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INTERFACE FOR OPERATIONAL MANAGEMENT SYSTEM IN MARSHALLING YARDS

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Abstract

This paper considers existing procedures that are performed in marshalling yards with empiric measured times of duration of main operations. In the first part of the paper are mentioned sources which are used for performing of the operations with inbound and outbound trains that are analysed afterward. Following part describes circumstances of non-optimised decisions and the reasons for them. In last part of the paper is stated proposal of data interface which is necessary for improvement of data flow in marshalling yards and is a base for development of considered marshalling yard management system.

Keywords

marshalling yard, processes, interface, sources

1 INTRODUCTION

System of single wagon load based on system of trains that connect senders and recipients through dedicated stations commonly equipped with hump and special devices. These stations – marshalling yards are the crucial part of the system. For ensuring reliability, speed and accuracy of transport according to customer needs seems necessary to develop new quality of information flow to and from marshalling yards. This new quality should be provided by proposed universal interface, that will interchange data between existing network information systems and considered new marshalling yard (MY) operation (management) system which have to involve real-time decision module for optimized operational management of sources.

2 ANALYSIS OF SOURCES AND CHARACTERISTICS OF ČESKÁ TŘEBOVÁ MARSHALLING YARD

For comprehension of the processes is in this part of the paper stated an overview of operations and facilities in the Česká Třebová marshalling yard.

Marshalling yard is a part of the railway station Česká Třebová. The station has standard conception that is common in Czech railway network. It means that the station consists from passenger part, (intermodal container) terminal, industrial area with sidings, locomotive depot with maintenance area and marshalling yard. It has arrival yard, hump, classification yard and departure yard. [1, 2, 6] Hump and classification yard is equipped with automatic classification and braking

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systems (GAC and ARS GTSS). [7] Planning in long-term period integrates arrival main line train paths <–> shunting and marshalling of single wagons and groups <–> departure mainline train paths.

Sources in marshalling yard are in general following

- line locomotive and its driver,
- hump locomotive and its driver,
- yard locomotive and its driver,
- hump,
- arrival tracks,
- classification tracks,
- departure tracks,
- siding tracks,
- dispatcher of yard infrastructure manager,
- dispatcher of yard railway undertakings,
- head shunter,
- shunter,
- brakeman,
- coupler,
- transport agent,
- inspector,
- signalman. [6]

In marshalling yard Česká Třebová there are three shunting locomotives. They work 24 hours a day, 7 days a week.

- Arrival/Hump locomotive – commanded by radio.
- Classification locomotive – commanded by radio.
- Departure and siding locomotive – commanded by radio and signalling. [6]

Track maximum length is 933 m (arrival yard) and 829 m (departure yard). Train average length is 650 m. Classification yard has 33 tracks in 4 groups of tracks. Minimum empiric time for changing of locomotive is 10 minutes. Minimum empiric time from arrival to departure of the train is about 4,5 hours. Average marshalling times with average wagon consists is about 6 hours. Average numbers of trains are following. Number of transit trains with some operations (e. g. change of locomotive) per day is 10. Number of trains that terminates its journey in arrival yard is 30 per day. Four of them are local connecting trains. Number of trains that starts its journey in departure yard is 27 per day. Six of them are local connecting trains [3]

Nowadays are all operations with train arriving to or departing from marshalling yard provided according to long-term plan. In railway environment long-term plan means timetable and its changes that come into force about every 3 months. Ad-hoc trains are served with no additional capacities (there are some reserves for the reason of ad-hoc trains). For preparation of railway undertaking's long-term plan of operational processes in marshalling is used software application. Namely it is "Timetable of operational processes in station" – TOPS. This application during the preparation of train timetable provide to a train planner (railway undertaking's staff) base tool for planning of all procedures with train. In the final plan of procedures are involved activities of all necessary sources. [3]

3 OPERATIONS

In this part of the paper is placed simplified analysis of operations which are necessary to do with terminating and departing train. Transit trains with no required procedures are not involved. Transit trains with only few operations (except marshalling) – for example changing of locomotive are mentioned in part “general overview” above. Values that are stated are empiric – the measurement had been made from 15th January 2018 to 15th March 2018.

All planned sources are matched to activities and arranged in correct sequence. [3] Common sequence is explained below. At first the trigger of the procedure in marshalling yard is announcement about train arrival that is provided by information system “Dispatcher information system of operational management” – DISOM or by infrastructure manager Dispatcher. This procedure is updated only “manually” by railway undertaking dispatcher according to train composition – system COMPOST. Decision about the order of trains to be processed (marshalled) is only on railway undertaking dispatcher which uses for the decisions support from the application “Operation information system” – OIS. In the OIS system are complete information about train unit. [5] The OIS does not provide any support for optimal decision. The quality of decision depends on how skilled is the railway undertaking dispatcher.

3.1 Inbound train and marshalling procedure

Beginning of the procedure is during the arrival of the train. During the arrival the wagon inspector is watching the train unit and is looking for failures e. g. flat wheels. At the same time is transport agent waiting at the place where stop forefront of the locomotive for taking over of train and shipment documentation. After arrival the train unit is secured by wheel chock or by tightening of wagon hand brakes. Next, the line locomotive is uncoupled. Average time is 3 minutes. Uncoupling is done by line locomotive driver. After that is line locomotive shunted to line locomotive sidings. Signalman set up and lock shunting route. Commands from railway undertaking dispatcher to the line locomotive driver are pursued by radio and signalling. [1, 2, 6] Main activities of inbound train procedure are possible to see in table 1 below.

Tab. 1 Inbound train procedure

Inbound train procedure	Time (min)	Perform
Moving train from surrounding network to yard – arrival	X	X
Taking over of train and shipment documentation (from loco driver to wagon inspector)	1	Transport agent / wagon inspector
Braking the train unit with wheel chocks	1	Line loco driver
Tightening of hand brakes of first five wagons	6	Line loco driver
Command to uncoupling of the line locomotive and to shunting	0,5	railway undertaking dispatcher
Uncoupling of the line locomotive	3	Line loco driver
Shunting from arrival track to the line loco siding	3	Line loco driver

Hump locomotive driver gets the information about track on which is train unit to be marshalled. The hump locomotive is coupled to rear of train unit. Screw couplings of wagons are loosened by shunter and head shunter according to sorting list. Hump locomotive according to commands from signalman and head shunter move train blocks to the hump. Loosened couplings are taken off by coupler with special rod. In case that some wagon is not allowed to be humped, this wagon is during the process of pushing the groups of wagon to hump decoupled and shunted to siding track next to hump. In a while when all blocks are humped, hump loco moves to siding track with non-humping wagons, couples it and shunts to classification yard on dedicated track. [1, 2, 6] Main activities of marshalling procedure are possible to see in table 2 below.

Tab. 2 Marshalling procedure

Marshalling procedure	**Time (min)**	**Perform**
Announcement to hump loco about track of unit to be marshalled	0,5	railway undertaking dispatcher
Announcement about dangerous goods	0,5	railway undertaking dispatcher
Shunting from yard loco siding to arrival track	3	Yard/hump loco driver
Coupling of train unit	3	Shunter
Loosening of hand brakes of wagons	6	Shunter
Releasing the train unit (put wheel chock away)	0,25	Shunter
Preparation for humping (e. g. loosening of screw coupling)	25	Shunter
Command to shunting with blocks of train	0,5	Head shunter
Shunting with block of train	5	Yard/hump loco driver
Cutting and humping blocks into classification yard	30	Coupler, brakeman, signalman
Shunting non-humping blocks into classification yard	6 per shunting	Shunter / coupler, Yard/hump loco driver
Securing of the train blocks against movement (wheel chocks and hand brakes)	0,5	Brakeman
Shunting with broken wagons	10 per shunting	Shunter / coupler

3.2 Procedure before departure

In a while when is one of the tracks completed begins procedure of train preparation to depart. The decision about beginning of this procedure is on railway undertaking dispatcher. Track could be completed because of the time norm, weight norm or there is no other wagon to be matched to the train in dedicated direction. During humping brakemen push the wagons or blocks one to each other and tight hand brakes of the wagons. Pushing wagons do brakemen manually. In case that is necessary due to weight or bad weather conditions to push blocks manually, the blocks are pushed by yard locomotive. If there is the completed track, brakemen couple blocks of train. Afterward is coupled yard locomotive. Hand brakes of wagons are loosened and wheel chocks are put away. Brake system of the train unit is filled and brake connection test is done. According to command of railway undertaking dispatcher yard loco shunts the unit train to departure yard. [1, 2, 6]

On dedicated track in departure yard is unit train again ensured against movement and wagon inspector provide technical and shipment inspection. Like is possible to see in table 3 below, this activity takes the longest time. It’s about 60 minutes and its duration except of number of wagons depends on type and length of wagon. Optimisation proposal have to reflect this attribute during calculation of necessary time for this activity. The activity listing of the train vehicles is provided by transport agent and takes about 35 minutes. It is provided at the same time with technical and shipment inspection. Then railway undertaking dispatcher command to shunt and couple line locomotive. The command is provided through radio and signalling. Line loco driver a shunters loose wagon hand brakes and put wheel chocks away. Next command is filling brake system by pressed air and line locomotive driver with cooperation with wagon inspector do the full brake test. Then line locomotive driver receive verbally the results of full brake test from wagon inspector. After that is necessary to take over and sign documents. The last activity is to send SMS “Ready to departure” by line locomotive driver to system DISOM. Afterward in appropriate time according to timetable and situation on surrounding network the train leave the departure yard. [6] Departure is issue that manage infrastructure manager dispatcher in coordination with railway undertaking dispatcher in the station and railway undertaking regional network dispatcher. Main activities of outbound train procedure are possible to see in table 3 below.

Tab. 3 Outbound train procedure

Outbound train procedure	**Time (min)**	**Perform**
Pushing (manually + yard loco)	20	Brakeman, yard loco driver
Coupling of train blocks	30	Brakeman
Shunting of yard loco	5	Yard/hump loco driver, shunter
Coupling of yard loco	3	Shunter
Filling of train unit brakes	4	Yard/hump loco driver
Shunting with train unit	5	Yard/hump loco driver
Technical and shipment inspection (generally)	60 (2 min per wagon)	Wagon inspector
Technical and shipment inspection (2/4/6/8 axles wagon)	1,5/2/2,5/3	Wagon inspector
Listing of the train vehicles	35 (1 min per wagon)	Transport agent
Command to coupling of the line locomotive to train unit	0,5	railway undertaking dispatcher
Shunting from line loco sidings to departure track	X	Line loco driver
Coupling of the line locomotive to train unit	3	Line loco driver
Command to filling of pressure brake by air	0,5	railway undertaking dispatcher
Loosening of hand brakes of wagons	6	Line loco driver, shunter
Releasing the train unit (put wheel chock away)	0,25	Line loco driver
Placing wheel chocks beside track	0,25	Line loco driver
Full brake test	30 (1 min per wagon)	Line loco driver, wagon inspector
Announcement of full brake test results	0,5	Wagon inspector
Taking over of train and shipment documentation (from car inspector to loco driver)	1	Line loco driver, wagon inspector
Signing of international train braking report	0,1	Line loco driver, wagon inspector
Taking over of commands for route	1	Line loco driver, wagon inspector
Signing of commands for route	0,1	Line loco driver, wagon inspector
Train readiness to depart announcement (SMS)	3	Line loco driver
Departure	X	X

3.3 Resume

At these times there are no bottleneck in marshalling yard except of extraordinary disruptions on the network that are naturally transferred to marshalling yards. Due to that could be marshalling yard used like bumper in case of delays. In case of lockouts on the infrastructure and other circumstances and due to that big delays of freight trains there comes to being problem with decision about order of trains to be marshalled. Like it is stated in this paper above the system OIS which provide to dispatcher information support has no optimisation feature. Decisions about which train should be served first according to direction of shipments in it and according to outbound train in dedicated direction became extremely difficult. In addition, in the inbound train could be placed shipment with so called “firm connection”. It means that dedicated shipment (wagon or block of wagons) have to be travelled by no others that dedicated trains. For railway undertaking dispatcher there is this information the main rule for decision. It is possible to break the rule only in extraordinary cases. Some of operations that are stated in previous chapter of this paper are dependent on each other and their correct providing depends on correct information at right time. In mentioned situation of big delays and many inbound trains there is for railway undertaking dispatcher almost not possible to calculate the time which is necessary for providing the operations and make optimal or at least good decisions.

First inconvenience is following. Though the railway undertaking station dispatcher has in system DISOM actual position of the inbound train is in many cases able to only roughly calculate estimated time of arrival (ETA). [3, 4],

The second inconvenience is that there is no real-time support tool for calculation of necessary time to serve the inbound and outbound train according to list of shipment and type of wagons. So there could emerge delays of outbound trains due to bad decision of train order.

Third problem which is connected to second one is that there is not possible to calculate estimated time of departure (ETD). Due to this reason the railway undertaking dispatchers and infrastructure manager of regional network dispatchers do not have information if the dedicated train unit use dedicated ordered train path or use other ordered train path or there will be necessary to order ad-hoc train path. From the other point of view, for railway undertaking regional network dispatcher there is very difficult to decide if is possible to use the train path of dedicated delayed train for other e. g. ad-hoc train. [6]

4 PROPOSAL

Before development of MY information system there should be developed interface to ensure transfer of information between “network” information systems and considered marshalling yard system. Consider only the problem in marshalling yard there is necessary to ensure not interrupted information flow through the whole marshalling process with connection to network processes.

Nowadays is possible to have at least an hour before arriving dedicated train into marshalling yard available relatively reliable information about ETA. The crucial object of proposal is interface between systems to be taking over information. After that there will be possible to build up new “marshalling yard operation system” – MYOS that will be effective supporting tool for railway undertaking dispatcher and in addition for other marshalling yard workers. The proposal in this paper does not involve the system but it is focused on data that should be transferred through interface.

Proposed interface data are divided into three groups. Proposed interface data, precisely attributes are possible to see in table 4 below.

In the first group are technical data, that represent limits for railway undertaking dispatcher or infrastructure manager dispatcher and MY workers. Maximum speed, power rate and braking power rate determine time of approaching to and leaving from MY.

Second group involve technological data which depends on actual situation. Train with the same number can in some case travel dangerous goods or priority shipment and in other case any of shipments that requires special care. According to actual situation will be prepared actual plan for marshalling of trains and calculated ETD.

In the third group are data for identification of train, train paths and contact to train driver. Some of proposed data are nowadays available in information systems (e. g. DISOM, OIS etc.) [3, 4, 5]. Other data (e. g. GPS position, maximum time of departure) are not available today. The data in the third group will be used for modelling of optimal procedure (e. g. planning of train routes in the marshalling yard) and to choose optimal train path for leaving of the train according to fluent travel on the network.

Tab. 4 Attributes of interface

Technical data	**Technological data**	**Information system data**
Length of train unit	Transfer of wagon (to which train)	Sender info (ID)
Braking power rate	Direction of wagon	Recipient info (ID)
Maximum speed	Transfer of wagon (in which station)	Train driver
Type of locomotive	Train ID number	Phone number of train driver
Length of wagon	Number of wagon	Equipment by tablet
Number of axles	Order of wagons in train	Path ID
Weight of wagon	RID / dangerous goods	DISOM train number
Weight of shipment	Firm/priority transfer of wagon	Actual position (station)
Traction (in-/dependent)	Info for manipulation (limits/regulation)	Actual position (GPS)
	Planed activities (actual) e. g. arrival technical inspection	Executive railway undertaking
	Estimated time of arrival (to point e. g. MY)	Licenced railway undertaking
	Estimated time of departure (from point e. g. MY)	Available paths in direction
	Number of train unit (case of unit train)	Available times for departure
	Type of transportation (unit train, single wagon load, special, military)	Other note
	Maximum time of departure (each wagon) – railway undertaking requirement	
	Train confidence	
	Origin station of wagon	
	Destination of wagon	
	Arrival track	
	Departure track	

Based on these data the system MYOS will be able to calculate necessary time to performance of all planned activities and due to that it will be able to estimate time of departure each train because the system will consider transfers of wagons. In addition, this tool will help dispatchers to make optimized decision which train accommodate and process first according to possibilities to depart connection train. Due to complex information during the whole marshalling process could be simplified process of train listing.

5 CONCLUSION

Non-interrupted data flow between marshalling yards and surrounding network as a base for optimized decisions is nowadays very important issue due to delays caused by engineering works on railway lines and other disruptions at least in the Czech railway business. This paper touches the existing procedures, sources and duration of main activities in marshalling yard Česká Třebová. Outbound of the analysis is resume of inconveniences that should be eliminated in the short-term future. Last part is focused on proposal of universal data interface for transferring information from network information systems to considered yard management system. Proposed interface should be compatible not only with Czech information systems but almost with systems that are operated abroad.

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