value chain

- Japanese companies need to pursue an integrated three-pronged framework for developing materials, components, and equipment; develop DC infrastructure based on Photonics Electronics Convergence technologies; and cultivate services that leverage the characteristics unique to Photonics Electronics Convergence

Layers where Japanese companies should take actions along the photonics electronics convergence value chain



Actions required of Japanese companies

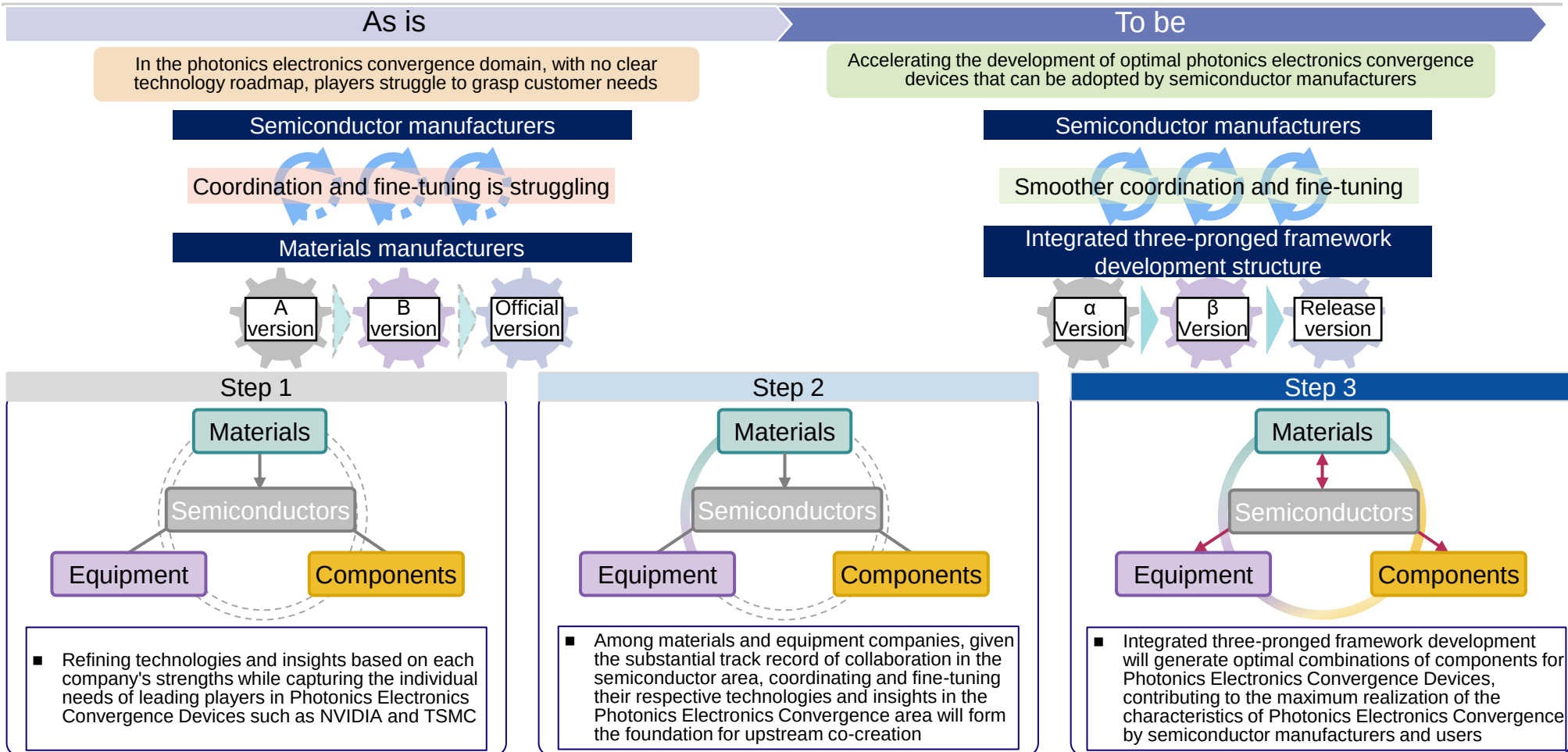


Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd.

I. Becoming the partner of choice through an integrated three-pronged framework: creating optimal solutions upstream through co-creation to realize characteristics that meet semiconductor companies' demands

- Forming co-creation frameworks in stages to build upstream structures capable of realizing the characteristics of Photonics Electronics Convergence Devices demanded by semiconductor companies
 - Consolidating the technologies and know-how of Japanese manufacturers, including companies that have previously had no contact with US and Taiwanese downstream players
 - Efficiently generating optimal combinations of constituent components for the advancement of Photonics Electronics Convergence Devices through development via an integrated three-pronged framework

Toward building an integrated three-pronged framework development structure for photonics electronics convergence



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

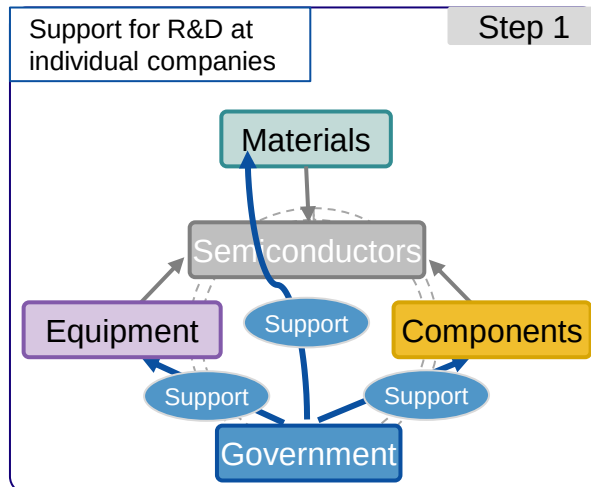
I. Becoming the partner of choice through an integrated three-pronged framework: beyond R&D and framework formation, government support for collaboration with semiconductor companies is also useful

- Government support is useful for strengthening R&D at individual companies and for forming co-creation frameworks
 - Support for collaboration with overseas semiconductor companies should also be considered, to reduce R&D uncertainty and promote the development of optical engines that meet demand

Forms of government support for upstream strengthening and structure building in photonics electronics convergence, and for collaboration with semiconductor companies

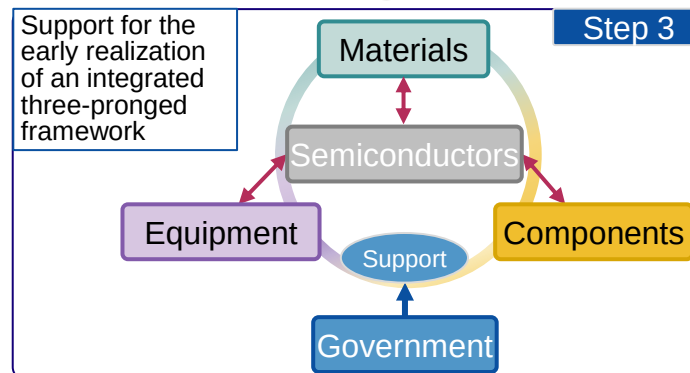
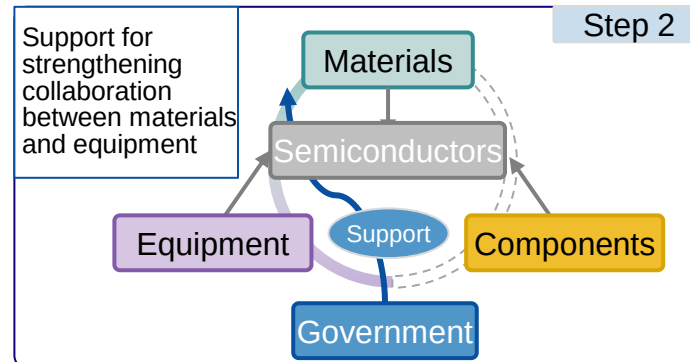
Support for R&D, etc. at individual companies

- In an environment with no clear technology roadmap and high uncertainty, provide support, including financial support, with the aim of reducing risks in R&D at individual companies



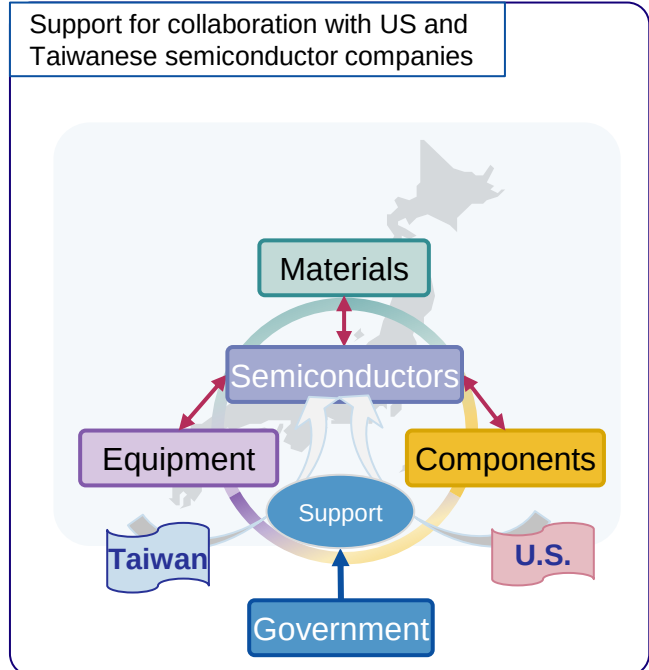
Support for forming co-creation frameworks

- Given that framework formation takes time, promote early framework formation through time-limited financial support



Support for collaboration with semiconductor companies

- Promote domestic R&D through government support for the establishment of domestic R&D bases by core US and Taiwanese semiconductor companies
- By also providing government support for R&D conducted in collaboration with integrated three-pronged frameworks, reduce R&D uncertainty for Japanese companies and enable the development of products that meet demand

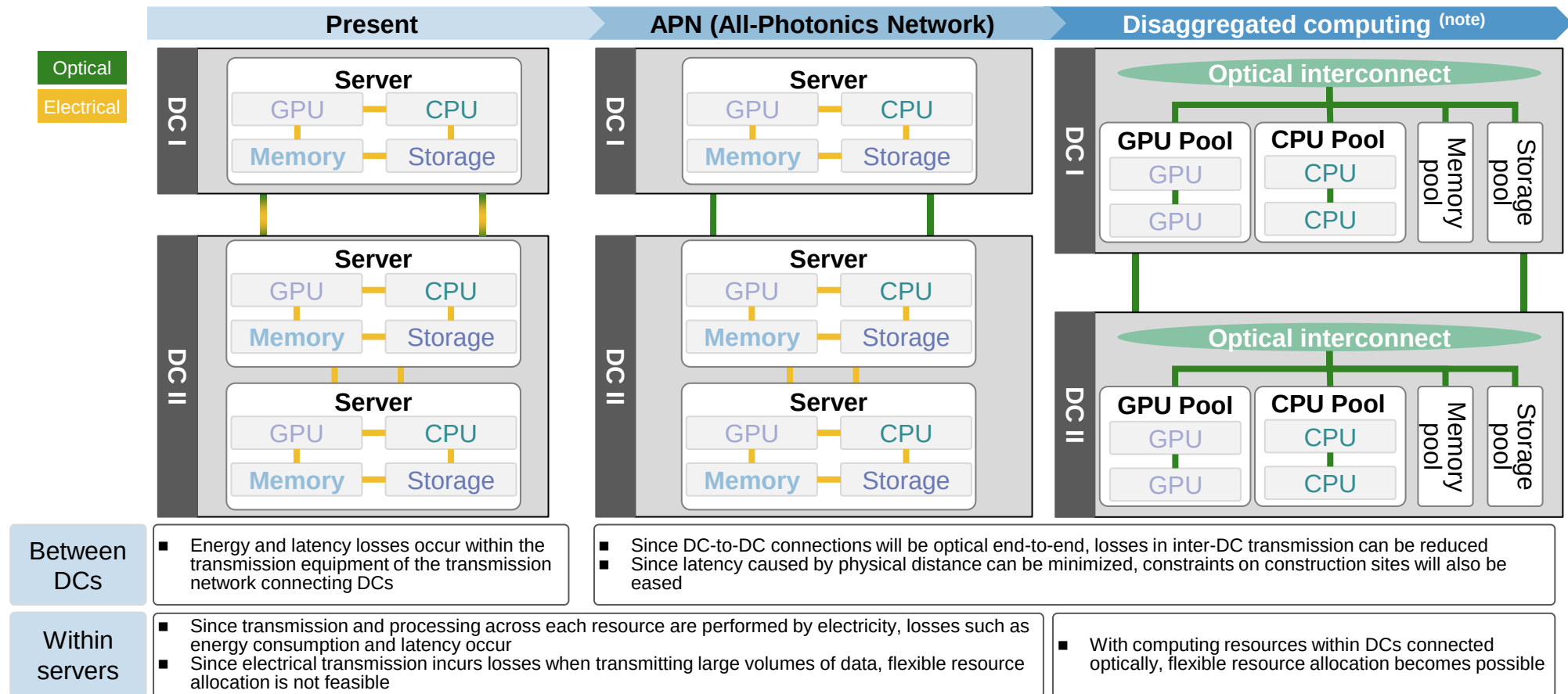


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

II. Developing DC services: building services that efficiently leverage DC computing resources is one approach

- Photonics Electronics Convergence enables optical transmission both between and within DCs, allowing the efficient utilization of computing resources
 - One approach is for telecommunications companies to build such DC services by integrating APN with systems (software and solutions)

Computing resource efficiency through photonics electronics convergence



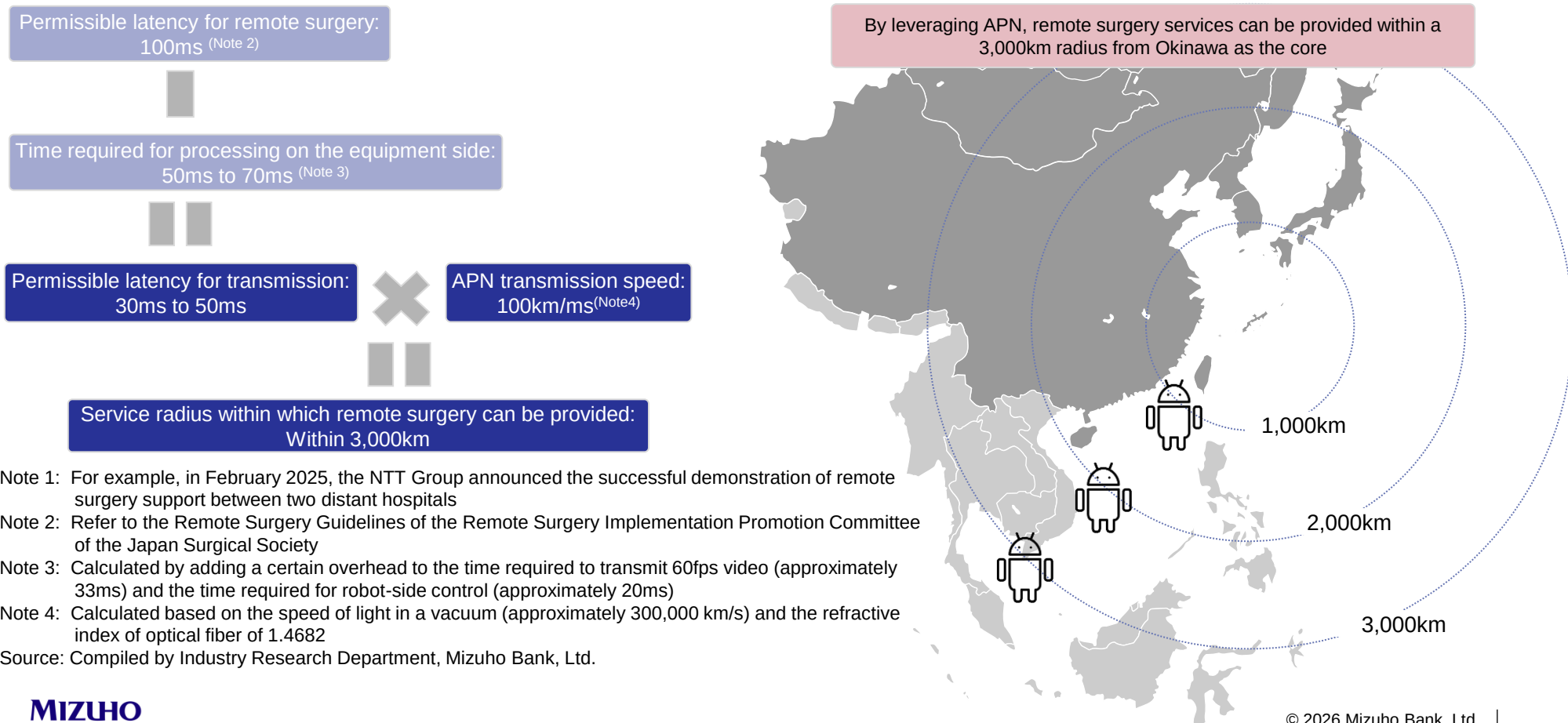
Note: A system in which resources such as CPU, GPU, and memory are located separately and can be flexibly utilized through software configuration

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on various publicly available information

III. Cultivating services unique to photonics electronics convergence: remote surgery services provided from Japan as the core are also an option

- Cultivating remote surgery services, where latency significantly affects safety, is a candidate that leverages the low-latency advantage of APN
- One approach is to provide services from Japan to high-income regions in East Asia, such as South Korea, Taiwan, and coastal China, as well as parts of Southeast Asia
 - Entry into remote surgery by telecommunications carriers, which will be the providers of APN services, is a strategic option
- For example, one approach is to launch remote surgery support services, which have already been demonstrated^(Note 1), from Okinawa as the core to Taiwan and Hong Kong, which are already connected by optical fiber.

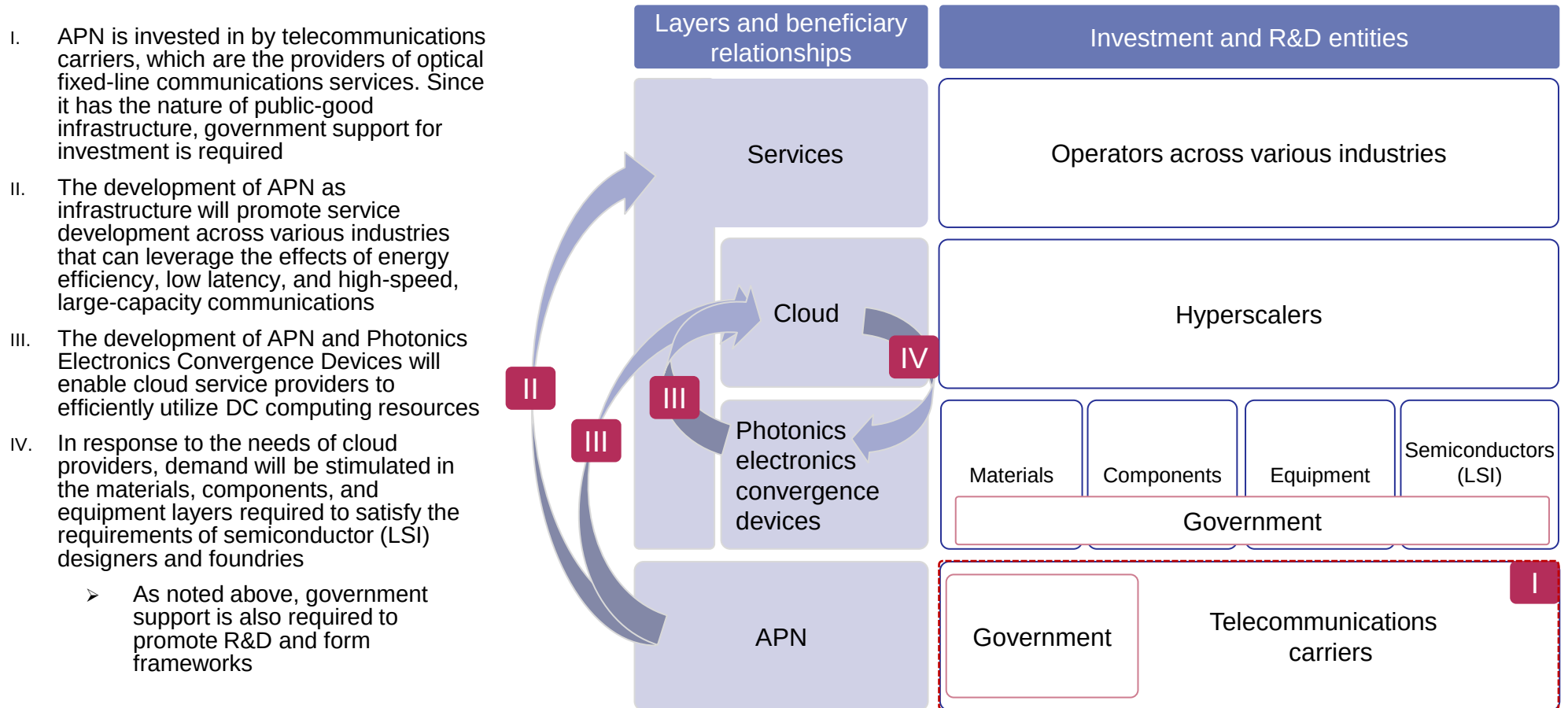
Approach to creating APN use cases (example of remote surgery services with Okinawa as the core)



Government support is also required to promote APN as infrastructure, given that investment and R&D entities differ from beneficiaries

- For APN, while telecommunications carriers are envisioned as the entities responsible for investment and R&D, the beneficiaries range widely from service providers across various domestic industries to cloud providers whose major players are overseas
 - APN is a technology with aspects of public-good infrastructure, requiring government support for its diffusion

Investment and R&D entities and beneficiary relationships for promoting photonics electronics convergence domestically

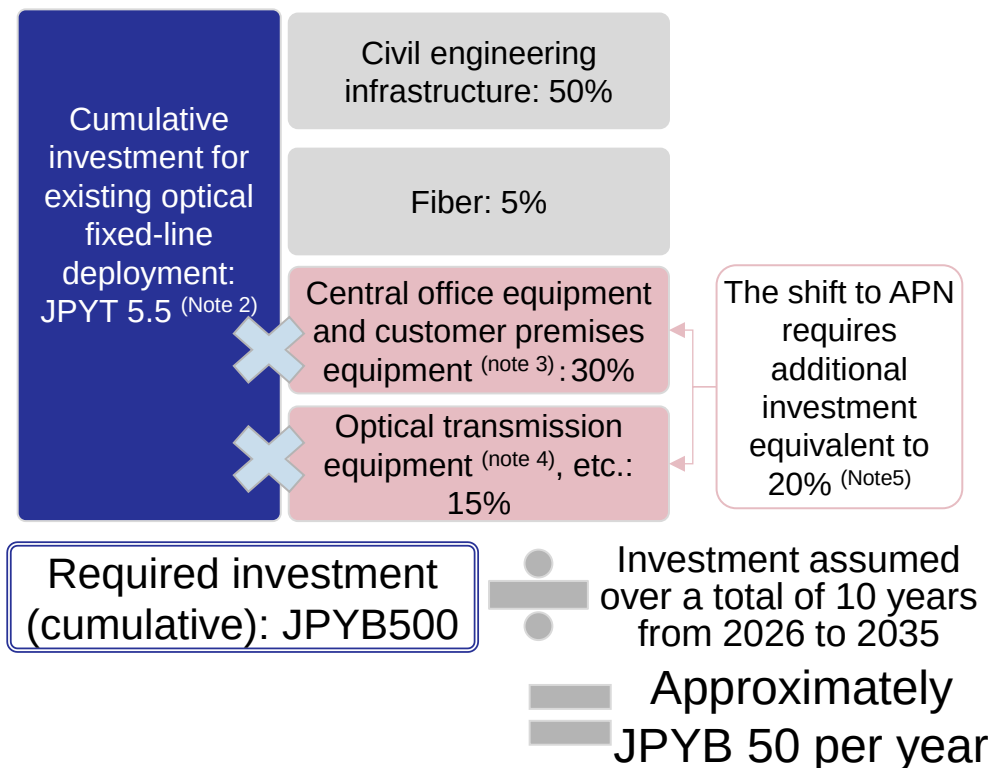


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

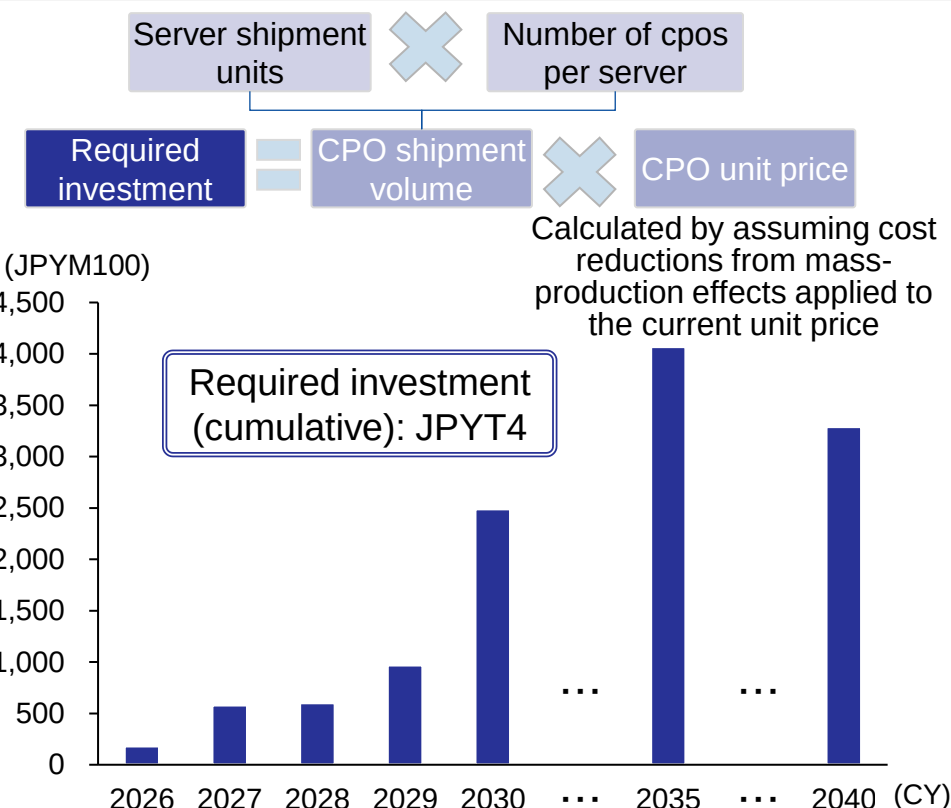
Required investment is estimated at a total of JPYT4.5, comprising APN construction and CPO deployment in servers

- An estimated total of JPYB500 in investment is required for APN construction, to replace Central Office Equipment and Customer Premises Equipment as well as Optical Transmission Equipment
- An estimated total of JPYT4 is required to deploy CPO ^(Note 1), a form of Photonics Electronics Convergence Device, for the optical conversion within servers at domestic DCs

Required investment for constructing APN domestically



Required investment for CPO deployment in domestic servers



Note 1: Abbreviation for Co-Packaged Optics. A device in which electrical circuits and optical-electrical conversion modules are packaged together

Note 2: Calculated based on the investment amounts of NTT East Corp. and NTT West Corp. for providing optical fixed-line services

Note 3: Refers to multi-wavelength-compatible transmission and reception equipment installed within the office buildings of telecommunications carriers, as well as terminal devices held by users within buildings

Note 4: Assumes the replacement with equipment that can dynamically add, delete, and switch routes by wavelength without converting optical signals into electrical signals

Note 5: Calculated based on various publicly available information, assuming that 10% of existing optical fixed-line related equipment will be replaced—at twice the unit price—to shift from systems that perform optical-electrical conversion during relay to all-optical transmission

Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd.

Realizing photonics electronics convergence enables investment effects exceeding the investment amounts; development ahead of the rest of the world is desirable

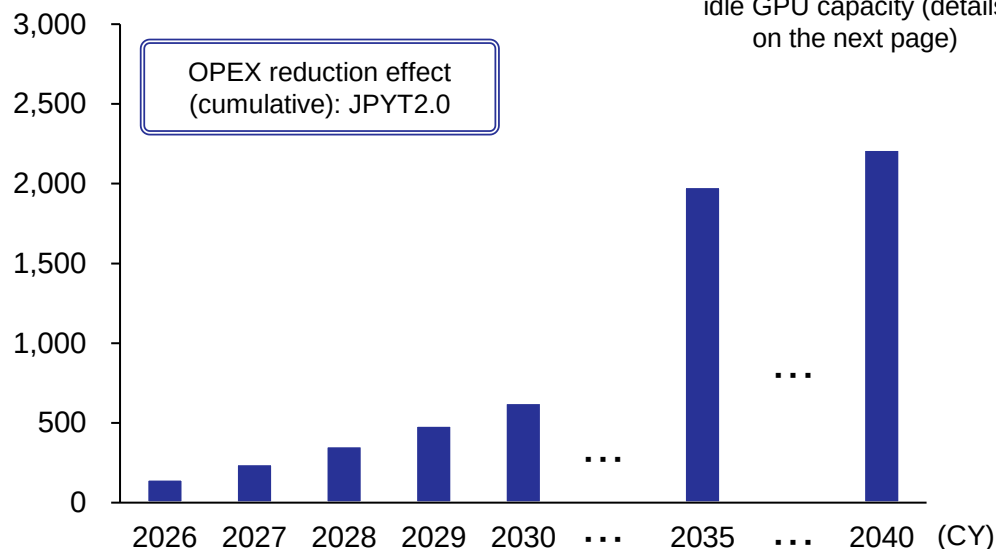
- The realization of Photonics Electronics Convergence is estimated to enable investment effects of reducing power consumption (a total OPEX reduction effect of JPYT2.0) and curbing accelerator (Note) investments (a total CAPEX reduction of JPYT3.8) through improved efficiency of DC computing resources
 - Considering the effects relative to the investment amounts, this means that efficient DC networks can be constructed, and development ahead of the rest of the world is necessary
- Furthermore, given the potential emergence and diffusion of ripple-effect services that leverage efficient DC networks, government support for investment is also useful

Effect of reducing power consumption within dcs (OPEX reduction effect)



Ultimately, a 15.5% effect is assumed through measures such as the efficiency improvement of idle GPU capacity (details on the next page)

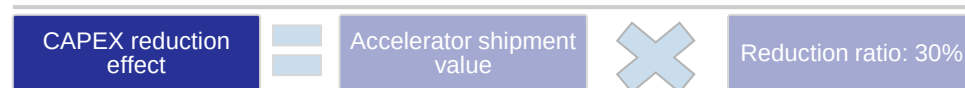
(JPYM100)



Note: Refers to semiconductors (LSI) specialized for AI computation within DC servers

Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd.

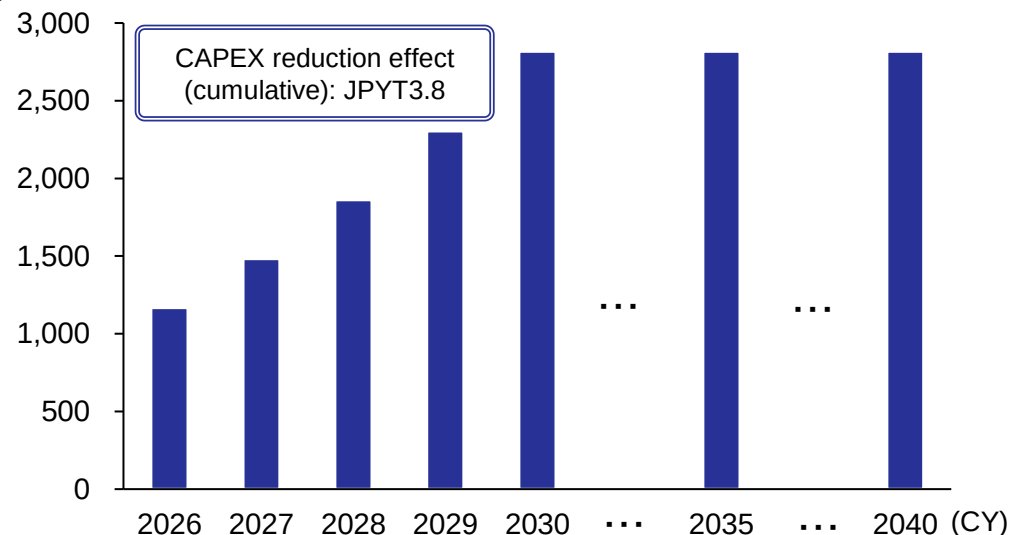
Effect of curbing accelerator investments within dcs (CAPEX reduction effect)



Domestic scale estimated based on global shipment value forecasts

Proportion of accelerators for which investment becomes unnecessary due to improved utilization rates

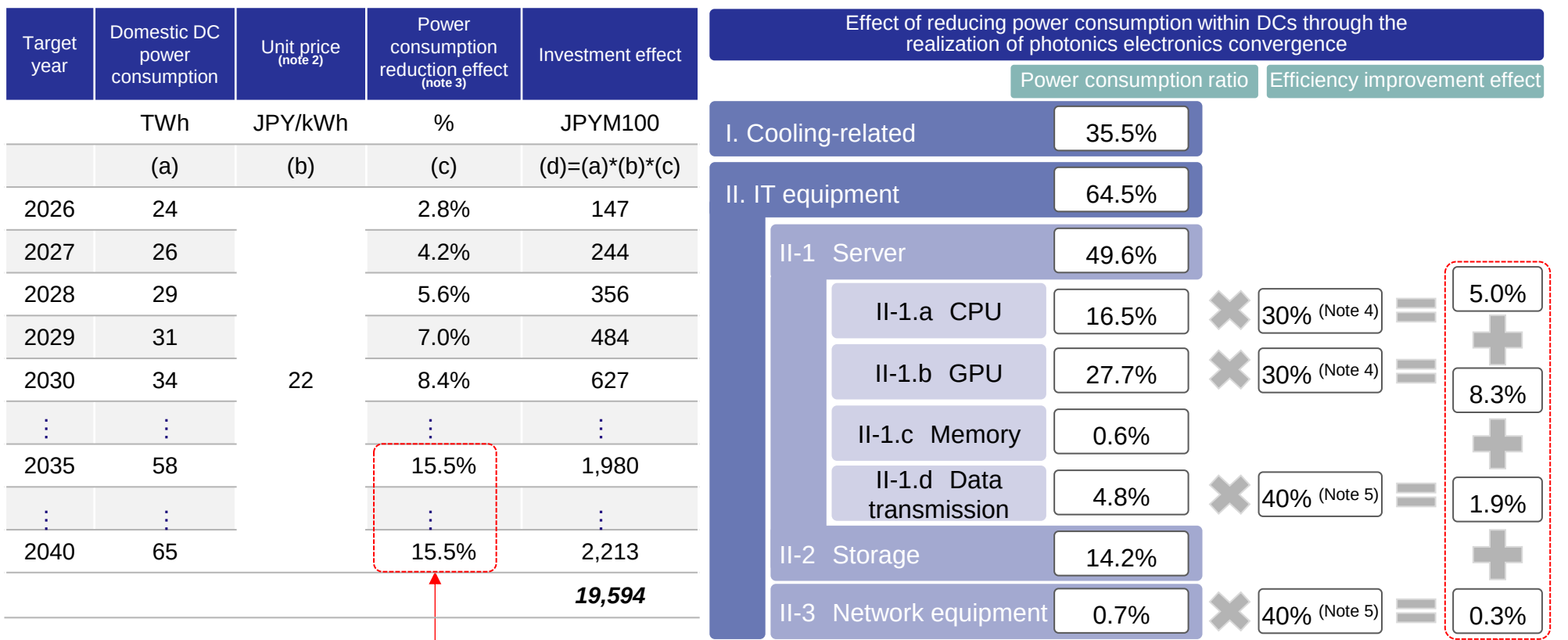
(JPYM100)



(Reference) the effect of reducing power consumption within domestic DCs through the realization of photonics electronics convergence is estimated at a cumulative maximum of approximately JPYT2

- At domestic DCs, an estimated cumulative maximum of approximately JPYT2-equivalent in power consumption reduction is achievable through factors such as the increase in GPU utilization rates resulting from the realization of Photonics Electronics Convergence
 - This estimate assumes that APN technology has been established and is being deployed in stages, and that transmission between LSIs in Photonics Electronics Convergence Devices will have been optically converted by around 2035

Approach to calculating the power consumption reduction effect (note 1)



Note 1: Since the power consumption reduction effect can vary depending on various environmental factors, this page presents theoretical values under the following assumptions

Note 2: Refers to industrial electricity costs in Tokyo in 2025, based on various publicly available information

Note 3: Assumes that APN for data center-to-data center connectivity will be completed in 2035, and that the power consumption reduction effect will progressively manifest from 2026 onward

Note 4: Under the assumption that the utilization rate is improved by 30 ppt, the processing time for the same volume of training and inference is assumed to be reduced by 30%

Note 5: Based on various publicly available information, the efficiency improvement effect for transmission is assumed to be 40%

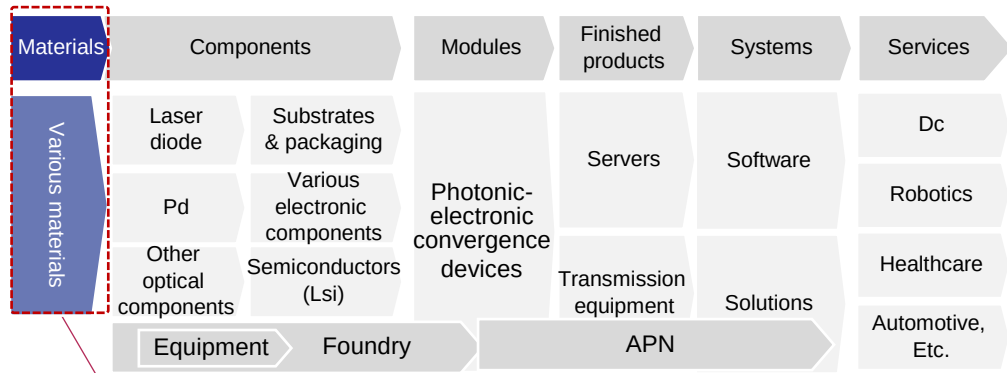
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Photonics Electronics Convergence Expected Effects on Japanese Society and Investment Amounts

(Reference) For the Materials Industry, There Is an Opportunity to Capture Growing Demand for Photonics Electronics Convergence Materials Driven by CPO deployment

- Materials for components that constitute CPO represent one of the areas where Japanese companies hold market share, presenting business opportunities that leverage their strengths
- As CPO deployment progresses for DCs and other applications, the global market for Photonics Electronics Convergence Device materials is estimated to expand to approximately JPYT1.2 by 2035. For materials manufacturers, it is important to capture this growth market through accelerated R&D and capital investment as well as through co-creation frameworks

Overview of materials for photonics electronics convergence devices

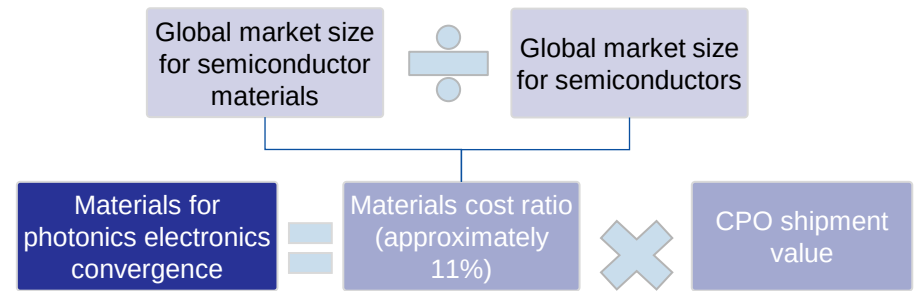


Application	Specific product examples
For LDs and laser PDs	- Compound semiconductors for LDs and PDs (InP / GaAs / AlGaAs) - Optical modulator raw materials (LN / InP, etc.)
For other optical components	- Optical waveguides (glass / polymer / Si, SiN) - Transparent adhesives for silicon photonics
For semiconductors (LSI)	- Front-end process materials (wafers, photoresist, CMP slurry, etc.) - Back-end process materials (BG tape, copper-clad laminates, encapsulants, etc.)

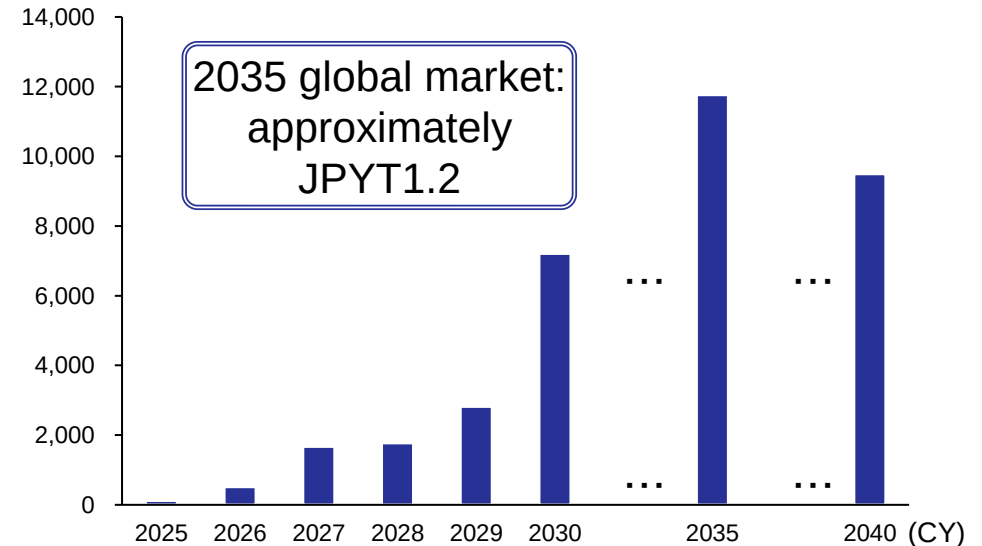
Note: The global market size for materials for Photonics Electronics Convergence Devices is estimated by Mizuho Bank Industry Research Department

Source: Both figures compiled by Industry Research Department, Mizuho Bank, Ltd.

Estimated global market size for materials for photonics electronics convergence devices ^(note)



(JPYM100)



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Mizuho Industry Research／80 2026

Published March 31, 2026

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