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European Transport Corridors and North Adriatic Ports

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Abstract From the ports in the northern Adriatic Sea (ports of Ravenna, Venezia, Trieste, Koper, Rijeka) a route from European ports of North Sea to the Far East is shorter by about 2000 nautical miles. It means a reduction of 6 to 8 days in shipping. These ports are reachable from commercial and industrial centers of Central and Eastern Europe. An assessment of the current situation and future development of the European transport corridors North - South, including possible interconnection by multimodal corridors Baltic ports in the north and Adriatic ports in the south, is included in this paper. This corridor is one of the ten basic corridors included in the new conception of the TEN-T European transport network with the assumption of financial support from the EU in the period of 2014-2020. Further, the paper also includes an analysis of a modal assessment (Modal Split) of transport connections of Central Europe with the Far East.
The heart of the paper is a proposal of connection of chosen seaports that serve as logistics terminals to current European multimodal corridors and further to proposed multimodal corridors.

Keywords North Adriatic Ports, European transport corridors, railway, multimodal transport corridors

JEL O33; R40; R41; R42

1. Introduction

Currently, the transportation of goods is performed mostly by maritime transport. For the future, options of land transport connections i.e. railway transport are considered and assessed. This includes connection of the Far East - Europe.

The opportunity of using railway connection between Asia and Europe depends on two essential facts. The first one is an adequate railway route through Asia up to Europe, the second one are sufficient railway corridors in Europe, including strategically located and adequately capacitated public logistics centers.

The Trans-Siberian Railway is a perspective possibility of rail connection (length more than 9,000 km) between Europe and Asia. It can be considered as a supplement of maritime route. The Trans-Siberian Railway can connect all the regions concerned, which may become part of the interconnected intermodal transportation system.

In the future, it is necessary to take into account planned canal Danube - Oder - Elbe. In the case of its implementation, it will be a multifunctional water work of major importance for the Czech Republic and Europe, which will connect a system of European waterways.

2. European Transport Corridors

When planning future transport corridors, it is necessary to use the Trans-European Transport Network (TEN-T), a network of road and rail corridors, international airports and waterways, and the Pan-European multimodal transport corridors (The Pan-European Traffic Networks), as the main transport axes between the EU and the countries of Central and Eastern Europe. It means nine rail and road corridors, the tenth, no. VII, is a water corridor – the river Danube.

These development corridors are currently different from the TEN-T network, which covers all the main routes within the European Union.

The concept of electronic freight transport (e-freight) - the electronic flow of information and tracking and tracing of goods during their journey, is also important. An essential precondition is the establishment of standard interfaces within the various transport modes and their interoperability across different transport modes. The implementation of information technologies in the freight logistics is in line with the document "Freight Transport Logistics in Europe - the key to sustainable mobility" (2006).

2.1. Association NAPA - North Adriatic Ports Association NAPA - Port of Ravenna, Port of Venice, Port of Trieste, Port of Koper, Port of Rijeka

The Association of ports in the northern Adriatic Sea – the NAPA was established in March 2010, the ports of Ravenna, Venice, Trieste and Koper. In November, Port of Rijeka became a full member of the Association. The North Adriatic Ports Association (NAPA) is an association of five North Adriatic seaports: Port of Koper, Port of Ravenna, Port of Rijeka, Port of Trieste and Port of Venice.
Port of Venice - key facts
- 2,200 ha surface area
- 30 km wharves
- 31 operating berthings

- 12/14 m depth
- 205 km internal railway network
- 70 km internal road network
- 24 terminals
- 1 dedicated cruise terminal + yacht facilities

Port of Trieste - key facts

- 2,300,000 m2, of which 1,800,000 m2 are a free zone
- 425,000 m2 of OPEN storage area
- 500,000 m2 of covered storage
- 12 km of quayside
- Berths with depths up to 18 m
- More than 20 well-equipped specialised terminals capable of handling every type of cargo
- Passenger terminals located in the heart of the historic city centre

Port of Koper - The Biggest Car Terminal in the Adriatic - key facts

- 2,800,000 m2 total port area
- 247,000 m2 of enclosed warehousing
- 76,000 m2 of covered storage areas
- 900,000 m2 of OPEN storage areas
- 3,300 m of quayside
- 143,000 m3 of shore tanks
- Max sea depth: 18 m

Port of Rijeka - Modernized Port of Competitiveness and High Efficiency - key facts

- 1,500,000 m2 total port area
- 335,000m2 m2 of enclosed warehousing
- 8,652 m of quayside
- 58 berths
- Sea depth at quays: 5.5 – 28 m
- Total reloading capacity 33,000,000 t
- Oil terminal: 2 berths (max. 20.000 m3/h)
- Port passenger terminal in the historic city centre

The five NAPA seaports are located at the northern tip of Adriatic sea, a natural waterway that penetrates deep into the middle of the European continent, thus providing the cheapest naval route from the Far East via Suez to Europe with a distance that is about 2,000 Nm shorter than other North-European ports.

More than 100 million tonnes of water-borne cargo are handled in the NAPA seaports every year. The cargo consists mainly of general cargo, containers, cars, ores and minerals, fossil fuels, chemicals and others types of cargo.

Due to huge variety of logistic services and the extensive traffic network, NAPA forms a perfect multimodal gateway to the key European markets. The near-by fifth Pan-European transport corridor provides a quick-link to 500 million European consumers. Large commercial and industrial hubs like Vienna, Munich and Milan are just few hours' drive away.

The four entities combine their strengths in order to promote the Northern Adriatic route and present themselves as an alternative to the North-European ports. In addition, the association anticipates cooperation in the development of maritime and hinterland connections, visits from cruise lines, environmental protection, safety and information technology. The ports of NAPA will also invest efforts into the coordinated planning of road, rail and maritime infrastructure, as well as the harmonisation of regulations and procedures in the field of port service provision.

On the Figure 1, there is a map of the connection of ports of the NAPA to the TEN-T and Pan-European corridors.

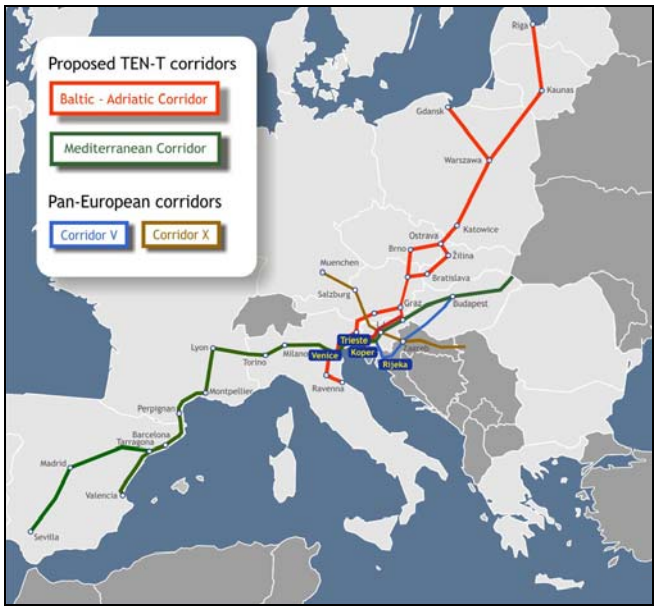

Figure 1. Connection of NAPA ports to the TEN-T and Pan-European corridors

From the ports, which are associated in the Association NAPA, the North Sea route towards the Far East (shorter by about 2,000 nautical miles, shorter navigation of 6-8 days) can also be used. The NAPA ports are easily accessible from the commercial and industrial centers of Central and Eastern Europe. The aim of the NAPA association's ports is to create significant competition from the North European ports. The maximum depth of the sea in these ports is 18 meters and ships of up to 6,500 TEUs can be dispatched there. Results of the NAPA in 2011 and 2013 of a total transhipment of cargo and container transport are shown in Table 1.

Table 1. The results of the NAPA in 2011, 2013 and 2014 of a total transhipment of cargo and container transport in comparison with other European ports

Total throughput of cargo in mil. tonnes			
Port	2011	2013	2014
Rotterdam	434,6	440,5	444,7
Antwerp	187,2	190,8	199,0
Hamburg	132,2	139,0	145,7
NAPA Ports	124,2	108,0	106,0
Marseille	88,1	80,0	78,5
Bremen	80,6	78,8	78,3

Transhipment of containers in mil. TEU

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Port	2011	2013	2014
Rotterdam	11,877	11,621	12,298
Hamburg	9,014	9,257	9,729
Antwerp	8,664	8,578	8,978
Bremen	5,916	5,831	5,796
NAPA Ports	1,8	1,6	1,8
Marseille	1,2	1,1	1,2

The important role of the NAPA for maritime transport to the Far East resulted from the first international conference on development of logistics in Central and Eastern Europe in the Austrian town of Villach (14 Dec. 2012).

2.2. The changing scenario

NAPA has been created to tackle several common issues that the ports are now facing. Changes in both the world economy (emerging economies' growing weight) and in the EU (the "eastward tilting" of the internal market) are modifying world freight routes, and will open new rooms of opportunities.

The growth of Europe-Asia trade will increase the traffic through the Suez Canal, modifying well-established routes, where Northern Range ports are nowadays handling the most part of the traffic.

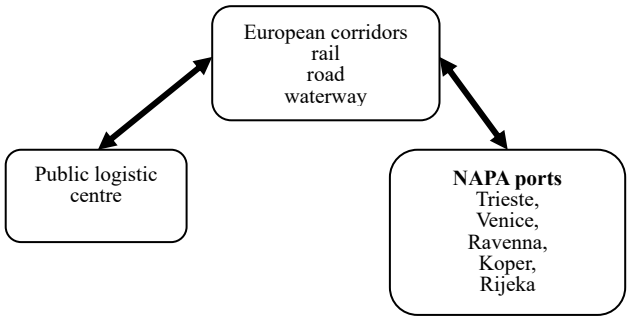

Figure 1. Scheme of connection NAPA ports to PLC and logistics terminals

The Northern Adriatic has a strategic and geographic advantage, being their closest Mediterranean seaport, but a critical mass must be achieved to cope with this challenge, and that is possible only if all the Northern Adriatic ports join their efforts.

The North Adriatic ports formally agreed to cooperate to create appropriate synergies in order:

- to have the North Adriatic ports assume the role as European logistics platform for traffic from the Far East to Europe and to and from Central and Eastern Europe;
- to promote coordinated planning of the development of road, rail, maritime, IT and telecommunications infrastructure at the service of the Northern Adriatic;

In particular, the Association promotes initiatives and actions to develop the following areas:

- tangible and intangible maritime and shore relationships with the foreland and hinterland of the ports, in order to expand their respective target markets; specific attention is given to the railway sector, seen as an essential way to improve competitiveness between port clusters as well as a key part of the sustainable development of land transport in Italy and Europe;
- cruise and passenger services;
- environmental protection and quality;
- safety and security;
- training;
- ITC services applied to the port sector.

The Association also promotes cooperation with logistics centres in their respective hinterlands.

At the logistic trade fair in Munich in 2012 an agreement was concluded between the association of NAPA and the BPA (Baltic Ports Association) in the cooperative support of implementation of a European transport corridor Adriatic - Baltic (one of ten basic corridors included in the new concept of TEN-T European transport network with the assumption of financial support from the EU for the period 2014-2020).

The ports of BPA shipped 800 million tons of cargo and 8.5 million TEUs in 2011, the ports of NAPA 124.2 million tons of cargo and 1.8 million tons of TEUs.

The port of Koper is also a member of the NAPA and its operational results are shown in the following Table 2.

Table 2. Operation results of the port of Koper in 2010, 2011 and 2012

Port of Koper			
Transhipment of cargo and containers in tons and TEU			
	2010	2011	2012
Cargo in total	1 445 631	1 383 354	1 438 833
Cargo in containers	4 276 137	5 309 346	5 292 047
Containers [TEU]	476 731	589 314	570 744

Direct sea routes to all major ports lead from the port of Koper. The Modal Split in the transportation of containers is: the railway transport up to 68 %, the road up to 32 % (according to Luka Koper Annual Report, 2011). The port of Koper is an important port for connecting with world's important seaports and European trade and industrial centers.

The basic activities performed in the Port of Koper are cargo handling and warehousing. They are conducted in 10 terminals specializing in handling and warehousing various types of goods, such as containers, general cargo, foodstuffs, light-perishable goods, livestock, RO-RO, timber, dry bulk and liquid cargoes.

Table 3. Distances from/to port of Koper

Distance in nm			
Koper - Alexandria	1.187	Koper - Malta	726
Koper – Buenos Aires	6.933	Koper - Montreal	4.824
Koper – Cape Town	6.634	Koper - Singapore	6.304
Koper - Haifa	1.359	Koper - Piraeus	835
Koper – Hong Kong	7.758	Koper - Sydney	9.584
Koper - Chicago	5.901	Koper - Vancouver	10.033

2.3. European Corridors in project A-B Landbridge

In a number of research projects other transportation corridors are examined - e.g. the European project Adriatic-Baltic Landbridge. It ran from 2006 - 2008 and a resulted in proposal of three European transport corridor areas, including related logistics centers. Three corridors of the A-B Landbridge project are shown in the Figure 4.

Figure 3. Transport corridors A-B Landbridge

The importance of these corridors is the possibility of shortening the European maritime route to the Far East by using southern European seaports and related European rail corridors in North-South direction for the collection and distribution to catching continental logistics centers.

- Western Corridor - Rostock - Berlin - Munich – Venice
- Central Corridor - Szczecin - Prague - Villach - Venice / Trieste
- Eastern Corridor - Gdansk - Ostrava - Vienna - Ljubljana-Trieste

An important aspect is the possibility of a future connection with a long-term planned project of interconnection of the waterways Danube - Oder - Elbe.

Designing of the Danube - Odra - Labe corridor takes into account the exceptional benefit of the Czech Republic area, which is the lowest point of the European water divide between the Danube and the Odra rivers (the Moravian Gate) whose length should be about 370 km at the current state of the implementation.

Waterway transport is particularly suitable:

- for transporting oversize cargo
- with regard to environmental protection
- for generating business activities along a watercourse

Multimodal transport is significant in terms of:

- interconnection of transport modes
- priority use of railways and inland waterways
- restrictions on road haulage
- environmental protection
- reduction of transport externalities
- reduction of traffic congestions

Realisation of infrastructure:

- financing
- environmental issues
- public participation
- institutional coordination

Policy issues for maritime sector:

- increasing connections with the Motorways
- coordinating planning and realisation activities with the rail sector
- planning adequate multimodal shift facilities

2.4. The possibility of connecting North Adriatic Ports by European corridors to the Trans-Siberian Railway or the Silk Road

For the opportunity of using railway connection between Asia and Europe it is necessary to assess two essential facts. The first one is a railway route through Asia up to Europe, the second one are sufficient railway corridors in Europe, including strategically located and adequately capacitated public logistics centers.

According to Eurostat statistics more than two-thirds of foreign trade in Europe in terms of value passes through seaports. It is likely that in connection with expected and by the statistics confirmed growth of container transportation, this number will grow. Cheu et al. (2013) state in their report at the conference of TRB (Transportation Research Board, Washington D.C., 13-17 January 2013), that the USA and the EU are two most important trading entities of the contemporary world. The second most important partner of the EU is China, which is also the EU's most important partner for import.

Trans-Siberian Railway - is a perspective option of rail connection (length of over 9,000 km) between Europe and Asia. It can connect all the regions concerned, which may become part of an interconnected intermodal transportation system. The company DB Schenker published in September 2011 a press release about connection Europe - China with a container train. China is also preparing a railway project, which should connect China's commercial metropolis such as Chongqing with Belgian Antwerp. This project, which is called New Silk Road or even Eurasian land bridge, should have a length of around 10,000 kilometers.

The sea route length is about 20,000 km; transportation time is 33-40 days.

The length of railway route is about 11,000 km; transportation time is 18-21 days.

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The Silk Road - first train to the Czech Republic arrived in November 2012 with fifty containers of computer components (duration 16 days). The advantage of this route, unlike the Trans-Siberian Railway, is more favorable weather conditions.

	Suez – Germany ports
	Suez – NAPA ports
	D – O – L (Danube – Odra – Elbe)
	Elbe, Danube
	rail corridor
	The Trans-Siberian Railway

Figure 4. Comparison lengths of seaways with use the opportunity NAPA ports, D-O-L and The Trans-Siberian Railway

Assessment of the possibility of connecting the NAPA ports by using existing corridors and corridors proposed

Connection of the NAPA ports to existing European corridors is possible, but with regard to prognosis of maritime, rail and road transport. In particular with regard to the plans for reconstruction of the Trans-Siberian Railway, respectively the Silk Road we should consider connection of the NAPA ports to these corridors. It is possible to use the project "Adriatic - Baltic Landbridge" to plan these routes.

Advantages of connection of the NAPA ports:

- shorter sea route, utilization of the route Suez - the NAPA ports
- use of European corridors, and increased use of railway transport
- implementation of public logistics centers of European importance in central Europe
- interconnection of European ports with railway Europe – China
- connection to the planned corridor Danube - Oder - Elbe, thereby connecting the Black Sea and Baltic Sea

In the graph below there are logistics terminals / inland ports, seaports identified as vertices (V).

Edges H1 to Hx are represented in length, transport modes, cost associated with the individual transport modes, capacity and reliability.

For a model of selection of transport mode in the transport network of the NAPA ports - Europe – Asia - USA, it is possible to take into account several variants of cargo transport.

- sea route via the Suez Canal – NAPA ports,
- sea route via the Suez Canal – Germany ports,
- NAPA ports – European Transport corridors - The Trans-Siberian Railway
- NAPA ports – European Transport corridors – D-O-L-inland waterway

There can be constructed a matrix of distances and transport modes for individual edges. In this graph, the transport network direct distance between individual vertices cannot be counted because these connections currently do not have adequate transport infrastructure.

Such transport network can be expressed mathematically as:

$$D = (U, V, H, d)$$

where

***U* ……..** a set of vertices (nodes) in the starting area,

***V* ……..** a set of vertices (nodes) in the target areas,

***H* ……..** set of segments (edges),

***d* ……..** evaluation and choosing of transport modes of edges.

Individual edges can be implemented by several transport modes.

The solution is to search:

- the shortest (minimum) routes;
- the most reliable routes (routes in meeting the date of delivery);
- routes with highest (maximum) capacity;
- the fastest routes (excluding direct air transport);
- the cheapest routes;
- routes with minimal cost of transporting of excess goods.

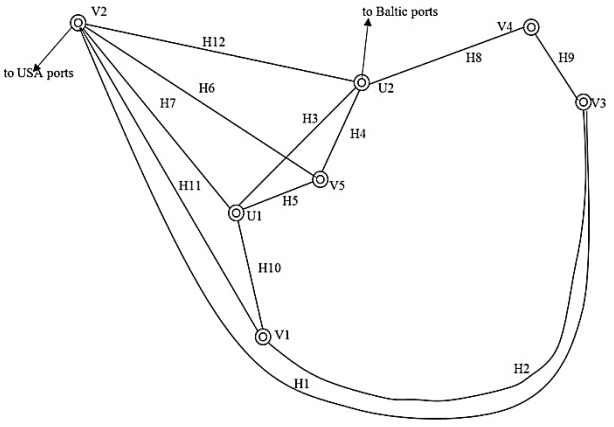

Figure 5. Graph of transport network of the NAPA ports – European Transport Corridors

V1…….. NAPA ports
V2…….. Germany ports
V3…….. Shanghai
V4…….. Vladivostok
V5……D-O-L
U1…….. public logistic centre - Czech Republic
U2…….. public logistic centre - Poland
H1…….. seeway Europa (Germany ports) - China
H2……seeway Europa (NAPA ports) - China
H3……..The Trans-Siberian Railway
H4…….. D-O-L – PLC Poland
H5…….. D-O-L – PLC Czech Republic
H6…….. Germany ports - D-O-L
H7…….. Germany ports – PLC Czech Republic
H8…….. Vladivostok - PLC Poland
H9…….. Shanghai – Vladivostok
H10……. NAPA ports - PLC Czech Republic
H11……. NAPA ports - Germany ports
H12……. Germany ports – PLC Poland

3. Assessment of individual risks when choosing options

The highest-risk factors:
- exceeding the investment costs
- implied investment costs
- failure to keep the design parameters
- failure to keep timetable of the construction
- no funding
- disapproval of the public
- demanding geographical circumstances;
- unresolved property circumstances;
- environmental protection
- rate of return
- coordination between individual states
- change of climatic circumstances

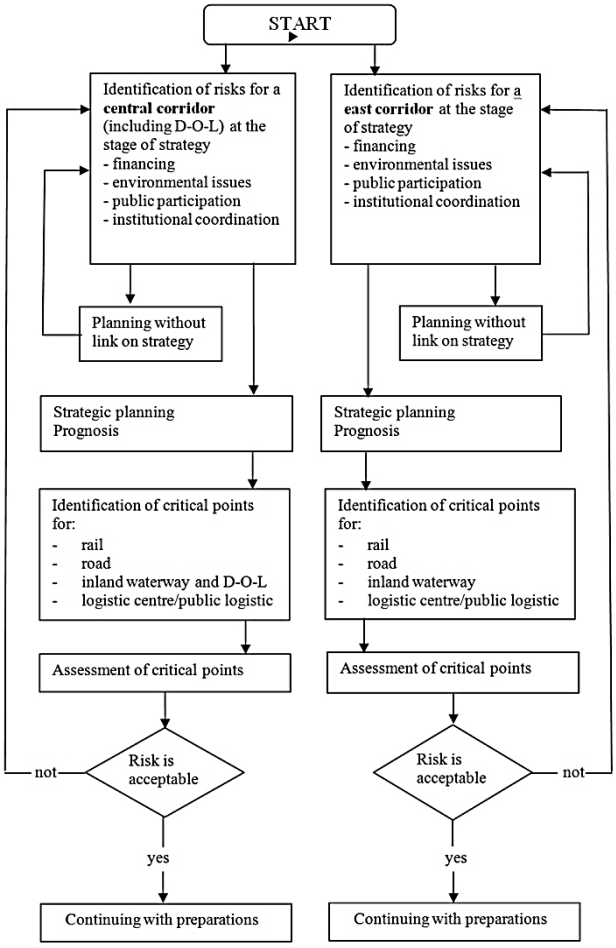

Figure 6. Risk assessment model

Crucial criteria for finding an optimal route are ordered by relevance as follows:
– transportation costs (in synergy with investment costs
– transportation time,
– transport reliability,
– transport safety,
– security measures to prevent illegal acts

Nowadays placed demands are on delivery times (e.g. in the automotive industry). It is even to expense of higher transport costs, respectively of lower reliability.

Table 4. Mathematical models of weights of criteria

Criterion	Importance/weight	Criterion name
K	Maximal	transportation costs
k – 1	……	transportation time
k – 2	……	transport reliability
1	Minimal	transport safety

It is necessary to determine:
– a set of criteria (criteria, wherein the higher values are preferred to lower)
– criteria weights (with using expert methods)
– sample Criteria

It is also necessary:

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– to assess results achieved (during the evaluation a reassessment of the weights of individual criteria or modifying of options, or extending number of variants can occur
– to assess risk - through risk analysis
– to assess and determine an optimal variant, to determine order of different options

When using a multi-criteria evaluation method the weight of individual criteria can be expressed through the vector of weights of criteria:

$$v = (v_1, v_2, \ldots, v_x); \sum_{n=1}^{x} v_1 = 1; \quad v_1 \geq 0$$

4. Conclusions

In the recent past the Suez Canal has been a problematic point, so-called "bottleneck". After the recent expansion and increasing the capacity of the canal it changed the situation. Use frequently some of ports in the Adriatic and their well-capacitated connection to existing transport corridors of the TEN-T, of the Pan-European multimodal transport corridors (The Pan-European Traffic Networks) and the Trans-Siberian Railway came again to the fore.

The use of other multimodal transportation corridors that are prepared in the European area depends on completion of missing infrastructure, especially railways and inland waterways. Transfer of freight traffic from road to rail and waterways is an important factor.

Advantages:

- shorter route Suez - Gibraltar - German ports
- direct connection from the Mediterranean Sea to European rail corridors
- possibility of connection with the upcoming project Danube - Oder – Elbe
- use of railways for freight transport
- reduction of the operation of naval ships along the northern coast of Africa

Connection of the NAPA ports with ports in the Baltic Sea, thanks to use of new or reconstructed multimodal corridors can be another option.

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