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The Semiconductor Question in the Russia-Ukraine Conflict

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Executive Summary

The invasion of Ukraine by Russia has raised a lot of questions on the effect it might have on international technology supply chains. With the ongoing chip shortage and an intricate supply chain with a number of dependencies, semiconductors have had the spotlight on them in recent times. The involvement of Ukraine and Russia in providing/exporting crucial materials (like Neon and Palladium) that remain integral to the seamless functioning of the entire industry has increased fears of a global chip production dip again. The comprehensive arguments made in this issue paper are:

1. The existing dependencies on Russia and Ukraine are not critical and redundancies or alternatives have been set in place for the efficient running of the global semiconductor industry for the time being.
2. The sanctions, embargoes, and export controls placed by the US will result in a chip import starvation to Russia and will have a negative effect on the nascent domestic semiconductor industry of Russia, especially on its economic/strategic sectors such as space, telecommunications, and automotive industry.
3. Russia can look to exploit certain circumventing measures to continue chip supply due to Chinese chip imports being affected with Chinese semiconductor firms under threat of secondary sanctions from the US government for any future exports to Russia.

I. Introduction

The global semiconductor supply chain remains a complicated and interdependent one, with international events triggering shocks across the entire industry. The recent invasion of Ukraine has resulted in the US placing harsh economic and technological sanctions on Russia. This has resulted in major semiconductor firms adhering to the US sanctions and cutting off their supplies to the country. The attack on Ukraine has also shed light on the country's role in the global semiconductor supply chain. With Ukraine reeling under the Russian military offensive, questions have arisen on how this recent crisis can have a bearing on the semiconductor industry. The world is still facing a chip shortage, and there are fears that such conflicts can exacerbate the issue.[1] This discussion document seeks to lay out the potential consequences of the ongoing Ukraine-Russia conflict and the sanctions placed by the West on the global semiconductor supply chain and the domestic semiconductor industry of Russia.

The onset of the COVID-19 pandemic had a significant impact on some of the crucial economic supply chains around the world. Semiconductors and their supply chain remain interdependent and have a host of factors that determine the industry's efficiency. The pandemic highlighted how such a globalised supply chain remains highly fragile and why building redundancy as a mitigation strategy is the need of the hour.

The entire process of manufacturing a semiconductor chip involves many processes ranging from design to packaging. Each process requires specific tools (software and hardware), materials, and competency.[2] This means that no country can manage to single-handedly take over the entire process of manufacturing chips without incurring significant public and private costs. The US and its firms dominate the design of semiconductor chips, while Taiwan has a monopoly over the fabrication process of the chips. The Netherlands and Japan have entrenched themselves in supplying equipment (photolithography tools) and crucial materials required for the fabrication process itself.[3] This is where the role of Russia and Ukraine in the global semiconductor industry comes into the picture.

Russia remains the world's largest producer and exporter of Palladium, a critical element used in semiconductor chips' coating and finishing process.[4] Ukraine has been a leading producer of Neon gas which is used in the etching process (a technology that will selectively remove material from a thin film on a substrate hence creating a pattern/design of that material on the substrate) during the fabrication of chips.[5] The recent unfolding crisis places the question of whether these dependencies the global semiconductor industry has on the two countries can be mitigated or if the escalation of the war can result in negative consequences for the supply of chips. Further, it is important to understand how the sanctions and export controls on Russia can affect its domestic semiconductor industry and the responses by Russia's traditional semiconductor partners.

II. Impact on the World's Semiconductor Chip Supply

It is evident that there is an ongoing shortage of semiconductor chip supplies worldwide. The long periods of inactivity due to the COVID-19 pandemic have slowed down the quantum of supply and production still not reached their pre-pandemic levels yet. The consumer electronics market as well as the automotive industry have been hit badly due to this shortage. Apple, an important manufacturer of mobile phones and laptops, has pushed the release of their new line of products and announced that the number of iPhone models being manufactured this year (2021-22) would be reduced due to the chip shortage.[6] Automotive manufacturers like Ford (among the others) have been forced to cut down production at their plants and are still reeling from losses.[7] This begs the question of whether the current Russia-Ukraine crisis has the potential to exacerbate the supply issue.

The Ukraine Dependency

As mentioned, the existence of several choke points in the semiconductor supply chain plays a vital role in determining the efficiency of the global supply. One such chokepoint can be the Neon gas, which is used as an etching gas in photolithographic tools. All semiconductor chips have definite patterns printed on them. Lasers are used to etch these patterns on the substrate/metal, which forms the base for the chip. Rare gases like Neon and Xenon, due to their non-reactionary nature, are used to power these lasers during the etching process. This remains a critical aspect during the fabrication of the semiconductor chip.

Ukraine remains one of the world's largest suppliers of Neon gas. Coincidently, the increase in production of Neon gas in Ukraine took place due to increased industrialisation activities in Russia post the breakup of the Soviet Union. A by-product of steel production, Ukrainian plants and companies were set up to filter the gases released during the manufacturing process of steel. One of these gases was Neon. The recent Russian attacks on the country have resulted in the closure of industries

specialising in producing these gases. The city of Odessa, which was one of the worst-hit cities due to the Russian bombings, houses companies named Cryoin and Iceblick. These are the country's top Neon-gas producers (Iceblick, in 2020, with its plants in both Odessa and Moscow, accounted for 65% of the world's total Neon production as well as 15% of the world's total Xenon and Krypton production) but were forced to shut down operations due to the Russian advancement into the city.[8]

With regard to alternative suppliers of the Neon gas itself, many semiconductor firms like Micron and ASML have preemptively decided to diversify their sources.[9] Some have also mentioned how there has been a reduction in dependency on Ukraine in recent times to import semiconductor-grade Neon. Countries such as the United Kingdom and a few in Asia (such as Japan and South Korea) have a number of firms operating that are exporters of semiconductor-grade Neon gas.[10] These will serve as alternatives in light of the recent crisis.

Concerns had been raised over how the non-supply of Neon by Ukrainian companies could potentially have ripple effects in global semiconductor production. Claims had also been made on how the possible stoppage of Neon supply from Ukraine can further slowdown the rate of chip production. But not all parts of the semiconductor supply chain can be used as chokepoints; alternative suppliers and substitute materials can absorb such shocks. Major semiconductor manufacturing firms have moved from dry etching processes that need rare gases like Neon and Xenon to plasma etching processes. Plasma etching processes use Chlorine and Fluorine based gases (halogen-based gases) which serve as credible alternatives to rare gases. Though more reactive in nature, these halogen-based gases now dominate the semiconductor etching domain.[11]

Hence, the non-supply of Neon by Ukrainian companies for the time being need not be a choke point for worldwide semiconductor production. Since alternative suppliers were already in place for rare gases, the question of additional costs for firms does not arise. Adaptation would be easier, the transition would be simpler, and the effect on global chip production would be minimal in the current stages of the conflict.

The Russian Dependency

Russia remains the world's largest producer and exporter of high-grade Palladium, a metal used in semiconductor chips' coating and finishing processes. Similar to Neon production, the rare metal of Palladium is a by-product of the Nickel manufacturing process in Russia. In 2021, the total production of this metal in the country stood at 2.35 million ounces. With the country now facing sanctions, export bans, and other economic blockades, there are fears that this would lead to a shortage in Palladium exports, resulting in exorbitant prices on the market. There is also the issue of Russia being one of the leading producers of the metal's possible alternatives, Rhodium, and Platinum.[12]

If Russia decides to ban the exports of these metals, then there is a fear of it leading to shortages in the market. As per some experts, this comes at a time when the automotive industry is slowly getting back on its feet after a chip shortage, and another shock may dampen the prospects of the industry's rebound. While this may hold true, considerations of such a scenario had already been made in the recent past due to Russia's actions. Hence, a bottleneck standpoint does not apply in this specific case.

The annexation of Crimea in 2014 also saw similar fears related to post which all semiconductor firms started diversifying the supply of Russian-dependent materials. Global stockpiles still exist for the short-term and alternative suppliers for these platinum-based materials for immediate use. The United States and the United Kingdom are major suppliers of Palladium themselves hence accounting for the void left behind by Russia, if any. Other than this, reports also mentioned that the US government had already indicated to its chipmakers of a possible escalation, asking them to find possible alternatives to Russian imports.[13] Currently, the semiconductor plating services are dependent on Palladium as a material but not Russia as the sole source of the material.[14]

Intrinsic interdependencies and the ability of different countries to contribute to the existing market sheds light on the global semiconductor industry's current nature. However, stop-gap measures have been created for the voids that might be left due to the current Ukraine-Russia conflict. In the short run, the conflict in Ukraine is expected to have minimal impact on the rate of production as well as the functioning of the global semiconductor industry. This assessment could change in case of a protracted conflict that impacts raw material supplies in and out of the two countries for an extended duration.

III. Impact on Russia's Semiconductor Industry

While the global semiconductor industry may come out of this conflict relatively unscathed, one thing for certain is the negative impact this conflict will have on Russia and its domestic semiconductor industry. The growing sanctions and import/export controls on Russia will cripple its domestic chip industry and can land a huge blow to its economy.

An understanding of the current capabilities of the Russian domestic semiconductor industry is necessary to comprehend the effects of the Western sanctions and other measures. Apart from the private industry, Russia has some state-owned conglomerates involved in the production of semiconductor devices.[15]

Rostec is a state-owned defence conglomerate with a company Ruselectronics under its wing. This company, Ruselectronics, is responsible for producing and manufacturing semiconductor devices and electronic components. It includes diodes and photo detectors, LEDs, other display panels, and microwave devices like isolators and circulators.[16] The company also has joint ventures with international companies like Alcatel-Lucent (French communications company), Tata Power (Indian defence electronic systems company), and CASC (Chinese Aerospace Science and Technology Corporation in developing Avionics).

In recent times, there has been an increase in the state's involvement in the electronics and semiconductors domain.[17]

In the name of national interest, the state has taken a controlling stake in major private firms (semiconductor companies dealing in both commodities and defence components manufacturing) Micron and Baikal Electronics remain effectively in the control of the government now. But the domestic private sector feels that the state support for the industry remains ineffective and does not contribute to the emergence of competitive products and enterprises. With growing sanctions against Russia preventing large-scale production even using 28-nm technology, the increased state involvement will also block

domestic enterprises from accessing foreign factories that produce products using more modern technologies.

Mapping the Russian Semiconductor Industry

Manufacturing - Russia's existing facilities do not offer much on the semiconductor manufacturing front. The only semiconductor firms with manufacturing capabilities are Angstrem-T and Mikron Group.

In 2008, Angstrem-T signed a joint venture with the German firm M+W Zander (Excyte) to build a semiconductor plant in Zelenograd, Russia. With a total investment of around $200 million, the goal of the plant was to manufacture 130nm integrated circuits.[18] A complete fab of around 6000 square meters including a clean room and central heating, cooling systems were built. However, in 2018, the company went bankrupt and was taken over by its primary creditor, the VEB.RF investment company.[19] As per a bankruptcy report, the firm only had the capability of manufacturing the 250 nm process node.[20]

The Mikron Group was a major electronics manufacturer even during the Soviet Era. It started the production of the 90 nm process node from 2012-13. A separate manufacturing and design center worth over 16 billion rubles was built to produce the 90 nm technology products with over 50% of the total investment financed by the Rusnano group. In 2014, the company announced the production of a domestic microprocessor called Elbrus-2SM (designed by the company MCST) using the 90 nm process.[21] Soon, the production facility upscaled and started the 65 nm production process in 2020.[22] The production capacity of this unit remains relatively unknown, but it is responsible for producing domestically designed chips.

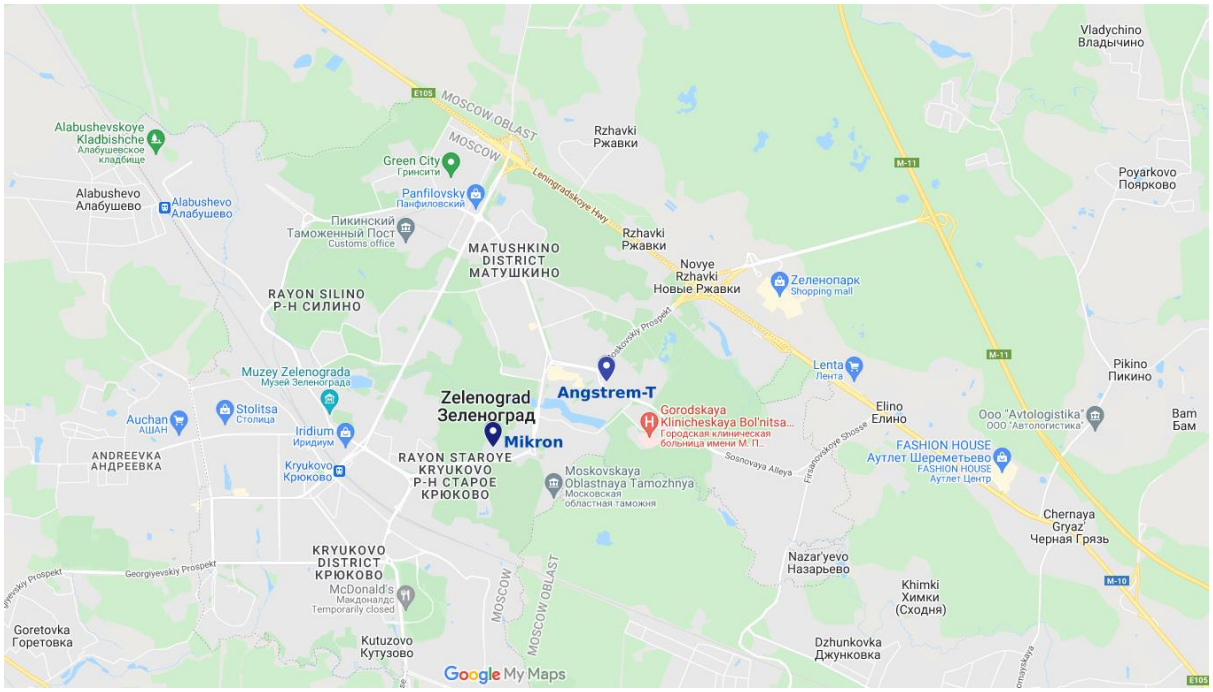

Figure 1: Russian semiconductor manufacturing and fabrication facilities (Source: Google Maps)

Design - Russia's domestic semiconductor design capabilities rest on a few firms involved in the 'fabless foundry' model focusing on designing semiconductor chips and outsourcing the manufacturing bit to giants like TSMC. The main firms include Baikal Electronics and MCST. Other companies like ELVEES focus on designing communications-specific chips using DSP modules (the Multicore series) that are used for space applications.

The Baikal-M series and the Elbrus models are the two main lines of Russian-designed semiconductor chips. The processors are designed based on the RISC V ARM architecture. However, the Baikal-M provides lower grade performance compared to the US's Intel and AMD counterparts and is still not suitable for their intended use case in servers for Sberbank's IT infrastructure.[23] Russia's domestically designed MCST Elbrus x86 CPUs are also not as efficient as their Intel and AMD counterparts. Thus, they would only be successfully used for small to medium-size businesses or bulky, inefficient personal computing needs.

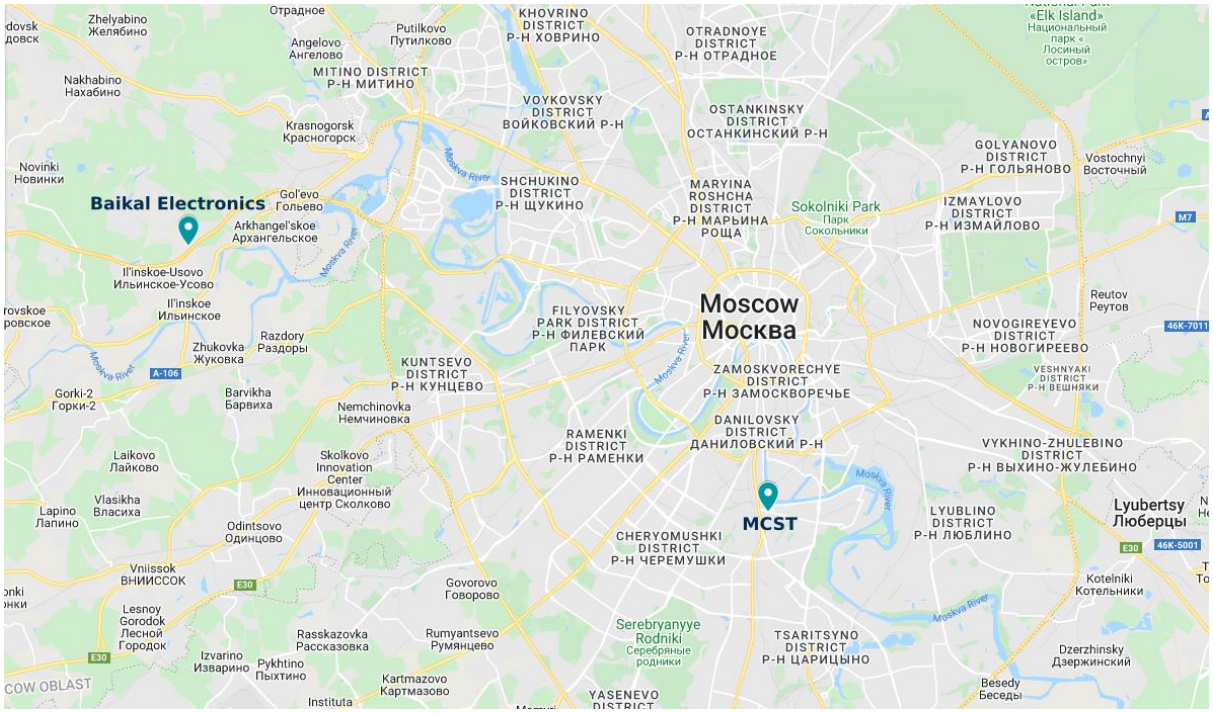

Figure 2: Russian semiconductor design facilities (Source: Google Maps)

ATMP - Many Russian private companies claim to have the capability to assemble, splice, and package ICs. One such company, GS NanoTech which has its facilities in the Kaliningrad region of Russia, is supposed to be an experimental assembly service provider for Russian CPU designer Baikal Electronics.[24]

The company is also involved in the production of "indigenous SSDs". The distinguishing feature of SSD production is that the company GS NanoTech produces packaging of NAND memory modules, mounting components on the board, final assembly, and packaging of products.[25] Cutting, packaging, and testing of memory take place in Russia with complete control at every stage of production, which should attract local integrators.

Other companies like SMT Technology offer services like wafer testing, semiconductor quality inspection, scribing and cutting, grinding, polishing of semiconductor wafers and substrates.[26] There are currently no major semiconductor ATMP companies in Russia with smaller companies catering to the local demand itself. Since the domestic production is comparatively lesser, the demand for these assembly and testing companies has not increased.

Equipment - The Russian government held meetings on coping with possible high-tech export controls with a ban on importing photolithographic equipment weeks before the sanctions and embargoes were announced. Presumably, Russia could not secure any new photolithographic equipment before the export controls came into effect.

The Ministry of Industry and Trade set aside 5.7 billion rubles to develop local lithographic scanners at the end of 2021. The Zelenograd Nanotechnology Center (ZNTC) was recently revealed to have begun design work on this order.[27] With the Ministry of Industry and Trade, the Center signed two contracts: one for the development of scanners with a topological level of up to 350 nm, and the other for up to 130 nm.

The 350 nm photolithography scanners are planned to be mass-produced in 2025. For installation, a ready-to-use semiconductor laser from a domestic manufacturer will be used. The 130nm scanner would take another year post 2025 to develop. To avoid using imported components, such as the lasers from the American company Cyber, which are now widely used in Russian semiconductor factories, a domestic 193-nm laser will be built from the ground up for this scanner. As a result, the 130 nm scanner project may take a bit longer to complete than the 350 nm one.

The Belarussian electronic manufacturing equipment building firm, Planar technologies, has been the traditional supplier of optical-mechanical and control equipment for Russian semiconductor firms. It has ties with around 50 Russian enterprises. As part of the 'Microsystem Technika' program, the firm was hired to manufacture equipment for big enterprises like Roselectronics, Rosatom, Rosvooruzhenie, and Roscosmos.[28] In the former Soviet Union, lithographic scanners (that still continue to exist in current Russian factories) were produced by the Planar Minsk plant.

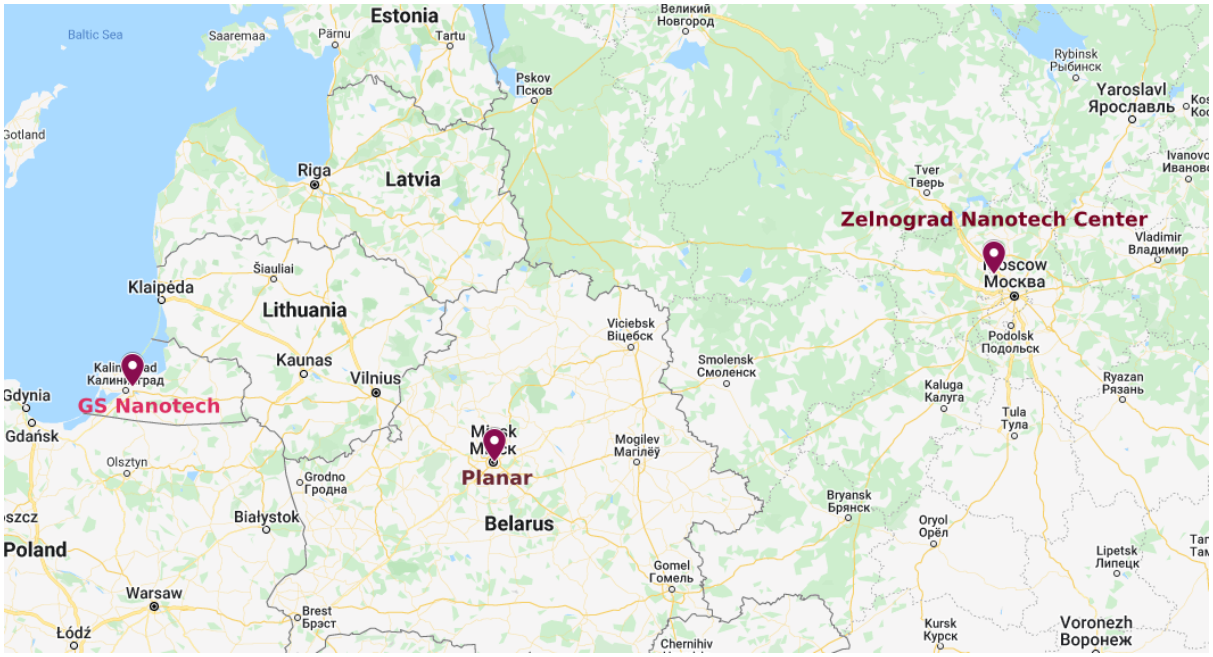

Figure 3: Russian semiconductor ATMP and equipment manufacturing facilities (Source: Google Maps)

The Russian government, specifically the Ministry of Industry and Trade of the Russian Federation, had planned to invest large amounts of money in building its domestic semiconductor ecosystem. A total of 1.2 billion rubles was set aside by the Ministry specifically for improving the end-to-end manufacturing process of semiconductors and a total of 5.7 billion rubles on the microelectronics industry alone.[29]

Even with financial incentives offered to domestic firms, most companies have not been able to comply with government directions due to their foreign dependencies. They have asked for extensions to be self-reliant in the field. For the time being, Russia purchases roughly 70% of its chip supplies from China.

Russia is not a significant direct consumer of semiconductors, accounting for less than 0.1% of global chip purchases, according to the World Semiconductor Trade Statistics (WSTS) organisation.[30] At the same time, India imported close to $3.14 billion worth of semiconductors in the year 2019 which is close to 0.7% of the world's chip purchases. But it should also be noted that Russia forms just 1.87% of the world's total population and that the broader Russian Information and Communication Technology (ICT) market totalled only about $50.3 billion out of the $4.47 trillion global market, according to the 2021 International Data Corporation (IDC) statistics.[31] Also, the majority of

semiconductor products actually coming into Russia are not finished chipsets but are through Original Equipment Manufacturers (OEMs).

With no significant manufacturing capability of its own and its firms producing low-end designs of processors, the semiconductor industry will definitely take a hit due to the imposed sanctions when trying to import high-end processors and chipsets (which might be needed for other strategic sectors).

IV. The Sanctions and the Embargoes

The real issue for Russia lies in the recently announced sanctions and export control mechanisms in the high-tech sector by the West, specifically the United States. It is the first time that export controls on high-tech components are targeted towards a specific country (in this case, Russia). According to the statement released by the Bureau of Industry and Security (BIS), the Department of Commerce, Government of the United States of America,[32]

"The US has imposed secondary and primary sanctions on Russia on imports of computers, chips, etc. The new controls mean the American government is in effect claiming jurisdiction over any person or company in the world that uses American technology to make products for sale in Russia. It forces anyone who wishes to sell a vast array of technologies, including semiconductors, encryption software, lasers, and sensors, to request a licence—which is denied by default. The control is enforced through the threat of further sanctions against any company, person, or country which sells to Russia in contravention of the rules. The dominance of American technology, which is used to make products worldwide, means that a huge array of products will be caught in the net."

It also mentions that "Only case-by-case exemptions may be given to 'safety of flight, maritime safety, humanitarian needs, government space cooperation, civil telecommunications infrastructure, government-to-government activities, and to support limited operations of partner country companies in Russia." This would mean that in the short term, many states and their respective domestic companies would stop supplying specific technologies to Russia in order to comply with the sanctions that have been issued.

All US companies now are required to take a licence to sell products like computers, sensors, lasers, navigation tools, telecommunication equipment, avionics (aerospace-

related electronics), and marine equipment.[33] Most of the companies are expected to toe the line of the US government due to caution and the fear of blacklisting. Even when a licence request is applied, the US government would deny these requests. Export licences for goods and technology that the US government feels come under the ambit of national security purposes would be completely stopped. This covers the dual-use technology goods which would be potentially used by the Russian military.

The official White House press release states that the imposition of these sanctions would severely impact Russia's financial institutions, crippling the national banking assets. It also emphasises how the export control mechanisms that have been imposed have the ability to cut off more than half of Russia's high-tech imports, restrict Russia's access to vital technological inputs, and prevent the country from diversifying its economy.[34]

The sanctions by the US effectively prevent Russia from importing a range of products, from chips to telecommunications equipment. But what is noteworthy is that the sanctions prevent Russian imports of both American products as well as products manufactured in other countries that use proprietary technology of any American firm or company to manufacture the products under the sanctioned list. This would mean that any firm, located in any country around the world, cannot export certain products even if they have been manufactured on that country's soil utilising any sort of American technology during the process of design and manufacturing.[35]

This has led to top-end American semiconductor companies like Intel and AMD putting a stop to all exports to Russia. Both companies issued statements stating that they were suspending all shipments and sales to all customers in Russia and Belarus.[36] Along with the US, the world's semiconductor manufacturing powerhouse Taiwan has also joined in with the sanctions. The Taiwanese company TSMC (Taiwan Semiconductor Manufacturing Company) has already suspended deliveries of fabricated chips to Russian semiconductor design firms like Baikal and MCST Elbrus.[37]

However, the import of consumer electronic goods like mobile phones, personal computers, and other gadgets does not seem to be affected by the imposed sanctions as of now. While the embargoes do not cover any day-to-day electronic items, the responses from big electronic goods manufacturers around the world are something to take note of. Apple has announced that they are pausing all product sales in Russia until the conflict

concludes. Global laptop manufacturers like Dell and HP have suspended all shipments to the country. South Korean mobile phone giant, Samsung, has also suspended product sales and shipments to all customers (wholesale and retail) in Russia. On the telecommunications front, equipment manufacturers like Cisco, Nokia, and Ericsson have all ceased all deliveries to the country. This means that even though the sanctions overlook the consumer electronics market, dealers have unilaterally stopped business in the country. This would hamper the supply of general electronic items to Russian citizens in the short term, at least.

Failure to comply with American directives also means that these companies (even if they are not Russian) are liable and at the receiving end of potential sanctions themselves. This has made countries and their firms wary of going against directives right now. Currently, the South Korean semiconductor firm SK Hynix, among the primary suppliers to Russia, has not issued any directive till now and has continued its supply of semiconductor chips to the country. Though the South Korean government joined in the sanctions imposed by the US, it has sought exemptions from the US for semiconductor exports as it could negatively impact its semiconductor industry.[38]

However, there is the issue of China. Russia has historically depended on its southern neighbour for semiconductor imports. Here arises the question of whether Chinese firms can still export semiconductor chips to Russia in the current scenario. China's state-owned and largest semiconductor enterprise, Semiconductor Manufacturing International Corporation (SMIC), also uses American IP related to semiconductor design and manufacturing. What remains to be seen is whether China (and subsequently its firms) go against the levied sanctions and continue to supply Russia with chips.[39] India has also been supplying some chips to Russia, and these restrictions might impact the country's chip exports too. The GLONASS chipsets, which are mainly used as part of navigation systems for receiving incoming signals in satellites, were designed by Russian firms, and production was outsourced to India.[40] These specific chips are essential to the national space agency, Roscosmos, and any export restriction on India in supplying these to Russia might impact their space program also.

V. Effects on Russian Economy Sectors

Even with continued Chinese imports, some of Russia's sectors will take a beating because of the non-capability of Chinese firms to manufacture leading-edge chips. Russia will be left with an influx of trailing-edge semiconductor devices meant for civilian and general use. Defence (autonomous weapons) and space (satellites) systems that require trailing technology node chipsets might still reach Russia through its allies like China. With sanctions on manufacturing equipment and design tools, the ability of Russia to produce even the lower-grade chips will decrease, and there will be an increased dependency on China for its imports. With China not well-versed in leading-edge node technology, these chips will still remain out of Russia's reach, at least for the time being. What will be interesting to watch is the response of the US government if China decides to ignore the American IP sanctions and continue exports to Russia. That might result in the US blacklisting Chinese companies using American IP and hence Russia not getting access to even the lower-grade chipsets affecting their defence and space exports, which form a significant part of their economy as well as national revenue. Since Russia doesn't have any significant manufacturing capabilities, the immediate impact will be on their data centres, as they are used by government-affiliated organisations, and hence subject to restrictions.

1. Impact on Large Russian Banks and IT companies

Russia's large conglomerates with mega IT infrastructure needs were on a spending spree to acquire a huge quantity of IT hardware just before the export controls came into effect. Sberbank, Russia's largest and most heavily sanctioned bank, splurged for "servers, data storage hardware, software" especially virtualisation software from VMware.[41] As the performance of Russia's Baikal and Elbrus processors is lacking, they are not really desirable for mega infrastructure needs.

2. Impact on Automotive Industry

Much of the semiconductors and ICs meant for assembly in Russian auto manufacturing factories will now be restricted and diverted elsewhere, possibly even India.[42] Given the use of 65nm and larger nodes in the manufacturing of chips needed for the auto industry, China might be able to support Russia to some extent with exports.

3. Impact on State Space Company ROSCOSMOS

Russia's state space company chief Dimitry Rogozin has admitted to the lower house of the Russian parliament, the State Duma, that ROSCOMOS can't launch certain satellites because they are semi-finished and can't be completed without certain microchips imported from the West which they can't import since 2014 because of sanctions.[43]

4. Impact on ROSTELECOM and Communications High-Tech Infrastructure Equipment

Russia's telecom companies have been hit hard as they are denied access to any new infrastructure and industrial equipment from western sources under the export control embargos. Russia only produces around 20% of this needed equipment and would have to rely on procuring the remaining 80% elsewhere, likely from Chinese sources.[44] This equipment namely "equipment for wired broadband access and data transmission, fixed wireless access and data transmission, PBX, backbone data transmission equipment, television and radio broadcasting and studio, navigation, satellite" also contain integrated circuits and their constituent semiconductors which would be under embargo with the new export controls' introduction.

Import Substitution and Mitigation Measures by Russia

Although the scope of Russia's response to the sanctions has been long in the making, it has achieved little to mitigate the damage. The Russian government had held meetings on coping with possible high-tech export controls, including a ban on importing photolithographic equipment by Russia, weeks before the sanctions and embargoes were announced. Presumably, Russia could not secure any new photolithographic equipment before the export controls came into effect.

Ever since the introduction and announcement of the export controls and other embargoes under sanctions Russian authorities have moved to mull and take policy decisions like letting companies raise prices, give them tax breaks, relief packages, and buying capital which was divested by exiting Western countries.[45] The discourse in government, business, and policy circles in Russia is centered around finding alternative facilities in jurisdictions for the manufacturing of their microelectronic products instead of acquiring photolithography equipment that can make Russia largely self-sufficient. This would likely make them even more dependent on Chinese foundries and other facilities with China enjoying a monopoly and dictating terms and prices to its advantage.

VI. Conclusion

A geopolitical event such as the ongoing Russia-Ukraine conflict always had the potential to alter some of the global technology supply chains. Semiconductors, being a globalised supply chain with multiple choke points, were going to be at risk due to such conflicts. But previous crises (such as the 2014 annexation of Crimea) ensured adequate responses by concerned stakeholders to have alternatives in place and create redundancies in the supply chain. Hence, the ongoing Russia-Ukraine war would have minimal impact on the global semiconductor supply but the possibility of a drawn-out war can impact prices (of Neon and Palladium) causing some disruptions in the future. The majority of the impact would be on Russia due to the Western sanctions and the stoppage of imports from crucial semiconductor firms. With strict export controls also in place, Russia's strategic sectors (like telecom, space, and defence) will bear the brunt of the semiconductor sanctions. One must keep an eye on how Russia's allies also respond to these sanctions and how the country looks to navigate the impending decreased supply of semiconductor chips.

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