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Adriatic ports in the evolving dynamics of the Mediterranean maritime landscape

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Abstract

Relatively peripheral to both Europe and the Mediterranean core business markets, the Adriatic Sea is characterized by a high intensity of maritime transport, relatively scattered on many small and medium-sized ports. Despite the "maritime cul-de-sac" position of the Adriatic Sea, traffic growth is particularly significant over the past decade, in particular large container ships, as well as ro-ro and oil tankers. As Central Europe becomes more integrated into international trade due to recent inland and Trans European corridors, some new markets opportunities are emerging for Adriatic ports. Although their total tonnage are still modest compared with those of their North Sea and Western Mediterranean counterparts, these ports have new ambitions, given the European outlook and modernized inland transportation networks.

This paper examines the positioning of Adriatic ports in the more global context of the Mediterranean Sea: with only 1% of the surface area of the seas, the Mediterranean alone concentrates 25% of the world's maritime traffic. Today, with a globalised and highly competitive shipping industry, the Mediterranean and the Adriatic Sea are experiencing a real restructuring in the maritime and port sectors leading to the emergence of major strategic disruptions that represent challenges and opportunities.

Two central elements will be addressed. Firstly, an analysis of the review of container terminal operators will examine the integration of the region's ports into the shipping industry's global strategies. Secondly, the use of AIS (Automatic Identification System) will enable us to understand the operational reality of this maritime network.

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1. Introduction

The Mediterranean, which covers only 1% of the world's seas, accounts for 25% of global maritime traffic. This makes maritime transport an excellent indicator of the world economy's pulse. Today, with a globalised and highly competitive shipping industry, the Mediterranean is experiencing a real restructuring in the maritime and port sectors leading to the emergence of major strategic disruptions that represent challenges and opportunities.

The Mediterranean is a significant transit route and transshipment area for international maritime transport, as well as a zone of intense traffic due to intra-Mediterranean maritime traffic. Its position makes it a crucial location for transportation. A recent trend has been the integration and specialization of several routes with feeder ships converging at major maritime intermediate hubs in the Mediterranean, in light of the negative impacts of deviations from main maritime shipping routes in terms of services and port calls' frequency.

The Adriatic Sea is a unique case within the Mediterranean area due to its semi-enclosed nature and peripheral location away from the economic heart of Europe.

In this paper, we propose to focus on container traffic and on the ports themselves, in particular with regard to the strategies of the stakeholders including port authorities, shipping lines and finally shippers and logistics providers. Methodologically, the article is based on a study of port traffic data and an analysis of container terminal operators' reviews (Drewry, 2022; Dynamar Database: ports & Terminals Europe & Africa 2023), as well as the use of AIS (Automatic Identification System). This recent and original deployment of AIS in transport geography is presented in numerous publications (Dupont, 2021; Yang, 2019) highlighting the methodologies developed (Serry, Lévêque, 2015; Serry, Kerbirou, 2020) and the issues at stake.

The paper's first section highlights the maritime significance of the Mediterranean in the inter-oceanic circulation of goods, while the second section focuses on the current situation on the Adriatic shores.

2. A maritime area of transition between Suez and Gibraltar

The Mediterranean Sea is traditionally divided into two basins: the Western Mediterranean Basin and the Eastern Mediterranean Basin, separated by the Italian hinge (Clément, 2004). The Mediterranean Sea is home to significant global transportation hubs, including those located on the African continent such as Tangier-Med and Port-Saïd, as well as island systems in Europe. A major port bisector runs through the Mediterranean, with Piraeus located at the eastern end, Gioia Tauro at the central convergence, and the Algeciras-Tanger Med duo at the western end (Alix, Montier, Fauray, 2020).

2.1. A dynamic region in the western Mediterranean

The Mediterranean is an unavoidable transit area connecting Asia, the Middle East and Europe. It is located at the crossroads of three major maritime passages: Gibraltar, the Suez Canal, and the Bosphorus. As a result, the Mediterranean generates and concentrates all types of maritime traffic. Around 120 international commercial ports are located here, with 33 of them expected to have traffic exceeding 20 million tons (Mt) in 2022.

Even if the region is crossed by major fossil fuel energies routes, and dry bulk flows, containers remain the primary focus due to their presence in a favorable geophysical and geopolitical configuration. The ports on both shores handle a total of approximately 50 million twenty-foot equivalent units (TEUs) of traffic, excluding the extremely high volume of transit traffic (see Fig. 1).

In Spain, the container market is dominated by the Mediterranean ports of Barcelona, Valencia, and Algeciras (Serry, Kerbirou, 2020). Barcelona, which ranks third in terms of importance with 70 Mt in 2022, is a multifunctional port. Valencia ranks second with 80 Mt. But the immediate hinterland of the Catalan port is shrinking, contributing to its decline in the hierarchy of continental container ports. The ports in southern Spain are part of a dynamic group located near the Strait of Gibraltar, which has established itself as the western gateway to the Mediterranean basin. Algeciras, the leading Mediterranean port in terms of tonnage (108 Mt), benefits from this location and has been chosen by Maersk Line to become a transshipment port and global hub. Valencia, which has partnered with Mediterranean Shipping Company (MSC), also benefits from this situation.



Fig. 1. Main container ports in the Mediterranean Sea in 2022.

However, the dominant position of Algeiras is now being challenged by the increasing power of the Moroccan port of Tanger Med (107 Mt in 2022). This strait area has experienced an unprecedented wave of port investments since the 2000s. Tanger Med is now the leading container port in the Mediterranean and Africa, with a traffic volume of 7.6 million TEU by 2022. It has direct connections to thirty-seven African ports. Tanger Med serves not only as a maritime hub but also as an industrial platform, supported by multinational corporations such as Adidas or Renault. It is the dominant port along the Maghreb seaboard, where most ports are medium-sized and have a regional or national function. Further north, the ports of Genoa and Marseille have centuries-old infrastructures. However, they remain relatively captive markets due to their peripheral location in the strategic transoceanic rotations of liner shipping companies.

2.2. A contrasted Eastern Mediterranean

In the Eastern Mediterranean, with the exception of Israeli ports, each country has its own main ports. Egypt has a relatively dense network, handling 145 Mt of goods in 2022, with the ports of the Suez Canal and Alexandria dominating. Turkish ports hold a prime position in this region (413 Mt in 2022), due to their proximity to the Black Sea and the country's economic potential. Turkish port authorities benefit from a strong national policy that encourages the development of infrastructure and services to support the country's economic and strategic influence in the Mediterranean and beyond.

The ports located in the central Mediterranean region are positioning themselves in the transshipment niche due to their proximity to the east-west route. Gioia Tauro handled over 3 million TEUs in 2022, Marsaxlokk handled 2.9 million TEUs, and Piraeus, which was privatized and taken over by Chinese state-owned Cosco Shipping in 2016, has established itself as a major new player with 4.4 million TEUs.

Following the dominant Algeiras-Tanger Med combination of Gibraltar straight, it is important to note that the other significant hub of the Basin is situated at the northern end of the Suez Canal. The Egyptian ports of Damietta (1.1 million TEU) and Port Said (4 million TEU) have become the dominant hubs of the Eastern Mediterranean (see Fig. 1). The recent strategic agreement between Maersk Line and the Egyptian government aims to supply the Danish giant's ships with green hydrogen produced in Egyptian ports. A strategic location connecting Europe, Africa, and the rest of the world.

The northern shore comprises an Adriatic “maritime cul-de-sac” with relatively diffuse traffic. Ports such as Koper (23 Mt) or Venice (24 Mt) remain medium-sized and share continental ambitions that require rail solutions connected to European freight transport networks.

2.3. A Platform for Global Competition

According to 2021, it should be noted that four of the Top 7 Global Container Terminal Operators are from the Far East and one represents the Middle-East. However, with the exception of China's Cosco Shipping, which has acquired a dominant stake in the port of Piraeus in Greece, those global terminal operators are not very active in the Mediterranean port area, unlike Northern European ports in particular. The two most dynamic terminal operators are APM Terminals (market shares in 11 terminals, mainly in the Western Mediterranean) of Denmark and Terminal Investment Limited (10 terminals heavily in the Eastern part) of Switzerland. These are terminal subsidiaries of the world's second-largest container shipping company (Maersk Line) and the world's largest container shipping company (MSC).

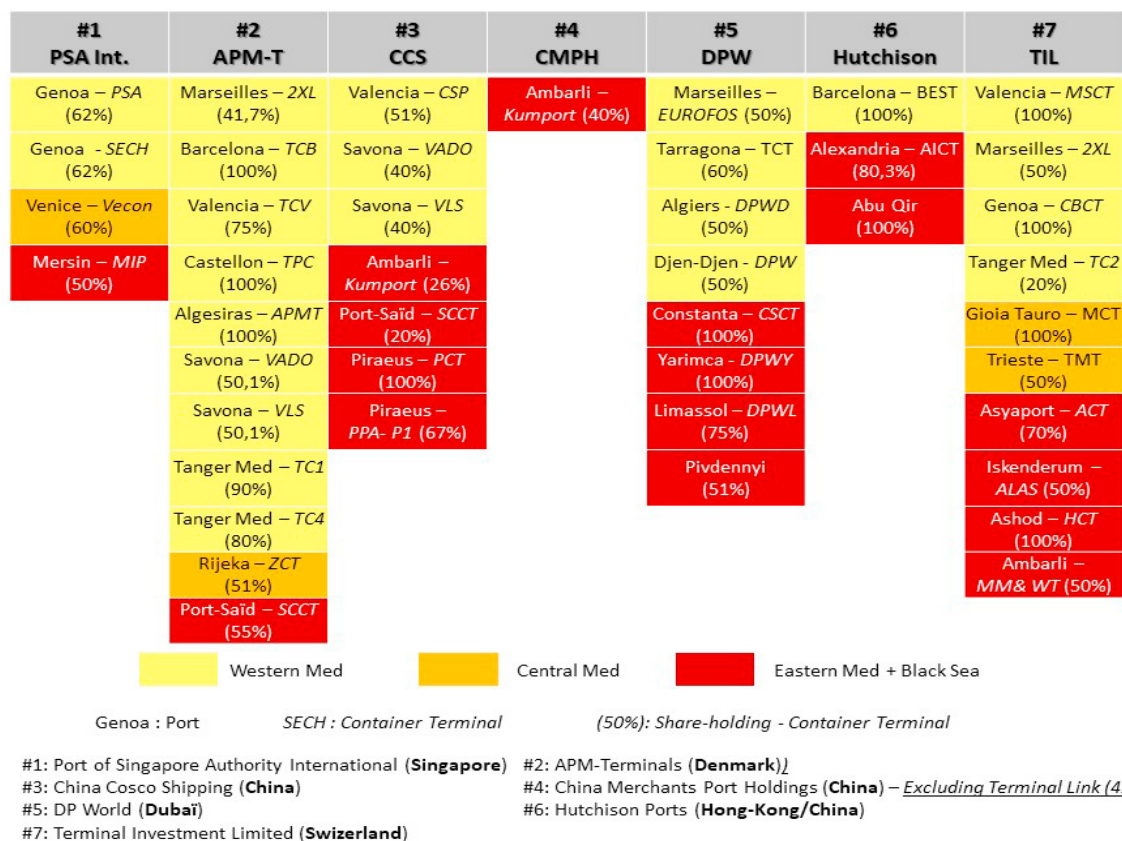


Fig. 2. The Mediterranean Container Terminal Network of The World's Top 7 Global Container Terminal Operators in 2021.

The Global Container Terminal Operators' equity-based throughput on the Mediterranean Container Market adds another perspective to the domination of the two European companies, which control 12.18 million TEUs and 7.52 million TEUs respectively. Another important finding from these market shares is that the Mediterranean port activities are still highly fragmented, with a large number of small and medium-sized operators mostly active in small and medium port gateway terminals, apart from concentrations in transshipment terminals.

Mediterranean transshipment ports are dedicated to relay and interlining operations, as well as important hub and spoke operations like Algeiras and Tanger Med, which act as turntables between Europe-Asia trade and diagonal routes, such as North Europe-West Africa and North Europe-South America (Notteboom, Parola, Satta, 2019). But the Mediterranean maritime and port area is highly diverse, lacking a cohesive maritime facade to reflect its strong focus on the sea (Mareš, Ducruet, 2014). The regional economies in which container ports operate have a major impact

on their performance. In particular, it has been shown that the economic weakness of certain regions in a globalised environment hampers the physical integration of these regions into value and logistics chains (Kaplinsky, 2004) and reduces the competitiveness of ports (Ducruet, 2008). Connected to the fact that the development of a port system is highly dependent on the strategic decisions of market players (Ducruet, 2016), this can partly explain why the Adriatic Sea stands out within the Mediterranean region. Indeed, the average size of container ships there is lower (2200 TEU in 2022) than that of the entire Mediterranean Sea (3828 TEU).

3. The Adriatic Case

3.1. Modest, peripheral Adriatic ports

The Adriatic Sea is considered peripheral in both Europe and the Mediterranean, with numerous small and medium-sized ports that are typical of this 'maritime cul-de-sac' localisation. (Alix, Serry, 2022). Maritime transport is highly intensive but relatively dispersed, presenting significant traffic growth over the last decade, especially in Koper receiving a larger number of large container ships, ro-ro vessels, and oil tankers (Perkovic, Harsch, Ferraro, 2016).

As Central Europe becomes more integrated into international trade, new markets are emerging for the ports of the Adriatic Sea. Although their tonnage levels are still modest compared to those of their North Sea and Western Mediterranean counterparts, these ports have new ambitions given the European outlook. For instance, in the bulk sector, the ports in the Adriatic serve as a natural gateway for Central and Eastern European traffic. They are well-positioned to benefit from any enhancements in hinterland infrastructure that could attract cargo currently routed through Northern European ports (Serry, 2020).

But, Notteboom and De Langen (2015) point out that the North Adriatic Ports faces scale disadvantages compared to the northern hub ports, which hinder the further development of the hinterland intermodal network (Stamatović, De Langen, Groznik, 2018). Although container traffic may not be dominant, it is rapidly growing, primarily due to the favourable geographical location maximizing the use of the maritime leg to the disadvantage of road and even rail transportation. Maritime transport from China to the EU is shorter in distance to the Adriatic ports than to those in Northern Europe (Twrđy & Batista, 2016). Door-to-door transport services takes advantage of the proximity of Adriatic ports to central and southern European production and consumption areas. Container traffic is concentrated in the northern part of the Adriatic (Lupi, 2019), which is considered a multi-port gateway. It comprises the Italian ports of Ravenna (228 000 TEU in 2022), Venice (534 000 TEU), and Trieste (878 000 TEU), Koper (1 018 000 TEU) in Slovenia, and the Croatian port of Rijeka (521 000 TEU). Koper is now the region's leading container port and its structure of throughput has changed: the share of containers has more than doubled since 2008 to reach almost 47% of total throughput in terms of tons in 2021 (Zanne, Twrdy, 2023).

We used graph theory and AIS data (Serry, Lévêque, 2015) to study the maritime networks of container ship operators and to highlight their structures. The dominant flow method was chosen due to its simplicity, ease of understanding, and ability to highlight the deep structure of the maritime network under study. This method defines a threshold and retains all relationships above it. The graphs were produced using R software and the "Igraph" package. Figure 3 displays the partial graph of the maritime container ship system in the Adriatic Sea for relationships with seven or more links in 2020. The graph illustrates the operational scheme of containerised maritime services organisation in Adriatic ports. It identifies a network that is dominated by the major Central and Eastern Mediterranean hub of Piraeus. According to AIS data, the Adriatic network is relatively poorly connected. However, several sub-graphs appear which are similar to regionalised organisations, such as the one between Venice, Koper and Trieste.

In reality, the northern Adriatic market is structured around the twin Trieste-Koper gateway, which offers the best assets for serving the hinterland of Central Europe (Beyer, Sevin, 2008). Rijeka is growing at a slower pace, handling 249,975 TEUs, which is approximately 40% more than in 2007 (Host, Pavlić Skender, Mirković, 2018). Feeder services with transshipment in the hub ports of Gioia Tauro, Marsaxlokk (Malta), Piraeus (Greece) and Port Said (Egypt) handle the majority of container traffic in the northern Adriatic ports. In contrast, the Adriatic ports have a negligible role in deepsea services, which refers to the maritime transport of goods on intercontinental routes, crossing oceans, as opposed to short sea shipping over relatively short distances.

It is evident that smaller ports, such as Bar, Durres, and Split, are situated on the periphery of the port system. This implies that they are connected to larger ports through feeder services with relatively low volumes.

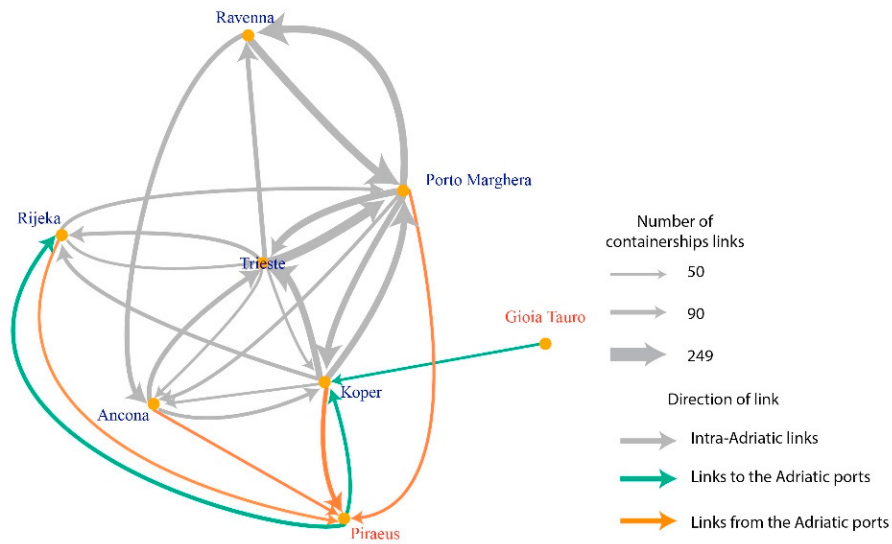


Fig. 3. Adriatic container network in 2020 (Over of 49 connection).

3.2. Dynamic approach

A study of the top 6 container ports in the Adriatic region will provide a better understanding of the dynamics and allow for the integration of shipping players' strategies, such as ports and shipowners, into our analysis. This study compares 2012 and 2022, a 10-year period marked by significant changes in the maritime industry, including the implementation of alliances between companies. In the Mediterranean region, this period was crucial, exemplified by COSCO's acquisition of the port of Piraeus in 2016. This investment in Piraeus is part of the Chinese state's 'One Belt, One Road' initiative and is COSCO's largest overseas project in terms of investment value. It is considered a significant milestone in the Group's international expansion (Zheng, Smith, 2017).

However, as previously demonstrated, the ports in the region are primarily linked to the main maritime routes through the central and eastern Mediterranean hubs. The impact of different strategies on Adriatic ports can be manifold, depending on factors such as the choice of transshipment ports or vessels. According to Golnar and Bešković (2023), there are some differences in the container services offered by shipping companies that provide direct overseas connections between Chinese ports and the northern Adriatic. In 2023, there were three direct container services in operation:

- On the westbound route to Koper, Maersk and MSC called at the following ports: Xingang, Dalian, Busan, Ningbo, Shanghai, Shekou, Singapore, Port Said, and Haifa. The service was operated by ships with a capacity of up to 15,500 TEU.
- The Ocean Alliance direct container service was operated jointly by shipping companies CMA-CGM, COSCO, Evergreen, and OOCL. The service scheduled westbound departures from the ports of Shanghai, Ningbo, Busan, Shekou, and Singapore, using ships with cargo capacity ranging from 8,500 to 10,000 TEU.

The German shipping company Tailwind's independent service, Panda Express, operated a direct service from Chinese ports to Koper. The westbound voyage to Koper began in Shanghai, Qingdao, Ningbo, and Shenzhen. Ships with a cargo capacity of 3,800 to 5,500 TEU were utilized.

When examining the connections between the Adriatic ports and several Mediterranean hubs, significant developments become apparent. Piraeus, although still the primary hub, appears to be losing its importance while Marsaxlokk is gaining power, in accordance with CMA CGM's strategy. CMA CGM is also increasing its presence in the Adriatic, with 562 calls in 2022 compared to 164 for COSCO. This represents a strategic shift in port selection

for both companies. MSC remains the leading company and the historic 'local' operator. MSC offers services operated by smaller vessels than CMA, with an average of 1718 TEU compared to CMA's 2355 TEU. In contrast, Maersk provides fewer ships but offers direct deep-sea connections, with an average size of over 10,000 TEU.

The evolution of container ship sizes calling Adriatic ports appears as a key indicator of this pattern of evolution. Although the overall size of ships has increased from 1,889 to 2,390 TEUs between 2012 and 2022, this trend varies across ports (see Fig. 4). Analysis of the AIS data reveals that the size of ships in the ports of Durres, Ravenna, and Venice has remained relatively stable. However, there has been a slight increase in ship size in Trieste, a 35% increase in Koper, and a 70% increase in Rijeka.

The case of Rijeka is noteworthy because it demonstrates the impact of shipping lines' strategies on port development. The increase in average size is directly related to the expansion of Maersk's services. In 2012, Maersk's operations in the region were very limited, with ships of no more than 7,500 TEU. However, it is now a significant player, deploying container ships of over 15,000 TEU. The Croatian port benefits from the aforementioned choices, connecting it directly to China, similar to Koper, while also maintaining ports of call in Mediterranean hubs like Port Said.

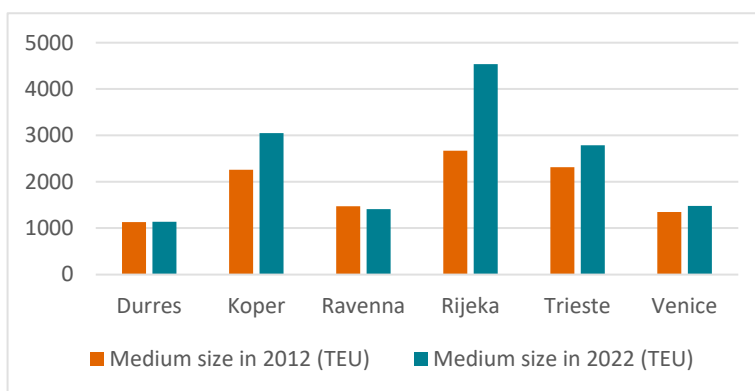


Fig. 4. Evolution of the average size of container ships in ports.

However, the study of AIS data suggests that hasty conclusions should be avoided based solely on the presence of large ships and high theoretical annual capacity: a direct correlation between the capacity offered by shipping lines and traffic intensity has not been demonstrated and can be discussed.

4. Conclusion

In the Mediterranean, the landscape of global container terminal operators presents a nuanced picture, with European companies largely dominating. Market shares show a high degree of fragmentation, with numerous small and medium-sized operators, particularly in gateway terminals. Transshipment ports such as Algeciras and Tanger Med play a key role in relay operations between Europe-Asia trade routes and diagonal routes, highlighting the diversity of maritime activities in the Mediterranean. However, the region lacks a coherent maritime façade reflecting its diverse economic landscapes and challenges. The Adriatic, with its lower average container ship size, stands out within the Mediterranean, suggesting a dynamic driven by regional economies and strategic choices made by market players.

The Adriatic is home to a dynamic but peripheral maritime network with significant potential for growth and integration into global trade. While the Adriatic ports, particularly Koper, have size disadvantages compared to the northern hubs, they are strategically positioned to serve as gateways to Central and Eastern Europe. The region's container traffic, while not dominant, is growing steadily, facilitated by favourable geographical proximity and developing hinterland infrastructure. Despite challenges such as limited deep-sea connections and dispersed maritime networks, there are opportunities for Adriatic ports to capitalise on their unique advantages and expand their role in

international trade. With smaller peripheral ports connected to larger hubs through feeder services, the Adriatic is emerging as a key maritime corridor, poised for further development and integration into the European perspective.

In conclusion, our study reveals the complex dynamics shaping maritime trade in the region. While Adriatic ports remain primarily linked to central and eastern Mediterranean hubs, shifts in shipping routes and vessel sizes reflect the evolving strategies of key players such as CMA CGM, MSC, Maersk and COSCO. In particular, the rise of Marsaxlokk and the strategic decisions of shipping lines have influenced port development, with Rijeka's expansion illustrating the impact of increased vessel sizes and direct connections to China. This study underlines the complexity of maritime trade dynamics in the Mediterranean region, especially in the Adriatic, and the importance of understanding the strategies of shipping actors for future analysis and integration into global trade networks.

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