Co-financed by the Connecting Europe Facility of the European Union

CORRIDOR RHINE ◇ ALPINE

Feasibility study on Railway Collaborative Decision Making (Rail-CDM)

WP 1 – Rail-CDM Approach

HACON

to70

WP 1 – Rail-CDM Approach

Project Approach Task 1.1

Content Status

WP1 – Rail CDM Approach

1. Kick-off Meeting
2. Transferability of Airport CDM
3. Railway Processes
4. Approach for Rail CDM

WP2 – Benefits and Investments

1. KPI’s & General Framework
2. Benefits and Investments report

WP3 – Recommendations and Roadmap

1. Workshop for Roadmap discussion
2. Recommendations & Roadmap report
3. Final meeting and presentation

Why the Rail sector may learn from Airport CDM (A-CDM)?

- Comparable challenges in last mile operations: inefficiencies and lack of collaboration
- Similarities in stakeholder landscape, roles and responsibilities
- Equal performance measurement needs to improve business processes
- A-CDM concept implementation methodology could be applicable in rail freight operations

A-CDM Introduction

Situation, motivation and lessons learnt

Challenges to overcome in the aviation industry

- Lack of situational awareness due silo thinking

  → Who has the complete picture of operations?

- Lack of common terminology, hence no level playing field for procedure adherence

  → e.g. 'estimated time of arrival/departure' interpreted differently by different stakeholders

- Planning uncertainties due lack of predictability, leading to re-active behaviour and no pro-active thinking
- No transparency in capacity and resource assignment, leading to wastage

  → 'we're not sweating the assets'

- Non-harmonised procedures, leading to confusion and misunderstandings
- No harmonised integration into the European Air Traffic Management Network

The consequences (1)

Who knows what is going on?

- Airport & Air Traffic Control do not know when an aircraft is ready for departure
  - → But the Ground handler and the Airline know
- Airlines do not know when their aircraft will receive clearance to start
  - → But Air Traffic Control knows
- Airport & Ground Handler know only when aircraft arrive, when they are about to land
  - → But the Airlines and Air Traffic Control know well in advance

The consequences (2)

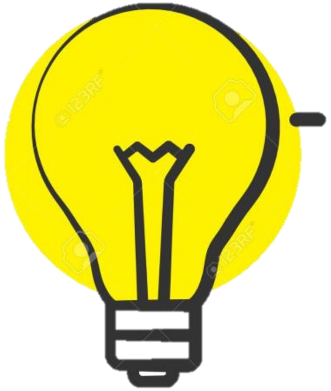
Inaccurate planning and information

- Flight plans not updated by Airlines (despite knowledge of delay)
- Aircraft taxi time durations based on rough averages instead of based on airport layout and traffic parameters
- Flight schedules with equal departure times, even though capacity at the runway is not available
- Aircraft queueing on their way to the runway
- Ground Handlers arrive too late upon arrival of an aircraft
- Considerable idle time in operational staff planning
- Aircraft parking position occupied upon arrival
- Late gate changes

Airport CDM – a concept developed to mitigate operational inefficiencies on airports

Specifically designed stakeholder collaboration model to:

- Increase situational awareness by sharing a common dataset among ALL operational stakeholders
- Facilitate decision-making, based on high-quality data
- Increase predictability to:
    - Make operations more resilient
    - Make better use of infrastructure and resources
    - Increase capacity
- Improve operational processes based on stakeholder performance monitoring
- Move away from the ‘blame culture’ and a ‘first come, first served’ attitude, towards a ‘best planned, best served’ environment



What is Airport Collaborative Decision Making?

- The baseline:

  Provide the right Information → at the right time → to the right People → for them to make the right decisions

- It is a concept and a procedural framework for humans, facilitated by technology. It is not a software tool

- It was created by European aviation stakeholders, together with EUROCONTROL, already 20 years ago
  - It is now mandated by Single European Sky Regulations
  - Implementations were partly funded by the European Union in the framework of the CEF programme

- The EUROCONTROL A-CDM implementation methodology is picked up by major airports across the world

Implementation methodology: step by step along 6 concept elements

1. Information sharing
2. Milestone approach
3. Variable Taxi Time
4. Collaborative pre-departure sequencing
5. A-CDM in adverse conditions
6. Collaborative management of flight updates

CE#1 – Information Sharing (1)

1. Information Sharing
2. Milestone Approach
3. Variable Taxi Time
4. Collaborative pre-departure sequencing
5. A-CDM in Adverse Conditions
6. Collaborative Management of Flight Updates

CE#1 – Information Sharing (2)

- This is the technological layer to support information sharing between operational partners, to create situational awareness → the **A-CDM portal**

- The scope of work involves:
  - Definition of data elements to exchange
  - Prioritisation of data sources (‘single source of the truth’ concept)
  - Connecting systems through new interfaces
  - Development of data exchange procedures to ensure timeliness and accuracy
  - Redundancy in system & procedures

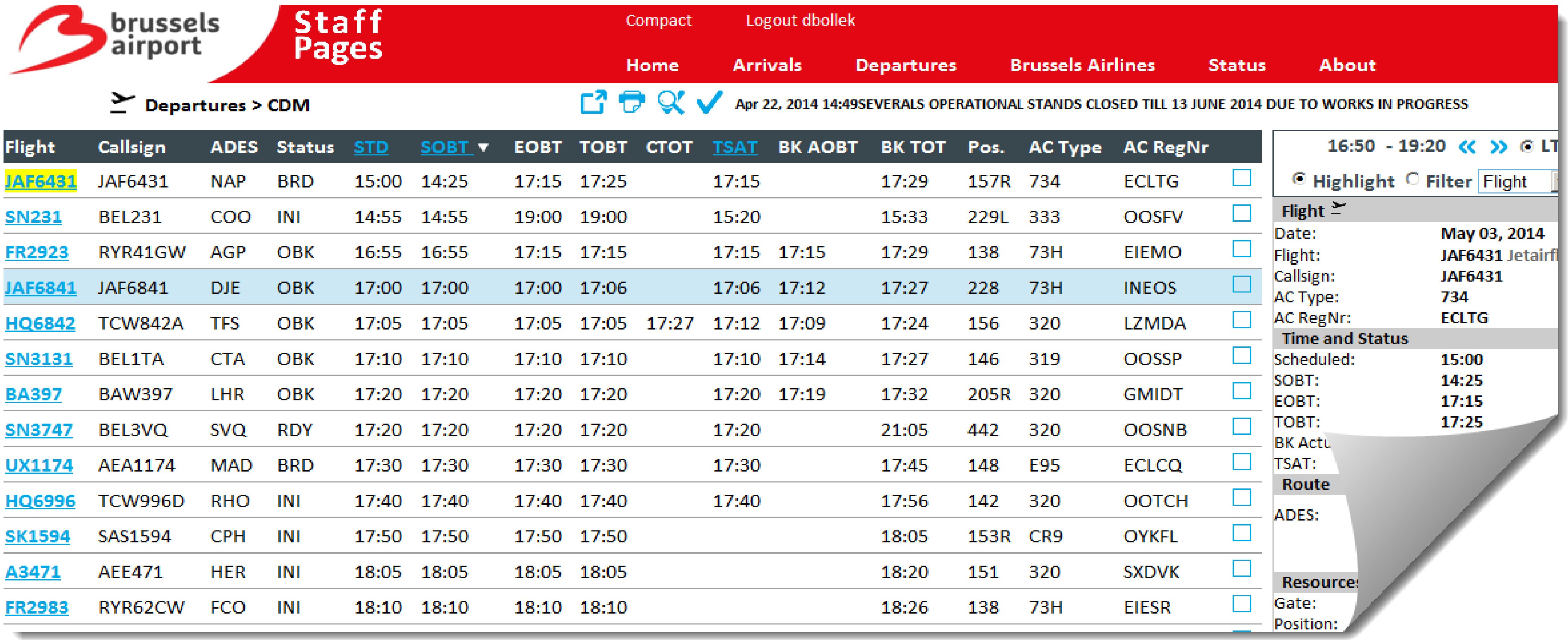
CE#1 – Information Sharing (3)

Principles of the A-CDM Portal:

- A user interface of the Airport Operational Database (AODB)
- Available free-of-charge for airport community
- GUI specifically designed to avoid information overload
- Uniform look and feel
- Selection of data elements expanded to remote information panels
- Optionally integrating ground radar images for enhanced situational awareness

CE#1 – Information Sharing (4)

The Brussels Airport A-CDM Platform



Flight	Callsign	ADES	Status	STD	SOBT	EOBT	TOBT	CTOT	TSAT	BK AOBT	BK TOT	Pos.	AC Type	AC RegNr
JAF6431	JAF6431	NAP	BRD	15:00	14:25	17:15	17:25		17:15		17:29	157R	734	ECLTG
SN231	BEL231	COO	INI	14:55	14:55	19:00	19:00		15:20		15:33	229L	333	OOSFV
FR2923	RYR41GW	AGP	OBK	16:55	16:55	17:15	17:15		17:15	17:15	17:29	138	73H	EIEMO
JAF6841	JAF6841	DJE	OBK	17:00	17:00	17:00	17:06		17:06	17:12	17:27	228	73H	INEOS
HQ6842	TCW842A	TFS	OBK	17:05	17:05	17:05	17:05	17:27	17:12	17:09	17:24	156	320	LZMDA
SN3131	BEL1TA	CTA	OBK	17:10	17:10	17:10	17:10		17:10	17:14	17:27	146	319	OOSSP
BA397	BAW397	LHR	OBK	17:20	17:20	17:20	17:20		17:20	17:19	17:32	205R	320	GMIDT
SN3747	BEL3VQ	SVQ	RDY	17:20	17:20	17:20	17:20		17:20		21:05	442	320	OOSNB
UX1174	AEA1174	MAD	BRD	17:30	17:30	17:30	17:30		17:30		17:45	148	E95	ECLCQ
HQ6996	TCW996D	RHO	INI	17:40	17:40	17:40	17:40		17:40		17:56	142	320	OOTCH
SK1594	SAS1594	CPH	INI	17:50	17:50	17:50	17:50				18:05	153R	CR9	OYKFL
A3471	AEE471	HER	INI	18:05	18:05	18:05	18:05				18:20	151	320	SXDVK
FR2983	RYR62CW	FCO	INI	18:10	18:10	18:10	18:10				18:26	138	73H	EIESR

CE#1 – Information Sharing (5)

The ground radar view in London Heathrow’s A-CDM Platform

CE#1 – Information Sharing (6)

A-CDM Milestones displayed at the aircraft stands

CE#2 – Milestone Approach (1)

1. Information Sharing
2. **Milestone Approach**
3. Variable Taxi Time
4. Collaborative pre-departure sequencing
5. A-CDM in Adverse Conditions
6. Collaborative Management of Flight Updates

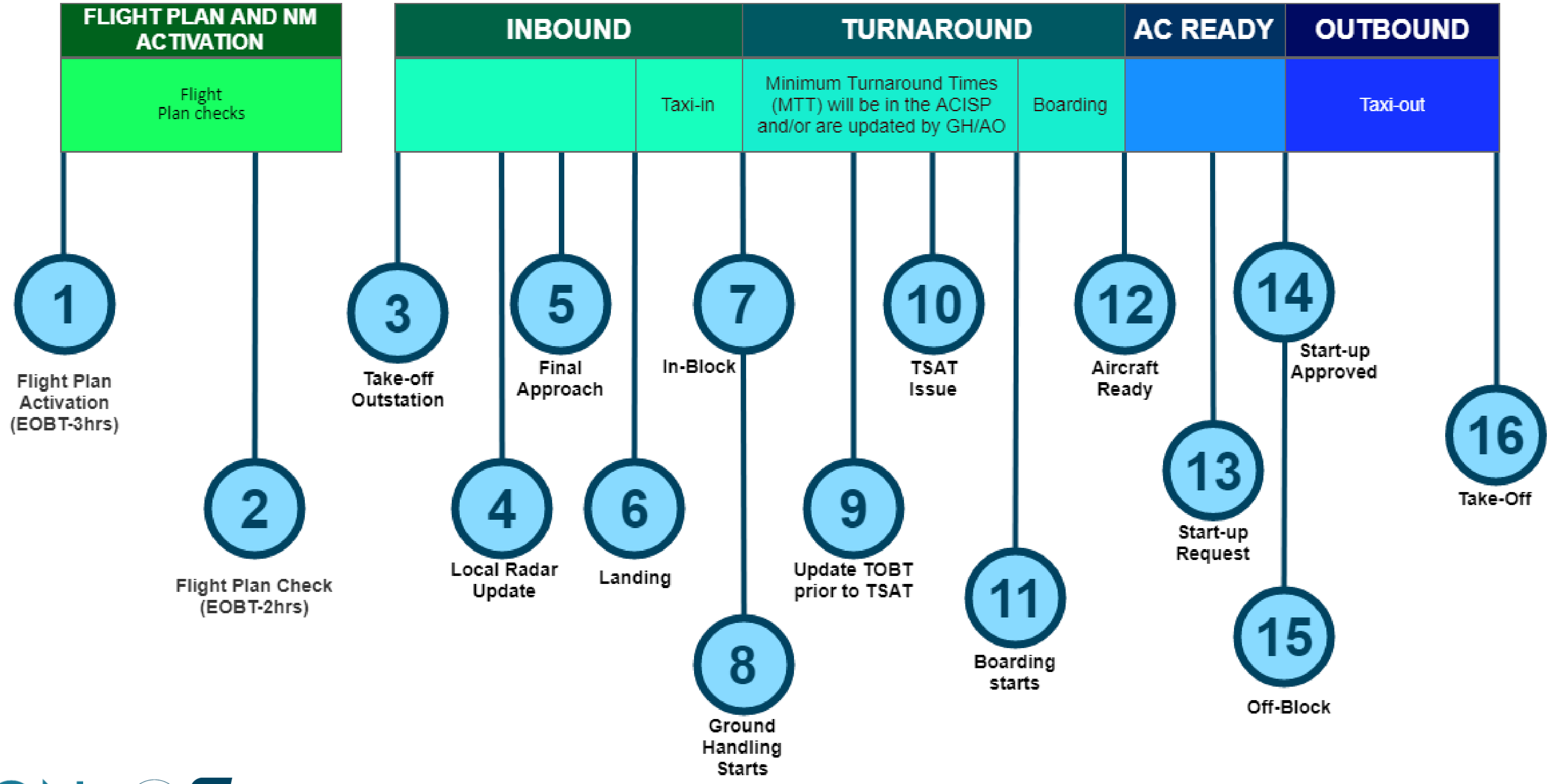
CE#2 – Milestone Approach (2)

- This Element breaks down the progress of an aircraft into 16 ‘operational events’, as early as the departure at the airport of origin, to the departure of the A-CDM airport. The full cycle is split up in 3 sub-processes: the inbound, turnaround and outbound process
- Objectives of the Milestone Approach
  - Define common definitions and data exchange procedures on the 16 steps
  - Define information updates and triggers
  - Determine non-compliancy alerts (late, missing or incorrect data) to monitor the information flow, and push those to the responsible stakeholder
  - Enable timely decision-making
  - Collection of operational data to report on performance post-ops

Note: not all airports have implemented all 16 Milestones. This is subject to data availability at one or more stakeholders

CE#2 – Milestone Approach (3)

A-CDM's 16 accredited Milestones



CE#2 – Milestone Approach (4)

The 2 key prediction parameters

- Milestone 9: *Final Update of* Target Off Block Time (TOBT)
  - The time Aircraft Operator/Handler estimates that an aircraft will be ready, all doors closed, boarding bridge removed, ready to start up/push back
- Milestone 10: *Publication of* Target Start-Up Approval Time (TSAT)
  - The time provided by local ATC in response to TOBT, informing all stakeholders when an aircraft can expect start-up and/or push back approval, taking into account ATFM restrictions

CE#2 – Milestone Approach (5)

Visualisation of A-CDM alerts in an A-CDM portal. The alerts are auto-triggered by set parameters to spot and communicate discrepancies in the A-CDM process (= the progress of a flight along the 16 Milestones)

The alerts are categorized in :

- Green alerts, or advisory alerts
- Orange alerts, or prioritized advisory alerts
- Red alerts, or blocking alerts (halting the A-CDM process unit the discrepancy is resolved)

<< < 1 2 3 4 5 6 7 8 9 10 > >> Showing 1 to 35 of 616

Alert	Flight	Callsign	Fltst	SOBT	EOBT	TOBT	AE
CDM104	HV6727	TRA6727	GCL	09-16:00	16:00	16:26	
	HV273	TRA273	TAX	09-15:45	16:30	16:30	
	HV5791	TRA28P	GCL	09-16:30	16:30	16:41	
	HV5355	TRA43F	BRD	09-16:40	16:40	16:44	
	TP679	TAP679	GCL	09-16:45	16:45	16:45	
CDM09; CDM104	HV5951	TRA69N	SCH	09-16:40	16:40	16:56	
	QY6725	BCS6725	SCH	09-17:10	17:10	17:10	
CDM104	KL1675	KLM75K	GCL	09-16:45	16:45	17:12	
CDM09	HV6705		SCH	09-14:40		17:20	
CDM104	EJU4892	EJU86NZ	AIR	09-16:40	17:08	17:35	
	QR8102	QTR8102	SCH	09-17:15	17:45	17:40	
	KL1705	KLM11S	AIR	09-16:55	17:45	17:45	
CDM104	OR295	TFL295	GCL	09-17:25	17:25	17:45	
	HV5819	TRA85E	TAX	09-17:45	17:45	17:45	
	KL1243	KLM19P	AIR	09-16:30	17:45	17:46	
	KL0863	KLM863	TAX	09-17:50	17:50	17:52	
CDM104	KL1989	KLM1989	GCL	09-16:40	18:20	17:53	
	KL0643	KLM643	AIR	09-17:55	17:55	17:55	
	KL1261	KLM1261	AIR	09-16:45	17:59	17:59	
CDM104	VY8318	VLG831Y	BRD	09-07:00	16:45	18:00	
	KL1149	KLM1149	TAX	09-16:50	18:00	18:00	
CDM104	KL1731	KLM1731	TAX	09-16:55	17:30	18:02	
CDM104	KL1023	KLM93K	TAX	09-17:15	17:45	18:04	
CDM104	VY8303	VLG83PW	GCL	09-15:15	15:15	18:05	
CDM104	EJU7939	EJU7939	TAX	09-16:55	16:55	18:05	
	CA1034	CAO1034	SCH	09-20:00	18:20	18:05	
	BE1276	BEE1VC	TAX	09-18:00	18:00	18:06	
	EJU4566	EJU32YZ	GCL	09-18:00	18:00	18:06	
	SU2695	AFL2695	GCL	09-18:15	18:15	18:07	
CDM104	LH2307	DLH9EP	GCL	09-17:25	17:25	18:10	
	SK1550	SAS48D	GCL	09-17:40	18:10	18:10	
	SWT7016	SWT7016	SCH	09-18:20	18:20	18:10	
CDM104	AZ0109	AZA109	GCL	09-17:30	17:30	18:11	
CDM104	EZS1356	EZS98DC	GCL	09-17:20	17:44	18:12	
	BA433	BAW433	GCL	09-17:50	18:14	18:15	

CE#3 – Variable Taxi Time (1)

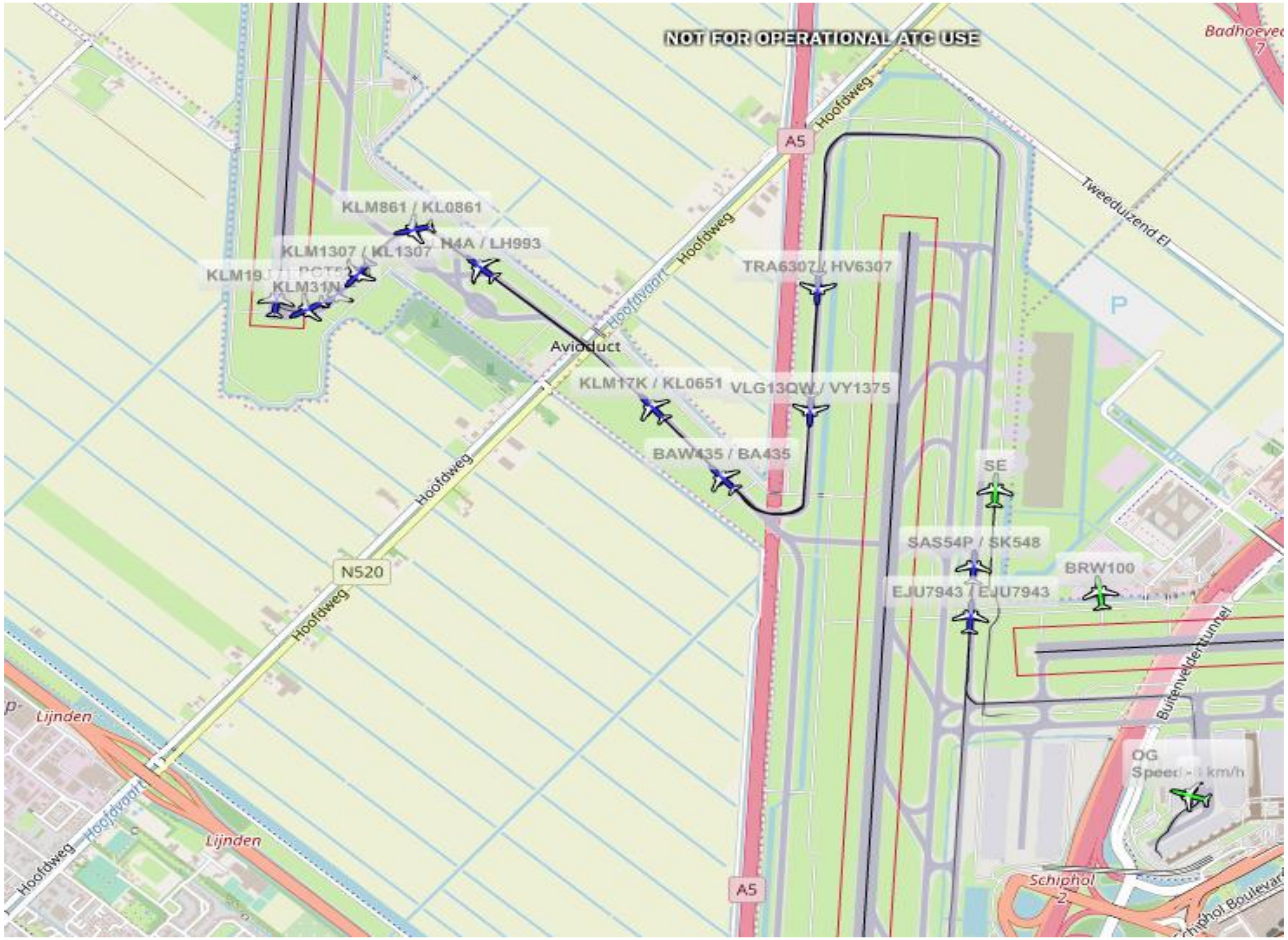
1. Information Sharing
2. Milestone Approach
3. **Variable Taxi Time**
4. Collaborative pre-departure sequencing
5. A-CDM in Adverse Conditions
6. Collaborative Management of Flight Updates

CE#3 – Variable Taxi Time (2)

- The Variable Taxi Time or VTT is the dynamic estimated time that an aircraft spends taxiing between its parking stand and the runway and vice versa.
- The VTT replaces the default taxi time of non-A-CDM airports, as they are not accurate enough
- Accurate taxi times are essential for calculating high quality timestamps:
  - The estimated time of arrival at the aircraft stand (feeding Milestone 7)
  - The estimated and target take-off time (feeding Milestone 16)
- The VTT enables Air Traffic Control to optimize start-up times and the departure sequence. As such, aircraft queuing and taxiway congestion can be reduced

CE#3 – Variable Taxi Time (3)

Taxi time duration is affected by many parameters, such as airport layout, choice of runways, traffic density, meteorological conditions, …



CE#4 – Collaborative Pre-departure Sequencing (1)

1. Information Sharing
2. Milestone Approach
3. Variable Taxi Time
4. **Collaborative Pre-departure Sequencing**
5. A-CDM in Adverse Conditions
6. Collaborative Management of Flight Updates

CE#4 – Collaborative Pre-departure Sequencing (2)

Airports usually have many bottlenecks, constraining the optimal traffic flow

- Occupied aircraft stands & gates
- Capacity of the runways
- Layout of the taxiways (crossroads, …)
- Ad hoc operations, such as aircraft de-icing

CE#4 – Collaborative Pre-departure Sequencing (3)

- The purpose of pre-departure sequencing is to establish an optimal order of departure for aircraft that are ready to leave the gate, taking into account constraint and capacity parameters, and operators' preferences. Ultimately, the capacity of the runway is maximally exploited, with a minimum of aircraft queueing on the taxiways towards the runway.
- The departure sequence is built through the TOBT timestamps (Milestone 9) and confirmed in the TSAT timestamps (Milestone 10)

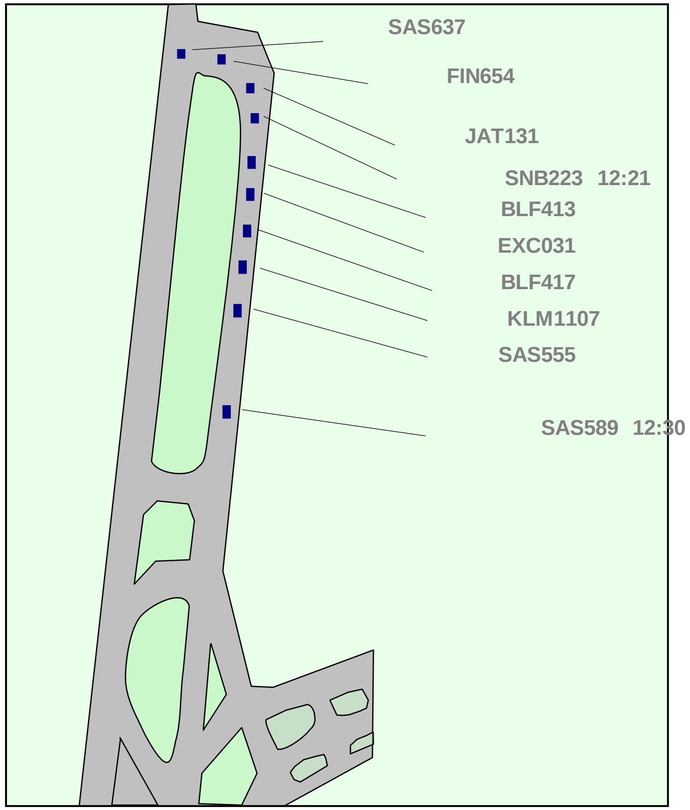
CE#4 – Collaborative Pre-departure Sequencing (4)

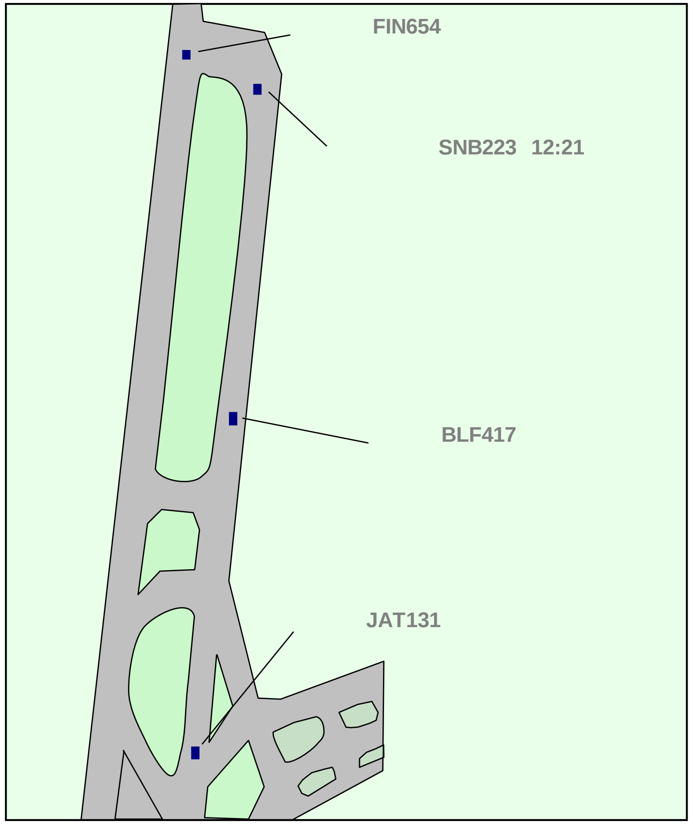
- The actual sequencing is performed by an algorithm. The sequencing tool can be configured with constraining parameters, to balance it with available capacity
- Sequencing facilitates the transition from 'first come, first served' to 'best planned (through TOBT), best served (through TSAT)'

TIME	CAP	DEM OUT	ARCID	TYP	WTC	ARC CAT	POS	SID	SOBT	EOBT	TOBT	TSAT	EXOT	TTOT	CTOT	DELAY REASON	ASAT	AOBT	ATOT
17:00	4	1	EZY80Y			C	B	DAXIB9T			16:40		26	*		-,-,-,-,-,-			17:00
17:10	4	1	IJM566			C		DAXIB9T			16:50	17:06	10	*17:16		-,-,-,-,-,-			17:14
17:20	4	2																	
17:30	4	5	RYR085			C		ATUDO5T			16:55	17:06	24	*17:31		-,-,-,-,-,-			17:19
			EZY9CU			C		BOSEV3T			16:55	17:05	30	*17:36		-,-,-,-,-,-			
			EZY1AT			C		KANIP1T			17:05	17:07	26	*17:33		-,-,-,-,-,-	17:03		
			EZY9UH			C		DAXIB9T			17:10	17:10	27	*17:37		-,-,-,-,-,-	17:05		
17:40	4	4	THY3RL			E		BOSEV3T			17:00	17:10	34	*17:44	17:44	-,-,-,-,-,-	17:06		
			EZY9194			C		BOSEV3T	16:50	16:50	17:08	17:10	30	*17:40		-,-,RW,-,-,-	17:12		
			RYR3MJ			C		DAXIB9T		17:15	17:21	17:21	28	*17:49		-,-,-,-,-,-	17:21		
17:50	0	8																	
18:00	3	14	EZY1W			C		DAXIB9T			17:00	17:35	24	18:00		-,-,RW,-,IC,-			
			EZY4ZJ			C		LORID6T			17:10	17:30	30	*18:00		-,-,RW,-,IC,-	17:07		
			EZY7ME			C		DAXIB9T			17:20	17:36	24	*18:00	17:44	-,-,RW,-,IC,-	17:15		
18:10	4	21	BEE4DZ			C		KANIP1T			17:20	17:44	26	*18:10		-,-,RW,-,IC,-	17:16		
			SWR102G			C		DAXIB9T	17:45	17:45	17:45	17:59	11	18:10	17:58	-,-,RW,CT,-,-			
			EZY63W			C		KANIP1T			17:25	17:39	31	18:10		-,-,RW,-,-,-			
			EZY6TC			C		LORID6T			17:25	17:39	31	18:10		-,-,RW,-,-,-			

CE#4 – Collaborative Pre-departure Sequencing (5)

The effect of sequencing on the flow of aircraft taxiing to the runway





CE#5 – A-CDM in Adverse Conditions (1)

1. Information Sharing
2. Milestone Approach
3. Variable Taxi Time
4. Collaborative pre-departure sequencing
5. **A-CDM in Adverse Conditions**
6. Collaborative Management of Flight Updates

CE#5 – A-CDM in Adverse Conditions (2)

Adverse conditions in the aviation industry:

- Meteorological conditions such as thunderstorms, snow and ice, wind and low visibility
- But also: staffing issues, system failures, industrial actions, …

Adverse conditions are all predictable and unpredictable disruptive situations which have an impact on the regular capacity of an airport

Stakeholder behaviour: there is a natural tendency to revert to re-active decision-making during disruptions, while A-CDM in adverse conditions provides a procedural framework for robust operations

CE#5 – A-CDM in Adverse Conditions (3)

The main objective of A-CDM in adverse conditions is to guarantee business continuity and stability of the operations, in order to retain an acceptable level of predictability. This is achieved by:

- Establishing procedures and pre-agreed mitigation scenarios for the different categories of adverse conditions
- Creating maximum awareness of those contingency procedures
- Defining a coordinator role
- Stressing on the key aspect of TOBT management under all circumstances, as an efficiency enabler

CE#6 – Collaborative Management of Flight Updates (1)

1. Information Sharing
2. Milestone Approach
3. Variable Taxi Time
4. Collaborative pre-departure sequencing
5. A-CDM in Adverse Conditions
6. **Collaborative Management of Flight Updates**

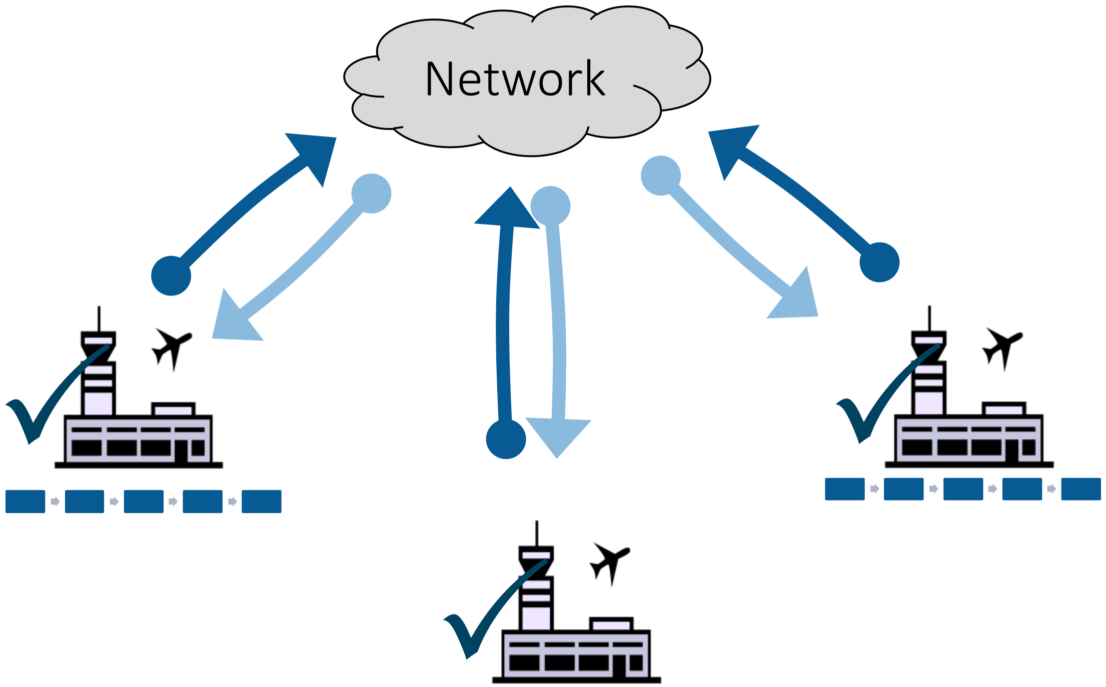
CE#6 – Collaborative Management of Flight Updates (2)

- While the previous Concept Elements relate to information sharing on local airport level, this Element establishes a bilateral data link with the EUROCONTROL Network Manager. The Network Manager (NM) is responsible for air traffic flow management across the member states of European Civil Aviation Conference (ECAC).
- Data on a selected set of A-CDM Milestones is exchanged in a specific message type with NM. In return, NM transmits valuable network information to the A-CDM airport. This ensures:
  - Completeness of the information exchange between networked air traffic management and airport operations
  - Improvement of the predictability of ground operations through high-quality inbound information
  - Improvement of the predictability of take-off times

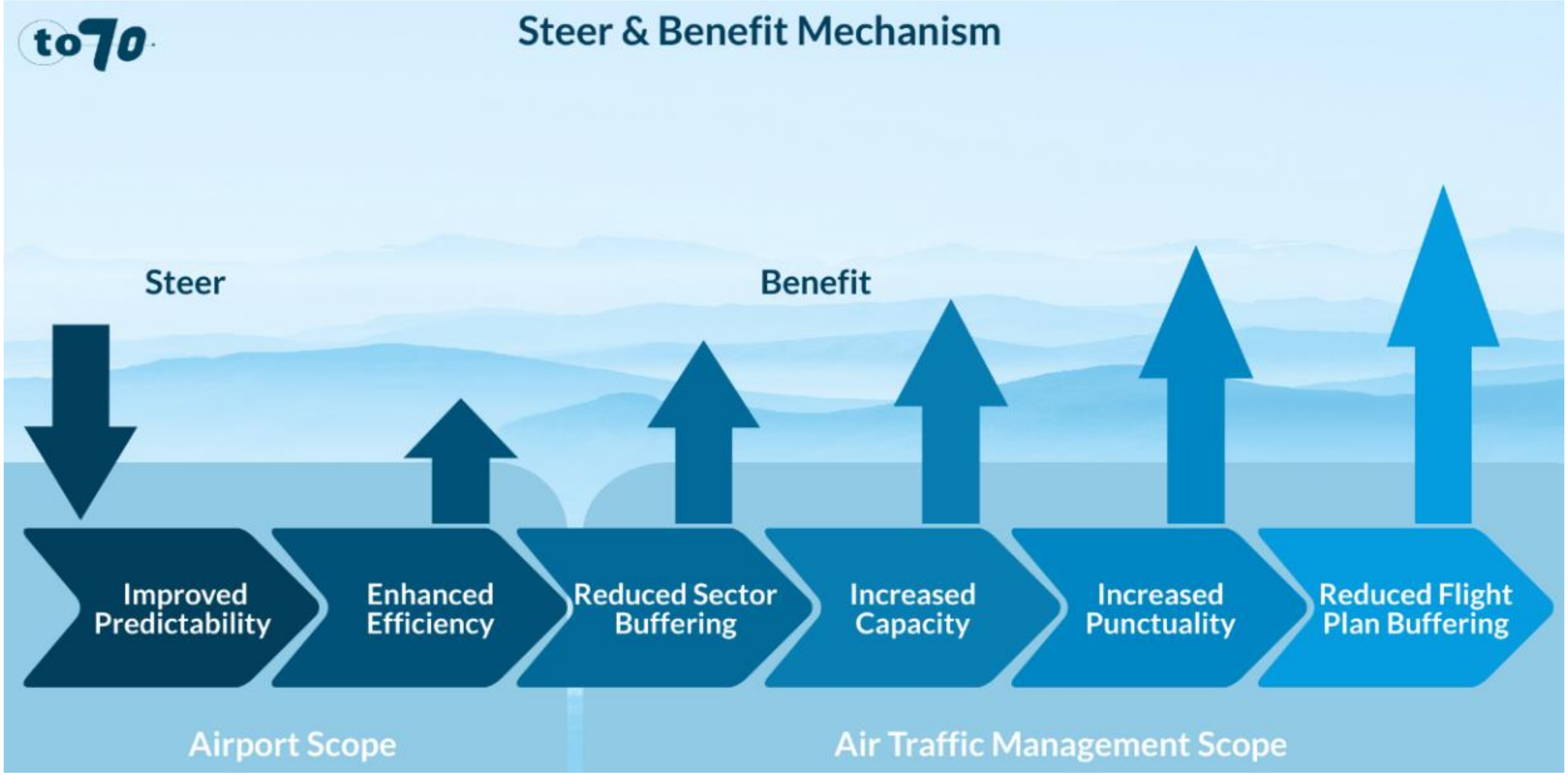
CE#6 – Collaborative Management of Flight Updates (3)

The concept:

- Local airport data on the progress of the turnaround is shared with the Network Manager (Departure Planning Information – DPI)
- En-route estimated landing times are shared with the airport of destination (Flight Update Messages – FUM)



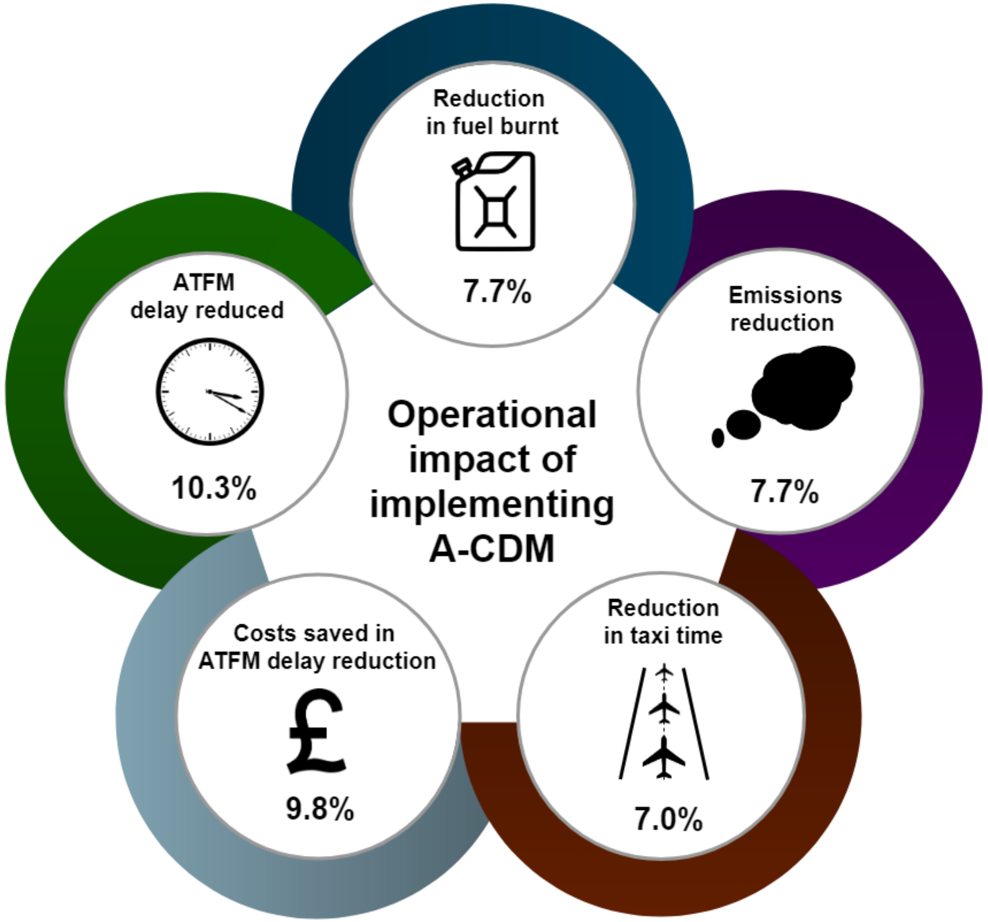
Direct and Indirect Benefits from Airport CDM Predictability



Which benefits have been recorded by A-CDM Airports?

As listed in the 2016 EUROCONTROL A-CDM Impact Assessment Study:

- Reduction in taxi time duration, hence less fuel burn and reduced NOx emmissions
- Overall reduction in start-up delay
- Improved predictability
- Increased peak departure rates from the runway
- Increased adherence to take-off slots
- Reduced network delay
- Quicker recovery from reduced capacity situations



(Source: A-CDM Impact Assessment 2016, Eurocontrol)

Conclusions from Airport CDM

- Airport CDM is a concept that is perceived to be transferable to other transport modes.
- Benefits are achieved for all stakeholders
- For conclusions of transferability to Rail Freight, criteria need to be agreed and met through analysis of rail processes.
- Deliverable D1.2 provides the criteria and conclusions for Transferability of Airport CDM to Rail.

Project Approach Task 1.2

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WP3 – Recommendations and Roadmap

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HACON to70

Introduction

Approach
Interview partner
Criteria for transferability

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Approach of Task 1.2

Note: For timing reasons, the work on Task 1.2 has been started in parallel to Task 1.1.

To provide the necessary input for answering the question of transferability, the following steps have been carried out:

- Generating public/sector interest during various presentations including discussions on transferability with
  - Railway Undertaking Advisory Group (RAG);
  - RNE Rail Freight Day;
  - Activities at ministry level;
  - Terminal Advisory Group (TAG);
  - Bilateral contact with stakeholders ;
- Establishing contact to several stakeholders covering different kinds of companies, different geographical regions and different business sizes ;
- Performing detailed 2 h working meetings (interviews), documentation and review with stakeholders (internal document / confidentiality requested);
- Developing process overviews based on consultant's know-how and stakeholder input;
- Assessing and analysing processes, stakeholder interests and interactions;
- Check of transferability from aviation to intermodal transport chain rail-road;
- Conclusions on transferability.

Interview partner

Note: List is subject to continuous changes; execution of working meetings in progress.

Country	Company	Type
NL	Combi Terminal Twente (CTT) Rotterdam	Terminal Operator
DE	Contargo Rail Services*	Intermodal Operator
DE	DB Cargo	Railway Undertaking
DE	DB Netz	Infrastructure Manager
DE	Deutsche Umschlaggesellschaft Schiene-Straße (DUSS) with Terminals Köln-Eifeltor and Ulm	Terminal Operator
IT	Hupac Terminal in Busto Arsizio-Gallarate*	Terminal Operator
NL	Hutchinson Ports with ECT DELTA / EUROMAX in Rotterdam	Terminal Operator
NL	Pro Rail	Infrastructure Manager
NL	Port of Rotterdam	Port Authority
CH	SBB Cargo International	Railway Undertaking

*due to time constraints of the interview partners it was decided to integrate them via the workshop in February

Transferability Criteria

C#1	Stakeholders and their operations shall be comparable;
C#2	Stakeholder challenges shall be similar to a high extent;
C#3	Freight train processes shall be relatable to those of an aircraft;
C#4	Performance areas and indicators shall be comparable or similar;
C#5	A-CDM Concept elements shall each be considered relatable to rail, answering the following questions positive:

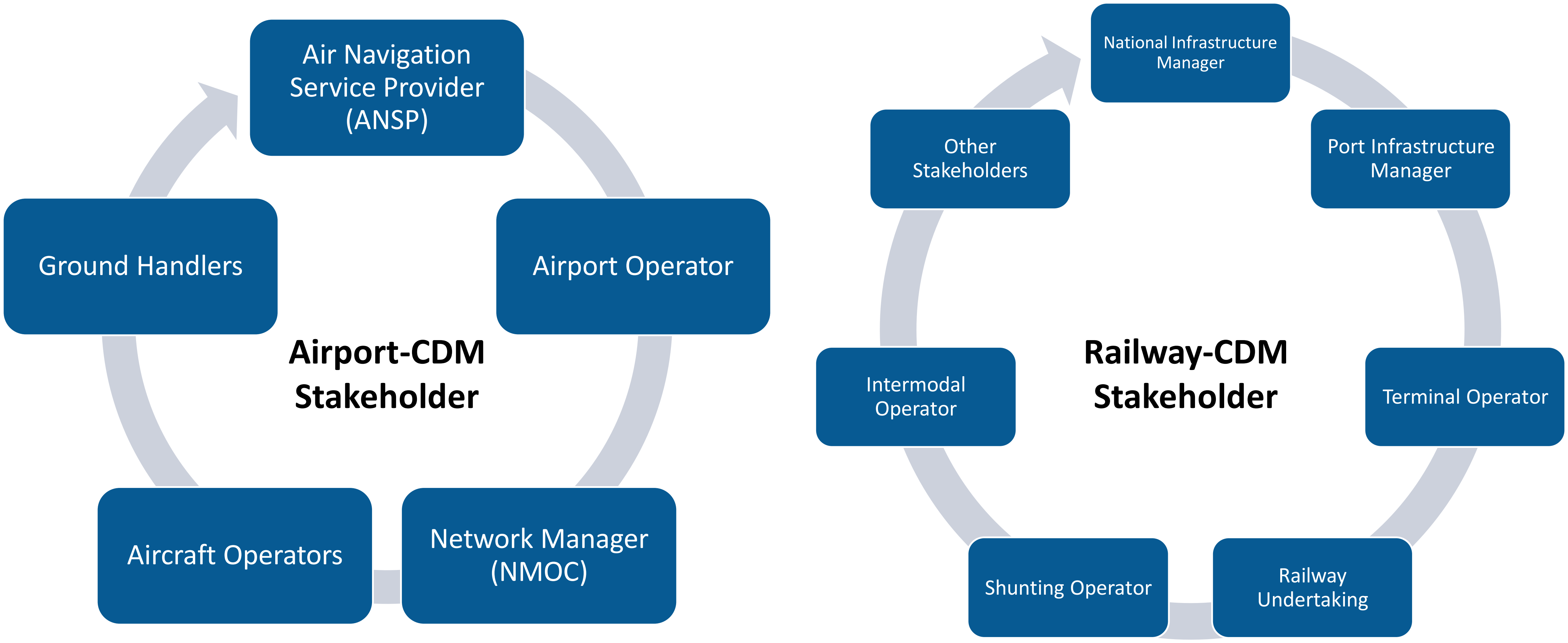
CE#1	For rail, is there an improvement possible on Situational Awareness?
CE#2	Can the rail journey be segmented into milestones, similar to a flight?
CE#3	Is there an uncertainty in the connection between Terminal and IM exit/entry point (last mile connection)?
CE#4	Can IMs similar to ATC influence the sequence of trains leaving a terminal or node when entering the main lines of their respective network?
CE#5	Is it possible to define special procedures in case of predicted or unpredicted loss of capacity due to adverse conditions?
CE#6	Is there a need for an international coordination support function for CDM?

Criteria#1

Stakeholders
and their operations

C#1 – Stakeholders and their operations (1)

Stakeholders for A-CDM and introduction of possible stakeholders for R-CDM



C#1 – Stakeholders and their operations (2)

Aviation	
Stakeholder	**Activity**
Air Navigation Service Provider	traffic management of aircraft on airports and in the air
Airport Operator	commercial and operational exploitation of airport terminals
Network Manager	organises and coordinates air traffic flow and capacity management on pan-European scale
Aircraft Operator	airlines
Ground Handler	providers of aircraft handling services, subcontracted by airlines

Rail	
Stakeholder	**Activity**
Terminal Operator	management of infrastructure and operations on terminals
Infrastructure Manager (incl. ports)	provision of infrastructure (timetables, operational and construction management, maintenance)
Railway Undertaking / Shunting Operator	provision of transport services by rail
Intermodal Operator	contract RUs for moving trains between terminals and TOs for transhipment on terminals
Other stakeholders	

Criteria#2

Stakeholder challenges
Opportunities
Advantages

C#2 – Challenges to overcome in the Rail Sector (1)

General observations:

- Lack of situational awareness due silo thinking → Who has the complete picture of operations?
- Lack of common terminology, hence no level playing field for procedure adherence
  → e.g. 'estimated time of arrival/departure' interpreted differently by different stakeholders
- Planning uncertainties due lack of predictability, leading to re-active behaviour and no pro-active thinking
- No transparency in capacity and resource assignment, leading to wastage → 'we're not sweating the assets'
- Non-harmonised procedures, leading to confusion and misunderstandings
- No harmonised integration into an European Rail Traffic Management Network

C#2 – Challenges to overcome in the Rail Sector (2)

What are the opportunities?

- To learn from a mature and already successful data-driven collaboration model in rail freight operations;
- The (partial) adoption of a 'tried and true' implementation methodology;
- To learn from advanced performance monitoring and reporting mechanisms out of the aviation industry;
- Factoring in lessons learned out of the A-CDM world ('don't make the same mistakes twice').

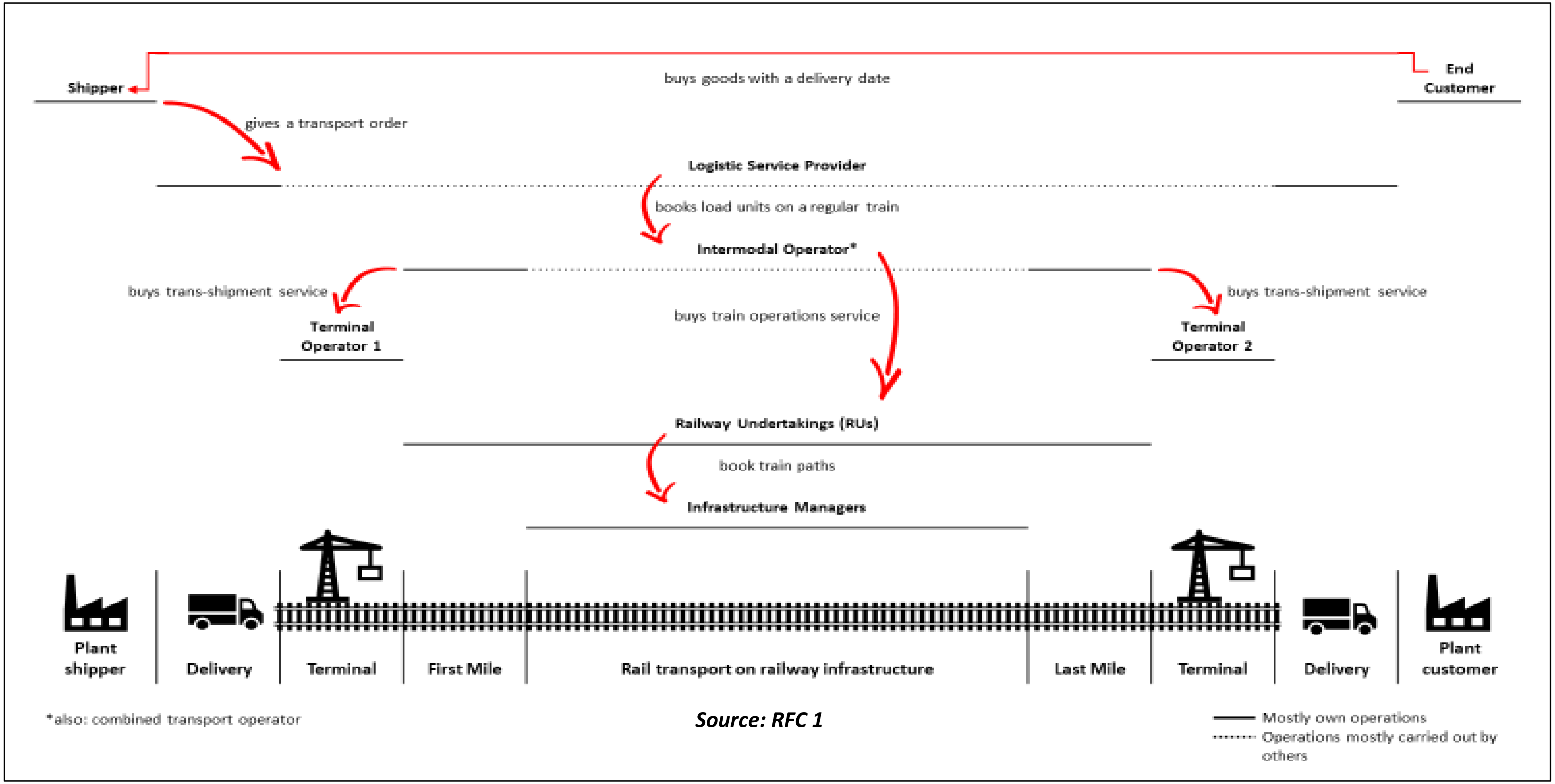
Take advantage of lessons learned and challenges in A-CDM implementations!

- Resistance to change;
- Lack of trust;
- Lack of operational and/or financial commitment;
- Continuous awareness and training efforts;
- Underestimation of the duration of the change process;
- Failing to see the importance of performance measurement, hence missing out on the ROI and sustainable improvements.

Criteria#3

Freight train processes

C#3 – Railway processes (overview)



Source: RFC 1

C#3 – Selection of relevant railway processes (1)

Starting point: **inbound** train approx. 240 min before arrival

Process	Category	Stakeholder Communication (simplified)		
		Outgoing	Description	Receiving
01	Main line train operation	IM	Sends and updates train run information (including ETA messages for IM exit point or other important operational points during train run)	RU, IO, TO
02		RU	Updates IM messages concerning specific RU topics (i.e. change of loco or personnel etc.)	IM
03		TO	Updates IM messages concerning terminal topics (i.e. temporary congestion or crane failure etc.)	IM
04		RU	Executes train transportation to handover station of destination terminal according to planned timetable and operational deviations	IM, SO
05	Shunting	SO	Takes over train and executes train shunting from handover station to terminal transhipment track(s)	TO, RU
06	Loading	TO	Tranships LU(s) from inbound train to outbound truck(s)	IO, TC
07	Shunting	SO	Executes shunting of wagon set(s) according to TO instructions; provision of wagon set for (re-)loading	TO, RU

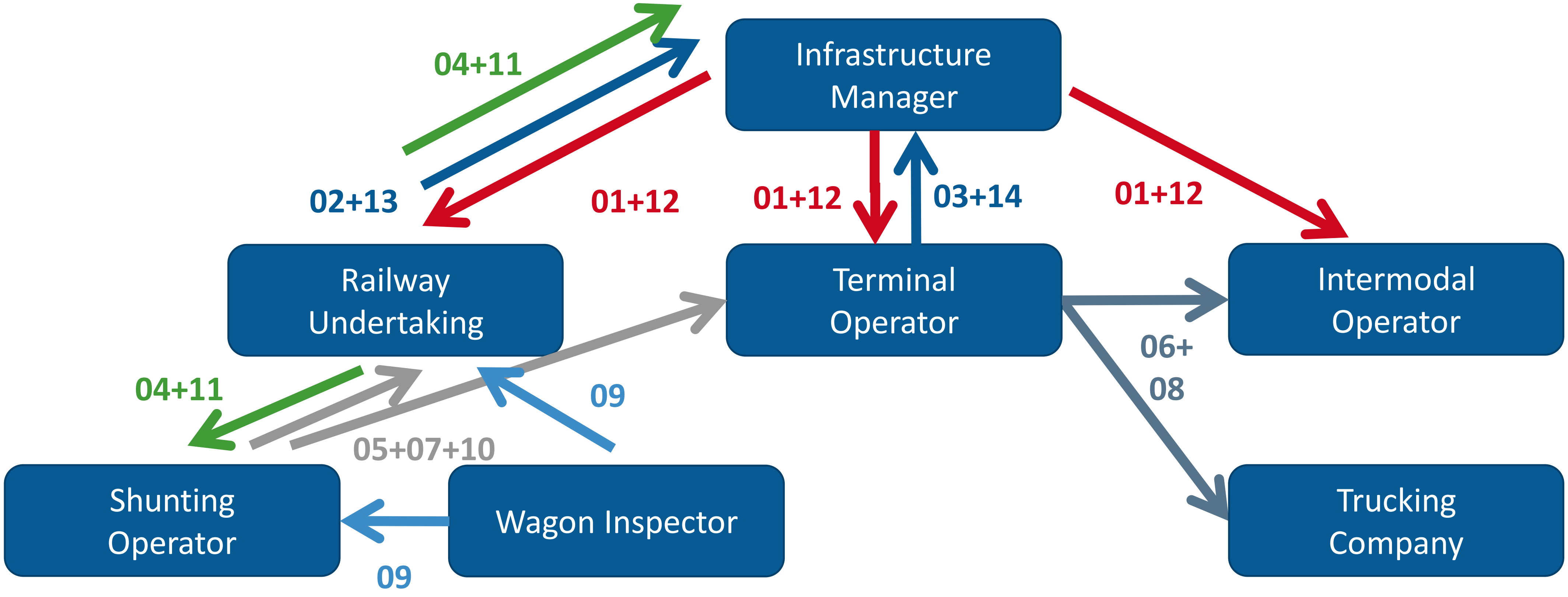
HACON to70

C#3 – Selection of relevant railway processes (2)

Ending point: **outbound** train after departing from handover station

Process	Category	Stakeholder Communication (simplified)		
		Outgoing	Description	Receiving
08	Loading	TO	Tranships LU(s) for outbound train from inbound truck(s)	IO, TC
09	Shunting	WI	Execution of the brake test and train inspection	SO, RU
10		SO	Executes train shunting from terminal transhipment track(s) to handover station	RU, TO
11	Main line train operation	RU	Takes over train and executes train transportation from handover station of departure terminal to handover station of destination terminal according to planned timetable and operational deviations	IM, SO
12		IM	Sends and updates ETA messages during train run	RU, IO, TO
13		RU	Updates IM messages concerning specific RU topics (i.e. change of loco or personnel etc.)	IM
14		TO	Updates IM messages concerning terminal topics (i.e. temporary congestion or crane failure etc.)	IM

C#3 – Communication process for railway operations



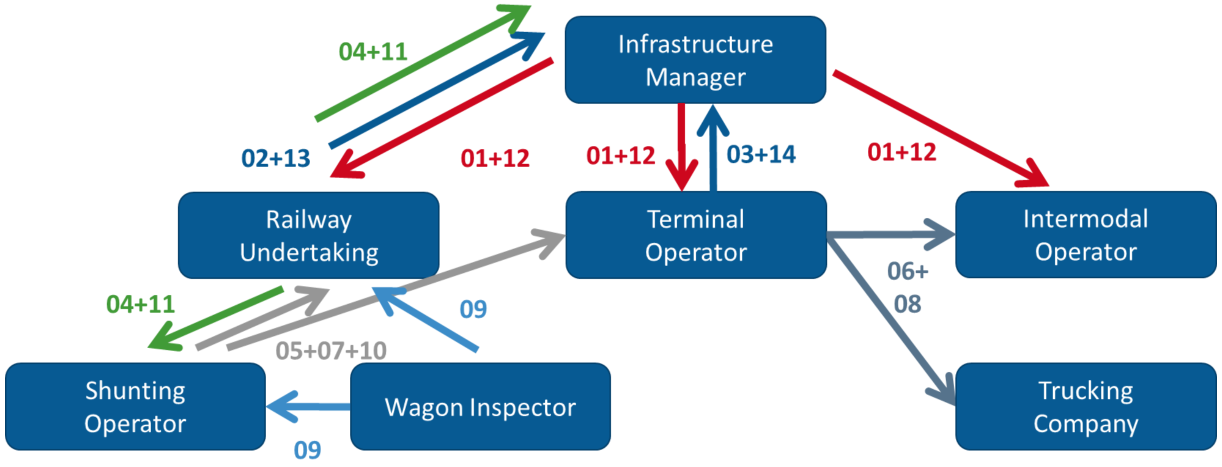
Note: Further details will be elaborated based on use-case(s)

HACON to70

P#1+12 – Update of train run information messages during execution (1)

Who is responsible?

- IMs provide capacity on the railway networks (capable of running trains; in this context not connecting lines and terminal infrastructure) and manage all capacity related topics;
- Each IM is therefore responsible to provide information on all trains running on their network.



P#1+12 – Update of train run information messages during execution (2)

Usual situation today incl. specific stakeholder feedback:

- There is no agreed common process for data provision and exchange;
- No continuous update of all relevant parts of the transport chain ;
- No interfaces / no common joint platform for the exchange of information;
- Selected parameters may be checked in different systems;
- Information exchange mainly bi-lateral via email/phone;
- Either information on train positions does not reach stakeholders at all, is delayed and arrives too late or arrives from different sources with contradictory content;
- RUs provide location of trains in separate stand-alone systems (e.g. mobile app);
- Systems like RNE TIS, TrainMonitor, ELETA are used as separate stand-alone system without interface connection.

P#1+12 – Update of train run information messages during execution (3)

Main challenges identified:

- Information not available in time;
- Information inaccurate;
- Information not available for all stakeholders;
- Missing data standards;
- Non compliant application of priority rules hamper predictions.

Selected initiatives/projects to work on improvements:

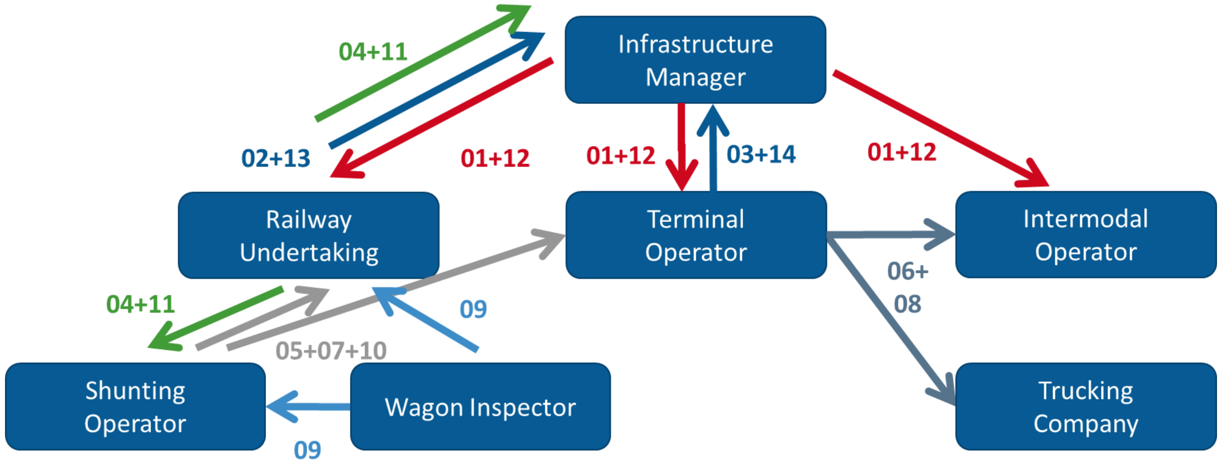
- TAF/TSI revision;
- ELETA;
- RNE TIS;
- Local data platforms (e.g. OnTrack, …).

→ **Missing situational awareness! Reactive instead of pro-active!**

P#2+13 – RU information update concerning train run on main line (1)

Who is responsible?

- The number of involved RUs per train run varies; at least one RU is organising the complete train run (incl. shunting) or every leg of the transport is in charge of another RU (i.e. SO departure terminal, main line RU1, (border crossing), main line RU2, SO (destination terminal);
- The responsible RU is therefore the leading RU.



P#2+13 – RU information update concerning train run on main line (2)

Usual situation today incl. specific stakeholder feedback:

- RUs do not provide information on transport related issues prior to departure e.g.
  - Timely departure is not possible as loco driver is not punctual;
  - Brake test failed (see P#9).

- RUs do not provide continuous feedback on transport related issues e.g.
  - Loco change is not possible as planned due to late arrival of replacement loco;
  - Personnel change is not possible as planned due to late arrival of replacement driver;
  - If feedback is provided, it is not following standardised procedures and is normally not processed and transferred via IT systems, but by direct personal contacts from operational staff of involved stakeholders.

P#2+13 – RU information update concerning train run on main line (3)

Main challenges identified:

- Missing detailed planning and transparent shunting movements prevent proper pre-information to other actors;
- Known factors that influence the operational process are not precisely planned and can be coordinated in real time.

Selected initiatives/projects to work on improvements:

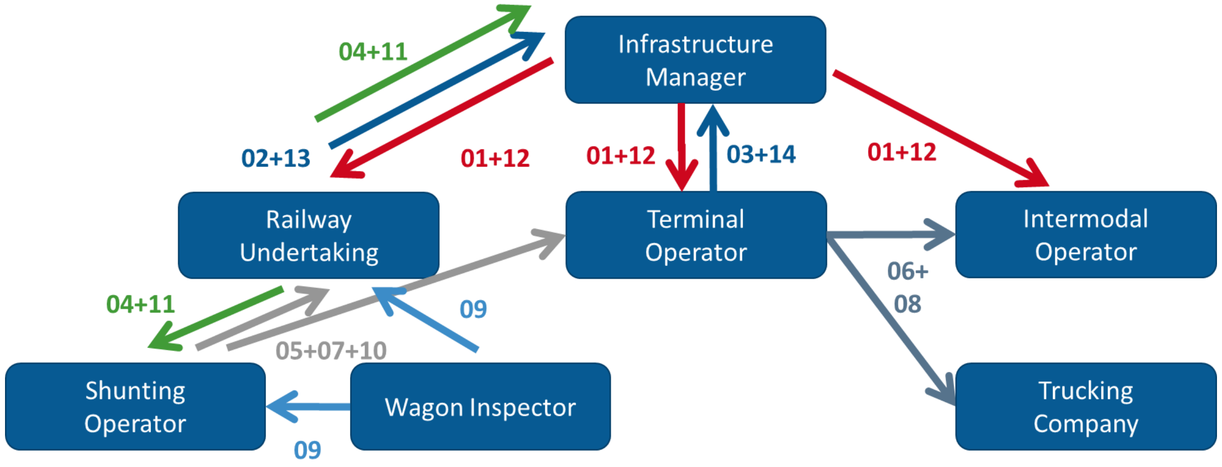
- ELETA Project;
- Additional information will be provided after further interviews with RUs.

→ **Missing situational awareness! Reactive instead of pro-active!**

P#3+14 – TO update concerning train treatment / processing on terminals (1)

Who is responsible?:

- Each participating terminal operator is responsible for the operation on its own infrastructure comprising arriving trains and the transhipment of LUs as well as (re-) loading of trains and departing trains;
- In some larger port areas, port infrastructure operators may be responsible for the coordination of slots and other capacity allocation on the accession infrastructure, which might have an impact on the terminal operation (terminal slot usage).



P#3+14 – TO update concerning train treatment / processing on terminals (2)

<u>Usual situation today incl. specific stakeholder feedback:</u>

- TOs do not provide continuous feedback on terminal related issues (e.g. temporary congestion of transhipment tracks, crane failures, …).

P#3+14 – TO update concerning train treatment / processing on terminals (3)

Main challenges identified:

- In case of failures/disturbances the information is not automatically provided to all concerned stakeholders;
- In case of delayed entrance of one train the delay transfer to subsequent trains is not communicated/ provided to involved stakeholders.

Selected initiatives/projects to work on improvements:

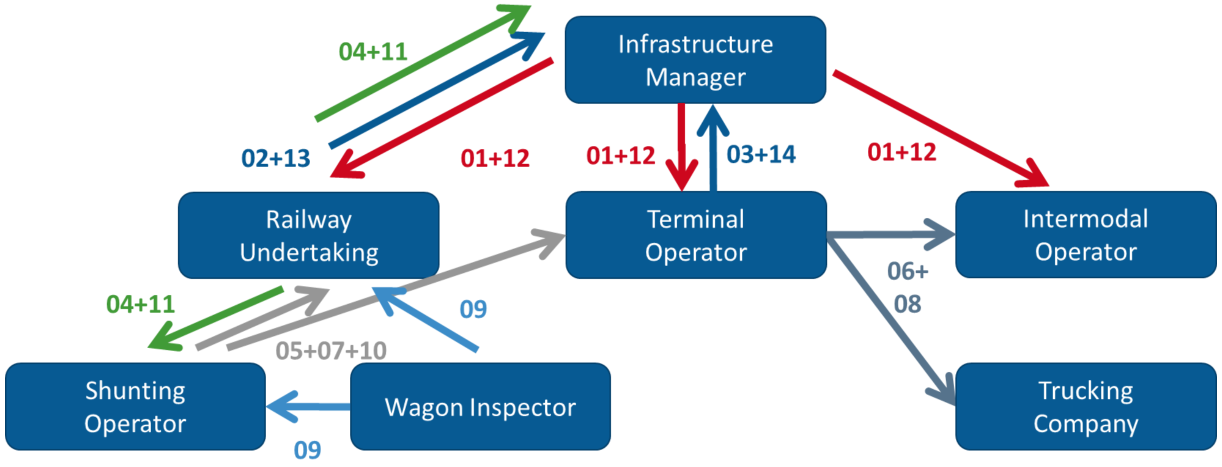
- Partly tackled in the current PSA project on "Enhanced real-time communication about train composition and estimated time of arrival“; which includes the connection of additional stakeholders to TIS

➡ **Missing situational awareness!**
Reactive instead of pro-active!

P#4+11 – Train execution on main line (1)

Who is responsible?

- For infrastructure related topics (allocation of infrastructure capacity in handover stations) → IM;
- For topics related to train run on main line → RU.



P#4+11 – Train execution on main line (2)

Usual situation today incl. specific stakeholder feedback:

- Mixed train operation on most networks (i.e. passenger trains, freight trains);
- Congested nodes due to local passenger traffic (i.e. local, suburban trains);
- Deviating operational speeds cause additional capacity constraints;
- Interoperability issues for international trains:
  - Traction;
  - Safety Systems;
  - Train numbers.
- Capacity restrictions due to construction works and maintenance;
- Many small disturbances, additional consequential delays, finally adding up to major disruptions.
- Unforeseeable events such as severe weather (storm, snow), damaged infrastructure (e.g. Rastatt) and major accidents cause breakdown of operations in large parts of networks (“chaos”);

P#4+11 – Train execution on main line (3)

Main challenges identified:

- In parts extreme demand for re-planning, also on small incident level, and subsequent communication;
- Electronically supported communication is missing so that all relevant stakeholders have such information at the same time;
- Preparation of contingency plans required at least for major recurring incidents;
- Definition of responsibilities and subsequent compliance is needed.

Selected initiatives/projects to work on improvements:

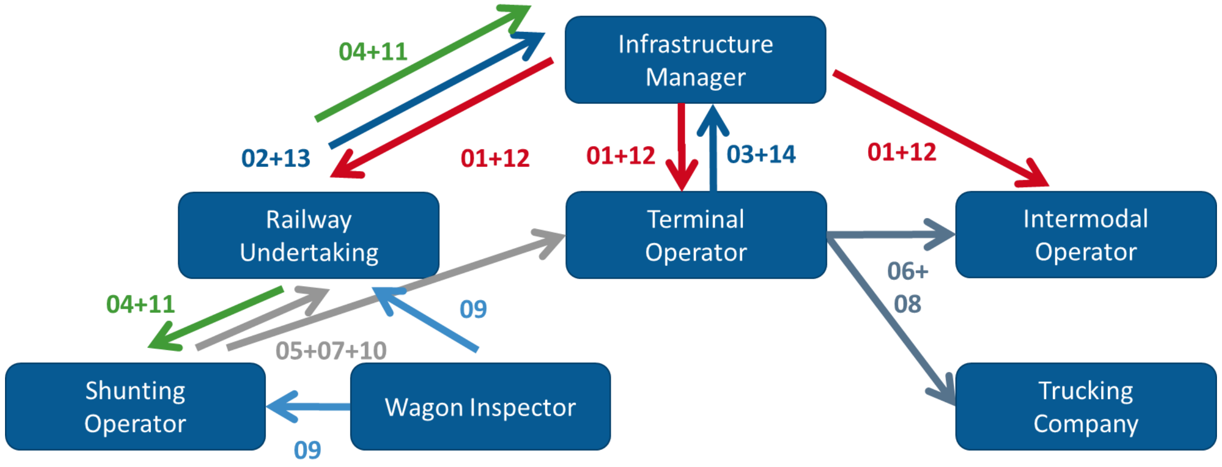
- RFC Rhine-Alpine Re-routing Scenarios elaborated for major disruptions.

→ **Missing situational awareness!**
Reactive instead of pro-active!

P#5 – Updates concerning handover of inbound trains/wagons (1)

Who is responsible?

- For infrastructure related topics (allocation of infrastructure capacity in handover station and terminal)
  → IM, TO;
- For topics related to train and shunting movements
  → RU, SO.



P#5 – Updates concerning handover of inbound trains/wagons (2)

Usual situation today incl. specific stakeholder feedback:

- Arrival of inbound train according to planned infrastructure allocation not possible due to tracks blocked from other operators (also storage tracks);
- Shunting of inbound train according to planned allocation of transhipment track(s) not possible due to congested handover tracks;
- In case of deviations from planned schedule or necessary deviating sequencing of shunting movements responsible SO(s) are not available on short notice.

P#5 – Updates concerning handover of inbound trains/wagons (3)

Main challenges identified:

- No electronic transfer of information and data;
- Often SOs cannot offer flexible service (or do not cooperate with TO and RU, IO efficiently and this has been identified as a "bottleneck" for efficient terminal operation in case of delays and/or disruptions);
- No standardised procedure for involvement of SOs (depending on local procedures).

Selected initiatives/projects to work on improvements:

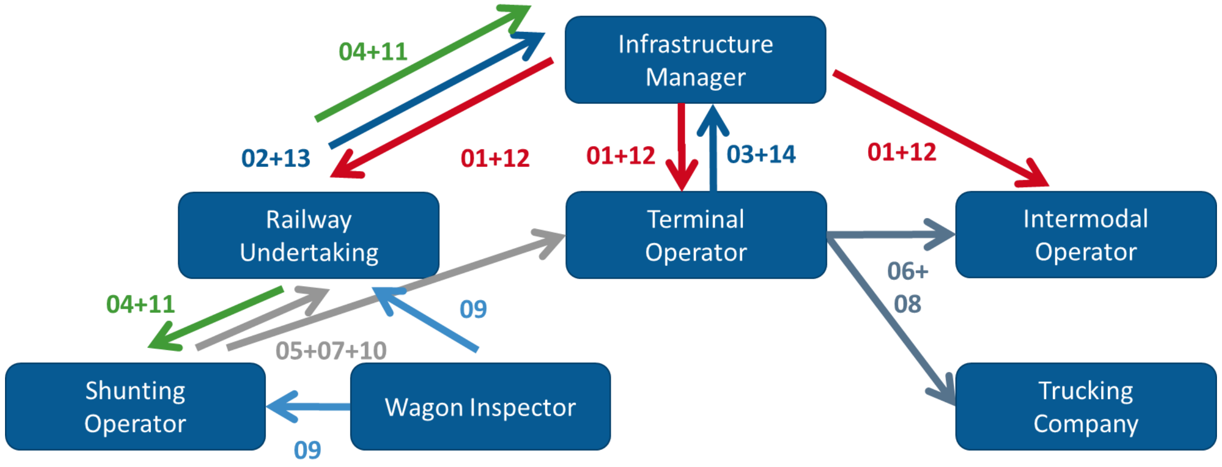
- TO consider becoming SO in order to ensure flexible shunting operations in direct coordination with their transhipment activities.

→ **Missing situational awareness! Reactive instead of pro-active!**

P#6+8 – TO update on terminal operations (1)

Who is responsible?

- TOs are responsible for providing the infrastructure for all terminal activities, especially the transhipment of LUs;
- IOs are responsible for agency operations.



P#6+8 – TO update on terminal operations (2)

Usual situation today incl. specific stakeholder feedback:

- Crane failures cause re-planning of transhipment process:
  - Prioritisation according to IO decisions;
  - Change of allocation of transhipment tracks;
  - Rescheduling of train departures.

- Late arrival of LUs due to:
  - Delayed maritime transportation;
  - Road/Parking congestion;
  - Congested handling of documentation in terminal agencies.

P#6+8 – TO update on terminal operations (3)

Main challenges identified:

- In parts demand for re-planning and subsequent communication required;
- Electronically supported communication needed so that all relevant stakeholders have such information at the same time.

Selected initiatives/projects to work on improvements:

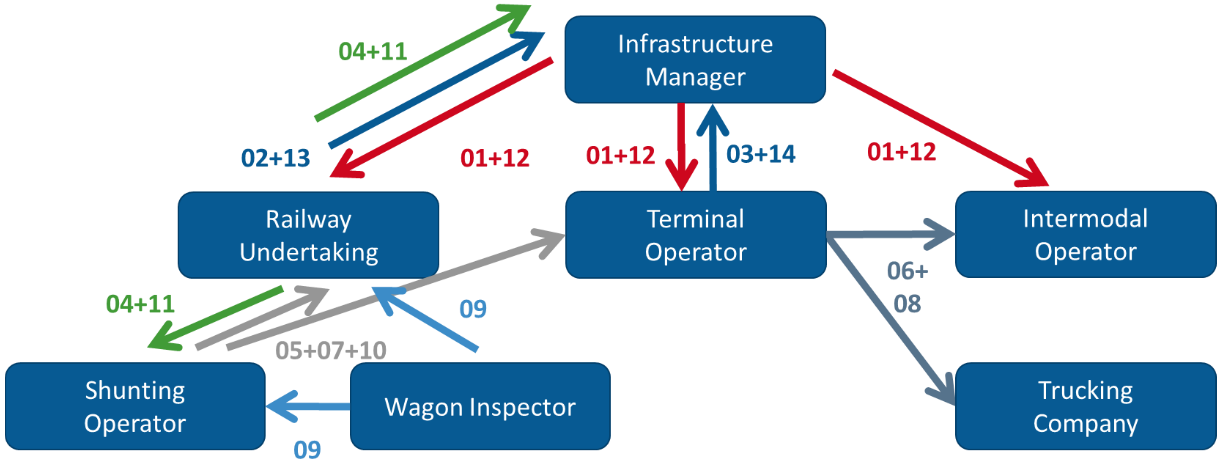
- Several ongoing projects / developments on automation of terminal processes and related data transfer (e.g. extension of BLU in the DUSS terminals).

→ **Missing situational awareness!**
Reactive instead of pro-active!

P#7 – Provision of wagon set for loading (1)

Who is responsible?

- Two basic cases: (1) inbound train = outbound train and (2) empty wagon set provided;
- Responsible (in most cases) is shunting operator, or RU (partly with liner loco) in coordination with IO and/or TO.



P#7 – Provision of wagon set for loading (2)

Usual situation today incl. specific stakeholder feedback:

- In most cases, inbound train will be re-loaded after unloading of wagon sets (shuttle trains or maritime intermodal transport);
- Problems occur, when inbound train is (significantly) delayed and loading units have to be unloaded (“stripping”) and (b) a set of empty wagon has to be provided for the formation of an outbound train by SO (unplanned).

P#7 – Provision of wagon set for loading (3)

Main challenges identified:

- No electronic transfer of information and data;
- Often SOs cannot offer flexible service (or do not cooperate with TO and RU, IO efficiently and this has been identified as a "bottleneck" for efficient terminal operation in case of delays and/or disruptions);
- No standardised procedure for involvement of SOs (depending on local procedures).

→ **Missing situational awareness!**

Reactive instead of pro-active!

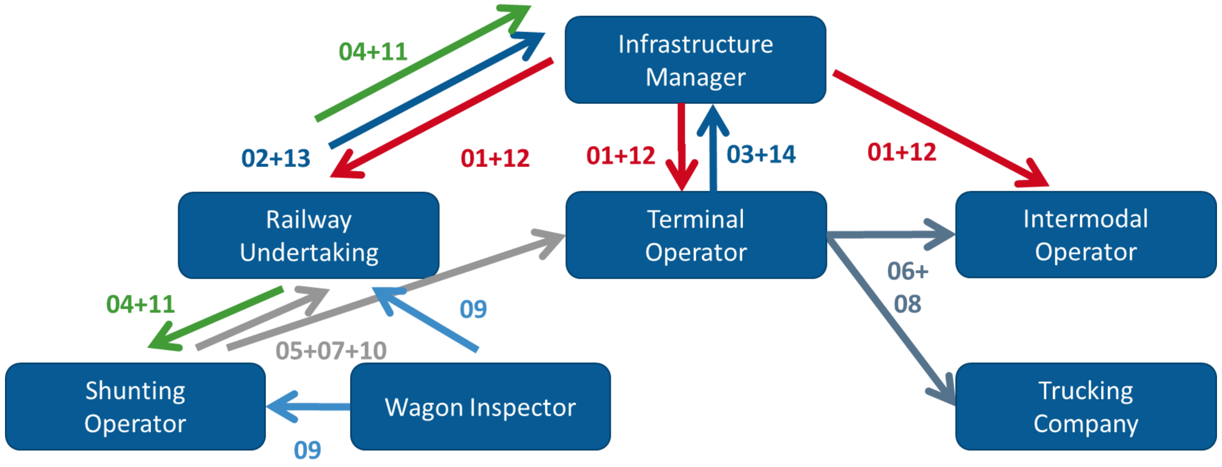
Selected initiatives/projects to work on improvements:

- TO consider becoming SO in order to ensure flexible shunting operations in direct coordination with their transhipment activities.

P#9 – Other selected important activities (1)

<u>Who is responsible?</u>

- The RU is responsible for performing waggon/train inspections;
- Agencies in the terminal gate have to be efficient in order to allow punctual delivery of LUs for outbound trains.



P#9 – Other selected important activities (2)

Usual situation today incl. specific stakeholder feedback:

- SO/RUs do not provide information on transport related issues prior to departure e.g.
  - Manual check of wagon numbers and LUs (incl. wagon sequence);
  - Manual detection of damaged LUs and subsequent required action;
  - Manual brake test discovering damaged brakes requiring shunting and detachment of the waggon.
- Mainly manual documentation forwarded from wagon inspector to RU only.

P#9 – Other selected important activities (3)

Main challenges identified:

- Information about delay due to additional waggon/train treatment is not provided/forwarded;
- Information about detached waggons with important load is not forwarded.
- Information about detached waggons in the inbound train which are also needed for the outbound train is not forwarded (also P#2+13).

Missing situational awareness!

Reactive instead of pro-active!

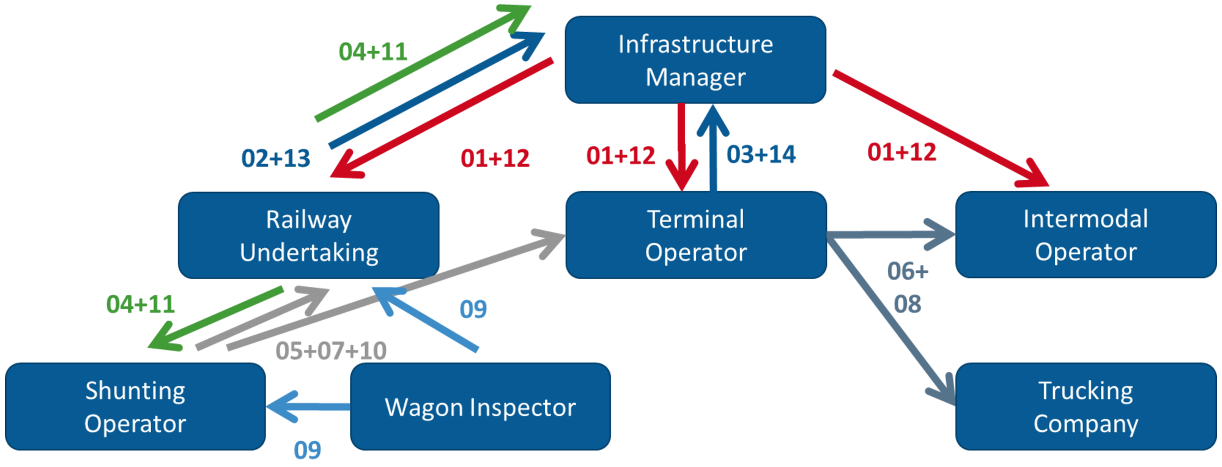
Selected initiatives/projects to work on improvements:

- DAC (e.g. Automatic Brake Tests);
- OCR (Optical Character Recognition e.g. detection of damaged LUs, recognition of wagon numbers for automated wagon sequence, allocation of LUs to wagons).

P#10 – Updates concerning handover of outbound trains/wagons (1)

Who is responsible?

- For infrastructure related topics (allocation of infrastructure capacity in terminal and handover station)
  → TO, IM;
- For topics related to shunting movements
  → SO, RU;
- In case of delays IOs influence sequencing of outbound trains.



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P#10 – Updates concerning handover of outbound trains/wagons (2)

<u>Usual situation today incl. specific stakeholder feedback:</u>

- Updated information/prediction about finalised transhipment is not forwarded to the SO. Consequently, the SO cannot start with its processes immediately;
- In case of deviations, responsible SO(s) might not be available on short notice leading to follow-up delays;
- Shunting of outbound train according to planned allocation of tracks in handover station not possible due to congested handover tracks.

P#10 – Updates concerning handover of outbound trains/wagons (3)

Main challenges identified:

- No electronic transfer of information and data;
- Often SOs cannot offer flexible service (or do not cooperate with TO and RU, IO efficiently and this has been identified as a "bottleneck" for efficient terminal operation in case of delays and/or disruptions);
- No standardised procedure for involvement of SOs (depending on local procedures) .

➡ **Missing situational awareness!**
Reactive instead of pro-active!

Selected initiatives/projects to work on improvements:

- TO consider becoming SO in order to ensure flexible shunting operations in direct coordination with their transhipment activities.

Criteria#4

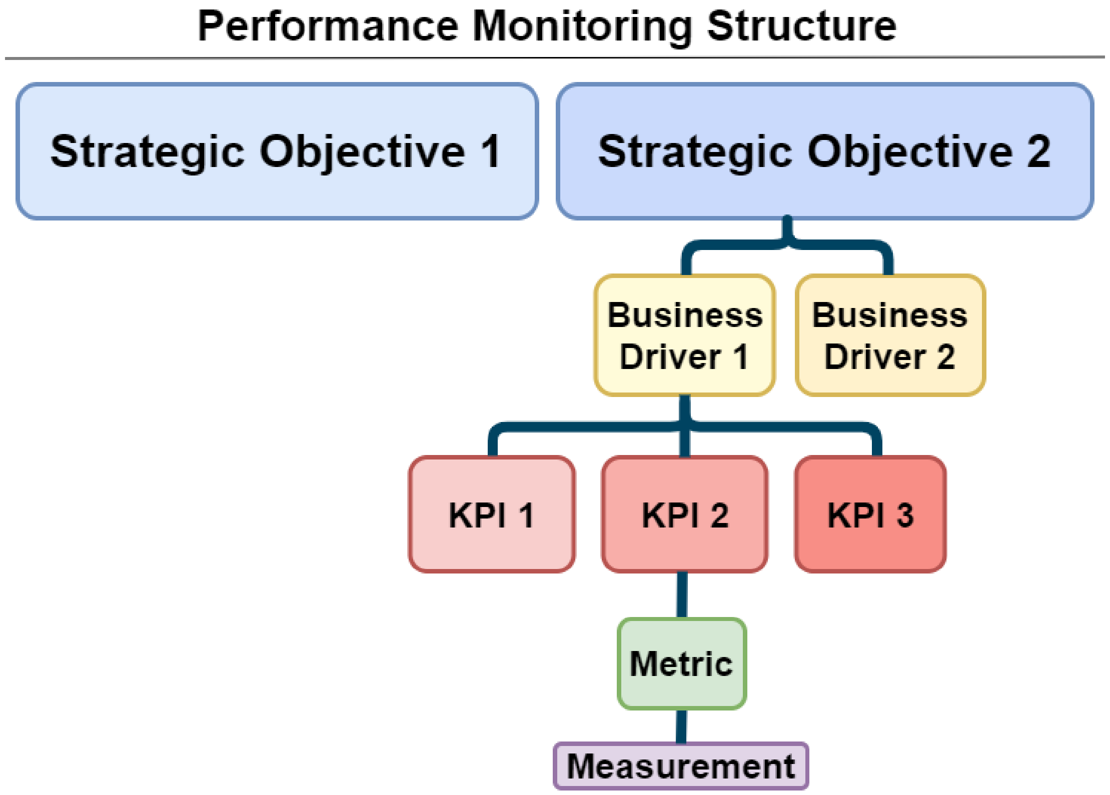
Performance areas
and indicators

C#4 – Performance areas and indicators (1)

Strategic Objectives are most likely similar in Aviation and Rail Freight and therefore transferable:

- Improve predictability
- Improve punctuality on timetable
- Reduce network delays
- Enhance resource efficiency
- Improve robustness

The business drivers can be selected based on Strategic Objectives.



C#4 – Performance areas and indicators (2)

Close the gap in rail freight stakeholder roles and interest towards transparent collaboration

- Identify and map the expectations and priorities of each stakeholder, and align those on common objectives
- Enrich existing performance indicators that drive the business today
- Identify missing information/data to perform optimally

Criteria#5

Concept elements

C#5 – Concept elements

Elements A-CDM

CE#1 – Information Sharing	Review platforms, data assessment, methods of information, sharing and exchange of protocols, investigate compatibility with TIS and ELETA
CE#2 – Milestone Approach	Identify existing process steps (Milestones) in the train journey, on which data can be collected to share among the stakeholders
CE#3 – Variable Taxi Time	Finding the main uncertainties in the transport process and breaking it down, including shunting at terminals sites
CE#4 – Pre-departure Sequencing	Which technology and processes are available to predict traffic distribution and an "order of departure" for the trains in the Corridor?
CE#5 – Adverse Conditions	Assess typical disruptions and causes for non-nominal and heavy impact delays
CE#6 – Collaborative Management of Flight Updates	Is there a need for an international coordination support function for CDM?

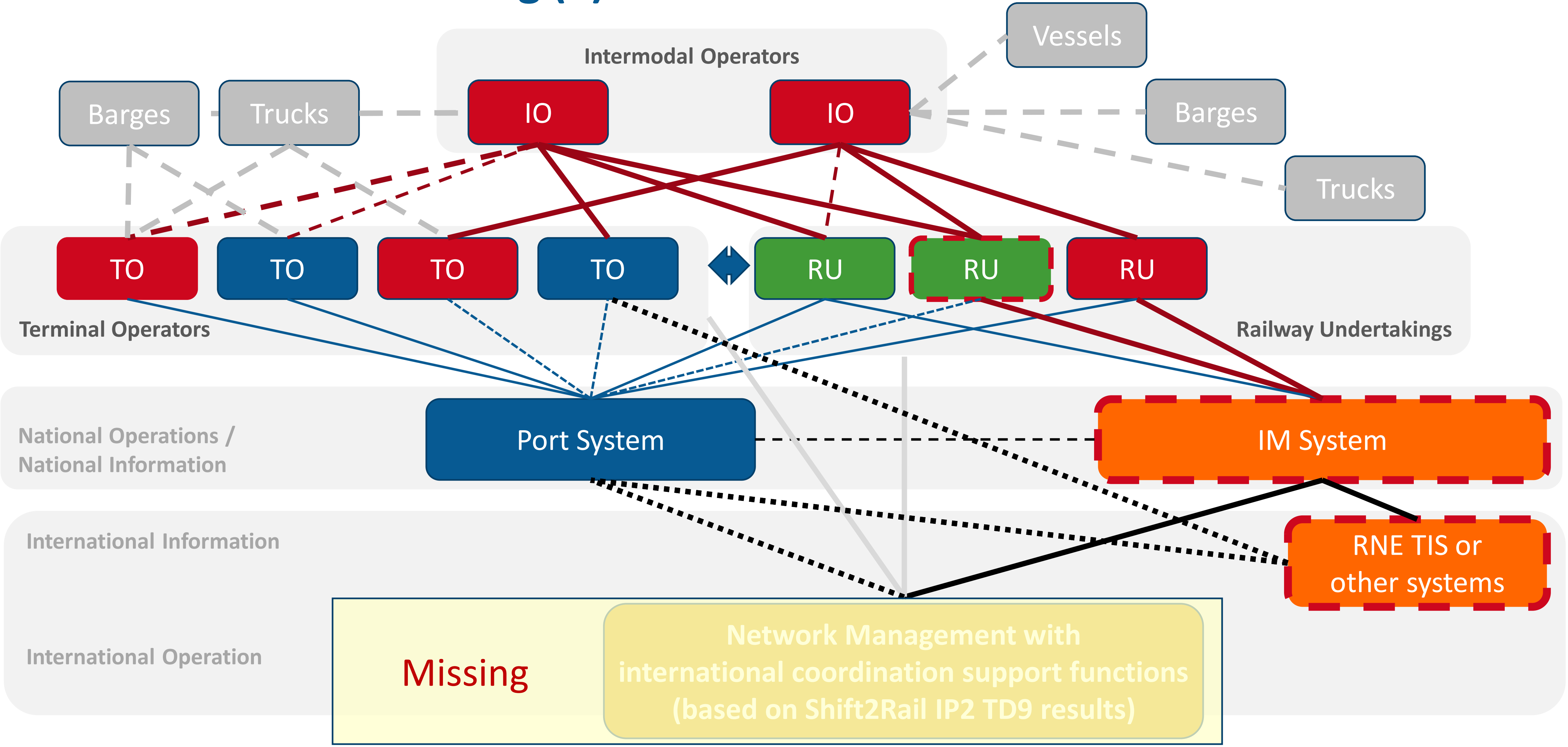
CE#1 – Information Sharing (1)

- Existing operating systems today are mainly used for internal activities only; i.e. Terminals and Railway Undertakings run Operating Systems in order to plan, monitor and document their own respective activities. These systems are usually either self-developed systems or have been developed according to the specific stakeholder requirements.
- Platforms for operational rail data are in operation in larger industrial sites i.e. maritime seaports (OnTrack in Rotterdam, Railport in Amsterdam or transPORT rail in Hamburg). These systems provide insight to the expected time of arrival and terminal handlings of trains. Information on last mile operations related to smaller terminals / industrial sites are often not available in digital form.
- Furthermore, there are various systems providing the location of trains. These can either be simple stand-alone apps running on mobile devices, more advanced systems operated by national Infrastructure Managers providing electronic data (e.g. DB Netz / LeiDis) which can be also be transferred to i.e. the above mentioned operating systems or to international information systems like RNE TIS, TrainMonitor, SmartVMS or others. Some of the systems are developed with specific functions for specific stakeholder groups. Data which is available in RNE TIS, can also be exchanged with these dedicated tool in electronic format via the RNE common interface. Some systems are TAF/TAP TSI-compliant.
- In order to communicate electronically with their customers various operators offer booking platforms for commercial data. Data transfer is achieved via B2B interfaces or at least via an online booking procedure on a web tool.
- In summary, it can be stated that there are individual initiatives in the sector to exchange information electronically. However, digitalisation is still far from complete. Stakeholders are still not prepared to share information and put forward various reasons for that.

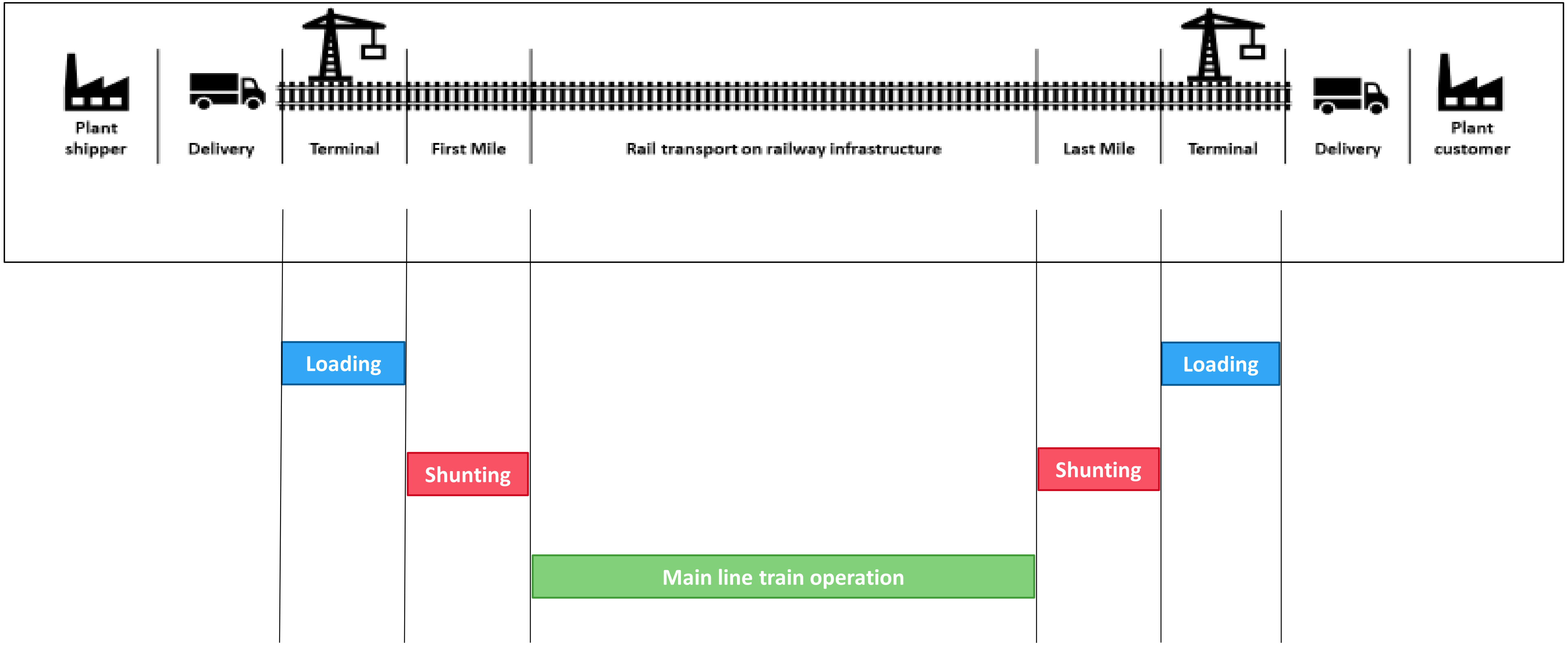
CE#1 – Information Sharing (2)

- The Technical Specifications for Interoperability (TSIs) define the technical and operational standards and ensure the interoperability of the railway system of the European Union.
- The Telematics Applications for Freight service TSI (TAF TSI) applies to applications for freight services, including information systems (real-time monitoring of freight and trains), marshalling and allocation systems, reservation, payment and invoicing systems, management of connections with other modes of transport and production of electronic accompanying documents.
- Regarding the further development of TAF TSI (TAF TSI Revision) ERA has published a Recommendation in autumn 2020. The purpose of the revised TAF TSI is "to ensure the efficient interchange of information …". It is intended to focus the technical scope to "cover the applications for freight services and the management of connections with other modes of transport which means that it concentrates on the transport services of an RU in addition to the pure operation of trains."
- Significant parts of the R-CDM are also related to the TSI OPE. This TSI applies to the operation and traffic management subsystem of infrastructure managers and railway undertakings related to the operation of trains on the rail system of the European Union. It covers those elements of the rail operation and traffic management, where principally there are operational interfaces between railway undertakings and infrastructure managers and where there is a particular benefit to interoperability. This entails traffic planning and management, train composition, train braking, train visibility, data recording, degraded operation etc.

CE#1 – Information Sharing (3)



CE#2 – Basic steps of intermodal rail transport



Note: These basic steps are developed into milestones in Task 1.3.

CE#3 – Variable Taxi Time

- In A-CDM, Variable Taxi Time is defined as the estimated time that an aircraft spends taxiing between its parking stand and the active runway or vice versa. Variable Taxi Time is the generic name for both inbound and outbound taxi time parameters.
- The taxi time is not depending on the coordination between different infrastructure managers or operators.
- For rail, the parking stand shall be equal to the terminal and the runway shall be equal to the main line. Connecting infrastructure elements are handover stations.
- The rail infrastructure is managed by at least two stakeholders, the Terminal Operator and the national Infrastructure Manager. In some maritime seaports Port Authorities are involved additionally.
  For train operations the involved stakeholders are the Railway Undertaking and the Shunting Operator.
- It is obvious that the Concept Element Variable Taxi Time does not cover all relevant aspects for rail and that an adjustment is needed.
- For R-CDM the Concept Element #3 is therefore renamed to Last Mile Prediction which is further developed in Task 1.3.

CE#4 – Pre-departure Sequencing

- In A-CDM, pre-departure sequencing delivers optimal traffic flow to the runway by factoring in accurate taxi time forecasts and route planning. The planned pre-departure sequences are used to assign to each flight a target start-up approval time that takes into account the gate where the aircraft is parked and how long it takes for the aircraft to taxi to the departure runaway.
- For rail, pre-departure sequencing shall focus on trains starting in handover stations entering the main lines.
- The sequence of trains on the main lines themselves has to be taken into account additionally. Capacity allocation due to the type of train and priority rules plays a much larger role in rail than in aviation. Aspects to be considered are of commercial nature such as passenger versus freight trains as well as technical aspects such as the top speeds of trains and the start up behaviour of trains related to their weight (light fast passenger trains versus heavy slow freight trains).
- Furthermore, the influence of delays of the different train products has to be considered. In almost all cases today delayed passenger trains drive out punctual freight trains .
  - Along the RFC Rhine-Alpine, international freight trains do not have a defined priority.
  - Except NL, all corridor countries apply different national priority rules based on a defined train list. In NL, ProRail establishes predefined operational rules in cooperation with the concerned RUs.
  - Except BE, international freight trains are not favoured. In BE, international freight trains partially can have a higher priority.
- Please refer to further elaborations in Task 1.3.

CE#5 – Adverse Conditions

- Predictable Disruptions:
  - Weather (e.g. wind, snow);
  - Maintenance (planned);
  - Personnel Action (e.g. announced strike).
- Unpredictable Disruptions:
  - Maintenance (unplanned);
  - Infrastructure Collapse;
  - Technical Disruptions;
  - Personnel Action (e.g. other strike, attack, suicide, …).

CE#6 – Collaborative Management of Flight Updates

- In aviation Collaborative Management of Flight Updates consists of exchanging Flight Update Messages and Departure Planning Information messages between the European Network Manager and the A-CDM.
- The Network Manager Operations Centre (NMOC) is operated by EUROCONTROL, a neutral pan-European, civil-military organisation dedicated to supporting European aviation. Functions are:
  - Demand capacity balancing;
  - Harmonization;
  - Performance monitoring;
  - Support to aircraft operators, airports and air traffic control for the detection of conflicts;
  - Mission: “*We exchange information with countries across the ICAO European region and beyond to improve traffic flows from the regional to the global level, enhance traffic predictability and increase network capacity.*”;
  - **Eurocontrol NMOC** should not be confused with **Eurocontrol Maastricht Upper Airspace Centre (MUAC)**, which conducts international air traffic control functions.
- Please refer to Task 1.3 on slides for further elaboration of this Concept Element.

Results for Task 1.2

Mapping of Concept Elements
Assessment of transferability criteria

Draft proposal for renaming of R-CDM CE

Mapping rail freight operations on the A-CDM Concept Elements

Elements A-CDM		Potential Elements R-CDM
CE#1 – Information Sharing	Review platforms, data assessment, methods of information, sharing and exchange of protocols, investigate compatibility with TIS and ELETA	CE#1 – Information Sharing
CE#2 – Milestone Approach	Identify existing process steps (Milestones) in the train journey, on which data can be collected to share among the stakeholders	CE#2 – Milestone Approach
CE#3 – Variable Taxi Time	Finding the main uncertainties in the transport process and breaking it down, including shunting at terminals sites	CE#3 – Last Mile Prediction
CE#4 – Pre-departure Sequencing	Which technology and processes are available to predict traffic distribution and an "order of departure" for the trains in the Corridor?	CE#4 – Pre-departure Sequencing
CE#5 – Adverse Conditions	Assess typical disruptions and causes for non-nominal and heavy impact delays	CE#5 – Adverse Conditions
CE#6 – Collaborative Management of Flight Updates	Is there a need for an international coordination support function for CDM?	CE#6 – International Coordination Support Function

Assessment of transferability criteria (1)

No	The following questions have to be answered positive:	full	in parts	Comments
C#1	Stakeholders and their operations shall be comparable		✓	Similar transparency and communication needs apply, but differences in operation
C#2	Stakeholder challenges shall be similar to a high extend	✓		
C#3	Freight train processes shall be relatable to that of aircraft		✓	Main differences regarding main line processes / partially comparable in nodes
C#4	Performance areas and indicators shall be comparable or similar		✓	Rail transport on main line from origin to destination and a flight differ significantly but indicators punctuality/predictability are comparable
C#5	A-CDM Concept elements shall each be considered relatable to rail (see next slide)		✓	Rail transport on main line from origin to destination and a flight differ significantly

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Assessment of transferability criteria (2)

No	A-CDM Concept elements shall be considered relatable to rail, answering positive the following questions:	full	in parts	Comments
CE#1	Is there improvement possible on Situational Awareness?	✓		Stakeholders have to be convinced
CE#2	Can the rail journey be segmented into milestones, similar to a flight?	✓		Milestone concept can be used, but processes themselves are different
CE#3	Is there an uncertainty in the connection between Terminal and IM exit/entry point, also known as last mile?		✓	Resources availability & coordination between different actors
CE#4	Can IMs similar to ATC influence the sequence of trains leaving a terminal when they are entering their network (main lines)?		✓	Pre-departure sequencing is possible and necessary but the main motivation is different
CE#5	Is it possible to define special procedures in case of predicted or unpredicted loss of capacity due to adverse conditions?	✓		
CE#6	Is there a need for an international coordination support function for CDM?	✓		High dependencies in planning & operation of international trains

Project Approach Task 1.3

Content Status

WP1 – Rail CDM Approach

1. Kick-off Meeting
2. Transferability of Airport CDM
3. Railway Processes
4. Approach for Rail CDM

WP2 – Benefits and Investments

1. KPI's & General Framework
2. Benefits and Investments report

WP3 – Recommendations and Roadmap

1. Workshop for Roadmap discussion
2. Recommendations & Roadmap report
3. Final meeting and presentation

Introduction

- How Airport CDM (A-CDM) works is described in Task 1.1 (D1.1), the Transferability to Rail is explained in Task 1.2 (D1.2), next there should be an elaboration on how the Rail CDM (R-CDM) concept and related elements could look like: an initial design description that functions as starting point for future stakeholder discussions and preparation of an European R-CDM Implementation Manual.
- The conclusion on transferability of parts of the general methodology leads to the assumption that steering on predictability as it is used in aviation is also applicable for rail. Given that performance indicators in transport are comparable, with punctuality essential for operators, we introduce predictability through a standardised process for reliability that will be complementary and effective. In a specific section below, the **“Basics of Predictability”** are explained: announcing a time of event in the future.
- Steering on predictability will not be the norm in organisations overnight: this requires a culture change in working. Operational train information is already vital to determine possible delay, and CDM aims to structure the process of obtaining this information. To make sure all stakeholders adhere, compliance should be stimulated by incentives. This deliverable therefore introduces another basic concept **“Best Planned Best Served”** for rewarding proactive stakeholders more than reactive or passive stakeholders.
- Having in mind A-CDM, Rail “Concept Elements” are introduced, including new data elements to break down a train journey in segments and introducing the concept of **“Milestones”**. The important operation on the **“last mile”** is addressed and a new **“Sequencing”** concept for departing trains is described. Finally **“Adverse conditions”** and integration into **“European network”** operations aim to govern a network optimisation, away from local sub-optimal performance.
- Finally as part of the basic draft R-CDM concept a first set of requirements is derived to determine future changes needed to embed CDM as a foundation in future rail operations.

Content D1.3 – Approach & Requirements for Rail CDM

1. **Concept of “Predictability”**
2. **Concept of “Best Planned Best Served”**
3. **Concept Elements**
    a) Concept Element #1 – Information Exchange
    b) Concept Element #2 – Milestones Approach
    c) Concept Element #3 – Last Mile Prediction
    d) Concept Element #4 – Pre-Departure Sequencing
    e) Concept Element #5 – Adverse Conditions
    f) Concept Element #6 – International Coordination Support Function
4. **Requirements**
    a) Stakeholder Equity
    b) Data Transparency
    c) Corridor and Network Operations
    d) System Interfacing Control - Departure & Arrival Planning Information
    e) Performance Steering, Monitoring, Management & Post-Operation Evaluation

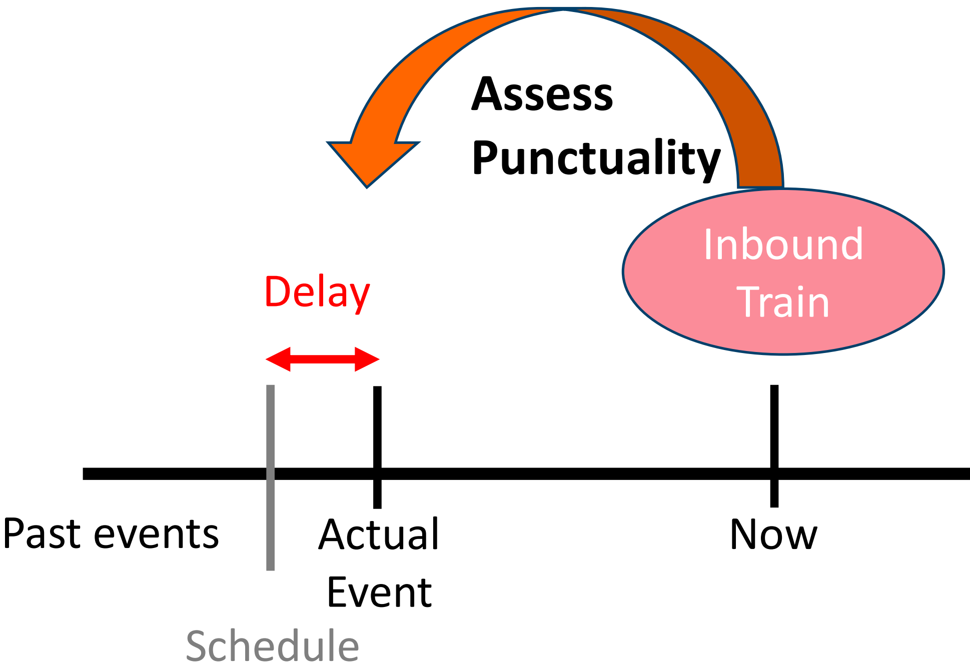
Concept of Predictability – Introduction (1)

As it is important to have a proper definition and joint understanding of the term **“punctuality”** and **“predictability”** these are explained on the following slides.

- **Punctuality**, or On-Time Performance (OTP), is the (level of) adherence to the schedule created by an operator;
- **Punctuality** can be assessed Post-Operation, comparing actual operation with scheduled (planned) times;
- **Punctuality** can be assessed during operations through:
  - Assessment of intermediate and past performance: actual versus scheduled times on a segment of journey;
  - Predictions on further (future) waypoints, and assessing that prediction with schedule;
  - Predictions on future waypoints however are subject to uncertainty. The process to generate reliable predictions requires stakeholder agreement, standardization, harmonization and transparency to enhance and maintain confidence.
- **Predictions** and a reliable generation process are the focus of CDM: organising and enhancing future journey predictions, as well as impact for the successive (next) train journey;
- For a train **punctuality** can be lost yet but the delay predicted very reliably, enabling adjustment of resource and capacity planning.

Concept of Predictability – Introduction (2)

- **Punctuality** is a backward assessment on a completed event;
- **Punctuality**, or On-Time Performance (OTP), is the (level of) adherence to the schedule created by an operator,
- **Punctuality and Predictability are complementary** and should not be confused or considered to be the same.

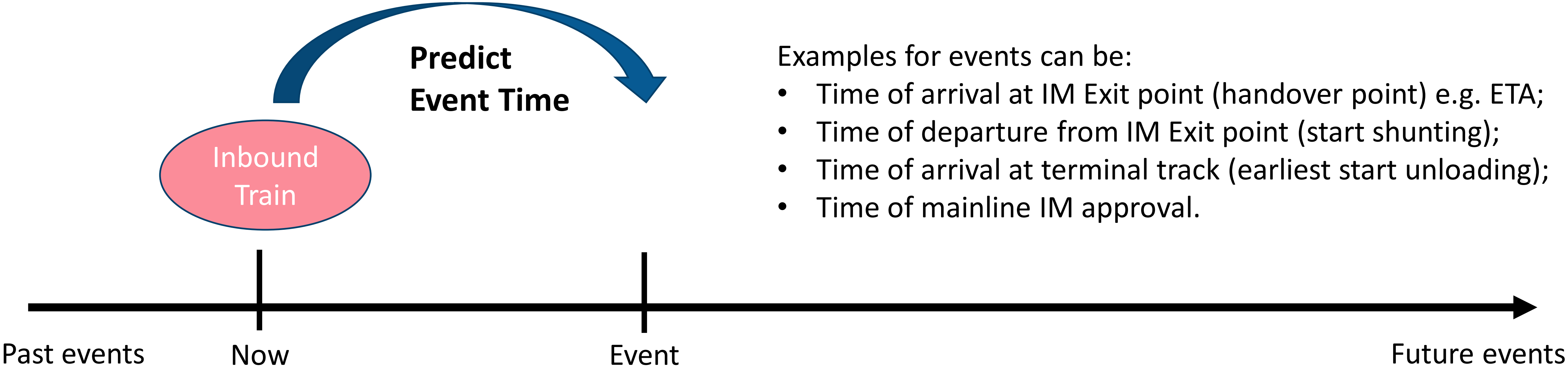


Past Punctuality assessment compares:

- Actual Time of arrival at Terminal Entrance point:
- Schedule Time of arrival at Terminal Entrance point:
- Delay is the difference between schedule and actual event and results in a loss off punctuality.

Concept of Predictability – Introduction (3)

- **Predictability** is a forward assessment on a future event;
- **Predictability** can therefore be a future assessment of potential gain or loss of punctuality, though uncertainty applies;
- The **accuracy of a prediction** determines its **reliability**, or confidence by stakeholders;
- **Predictability** is the continuous process that enables accurate predictions through frequent updating, enhancing stakeholder confidence to act on prediction;
- For a train, **punctuality** can be lost yet but an accurate prediction of the time at future waypoints enables adjustment of resource and capacity planning.

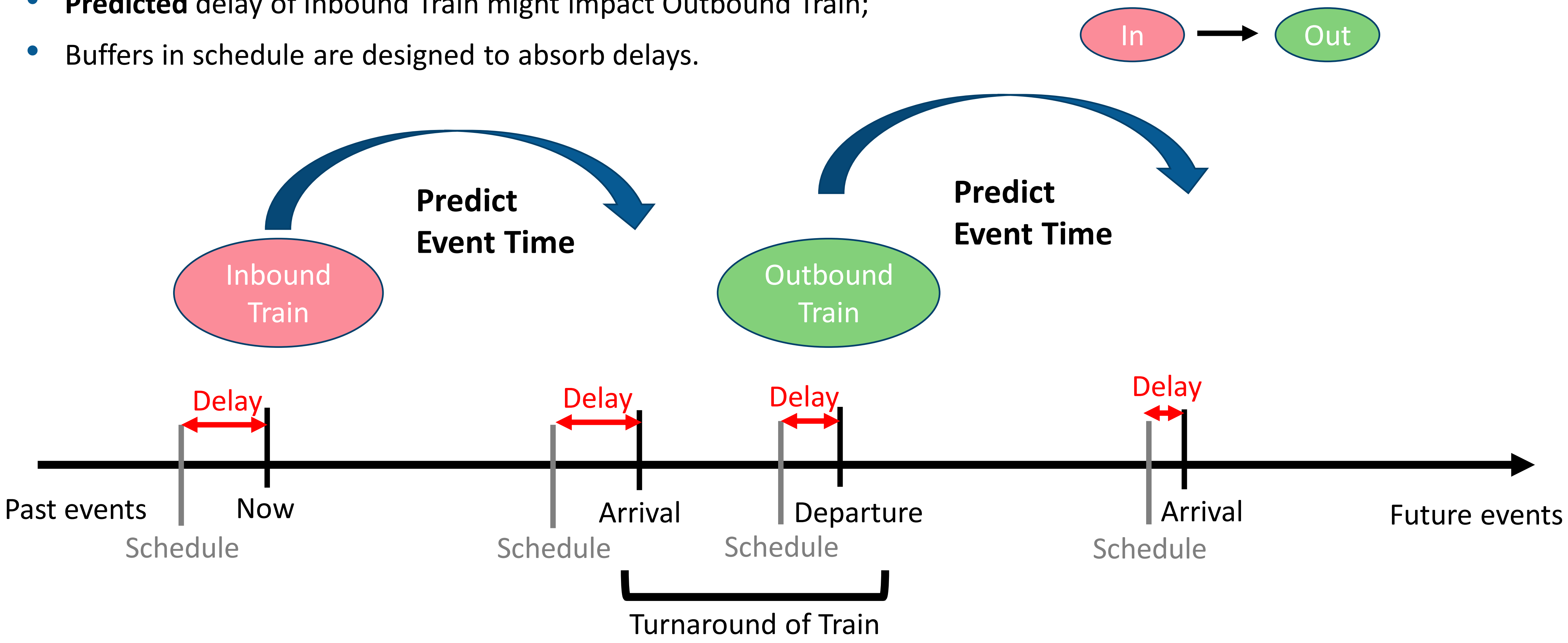


Examples for events can be:

- Time of arrival at IM Exit point (handover point) e.g. ETA;
- Time of departure from IM Exit point (start shunting);
- Time of arrival at terminal track (earliest start unloading);
- Time of mainline IM approval.

Concept of Predictability – Introduction (4)

- **Predicted** delay of Inbound Train might impact Outbound Train;
- Buffers in schedule are designed to absorb delays.



Concept of Predictability – Difference to Punctuality (1)

- For most (but not all) rail processes applies that there is **a proper and detailed planning of the operation (schedule or timetable) including resources**. These are coordinated or at least communicated between the actors in the **planning phase**, so that a smooth operation is theoretically possible;
- **Problems and challenges arise if one (or more) deviations from the plan occur**. That can be delays in one process or the non-availability of the planned resource, which leads to delays or even disruptions of the planned follow up services;
- **Punctuality** is a key indicator in operation and has double impact. Any improvement to daily operation should endeavour a higher level of punctuality, serving involved actors, as well as customers of the rail freight services (e.g. forwarders as customers of the intermodal operators), who compare the contractual agreed arrival times based on the initial plan with the actual arrival times;
- **Punctuality** aims to reach contractual satisfaction but also to prevent or reduce friction in operations;
- **Predictability** aims to assess whether a train remains punctual, as a later delay (or the punctual arrival) can be predicted based on information about disruptions in the subsequent train run. Predictability is not in contrast or competition to punctuality yet indicates through an agreed process if enough information is available to provide an accurate and reliable prediction for the future.

Concept of Predictability – Difference to Punctuality (2)

- **Predictability complements Punctuality!**
- **Punctuality** is intended schedule for operation, and requires frequent evaluation;
- **Predictability** provides additional information during operation to all stakeholders, and can impact punctuality;
- **Punctuality** indicators provide results on past performance (deviation is used to evaluate the operation afterwards);
- **Predictability** enables real time changes to ongoing operation → Anticipation of subsequent timestamps for milestones:
    - Adjustments to capacity assignment;
    - Adjustment to resources assignment;
    - Decision making on priorities.

<u>Rail CDM Timeframe</u>

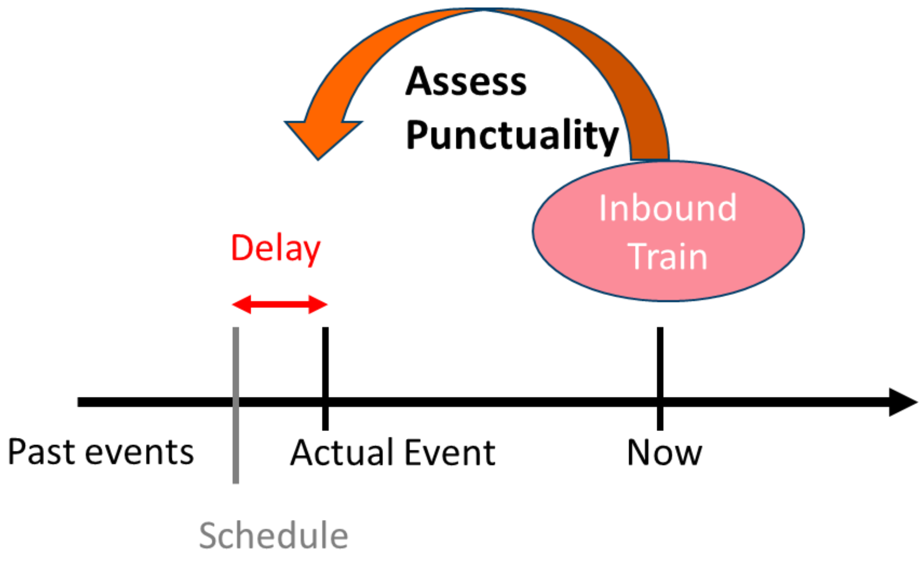
- **Predictions** of events are made upon (preparation of) train operations:
    - Hence, the timeframe for R-CDM should be related to a subset of the day of operation in which events can be predicted;
    - The timeframe might be extended for long distance international trains with a journey exceeding one day.

Concept of Predictability – Benefits

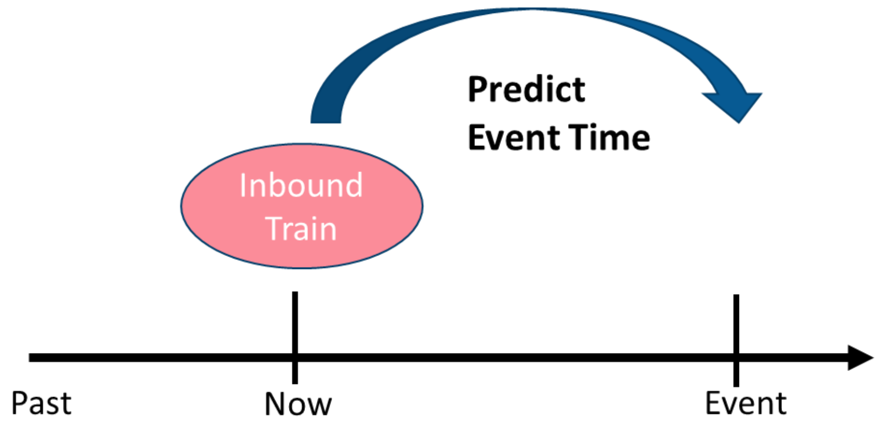
- **Predictability** depends on real time communication:
  - The moment an event (which has an effect on subsequent processes) is known to take place this should be shared (potentially via platforms) to all concerned stakeholders;
  - Post operation the accuracy of predictions need to be evaluated (trust in prediction / prediction improvement);
  - Procedures to share data require compliance and adherence;
  - Automated and standardised direct electronic data provision reduces delayed or inaccurate human input provision.
- Steering based on **predictability** and procedure compliance enables efficiency:
  - for IMs optimising national infrastructure and service facility capacity as well as personnel;
  - for TOs optimising infrastructure and transhipment equipment, as well as personnel;
  - for RUs and SOs optimising personnel and locomotive resources;
  - for IOs optimising last mile transport resources and gaining confidence from their customers.
- **Reliability and Accuracy**
  - Reliability and accuracy are important to improve situational awareness and in order to regain trust from stakeholders and clients.
- <u>The more stakeholders participate in R-CDM and data sharing according to procedures, the higher the benefits!</u>

Concept of Predictability – Summary

- **Punctuality**
  - Punctuality adherence to the schedule created by an operator;
  - Punctuality can be assessed Post-Operation: actual versus schedule;
  - Punctuality is a backward assessment on a completed event.



- **Predictability**
  - Predictability is a forward assessment on a future event;
  - Predictability is assessment of potential gain or loss of punctuality;
  - Predictability complements punctuality.



- **Reliability and Accuracy**
  - Reliability is when stakeholders can place confidence in predictions;
  - Accuracy enhances confidence through evaluation of predictions .

Best Planned Best Served – Introduction

- Current operations do not invite for stakeholder investments without reward of benefit:
  - R-CDM will require changing procedures, systems, organisations;
  - Incentives are essential to invite stakeholders to participate and funders to understand the investment.
- To enable a shift from the current operations into pro-active, standardised information sharing, predictable train operations and incentives are considered effective. Cost Benefits Analysis as well as incentives are essential for decision makers (owners, investors).
- Lessons from Aviation inform Rail stakeholders that change is difficult. Especially when benefits are unclear and confidence in other stakeholders is low, investments are postponed.
- Confidence requires structural collaboration on procedure development and continuous operational monitoring. Stakeholders, who are early adopters of R-CDM, should clearly see and obtain early benefits. Benefits that are achievable for all stakeholders, require new cooperation, participation, changes in operation, systems, willingness to data sharing and organisation.
- When rail operators (RU, SO, IO, and others) can provide improved predictions about the readiness of trains, prior to departure as well as during a train run, this should be resulting in enhanced predictability and transparency from the IMs:
  - Early and accurate information is rewarded by IM’s (**Best Planned**);
  - Early and stable sequence slots are created and communicated (**Best Served**).

Best Planned Best Served – Principles for future operation

Principles for change

- Equality of stakeholders in procedure development, operations and performance evaluation;
- Common specification for functionality and information exchange;
- Transparency of information, procedures and standards to generate and share information;
- Steering, Management, Monitoring, and Evaluation on Post Operation performance and compliance analysis;
- Assignment of responsibility for information updates to stakeholders;
- When taking disposition decisions for international trains the effects on the complete train run in other European countries, regions as well as on other trains using the same part of the network will be taken into account.

Best Planned Best Served – Concept of Operations (1)

General

- Collaborate for steering on Predictability in order to change culture of stakeholders and operations:
  - Applying new CDM Concept Elements to enhance operational efficiency;
  - Organise on local, national and international level to steer, manage, monitor and evaluate.
- Managing operational efficiency according to CDM Concept Elements, processes and procedures and consequently through newly to be developed or updated systems in the nodes.;
- Monitoring performance and compliance of all stakeholders;
- Post-Operation analysis, evaluation and enforcement according to agreed procedures.

Specific (regulatory framework needed)

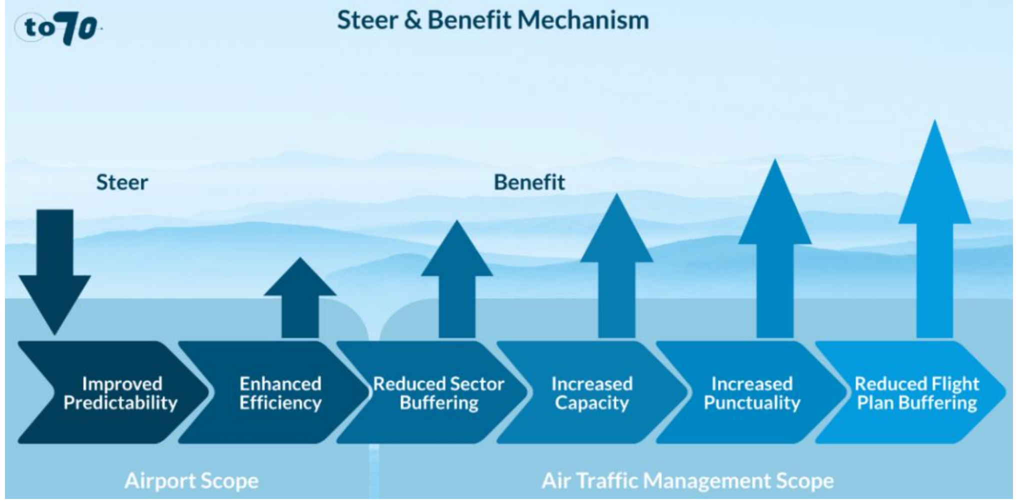
- Create incentives in "operational service" for stakeholders who comply and perform as agreed:
  - Those sharing information early and accurate into agreed CDM platforms (the "Best Planned");
  - Those complying to procedures.
- Less incentives for stakeholders who do not participate or not perform as agreed.

Concept of Best Planned Best Served – Summary

- **Reactive operations**
  - Reactive operations usually reward few selected stakeholder and distribute delays unequal;
  - Decisions taken by humans naturally include preferences and hinder equal operations;
  - Sub-optimal performance or occasionally contra-productive operations.

- **Proactive operations**
  - Automated process and transparency for information sharing;
  - Agreed decision making rules for all stakeholders, including IMs;
  - Predictability on train ready time and IMs approval time.

- **Incentives for information sharing**
  - Create fair playing field for all stakeholders;
  - Reward those providing accurate predictions;
  - Create trust through performance monitoring and evaluation.



List of potential R-CDM Concept Elements

1. • CE#1 – Information Sharing
2. • CE#2 – Milestone Approach
3. • CE#3 – Last Mile Predictability
4. • CE#4 – Pre-departure sequencing
5. • CE#5 – Adverse Conditions
6. • CE#6 – International Coordination Support Function

CE#1 – Information Sharing Creating Situational Awareness

As in aviation the first concept element on "information sharing" has the basic aim to improve/provide the necessary framework conditions and technologies to improve the situational awareness by sharing data in an appropriate way. Basic components and requirements of this concept element are listed on the following pages.

- Real-time sharing of information to other stakeholders through common functional specifications and interfaces Taking into account TAF TSI, other current standardisation activities and development activities (e.g. Shift2Rail);
- Create new stakeholder data elements focus on prediction of train target departure times, including updated status of the train prior to departure e.g. (to be seen in connection with milestones in CE#2):
  - When is the train ready at terminal for shunting to handover station?
  - When is the train ready for entrance to IM main line?
  - When is the IM ready to approve entrance on the main line?
- Automated processing of data and generating alerts for discrepancy and stakeholder action for adjustment;
- Procedures for updating each data element and creation of interface messages updating network databases:
  - Departure, En-route and Arrival Planning Information Messages for each train on each milestone.
- Access for all stakeholders to shared data (either directly or via platforms) to provide own input on updates and receive connected output data for own resource management systems;
- Common interfaces for industrial standardisation and fair market competition by CDM IT-system suppliers.

CE#1 – Information Sharing
Stakeholders and Process Ownership

- Integrate all stakeholders, (re-)define roles and responsibilities with regard to data provision/handling, potentially discuss and regulate data ownership and confidentiality rules.
- Change may come to:
  - IMs: Traffic Management operator's application of train equality (explained in section requirements), as well as execution of outbound sequence planning;
  - TOs: Accept clear segregation of operating roles from IO and RU’s and provide accurate information and predictions about start and end of train run and terminal train operations;
  - RUs: Provide continuous information on status of train and future readiness of staff, locomotive and train;
  - SOs: Provide continuous information on status of train and future readiness of staff, locomotive and train;
  - IOs: If company areas of the IOs or their affiliates assume also the roles of other stakeholders, they have to enable the same transparent responsibility and communication procedures (internal/external);
- Aviation has shown that an international coordination support function, which is not a European traffic management, is recommendable for rail as well.

CE#1 – Information Sharing Requirements

Use and reform existing or new information platforms to improve stakeholder situational awareness

Purpose: Right information → right time → right people → right decisions

Exchange rail information data elements:

- Create new sources for data collection & entry;
- Enhanced identification of:
  - trains and wagons;
  - Freight.
- Connect systems through new interfaces;
- Share data based on procedure or process protocol;
- Redundancy in system & procedures;
- EU specifications for R-CDM IT systems:
  - Defining mandated functionality;
  - Defining interface control.

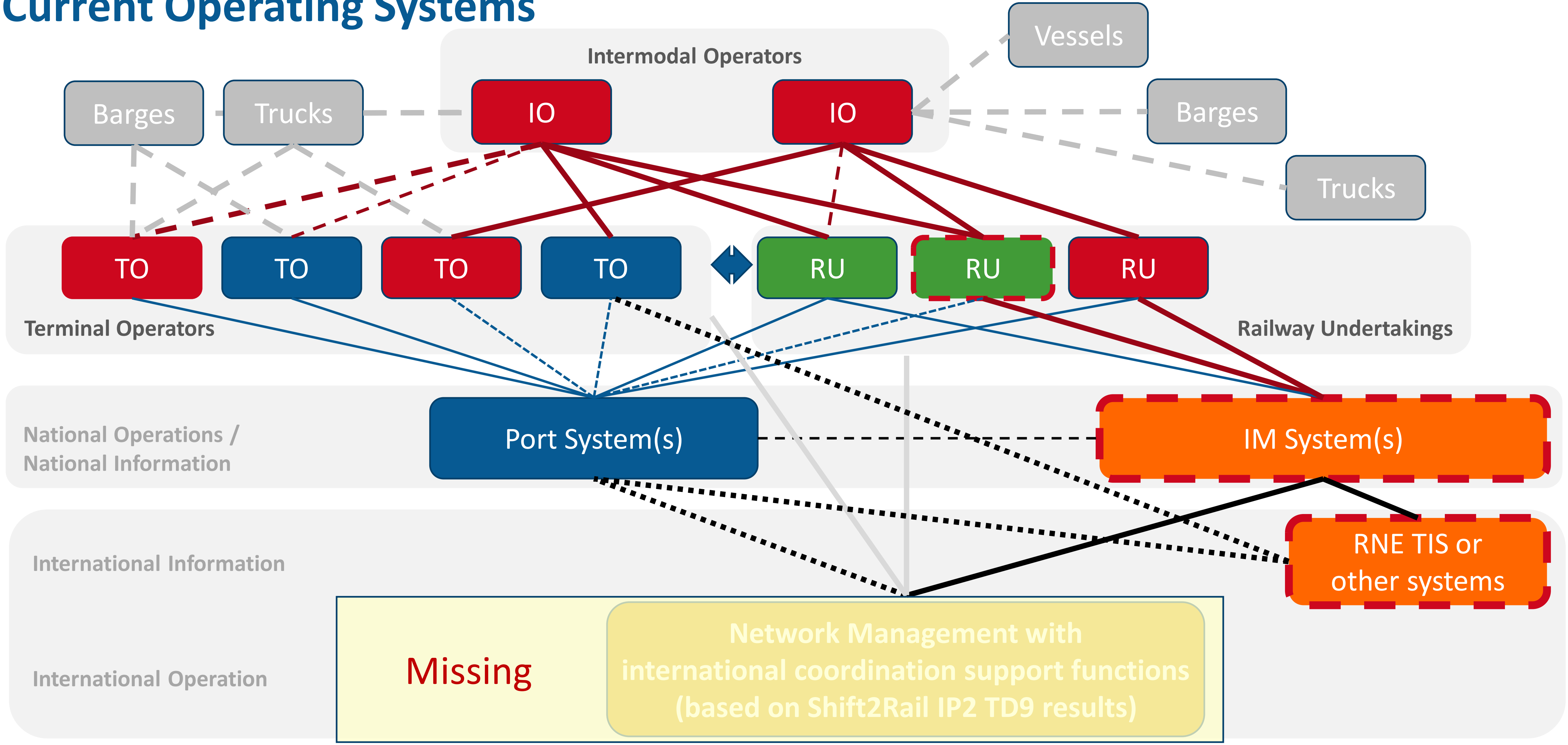
CE#1 – Information Sharing
Rules and Roles

- Current connectivity between stakeholders (directly or via platforms) needs to be uniform;
- Clear segregation and definition of responsibilities for stakeholder with dual roles:
  - Even if some stakeholders have overlapping roles based on their specific business model it must always be clear which kind of information is provided from which source and by whom to whom;
  - Potential commercial links/connections and the contractual relations have to be ignored when defining the responsibilities in the operational information chain;
  - Even if stakeholder with different roles (e.g. RUs and IMs) are controlled by the same company / holding, this shall not have any impact on their neutrality, responsibilities and equity principle;
  - The segregation requirement is visualised on slide 24.

CE#1 – Information Sharing
Explanation for the figures on the next slides

- Same colour means same stakeholder ownership and interests
- The boxes represent the “operating/managing” systems of the stakeholders;
- The lines indicate an exchange of “operational data” between the systems independent from the “direction” of the data flow:
  - IM = Infrastructure Manager System(s)
  - TO = Terminal Operator System
  - RU = Railway Undertaking System
  - SO = Shunting Operator
  - IO = Intermodal Operator System
  - Port System(s) = Neutral stakeholder representing group of terminals in port area
- Dotted lines indicate dependencies or control relationships;
- Port systems could play a central role for CDM around ports;
- International Coordination Support Function is required for full efficiency of CDM.

CE#1 – Information Sharing
Current Operating Systems



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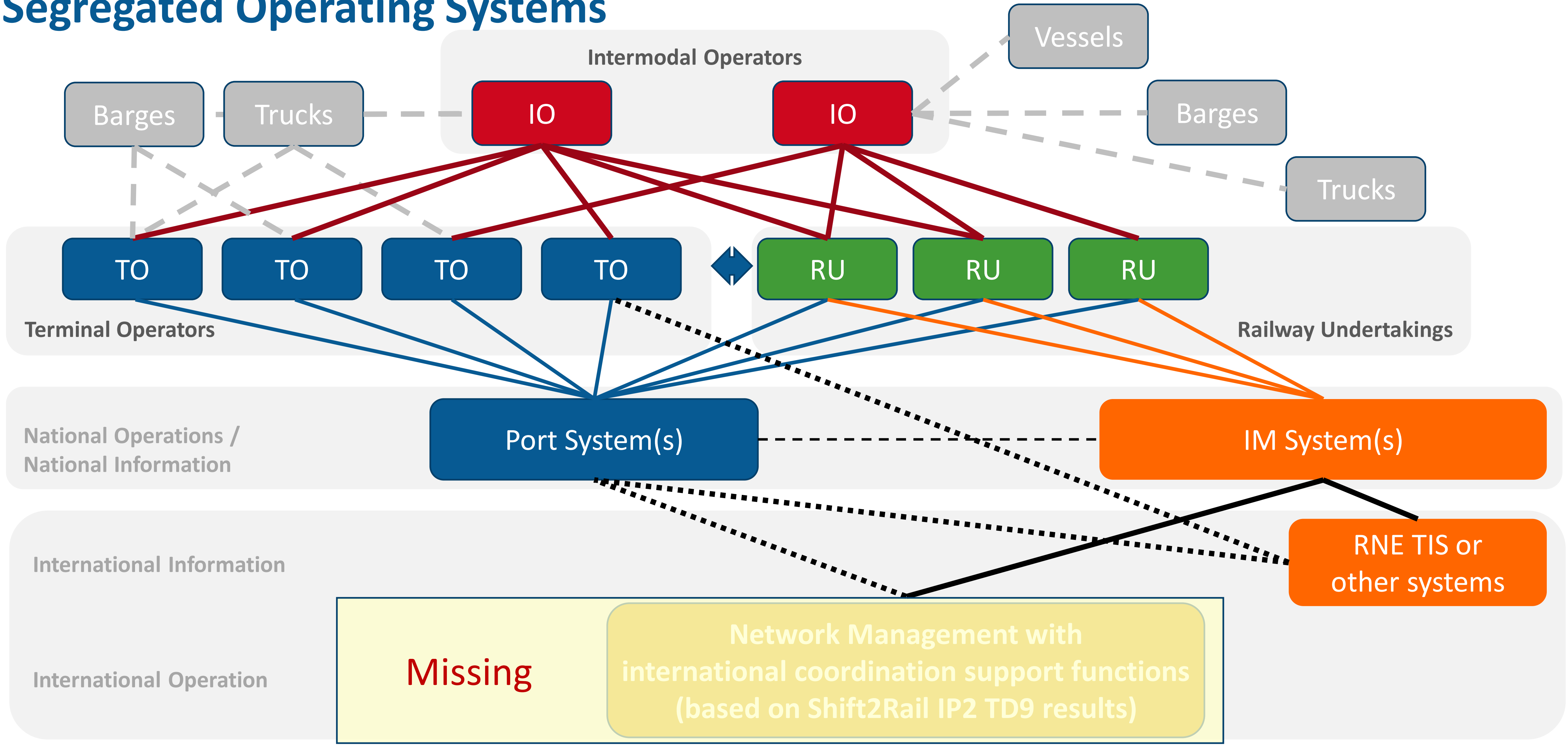
CE#1 – Information Sharing
Segregated Operating Systems



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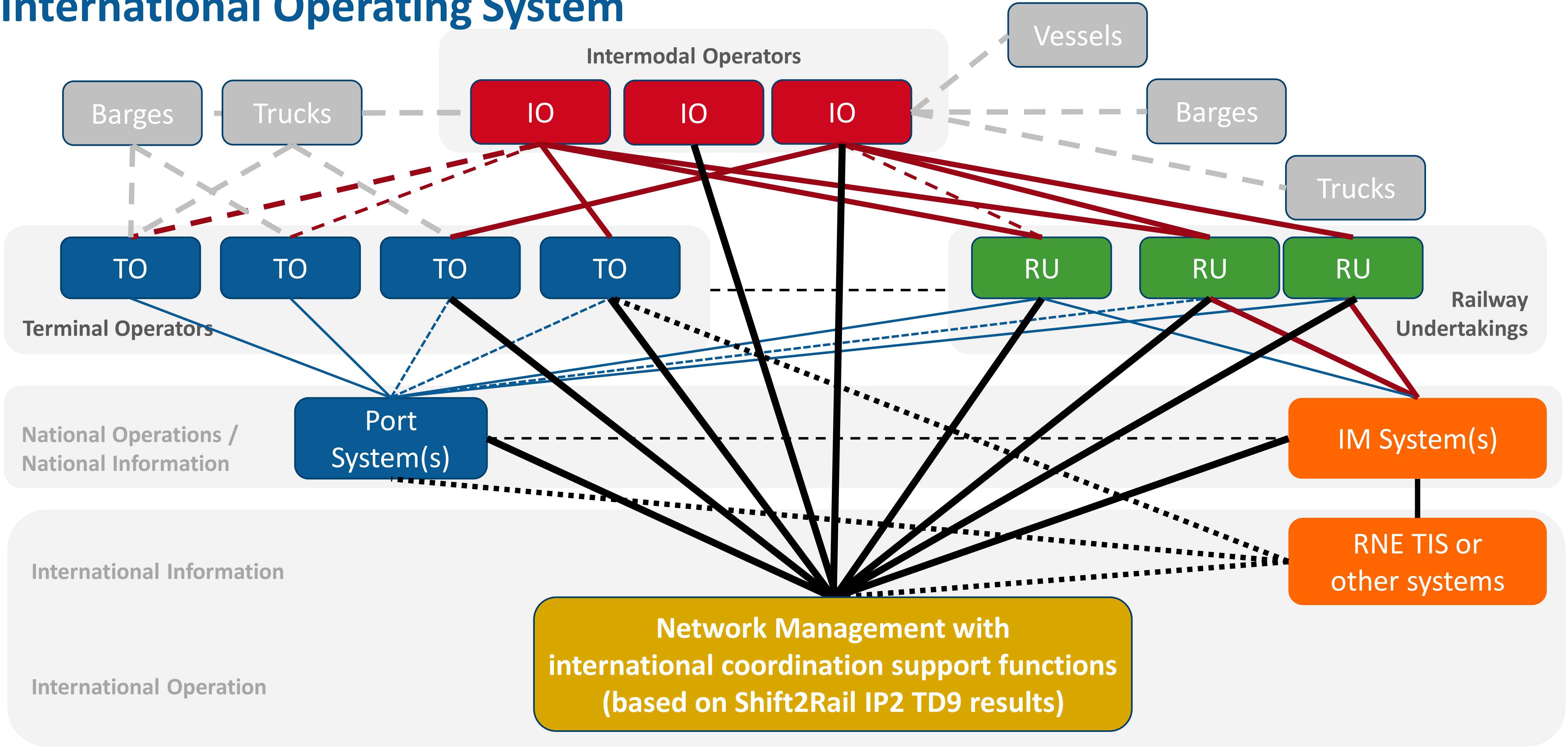
CE#1 – Information Sharing
International Operating System



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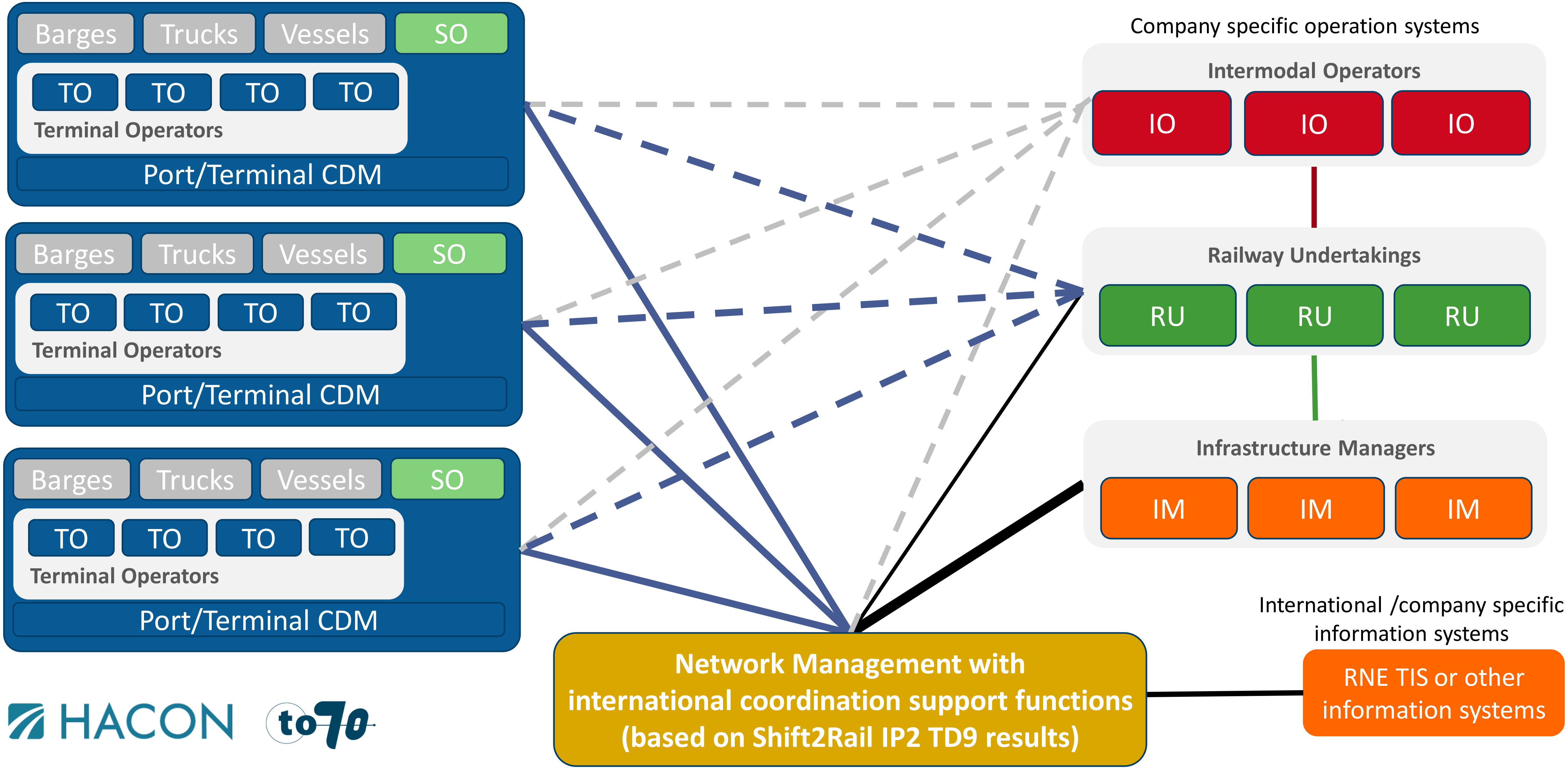
CE#1 – Information Sharing
Operations with International Coordination Support Function



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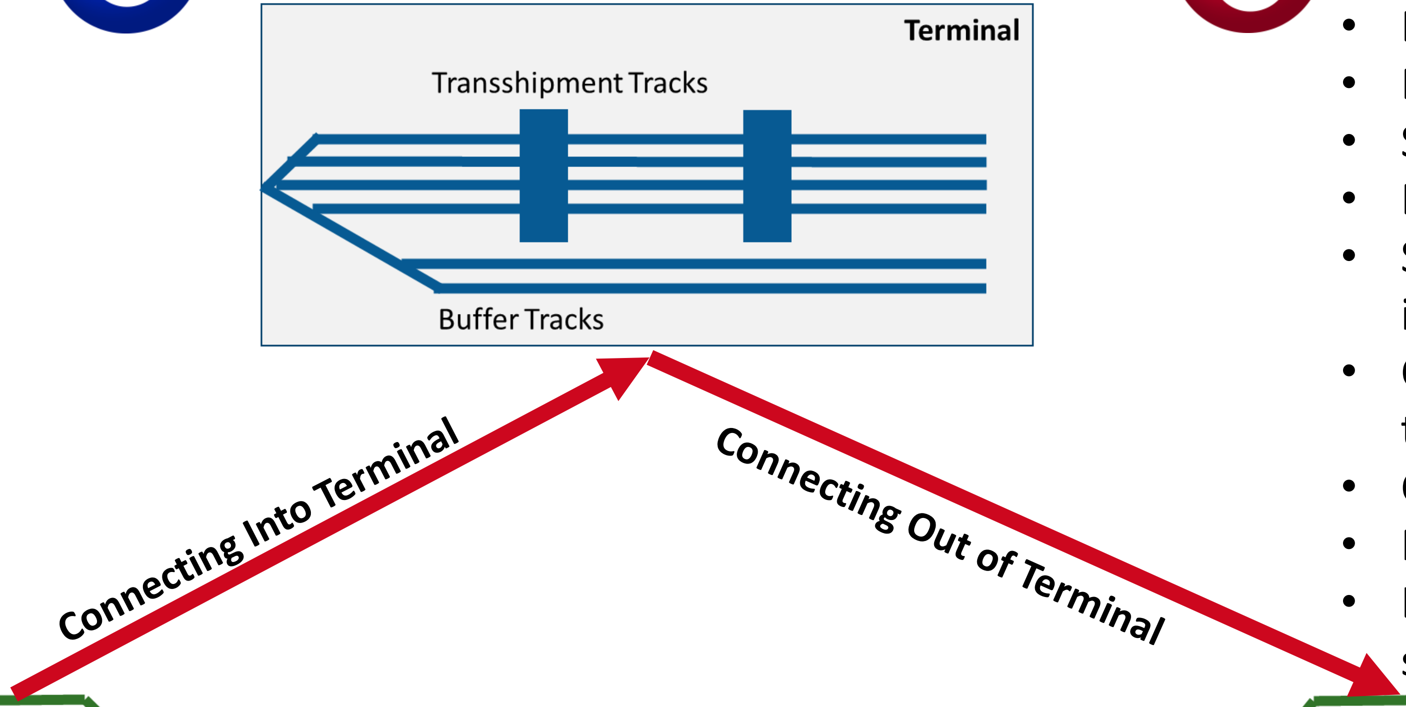
CE#2 – Milestone Approach
Elaboration of potential milestones

As in aviation it important to identify the relevant (common) processes (see Task 1.2) and to define appropriate milestones. The definitions which are important for a common understanding and the basic steps in this process are shown on the following slides.

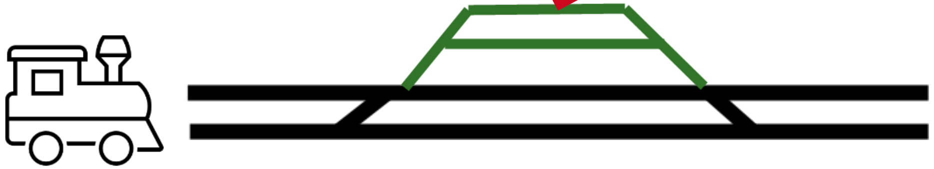
- Milestones are a breakdown of common actual rail operation events;
- Actual events are not planning or estimates; they apply to the actual movement and status of the train;
- En-route events can be related to trains passing nodes, certain signal points or other defined operating points;
- Before entering the last mile and during the transport towards and from terminals operational events occur more rapidly, and granularity of multiple events requires multiple identification points:
  - Arrival phase approaching end of main line, and exit of main line;
  - Terminal phase including last mile, exit of main line, and shunting handover;
  - Departure phase leaving terminal and approaching main line.
- The numbering of the key operational rail events (which are candidate to be defined as milestones) on the next slides does not represent any coherent/final numbering for an R-CDM, as this is part of the development, coordination and verification of an implementation handbook. They just indicate the draft potential milestones which could be part of the R-CDM. Depending on the outcome of the stakeholder discussions in the second and third phase of the feasibility study, it may be possible to include an updated list in the final recommendations.

CE#2 – Milestone Approach
Rail milestones Inbound – Outbound

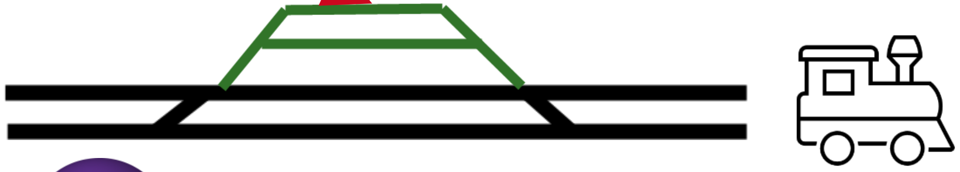
Terminal Arrival Events (2)
- Entry transhipment
- Start unloading
- End unloading
- Start decomposition
- End decomposition



Terminal Departure Events (3)
- Start composition
- End composition
- Empty inspection
- Start loading
- End loading
- Start brake test & train inspection
- Completed brake test & train inspection
- Corridor path confirmed
- Ready for shunting
- Leave terminal = Start shunting



Main Line Exit Events (1)
- Leave main line
- Leave handover station
- Leave connecting line



Main Line Entrance Event (4)
- Leave connecting line
- Entry handover station
- Entry main line

CE#2 – Milestone Approach
Summary of rail milestones

Inbound

1. Leave main line
2. Start final IM network
3. Leave main line = Train enters handover station
4. Leave handover station = Train enters connecting line
5. Leave connecting line = Train entry at transhipment

Terminal

1. Start unloading
2. End unloading
3. Empty train inspection
4. Start loading
5. End loading (closing date)
6. Start brake test & train inspection
7. Completed brake test & train inspection
8. Corridor path confirmed (Approval of time to enter the main line)
9. Ready for shunting (Terminal exit)

Outbound

1. Leave terminal = Start of shunting
2. Leave connecting line = Train enters handover station
3. Ready for main line entry = Train ready for departure
4. Train enters (starts) main line (actual)

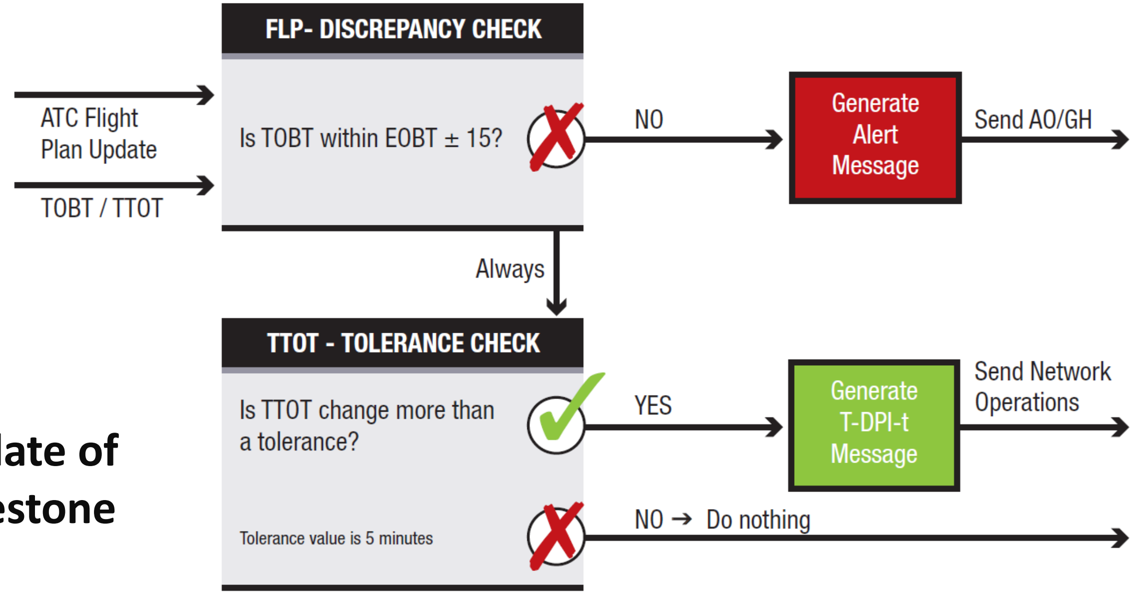
HACON to70

CE#2 – Milestone Approach
Introduction of new predictions

- New time predictions are needed complementary to existing milestones:
  - Target Ready for Shunting Time (TRST) – Time SO indicates to be ready for shunting;
  - Target Ready for Mainline Time (TRMT) – Time RU indicates to be ready for mainline entry;
  - Target Mainline Approval Time (TMAT) – Time IM aims to provide green light to train for entry to mainline.
- TMAT depends on TRMT. Preferably they are the same time, yet when IM creates pre-departure sequence, there may be difference to reflect mainline congestion at nodes or terminals;
- Milestones are actual publication, or issue, of key predictions on CDM platforms:
  - **Issue TRST** – The time TRST is shared by SO on CDM platforms;
  - **Issue TRMT** – The time TRMT is shared by RU on CDM platforms, visible for all stakeholders;
  - **Issue TMAT** – The time TMAT is shared by IM on CDM platforms, visible for all stakeholders.

CE#2 – Milestone Approach
Use of milestones (1)

- Milestones trigger prediction updates through a defined generic process;
- R-CDM milestones focus on prediction of train events that could impact capacity on corridors and international networks, including the destination terminals. Locally these generic processes can be tailored to different needs;
- Each Milestone that is adopted needs a definition similar to the generic processes in the Eurocontrol Airport CDM Manual;
- Each milestone triggers a process for:
  - Contingency and discrepancy checking;
  - Information message sharing to stakeholders;
  - Alert message sharing to stakeholders.

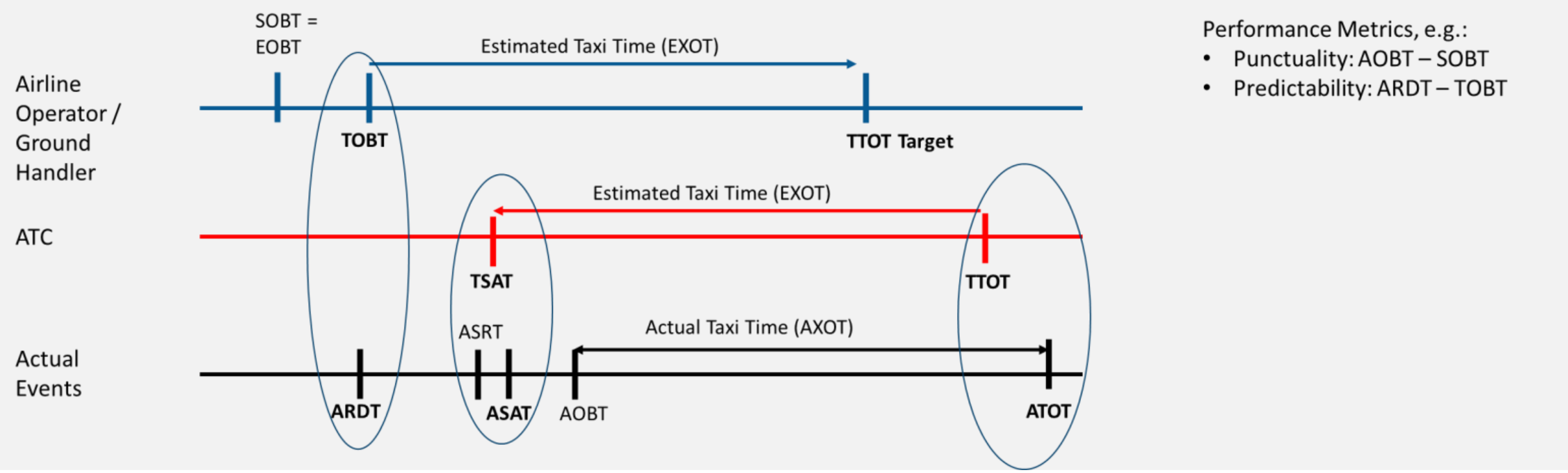


Generic check and update of process related to milestone

CE#2 – Milestone Approach
Use of milestones (2)

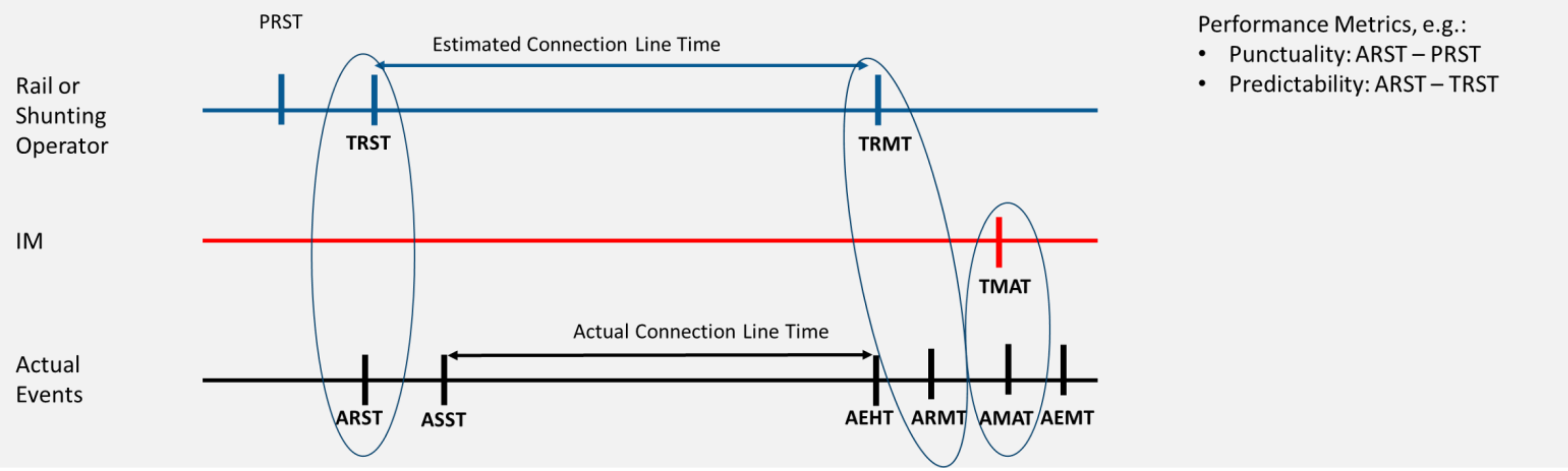
Airport CDM Timeline

- The aviation timeline provides for a benchmark comparison how to focus on predictions from the aircraft operators, Air Traffic Control and compare the predictions with actual events for performance evaluation.



Rail CDM Timeline

- The rail timeline provides similar prediction points for railway or shunting operators, Infrastructure Manager, and compare the predictions with actual events for performance evaluation.



HACON to70

CE#2 – Milestone Approach
Data Elements, Principles and Definitions

All acronyms used for CE#2 are made of four characters to enable sufficient variation reflecting the action and responsible stakeholder. The first character represents the status of the message to be exchanged at the respective milestone.

- **Planned Times** are defined as originally planned times used for the initial (long term) planning and contractual agreements between the stakeholders/customers;
- **Estimated Times** are defined as estimate times based on real-time information about the current status, aimed to facilitate re-planning to secure capacity from Terminal Operator or Infrastructure Manager;
- **Target Times** are defined as dynamical updates of the intentions /plans for the subsequent process milestones based on actual status of train operational progress;
- **Actual Times** are defined as events that actually take place and shall not be mixed with Estimates or Targets.

The second character determines the action of the trains/stakeholders: "Enters", "Leaves", "Starts", "Finishes", "Ready", "Approval".

The third character determines the type of action: "L = Loading", "M = Entering Main-line", "B = Brake Test", "I = Inspection", "S = Shunting"

The fourth character indicates the timestamp by making the fourth digit a "T"

Note: As all actions and acronyms apply to trains, we should omit using "T" for Train in any digit. The comparison of Planned vs. Actual, Estimated vs. Targeted vs. Actual Times enables performance monitoring and analysis.

CE#2 – Milestone Approach
Milestone Overview and potential abbreviations

Key train events candidate for milestone definition

#	Milesstones Descriptions (Key train events)	**Related Timestamp to Milestone**	**Who Inputs**	**Timestamp Acronym**	Aviation Equal	Planned	Estimated	Targeted	Actual
1	Train enters the main line at origin terminal	**Actual Enter Main line Time**	**IM**	**AEMT**	-	**PEMT**	EEMT		**AEMT**
2	Train enters the network of the final IM	Actual Enter Final IM Time	IM	AEFT	-	**PEFT**	**EEFT**		**AEFT**
3	Train leaves the mainline and enters the handover station	**Actual Leave Main line Time**	**IM**	**ALMT**	ALDT	**PLMT**	**ELMT**		**ALMT**
4	Train leaves the handover station and enters the connection line	Actual Leave Handoverstation Time	RU/SO	ALHT	-	PLHT		TLHT	ALHT
5	Train leaves the connection line and enters the transhipment track	**Actual Leave Connection line Time**	**TO**	**ALCT**	AIBT	**PLCT**		TLCT	ALCT
6	All potential checks are done and unloading starts (Bereitstellung)	**Actual Start Unloading Time**	**TO**	**ASUT**	ACGT	**PSUT**	ESUT	TSUT	ASUT
7	The unloading of the train ends	Actual End Unloading Time	TO	AEUT		PEUT			
8	*Start of shunting/decomposition if waggon sets are stored in a siding*	*Actual Start Decomposition Time*	*TO*	*ASDT*					
9	*End of shunting/decomposition if waggon sets are stored in a siding*	*Actual End Decomposition Time*	*TO*	*AEDT*					
10	*Start of shunting/composition if waggon sets were stored in a siding*	*Actual Start Composition Time*	*TO*	*ASCT*					
11	*End of shunting/composition if waggon sets were stored in a siding*	*Actual End Composition Time*	*TO*	*AECT*					
12	The inspection of the empty train is completed	Actual Empty Inspection Time	TO	AEIT					
13	The loading of the train starts	Actual Start Loading Time	TO	ASLT	ASBT	PSLT			
14	The loading of the trains ends (Ladeschluss)	**Actual End Loading Time**	**TO**	**AELT**		**PELT**	EELT	TELT	AELT
15	The brake test & train inspection starts	Actual Start Brake test Time	TO	ASBT		PSBT			ASBT
16	Timestamp when the target time for the "train ready for shunting to handover station" is issued	**Target Ready for Shunting Time**	**RU**	**TRST**	TOBT				
17	The brake test & train inspection ends / is completed without failure	Actual End Brake test Time	TO	AEBT		PEBT		TEBT	AEBT
18	Timestamp when the target time for the "approval of time to enter the main line" is issued	**Target Mainline Approval Time**	**IM**	**TMAT**	TSAT		EMAT	**TMAT**	
19	Timestamp when the target time for the "train ready to enter main line" is issued	**Target Ready for Main line Time**	**RU**	**TRMT**					
20	Train is declared ready for shunting (Terminal exit)	**Actual Ready for Shunting Time**	**TO/SO**	**ARST**	AEGT	PRST		TRST	ARST
21	Train leaves the transhipment tracks and enters the connection line	**Actual Start Shunting Time**	**TO/SO**	**ASST**	AOBT	PSST	ESST	TSST	ASST
22	Train leaves the connecting cine and enters the handover station	Actual Enter Handoverstation Time	SO	AEHT		PEHT		TEHT	AEHT
23	Train is declared ready for main line entry (Train Ready for Dep.)	**Actual Ready for Mainline Time**	**RU**	**ARMT**	ARDT	PRMT		**TRMT**	**ARMT**
24	The IM provides the actual main line approval (Green Light)	**Actual Main line Approval Time**	**IM**	**AMAT**	ASAT				
25	Train enters the main line (actual movement detection by sensor)	**Actual Enter Main line Time**	**IM**	**AEMT**	ATOT	**PEMT**			**AEMT**

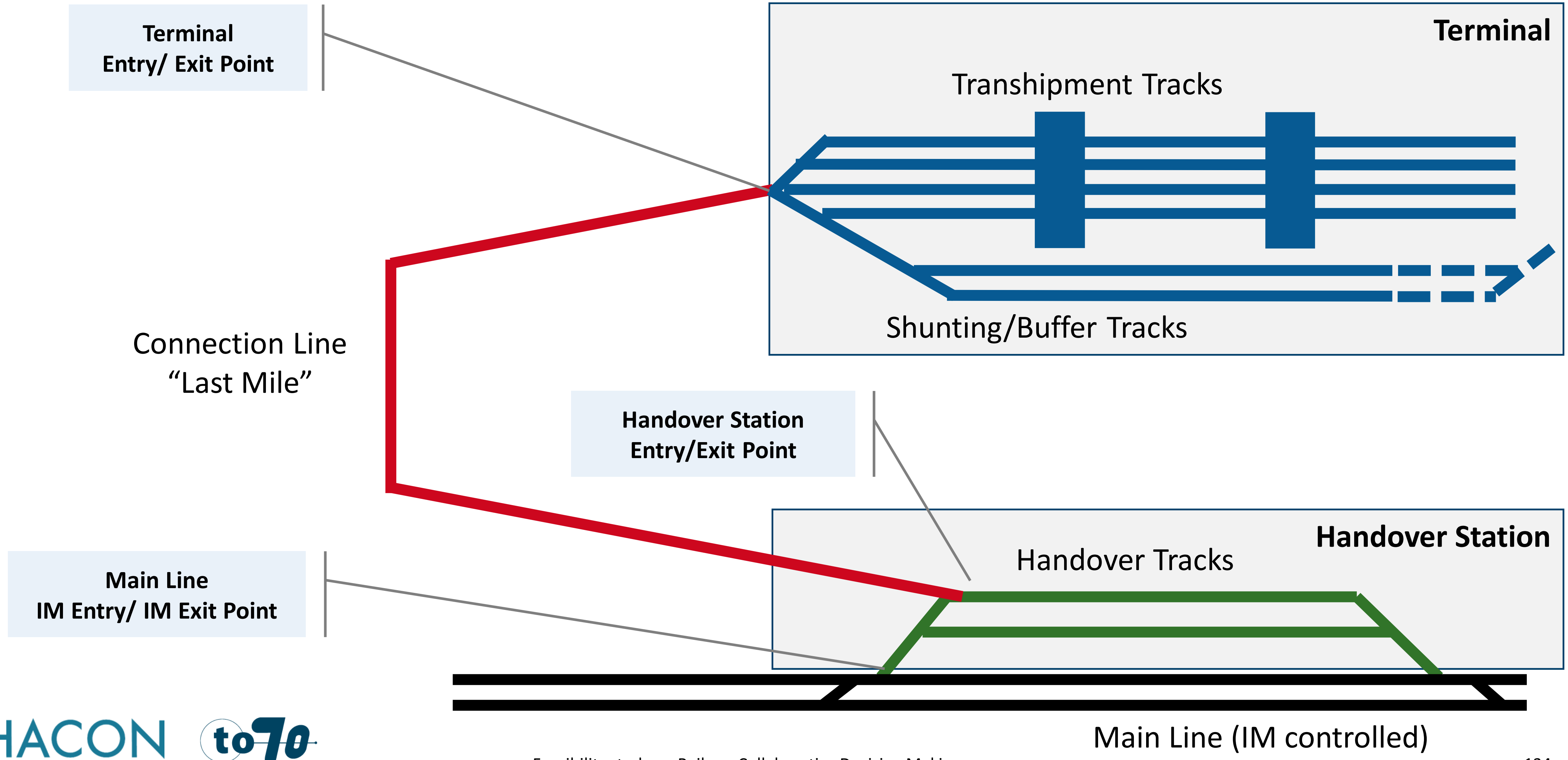
- The present table for rail freight transport was drawn up as part of the feasibility study and represents a starting point for later discussion;
- **The list is an initial overview of potential milestones, which might be prioritised and then implemented step-by-step;**
- To discuss, evaluate and agree on the final list of milestones and terminology is a process which is part of the implementation manual.

HACON to70

CE#3 – Last Mile Prediction Introduction

- In aviation CE#3 treats the "Variable Taxi Time" and is focussed on calculation and prediction of the outbound taxi time from the gate to runway take-off. In rail this relates to prediction and optimised re-planning of the inbound and outbound processes of the last mile actors;
- Before a flight departs, operations regarding pushback, start-up, taxi-out and take-off are handled by ATC and aircraft flight crew only. When a train departs multiple actors are involved in their resources must be coordinated in order to handle train inspection, shunting process and the final train operation by a main line RU;
- Ongoing rail research and demonstration activities are currently ongoing (e.g. "PROMI" in the German funding program for rail freight), which focuses on the last mile predictability by improved direct electronic connection of stakeholders in combination with improved ETA predictions for the arrival at the handover station and coordination of predictions for the shunting processes. This could be used as starting point for learning more about requirements, capabilities and effects of CE#3, as well as component for local CDM systems;
- The list of process steps may be more detailed than introduced in the milestone overview (see CE#2), as for the last mile "internal" coordination intermediate steps might be more relevant for local operations.

CE#3 – Last Mile Prediction Definitions



CE#3 – Last Mile Prediction
Process steps – inbound

Candidate process steps/ prediction points (Basic list based on often reported operational procedures)	**Responsible Stakeholder** (providing predictions)	**(Subsequent) Stakeholders requiring the prediction**					
		SO	**TO**	**RU**	**IM**	**IO**	**other**
Train leaves (exits) main line (IM Exit Point) = Train enters handover station	IM	x	(x)			(x)	
De-coupling of line locomotive / shunting of line locomotive	RU	x	(x)				
Arrival and coupling of shunting locomotive / simplified brake-test	SO		x				x
Request to the terminal manager (local IM) for the path clearance for shunting via the connecting line into the loading track	SO->TO		x				
Train leaves (exits) handover station = Train enters connecting line	SO		x				
Train leaves (exits) connecting line = Train entry at transhipment Detailed prediction of transfer time needed / Runtime calculation	SO		x			(x)	
Inspection of wagons and loading units if not done via video gate when entering the terminal area	TO/other					x	x
Start of unloading the train	TO					x	
End of unloading the train	TO	x				x	
Coupling of shunting locomotive including break test	SO		x				
Request to the terminal manager (local IM) for the path clearance for shunting the empty waggon to a buffer siding	SO->TO		x				
Start of shunting movement = clearance of the terminal track	SO		x				
End of shunting movement = De-coupling = shunting locomotive available for new duties / Prediction of transfer time needed	SO		x				

HACON to70

CE#3 – Last Mile Prediction
Process steps – outbound

Candidate process steps/ prediction points (Basic list based on often reported operational procedures)	**Responsible Stakeholder** (providing predictions)	**(Subsequent) Stakeholders requiring the prediction**					
		SO	**TO**	**RU**	**IM**	**IO**	**other**
Information about the targeted loading time of the outbound train	IO, TO	x					x
Arrival & coupling of shunting loco to empty waggon in siding / potentially composing waggon / simplified brake-test	SO		x				
Request to terminal manager (local IM) for path clearance for shunting empty train to transhipment track	SO->TO		x				
Start of shunting = clearance of the buffer track	SO		x				x
End of shunting = De-coupling = shunting locomotive available for new duties / Prediction of transfer time needed	SO		x				x
End of inspection of the empty waggons before loading	TO, other		x			x	
Start of loading the train	TO					x	
End of loading the train	TO					x	
End of Waggon and load inspection	TO, other	x	x			(x)	
End of full-break test (if respective installations available)	SO, other		x	x			
Corridor path confirmed (Approval of time to enter the main line)	IM	x	x	x		x	x
Coupling of shunting locomotive incl. full break test => Ready for shunting	SO		x	x			
Request to the terminal manager (local IM) for path clearance for shunting via connecting line to handover station	SO->TO		x	x			
Start of shunting = clearance of terminal track	SO		x	x			
End of shunting = De-coupling = shunting locomotive available for new duties / Prediction of transfer time needed	SO			x			
Coupling of line locomotive including simplified brake test	RU			x			
Train ready for main line entry = Train ready for departure	RU				x		
Train leaves handover station = Train enters main line (ETA IM Entry Point)	IM, RU				x	(x)	

CE#4 – Pre-departure Sequencing
Introduction

The concept element “pre-departure sequencing” (PDS) has been identified as being transferable, nevertheless the challenges and the therefore the focus of the concept element is slightly different.

- Departure sequencing today is mainly applied by the respective train operators when they decide which of their trains should be prioritised in a terminal (at handling or departure). In future the departure sequencing could depend on several aspects from different stakeholders taking also into account the real-time situation on the main line;
- Similar to aircraft at runway entry or regulating pushback order, the sequence of trains on the main line is best done prior to departure, enabling a minimally disrupted journey to destination. Whilst aircraft en-route can be separated in three dimensions, overtaking or resequencing trains may only be possible at certain restricted points;
- Such an overtaking process is usually not only associated with additional delays and costs (e.g. energy consumption when starting a heavy freight train), but also with capacity restrictions of the entire network, as faster or higher priority trains have to follow a freight train until it reaches the next overtaking opportunity. Alternatively, the freight train would have to be overtaken much earlier, which in turn would lead to greater quality losses for the freight train;
- Even if certain overtaking on international traffic lines has to be planned, new additional necessities for overtaking will always arise in later operation due to delayed trains and additional conflicts;
- The traffic situation on the main network is only known to IMs. Their systems display network status, and dispatching decisions to solve (imminent) conflicts are usually made manually by operators without check of impact on (international-) route beforehand.

CE#4 – Pre-departure Sequencing Objectives

- Similar to aviation, Rail Pre-Departure Sequencing could support optimised operations on the main line. However, this requires a system for pre-departure sequencing in order to assess what train sequence is considered optimal on a local mainline, and where possible include regulations or constraints from corridors or international networks, e.g. International Coordination Support Function (see CE#6);
- Pre-Departure Sequencing should achieve:
  - Optimal operations in the last mile area where both connecting, shunting and handover tracks are optimally used;
  - Sequence trains into the operation on the main network and the time they should depart from the handover station or, if necessary, with the mainline locomotive directly from the loading track.

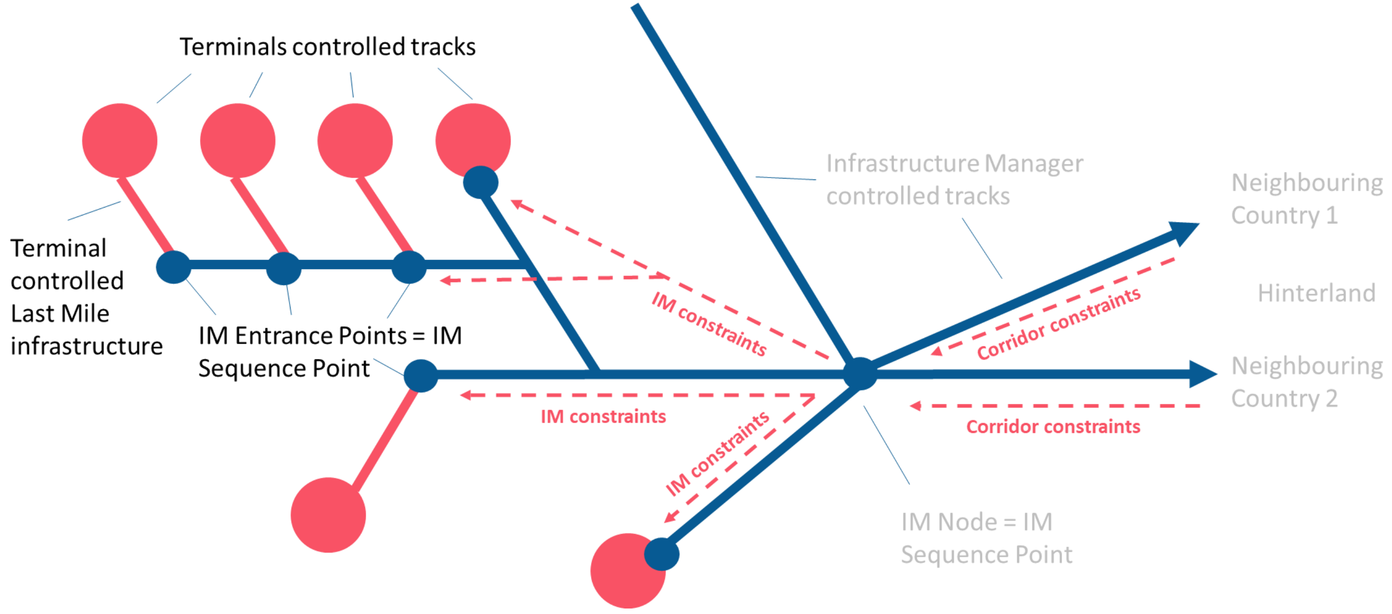
Where is Rail CDM Pre-Departure Sequencing needed?

Terminals → TOs:

- Preparation of train departure;
- Entrance to the IM network.

Main Line / Nodes → IMs:

- Sequencing of trains coming from and going to different directions.



CE#4 – Pre-departure Sequencing
Current role of IMs

The term IM is used in the context of this feasibility study for the owner and operator of the main lines or the main network. There are, of course, many more parties involved who own and operate infrastructure, such as the loading tracks and shunting areas belonging to the terminal, or private feeder lines. For the sake of simplicity, this type of infrastructure is assumed to be the operational responsibility of the terminal in the study.

In general the IM has some main duties in planning and operation:

- Provide access to the infrastructure and connected services based on common neutral rules;
- Manage the trains movements in a safe, reliable and efficient way, ensuring equality and an optimum use of resources. The later is nowadays hindered by missing information/prediction:
  - either from terminals or other stakeholders about trains readiness;
  - or from neighbouring IMs about the train run on any previous section.
- Example aviation: Optimisation of **Infrastructure Capacity** in the pre-tactical timeframe prior to operations:
  - Airport CDM: activation of flight in ATC and A-CDM systems 3 hours prior to operation according to flight plan;
  - Rail CDM: activation to be determined based on common operation (to be further discussed in the implementation phase).

CE#4 – Pre-departure Sequencing
Future role of IMs

The role of an IM in CDM needs to be expanded:

- Generate structural inbound predictions, with the “ETA IM Exit Point” used in the ELETA project, for milestone “Actual Leave Main line Time”. This role could be handed over (at least for cross border trains) to the International Coordination Support Function;
- Generate structural outbound predictions, when the train is allowed to enter the main line (Target Mainline Approval Time / TMAT). In an optimal case this target time could be in line with the scheduled planned time the for entering the mainline (PEMT):
  - TMAT shall never be earlier than the Ready for Mainline Time provided by RU;
  - IMs provide Actual Main line Approval Time (AMAT) .
- Monitoring of the milestone “Actual Enter Main line Time (AEMT)” is easiest to be done by trackside installations by the IM as well, even if some RUs might record it also in their systems for performance control purposes.

As stated above relevant infrastructure **Entrance or Exit Points** and other Infrastructure **Nodes** have to be defined in the implementation phase.

CE#4 – Pre-departure Sequencing
Demand and constraint management

- Primary input is **Train Demand** and Infrastructure Capacity: the time any train is targeted to be ready and wants to enter IM main line/network. Rail can work similarly: predict readiness of the train based on and by:
  - TRMT is similar to Target Off-Block Time (TOBT) announced by Ground Handler in Airport CDM. Target Time must be verified by Actual Ready Time (ARMT) for performance evaluation. TRMT prediction is updated based on:
    - Shunting the wagons of the train to be loaded by SO;
    - Assigning and moving a locomotive for the train by SO or RU;
    - Loading of the freight onto wagons by TO or IO;
    - Last Mile shunting and connecting the locomotive by RU;
    - Other preparation planning to determine the target entrance time for entering the IM network.
- Secondary input is any operational **Constraint** provided from downstream IM sectors or later on by a International Coordination Support Function (see CE#6) that impact on the sequence of trains rolling out of any terminal or passing a node;
- Together these inputs can be the starting point for systems to determine Target Mainline Approval Time (TMAT).

CE#4 – Pre-departure Sequencing Capacity Demand Balancing

- Business Rules per entrance point or infrastructure node are determined by IM in cooperation with rail, terminal and intermodal operators to achieve equality, transparency, and corridor or network capacity optimisation, not just local optimisation;
- The Business Rules should be coherent at least on a corridor, better on international level, but might differ slightly to reflect local/regional/terminal specific framework conditions;
- Using Train Demand, Train Constraints and Rail Capacity constraints per IM Entrance Point or Infrastructure Node, a targeted sequence can be determined for all trains in the pre-tactical timeframe, e.g. the coming 6-12 hours;
- Pre-Departure Sequencing can be an automated method based on the business rules and respective algorithms in the local IM to determine the IM entrance approval time for each train on a certain Entrance Point or Sequence Node:
  - Similar to Target Start-Up Approval Time (TSAT) in A-CDM;
  - Target Time must be verified by an Actual Start-up Approval Time (ASAT) for performance evaluation;
  - International restrictions from European Network Management are included into Pre-Departure Sequencing business rules.
- Performance Evaluation shall be institutionalised for operations on a set of common strategic objectives, business drivers, and performance indicators. Frequent evaluation of all stakeholders and enforcement of mandated regulations and procedures shall be created.

CE#5 – Adverse Conditions
Approach and predictability categorisation

Similar to aviation the main objective of R-CDM in “adverse conditions” is to guarantee business continuity and stability of the operations, in order to retain an acceptable level of predictability. Especially when capacity is restricted, predictability is used for reliable predictions to utilize remaining capacity and recover quickly after restrictions end. This is achieved by:

- Establishing procedures and pre-agreed mitigation scenarios for different categories of adverse conditions;
- Creating maximum awareness of those contingency procedures and assign local or regional coordinator;
- Stress TRMT management to maintain train demand awareness, similar as enabler TOBT in aviation.

CE#5 is focussed on contingency plans and procedures which are prepared for the different adverse conditions which were categorised in Task 1.2. Depending on predictability of these events there is a difference in activating these contingency plans.

Some adverse conditions mentioned have impact on the capacity on the main or connection line and not only on the terminal. If these are seen in context of R-CDM, contingency plans prepared for these disruptions shall considered.

As stakeholders tend to revert to re-active decision-making during disruptions, R-CDM in adverse conditions should provide a clear procedural framework for robust operations aimed to maintain predictability as enabler for optimal use of available capacity, so stakeholders maintain confidence.

CE#6 – International Coordination Support Function Terminal, Corridor & Network Integration (1)

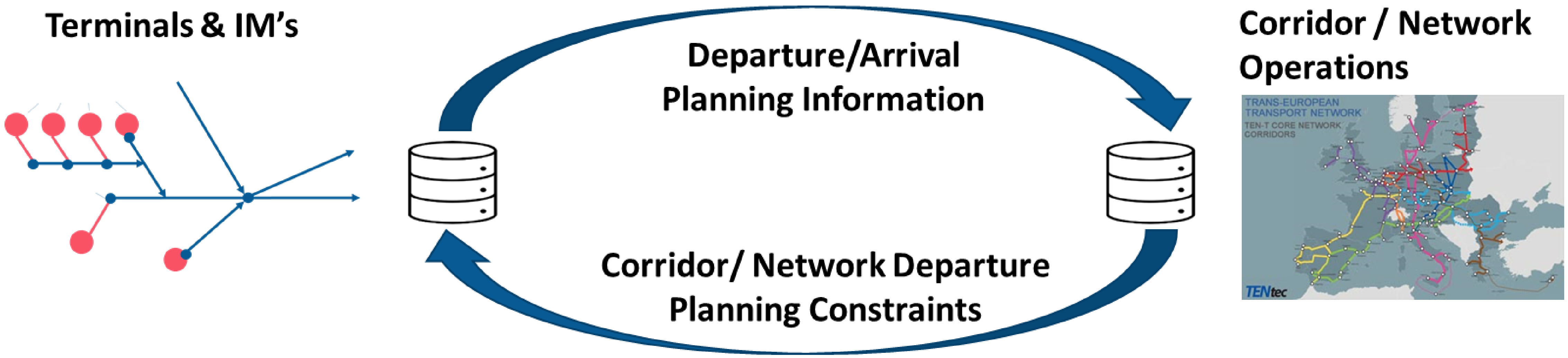
As identified in Task 1.2 and in connection with the CE#4, the International Coordination Support Function is a requirement for the optimisation of international trains runs and cross border benefits of R-CDM.

General findings (details have to be discussed in the implementation phase):

- The CDM concept is depending on reliable connections between the start and end point of the services;
- The required coordination of capacity and operation needs to be supported by an International Coordination Support Function;
- To provide the right information for situational awareness it is important to identify any relevant network constraint/conflict;
- Capacity restrictions in the corridor could have impact on trains destined for that restricted area. An International Coordination Support Function could enable as decision support function/system the involved stakeholders to re-sequence (dispatch) trains pre-departure, preparing at terminal site, or trains that could be moved into buffer tracks prior to congested nodes;
- An International Coordination Support Function should process all (international) train information to enable informed capacity-demand balancing and tactical dispatch for congested rail sections on international lines/corridors. Depending on the technological system used, decision support for tactical dispatch can be provided to national IMs, but it is assumed that the final dispatching decisions and the execution remains in their full responsibility;
- An International Coordination Support Function could provide calculated predictions based on the real-time operational situation and shall provide these in the framework of the CDM to the concerned stakeholders;
- How this function could/should be implemented will be point of discussion with the whole sector and the involved institutions in the follow-up process of agreeing on an implementation manual. There are different opinions and factors to be taken into account in a transparent decision making process. Therefore in this feasibility study there is no recommendation in one or the other direction;
- This CE#6 function does not imply the need for a central European Traffic Control for the R-CDM implementation.

CE#6 – International Coordination Support Function Terminal, Corridor & Network Integration (2)

Integrated via standardised train messages, local operations in terminal, ports, and national IM systems iterate predictive information with the International Coordination Support Function that covers the participating network or corridors. Integration layers and other functions as developed in Shift2Rail should be used to facilitate the integration or connection of national systems.



Requirements
Stakeholder Equality and Values

The culture of a future R-CDM shall be about inclusivity and equality of all stakeholders, where collaboration shall be the acceptance of each stakeholder as partner in the rail sector:

- All stakeholders shall be equal in the development, implementation, harmonization and monitoring of R-CDM performance;
- Equality means that all stakeholders have a seat on the table in future decisions on R-CDM, either through participation or representation;
- Responsibilities and Roles are (re-) defined where they require clarifications, and enforcement stipulated by European Union regulations.

Requirements
Data Transparency

- All defined and required data elements shall be documented, defined, harmonised and recorded in databases meeting European Union standards for data storage and archiving;
- New data elements will be defined for R-CDM and standardised and harmonised in formatting of definitions, acronyms, unit type and value accuracy (in coordination and by developing TAF TSI further);
- All data shall be recorded by stakeholders and shared to partner stakeholders free of charge, meeting update frequency and definition through defined interfaces and protocols, real time and automated where possible;
- Legal limitations that obstruct any stakeholder from sharing agreed data elements with the rail sector partners shall be removed;
- Data shall be protected for security and privacy in line with EU regulations, though not in conflict with the need for sharing of information with other stakeholder for purpose of operational performance.

Requirements
Corridor and Network Operations

- The corridor and network operations have an important influence on the last mile and terminal performance. And shall therefore be based on accurate, reliable and through going train path and resource planning.
- Conflicts and/or potential conflicts must be continuously identified or anticipated in order to create situational awareness and to be able to initiate proactive measures.
- Operational planning, monitoring and control should be supported by the International Coordination Support Function on reliable detailed data without system interruptions.
- For any scheduling/dispatching decisions, at least the effects (like potential new arising conflicts) for all network areas through which a train passes, must be identified so that informed decisions can be made or recommended.
- International freight trains should be considered and managed as one international train run and not as two individual national trains joined at the border.
- Through appropriate integration layers all information relevant for operations should be considered.
- Relevant predictions for the agreed milestones shall be provided to all concerned stakeholders.

Requirements
System Interfacing Control

- A set of Departure Planning Information and Arrival Planning Information messages shall be created for milestone triggered updates of the relevant network or corridor traffic demand overview;
- Messages shall reflect status of the train and accuracy of the information;
- Common R-CDM Requirements to functions, alerts, messages and interfacing to harmonize Industry standard and developments;
- Community Specification or Mandate issued by European Union to enforce harmonization and push industrial standards.

Departures

- Initial departure planning information is sourced by intermodal or rail operator, including shunting operator;
- Final departure planning information is completed with IM sequence information, reflecting planned sequence of trains departing from terminals and nodes.

Arrivals

- Initial arrival planning information shall be sources by schedule information, enriched by actual IM departure time from international terminal or corridor node as well as related arrival time estimation;
- Final arrival planning information shall be completed by IM actual departure time from IM local nodes.

Requirements – Performance Steering, Monitoring, Management & Post-Ops Evaluation

To achieve benefits:

- Data analysis and performance reporting;
- Preparing stakeholders to steer, monitor and manage;
- Steering on Predictability and Procedure Compliance.