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TABLE OF CONTENTS

List of Tables

List of Figures

LIST OF ABBREVIATIONS

Acronym	Description
ERTMS	**E**uropean **R**ail **T**raffic **M**anagement **S**ystem
ETCS	**E**uropean **T**rain **C**ontrol **S**ystem
GSM-R	**G**lobal **S**tandard for **M**obile Communication - **R**ailway
INESS	**IN**tegrated **E**uropean **S**ignalling **S**ystem
IXL	**I**nterlocking
RBC	**R**adio **B**lock **C**entre

Section 1 – EXECUTIVE SUMMARY

This report collates first hand data from suppliers and railways on the fallback and migration strategies employed on state of the art ETCS projects in Europe.

The intention of this report is to present the data so that Work Package E4 can perform more detailed analysis of fallback and migration strategies using data of known pedigree. Work Package E4 will draw out the trends and make conclusions on the data. As this report is part of Work Package E1, there is no attempt to extract detailed conclusions in this report.

The fallback and migration data is presented herein in tabular and graphical form. No raw data is contained in this report. Although this report does not attempt to analyse the information in detail, some basic trends can be observed. These are:

The data compiled shows that almost all suppliers and railways use fallback systems. The rationale for this is the need for continued operation of line, and continued need for safety.

ERTMS has had a positive effect on the harmonisation of fallback systems used both at the technical and operational levels.

Any European standardisation of interlocking definition should ideally define the different levels of fallback and this should be consistent with fallback layers present in ERTMS.

The data compiled shows that each railway has at least one migration strategy. However, the problem of migration can be complex and sometimes this necessitates multiple migration strategies. The rationale for choosing the right migration strategies is largely economic and technical.

Line wise migration is the preferred approach but some railways are attempting a step wise approach. The rationale for these decisions is primarily economic but also political.

With interlocking architectures being so varied and the European supplier and railway community being so diverse, there was scope for the data collection exercise to generate misleading data. Hence, considerable attention was given to the information gathering techniques and best practice was used in the data collection in order to maximise the quality of the data. Consequently, the data should be reliable and the broad conclusions drawn from this report offer no surprises, indicating trends that are in line with expectations.

Section 2 – INTRODUCTION

This document presents information on the fallback and migration strategies used in state of the art signalling projects in Europe.

This information has been collated in order that Work Package E4 can develop its report on Trackside Migration and Fallback Issues using authentic, relevant and up to date information.

The information itself was gathered by Workstream E from a questionnaire that was created by the Workstream and distributed to the supplier and railway partners in INESS. Hence, all the information herein is based upon primary data and should therefore represent first-hand statistics.

The questions presented in the questionnaire were developed, reviewed and agreed by Workstream E with the intention of eliciting the different approaches to fallback and migration. Partners were asked to complete questions for a specific project, and ideally this should be an ETCS project. The partners were encouraged to focus their answers towards one interlocking and its interfaces. Where partners felt able to comment on multiple projects, they were invited to complete a separate questionnaire.

Although this report is based upon primary information, received from partners based upon a number of projects, any such data collection exercise will rely upon a number of assumptions and simplifications. To minimise these, the questions were:

- defined in a systematic manner in order to assist assessment activities;
- designed to require minimal effort to complete, so that participants remained engaged during the completion of the questionnaire;
- designed with a structure to lead the participant through the questionnaire and minimise risk of misunderstandings;
- written using well established terms and language, to avoid misinterpretation;
- directed to provide information that was valuable to later work stream packages and not present unnecessarily difficult or time consuming probing;
- the scope of questions was precise and clear, in order to avoid mismatching of answers;
- finally, the questionnaires were presented in forms that were as accessible as possible – both an automated excel spreadsheet that guided the user through completion of the questionnaire; and also allow users to enter the data directly into the spreadsheet.

Hence, the data herein represents a spread of first hand results from many suppliers and railways in Europe. It does not guarantee that every fallback and migration strategy has been considered but it will allow quantitative analysis.

Section 3.1 of this document presents the information received on fallback. Section 3.2 presents the information received on migration. Both these sections present the results in tables and graphs but not

in its raw form. Section 4 goes on to draw some basic conclusions on these results. This document does not intend to make extensive analysis of the data as that is the responsibility of Work Package E4.

Section 3 – FALL BACK AND MIGRATION STRATEGIES

3.1 Fallback

A Fallback system is according to Oxford Advanced Learner's Dictionary (OALD) "a plan or course of action that is ready to be used in an emergency if other things fail".

Another definition is provided by Dictionary.com: "1. an act or instance of falling back. 2. Something or someone to turn or return to, especially for help or as an alternative"

For the purpose of the INESS project, we will consider that fallback means something (technology, techniques, rules, etc), that has to or can be used in case that a particular entity (system, component…) can not be used.

Techniques are "a particular way of doing something, especially one in which you have to learn special skills" or the "the skill with which somebody is able to do something practical". Fallback issues can therefore be seen on three levels:

1. The interlocking (IXL) as a fallback level for other ERTMS parts (RBC, GSM-R) or for operation overhead e.g. dispatching systems →Upper level.

2. Several fallback levels inside the IXL, e. g. failure in logical operating layer → Inner level.

3. One or more fallback levels behind the IXL for the trackside equipment, e. g. drive on-sight for failure of point locking → Lower level.

On the definition / design of a fallback system/issue the solutions adopted could be:

- Technical: this is a technical solution of a fallback problem
- Operational: this a solution by involving railway staff, e. g. signaller
- A hybrid solution, technical and methodical /operational

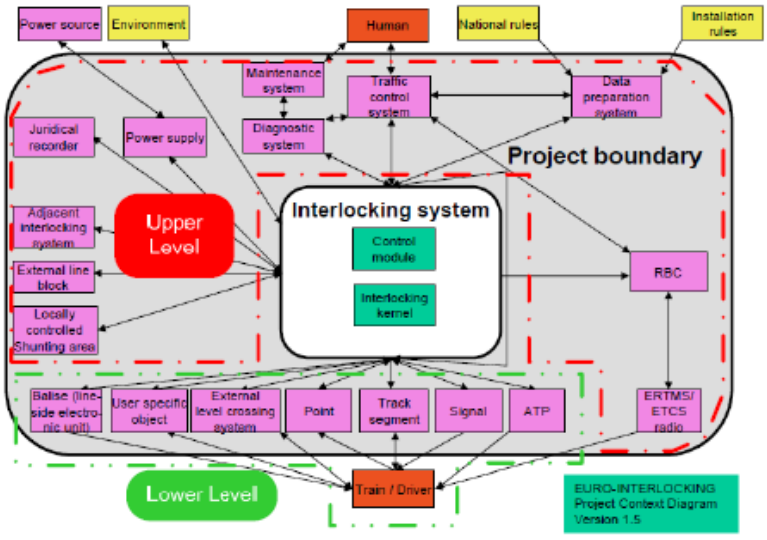


Figure 1 Fallback levels

The following sections 3.1.1 to 3.1.4 present the results of the questionnaire for fallback issues.

3.1.1 General Fallback

The following table shows the results from the questionnaires received regarding general fallback issues. All suppliers/vendors contacted use fallback systems and 11 out of 12 use fallback in the 3 levels explained above.

Most of them use different fallback systems for each generation of IXLs. The reasons for these differences, mainly technical or due to historical development, are also given in the table.

	Fallback used?	**Fallback in 3 levels described**	**Different for IXL generations**	**Reasons**			
				Technical	**Operational**	**Historical**	**Others**
1	Yes	Yes	Yes	✓	No	No	No
2	Yes	No	Yes	✓	No	✓	No
3	Yes	Yes	Yes	✓	✓	✓	No
4	Yes	Yes	Yes	✓	No	✓	No
5	-	-	-	-	-	-	-
6	Yes	Yes	Yes	No	No	✓	No
7	Yes	Yes	Yes	No	✓	✓	No
8	Yes	Yes	Yes	✓	No	✓	No
9	Yes	Yes	Yes	✓	✓	✓	Depends on the traffic
10	Yes	Yes	No	-	-	-	-
11	Yes	Yes	Yes	✓	No	✓	No
12	Yes	Yes	-	-	-	-	-
13	Yes	Yes	Yes	✓	✓	✓	No
Total	**12**	**11**	**9**	**8**	**4**	**9**	

Table 1 : General fallback questions

The following Figures show these results graphically:

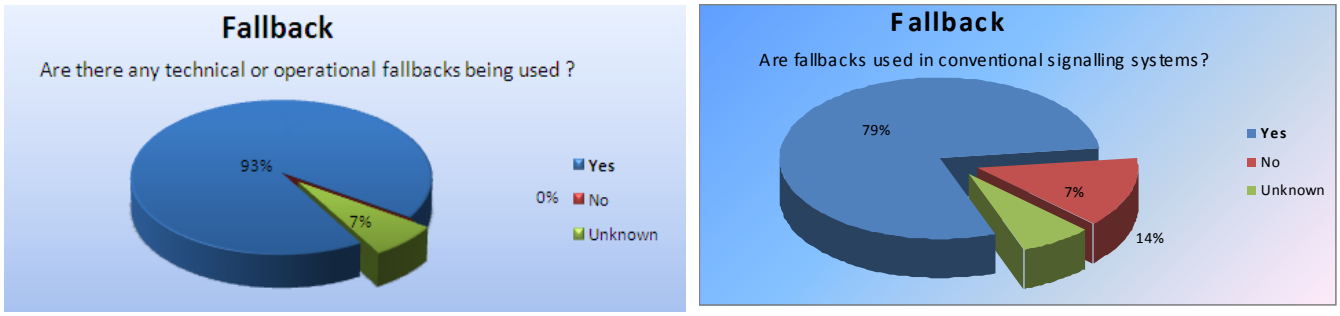


Figure 2 Fallback use

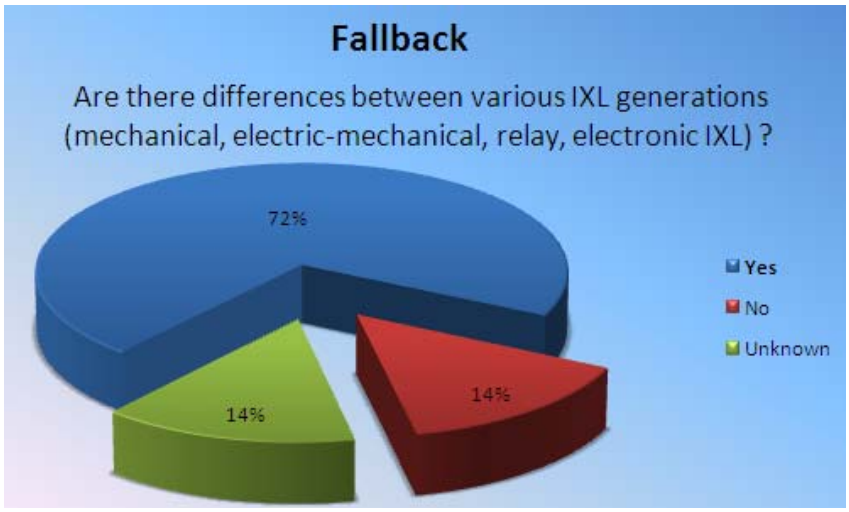


Figure 3 Fallback Differences

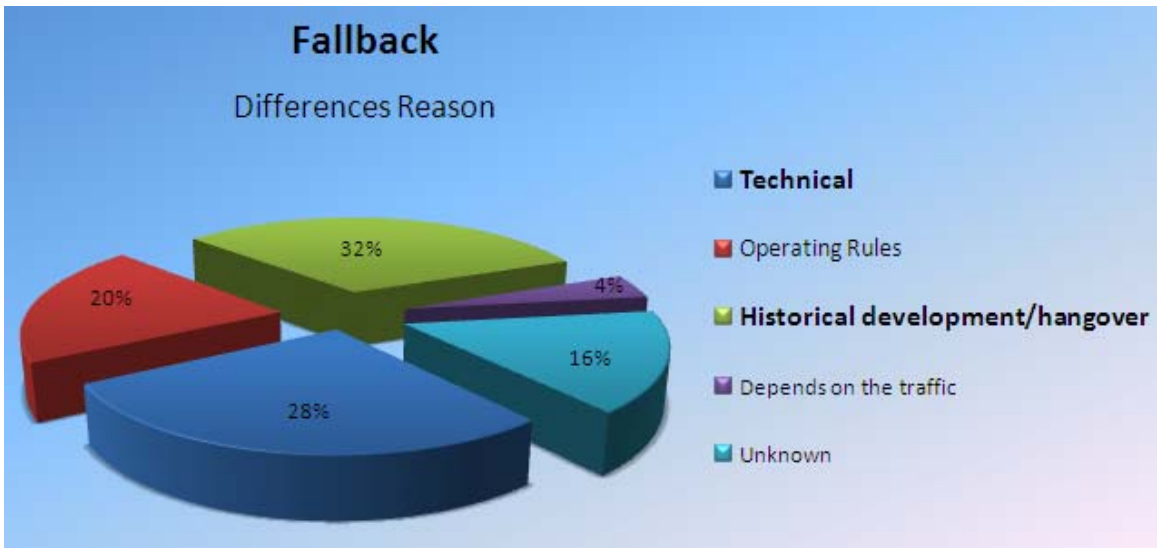


Figure 4 Fallback differences reasons

For each trackside element interfacing to IXL System, the following results have been obtained from the questionnaire data about the effective use of a fallback system in all evaluated projects:

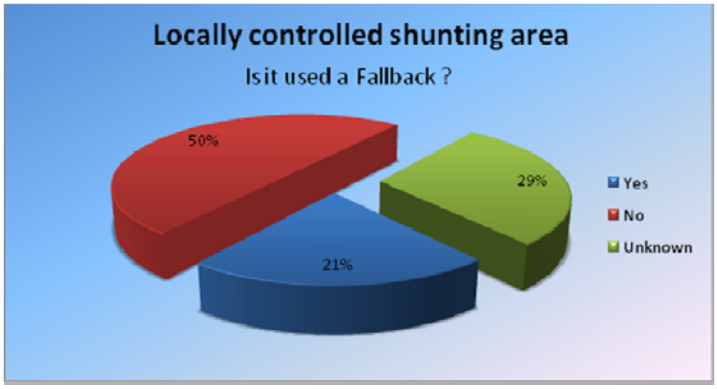
Answer	LSA	Balise	User Specific Object	External LX	Point	Track Segment	Signal	ATP	External Line Block
Yes, I use fallback for this kind of trackside element	3 (21%)	3 (21%)	2 (14%)	4 (29%)	6 (43%)	5 (36%)	4 (29%)	3 (22%)	3 (22%)
No, I don't use fallback for this kind of trackside element	7 (50%)	6 (43%)	4 (29%)	7 (50%)	8 (57%)	9 (64%)	9 (64%)	8 (57%)	9 (64%)
I don't know	4 (29%)	5 (36%)	8 (57%)	3 (21%)	0 (0%)	0 (0%)	1 (7%)	3 (21%)	2 (14%)

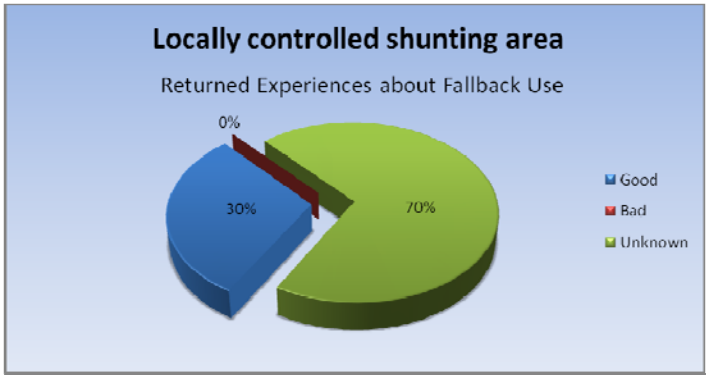
Table 2: Use of Fallback for each Trackside Elements

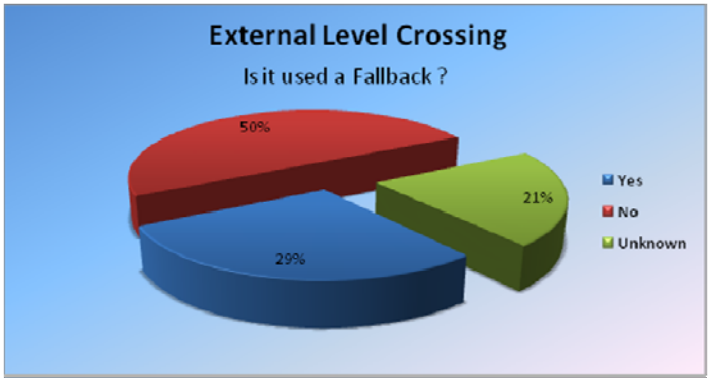
Answer	LSA	Balise	User Specific Object	External LX	Point	Track Segment	Signal	ATP	External Line Block
I had a **Good** experience in the use of fallback for this kind of trackside element	3 (30%)	4 (45%)	2 (33%)	4 (36%)	5 (36%)	4 (29%)	4 (31%)	3 (27%)	2 (17%)
I had a **Bad** experience in the use of fallback for this kind of trackside element	0 (0%)	1 (11%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (8%)
I don't know	7 (70%)	4 (44%)	4 (67%)	7 (64%)	9 (64%)	10 (71%)	9 (69%)	8 (73%)	9 (75%)

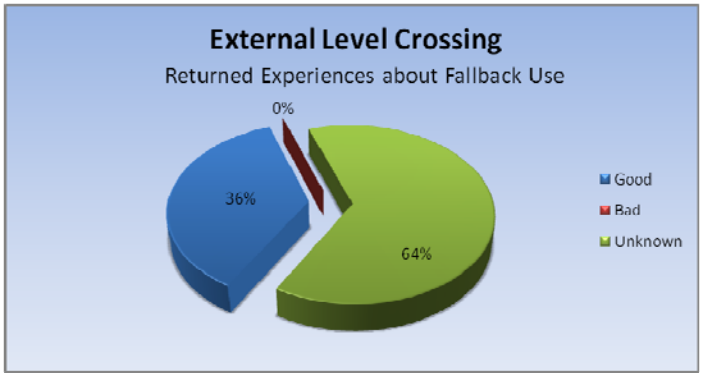
Table 3: Returned experiences about fallback use for each trackside element

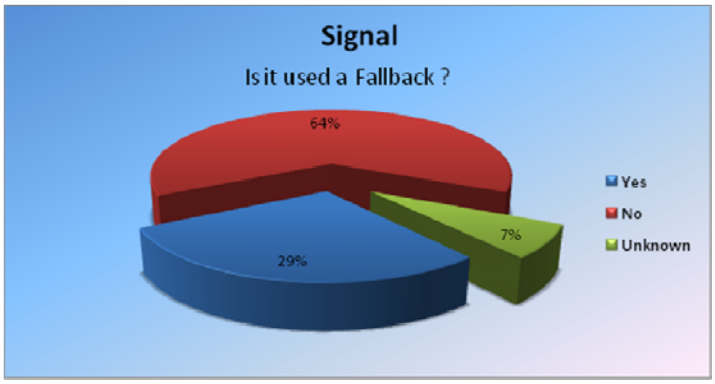
The same information is shown graphically in the following figures:

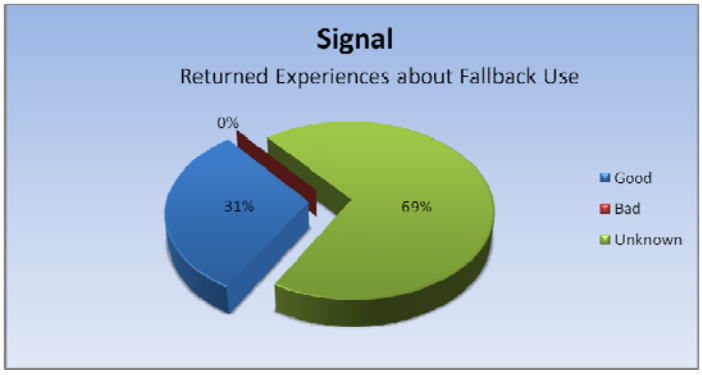


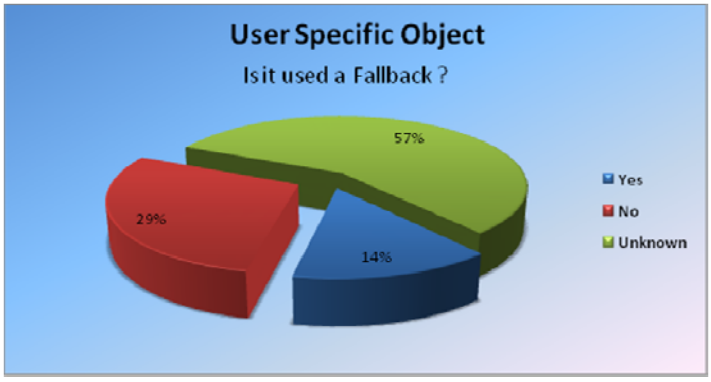


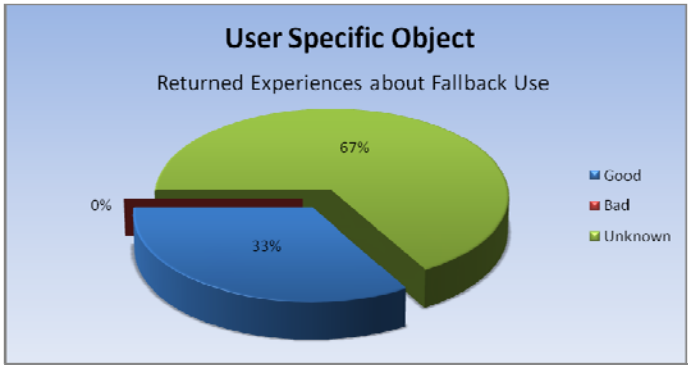


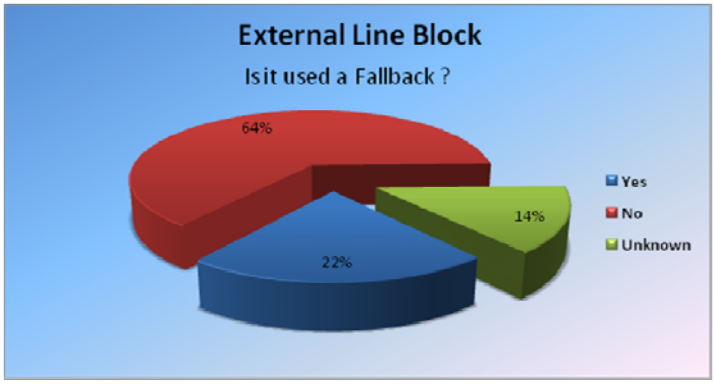


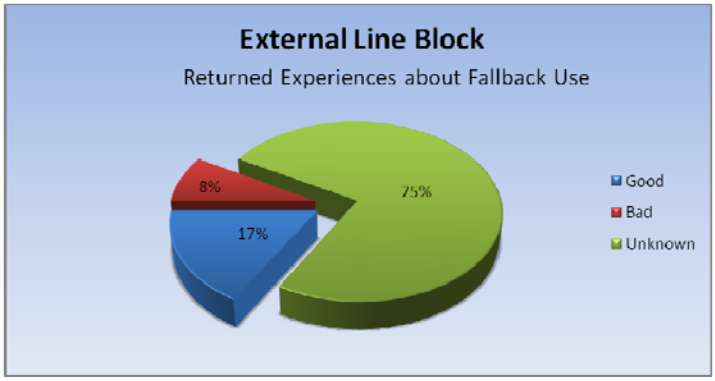


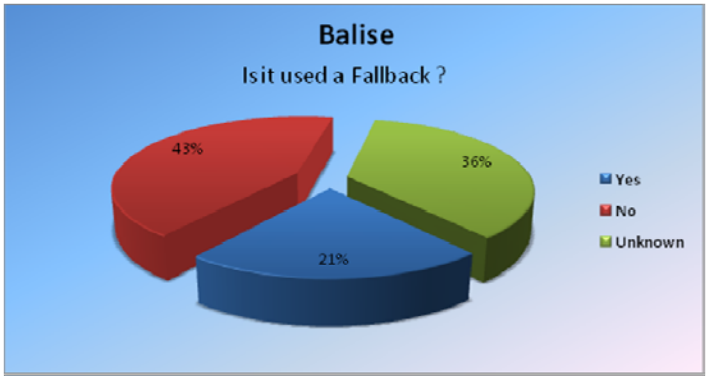


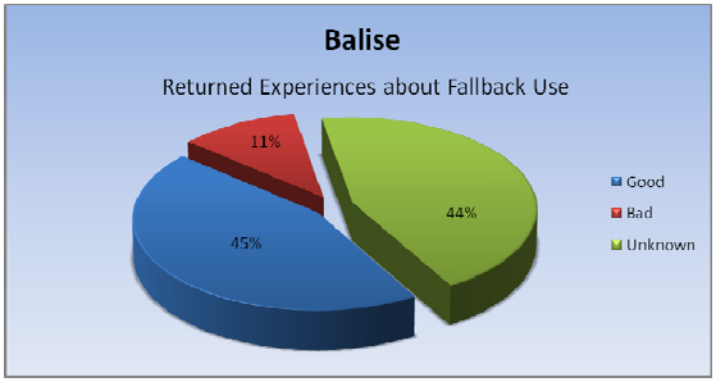


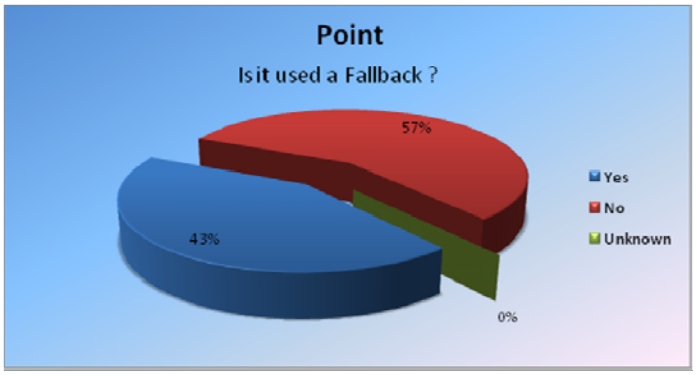


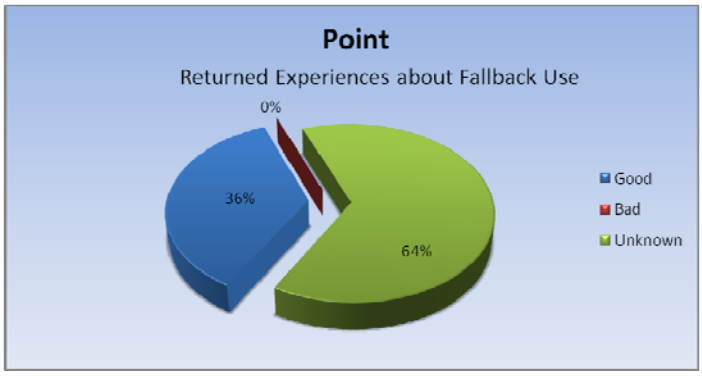

External Line Block
Is it used a Fallback ?
64%
14%
22%
Yes
No
Unknown

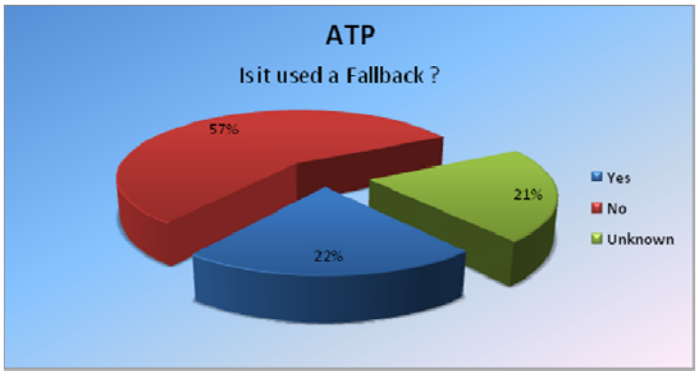

External Line Block
Returned Experiences about Fallback Use
8%
75%
17%
Good
Bad
Unknown

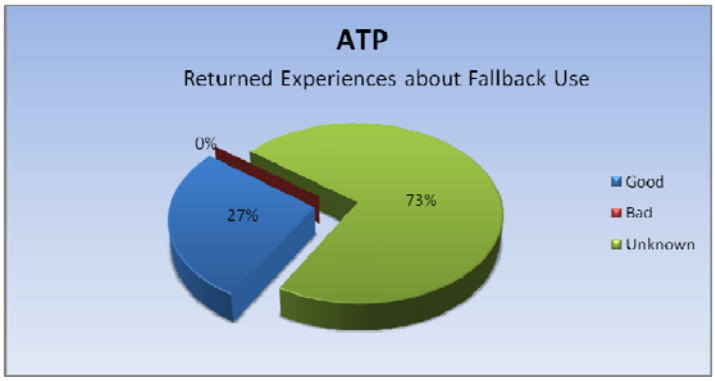

Balise
Is it used a Fallback ?
43%
36%
21%
Yes
No
Unknown

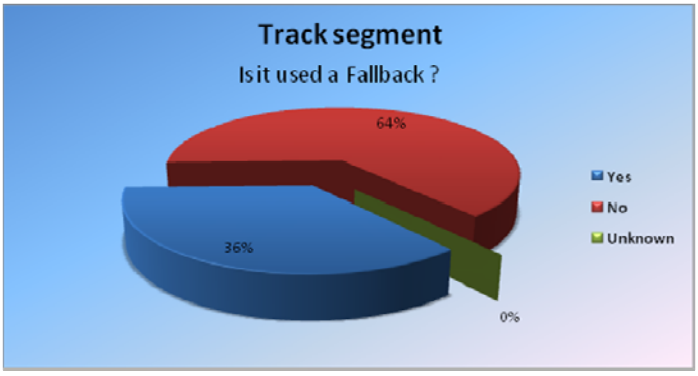

Balise
Returned Experiences about Fallback Use
11%
44%
45%
Good
Bad
Unknown


Point
Is it used a Fallback ?
57%
43%
0%
Yes
No
Unknown


Point
Returned Experiences about Fallback Use
0%
36%
64%
Good
Bad
Unknown


ATP
Is it used a Fallback ?
57%
21%
22%
Yes
No
Unknown


ATP
Returned Experiences about Fallback Use
0%
27%
73%
Good
Bad
Unknown



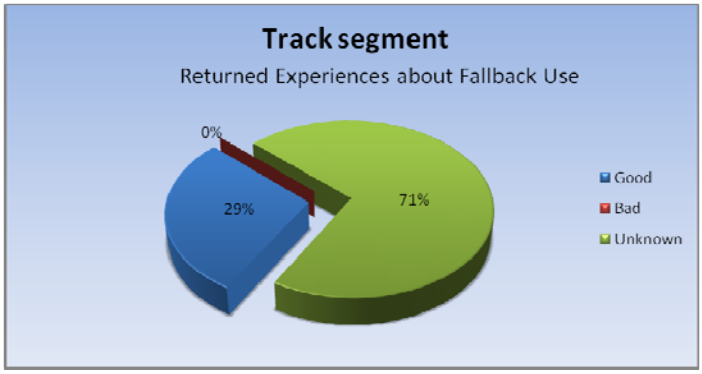


Figure 5 Use of fallback for each trackside element and returned experiences

3.1.2 ERTMS Fallback

This section gathers the data related to the fallback systems used in ERTMS. Only the positive inputs are shown in the following table. Suppliers/vendors that do not appear answered with No/None/Not applicable.

In the ERTMS context, fallback systems and procedures are already considered in the specifications. Level 1 is fallback for Level 2, SR and OS procedures, etc. This implies that the fallback used in ERTMS by the different suppliers / vendors is more homogeneous. Nevertheless, there are still some differences that can be seen in the following table:

Fallbacks issues provided in ERTMS	**New fallback issues based upon National Requirements**
Conventional signals and ASFA (the Spanish national signalling system) are a fallback for ERTMS Level 1 is a fallback for level 2	ASFA
Fallback issues are used in compliance with UNISIG Subset-026, ERTMS/ETCS Class 1 System Requirements Specification	No
Local Point operation activated by a key (the key is set to local control after a certain amount of time). This is used in case of interlocking failure in the main interlocking computer OS-mode activation in the train comes from ERTMS specifications (not national)	SR-train routes were introduced at the national level. Special train routes are used when OBU is not working or a vehicle is not ETCS equipped.
IXL typically provides as fallback functionality additional 'special' signal aspects. These can under certain circumstances be used by the RBC via special MAs. Otherwise operational fallbacks (written orders) are used in the	No

Fallbacks issues provided in ERTMS	**New fallback issues based upon National Requirements**
conventional system and ETCS	
Fallback on IXL: Local Point operation activated by a key (the key is set to local control after a certain amount of time). This is used in case of interlocking failure in the main interlocking computer	SR-train routes were introduced at the national level. In ERTMS applications equipped with Centralized IXL (Multistation) a peripheral "back-up" IXL in the same part of logic and SW configuration of the central operating IXL is provided. A procedure rules the automatic switch in case of fault.
Technical Operating Rules	No
All Italian ERTMS applications are equipped with a RBC back-up system in the same logic and SW configuration of the operating ones. In the applications equipped with centralized IXL (multistation) a back-up IXL in the same logic and SW configuration of operating IXL is provided too. A specific procedure rules the switching in case of fault.	OS-mode activation in the train comes from ERTMS specifications (not national) SR-train routes were introduced at the national level
SR ATP mode PZB (STM) No L1 as fallback for L2	-

Table 4 : ERTMS Fallback

This same information is presented graphically here:

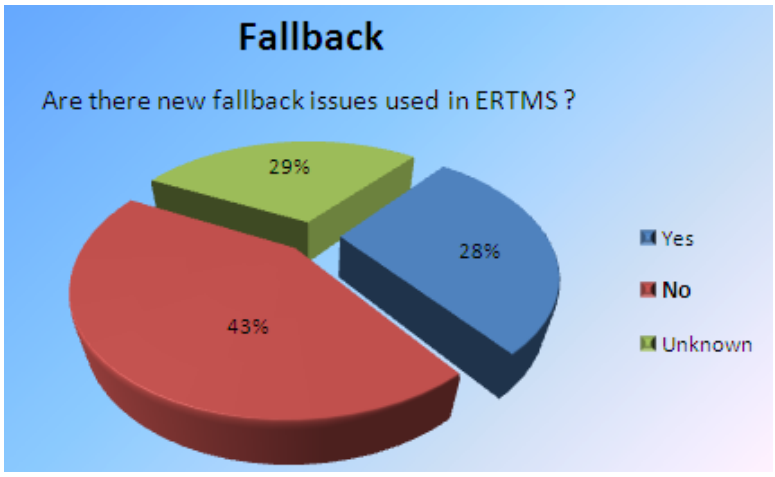


Figure 6 Use of Fallback in ERTMS

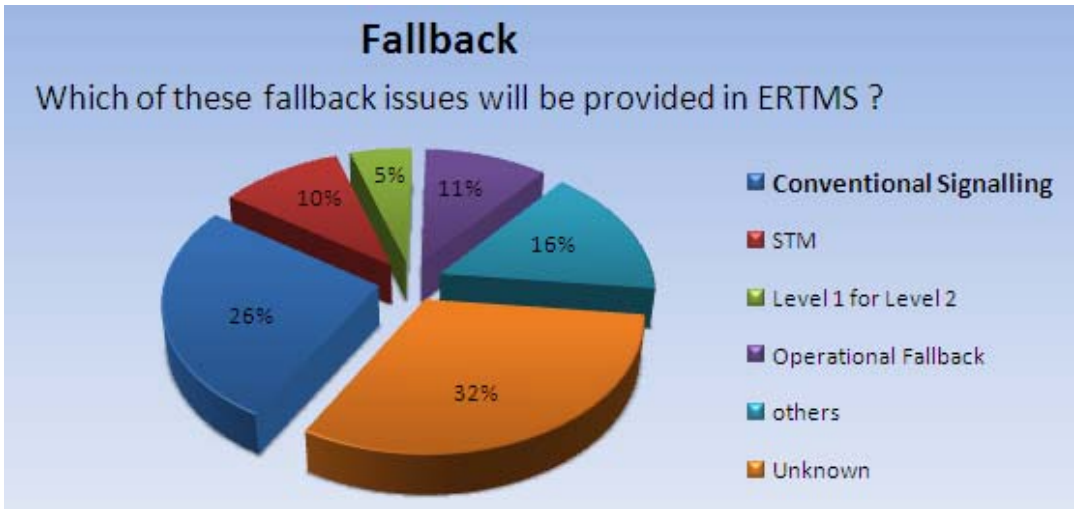


Figure 7 ERTMS Fallback

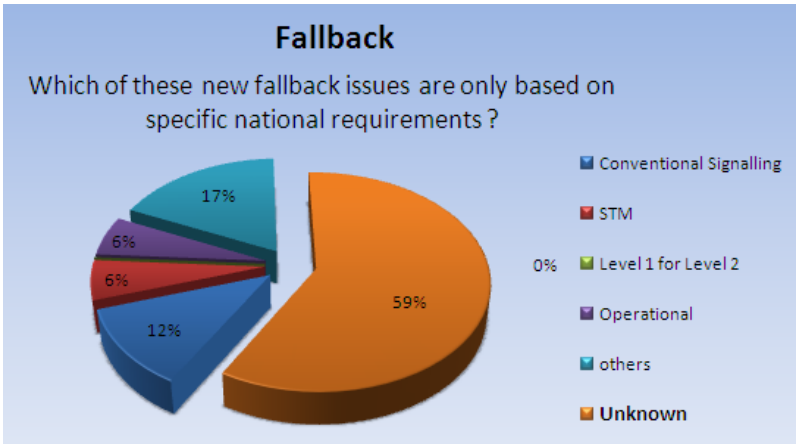


Figure 8 National requirements

3.1.3 Mandatory/Optional Fallback

The following table shows the fallback systems used currently by the suppliers / vendors interviewed and their classification attending to Mandatory / Optional considerations:

	Fallbacks: Mandatory(M) or Optional (O)	
1	Level 1 (M) ASFA (M)	
2	Operational fallback issues (e.g. dispatches) (M)	Issuing IXL as a lower fallback level for ERTMS systems (RBC, GSM-R) (O)
3	As specified by the TSI and subset 026	
4	Operational Rules (M)	
5	-	-
6	All fallbacks are Mandatory	
7	Depending on the technical solution fallbacks are M or O	
8	All fallbacks are Mandatory	
9	Operational fallbacks (M) Technical fallbacks required for safety (M) e.g. 2oo3	Technical redundancy is decided during design based on RAMS (O)
10	Route setting in OS mode is always possible if occupation in route has been reported (M)	
11	All fallbacks are Mandatory	
12	Operational fallback methods (M) Local operation box at each station (M)	
13	USP (M) Relief signal (M) Train radio (M) Substitute MMI (M) Double bulb lamps (M) Redundancy of intelligent subsystems (M)	Power supply provider (O) Topological redundancy (O)

Table 5 : M/O Fallback systems

This same information is presented graphically here:

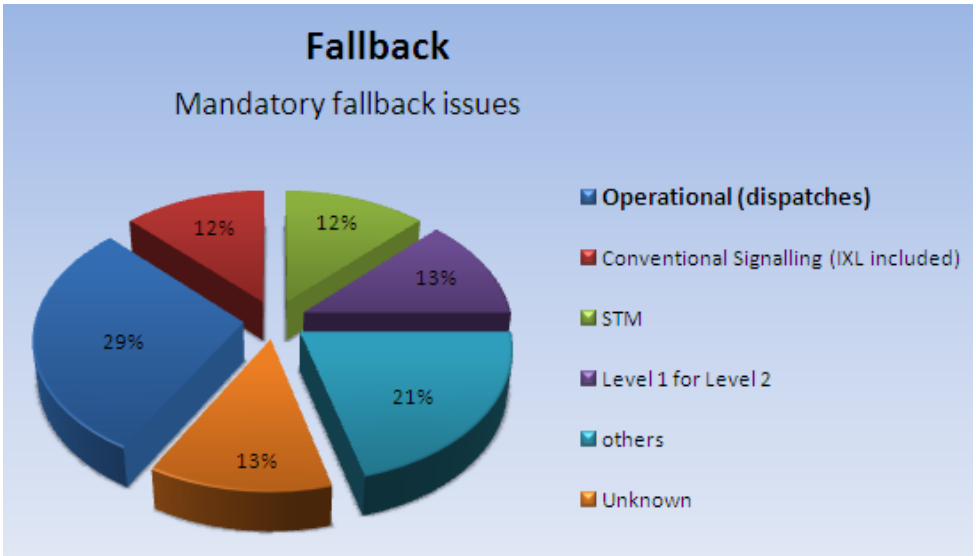


Figure 9 Mandatory Fallback Systems

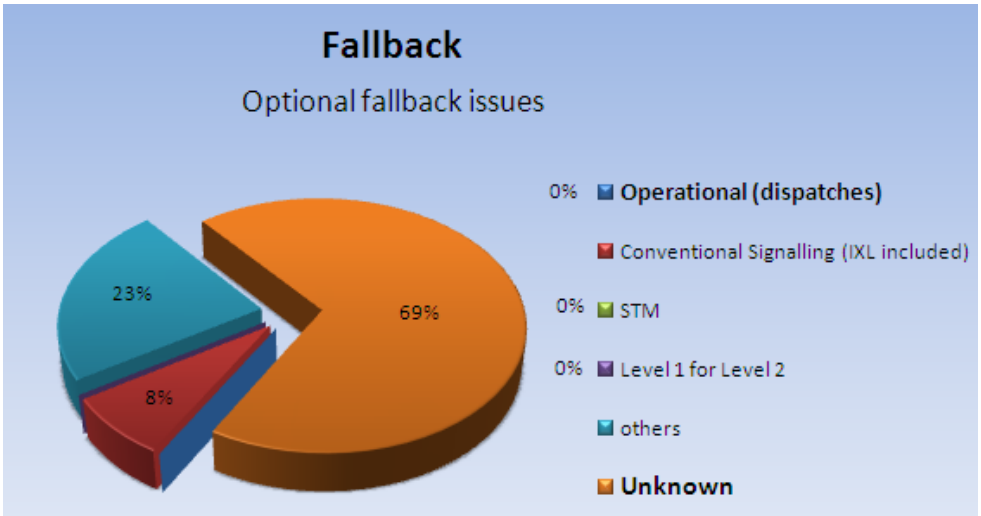


Figure 10 Optional Fallback Systems

3.1.4 Benefits of Fallback Systems

What is expected from a fallback system is to allow continuous operation within the foreseen parameters (velocity, etc). But even if the performance of the line can not be maintained, the fact that at least the line continues to operate is enough to justify the use of fallback systems.

Another way of expressing this is that a fallback system is expected to be efficient, meaning that it will be a well-handed degraded situation.

In general every stakeholder interviewed agrees on the fact that fallback systems do bring some benefits. Benefits derived from the use of fallback systems are expected even for the suppliers/vendors that have not implemented them yet.

Some fallback systems can bring more benefits than others. For example, the maximum speed at which a line can be operated is 300km/h when using ERTMS Level 1 as fallback and only 200 km/h if the Spanish national signalling system ASFA is used. Some suppliers think that the higher the level of fallback system the higher will be the level of provided safety, customer satisfaction and, at the same time, the legitimacy acquired by the service provider.

Fallback systems also add less tangible benefits (i.e. not linked directly with economic issues) such as customer satisfaction, increased safety etc.

Regarding the optional fallbacks, not many companies/administrations implement them because implementing an optional fallback system means higher costs to be paid by the infra-provider. However, it is understood that all these costs can be justified by a better operability of the system and by the fact that the infrastructure provider will be able to maintain a high level of customer satisfaction. In other supplier's views, optional fallbacks systems (e.g. topological redundancy) are rather expensive and only used for high capacity stations.

One last opinion is that optional fallbacks are about improving availability of the system through duplication and diversity. Duplication and diversity add costs, but not as much as providing fallback line side signalling or drive-on-sight signals. The last two add significant whole-life costs because they need more maintenance.

The following table shows the benefits identified by each vendor/supplier. Those marked as ($) are direct benefits. Those unmarked were classified as other benefits (not directly related to an economical benefit).

Benefits	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
The line continues to operate ($)	x										1
Keeps trains running ($)									x		1
Decreasing sum of delay minutes($)		x	x				x			x	4
Maintaining the operability of the system, even if this is maintained at a reduced capacity ($)		x	x								2
Maintaining of reasonable value of service and operational expenses($)			x								1

Benefits	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Increasing the available time for repairing / maintenance ($)		x									1
Maintaining of the minimum level of safety integrity($)			x								1
Expected but no experience yet ($)					x	x		x			3
Legitimacy of the service provider		x									1
Confidence of passengers in safety and/or reliability of railway transport			x								1
Passenger acceptance of railway system by increasing availability in case of system break down										x	1
Reduce the hazard rate within the fault				x							1
Increased Safety		x			x	x		x			4
Increased availability								x			1
Customer satisfaction		x							x		2
Company image is not damaged	x										1
Assure safe operation with support of technical equipment (avoid fall back to operation without technical support($)										x	1

Table 6 : Benefits derived from the use of fallback systems

The following figures show these results graphically:

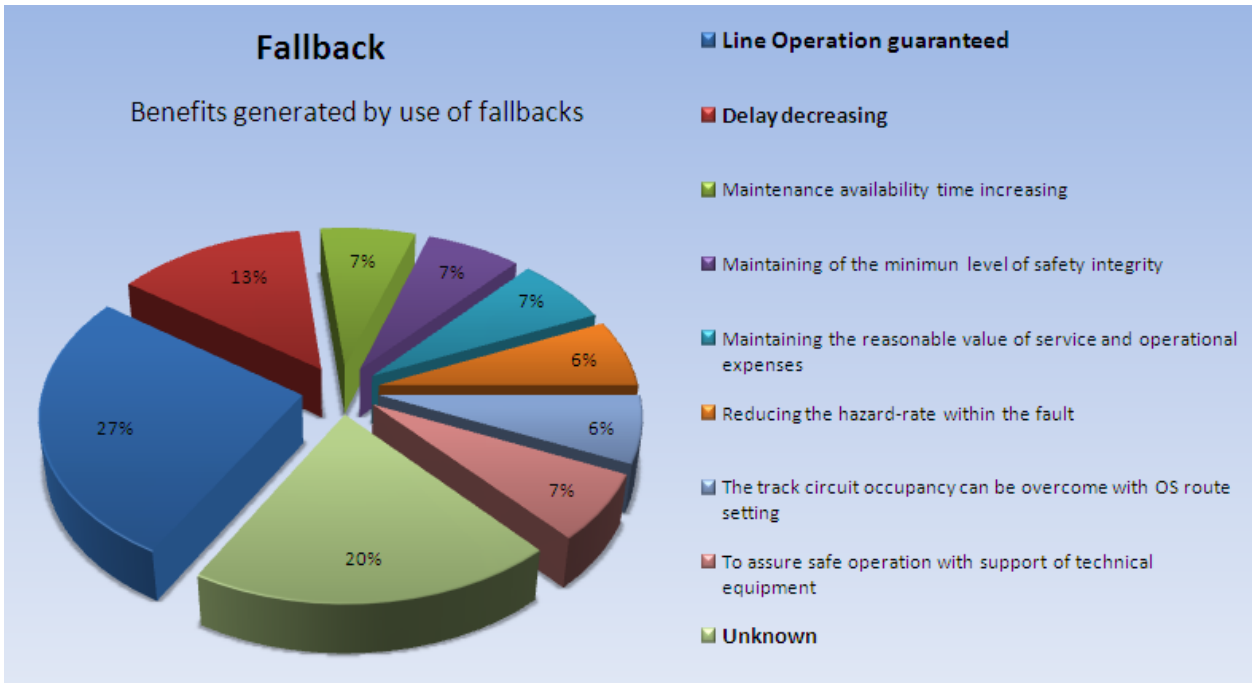


Figure 11 Benefits derived from the use of Fallback

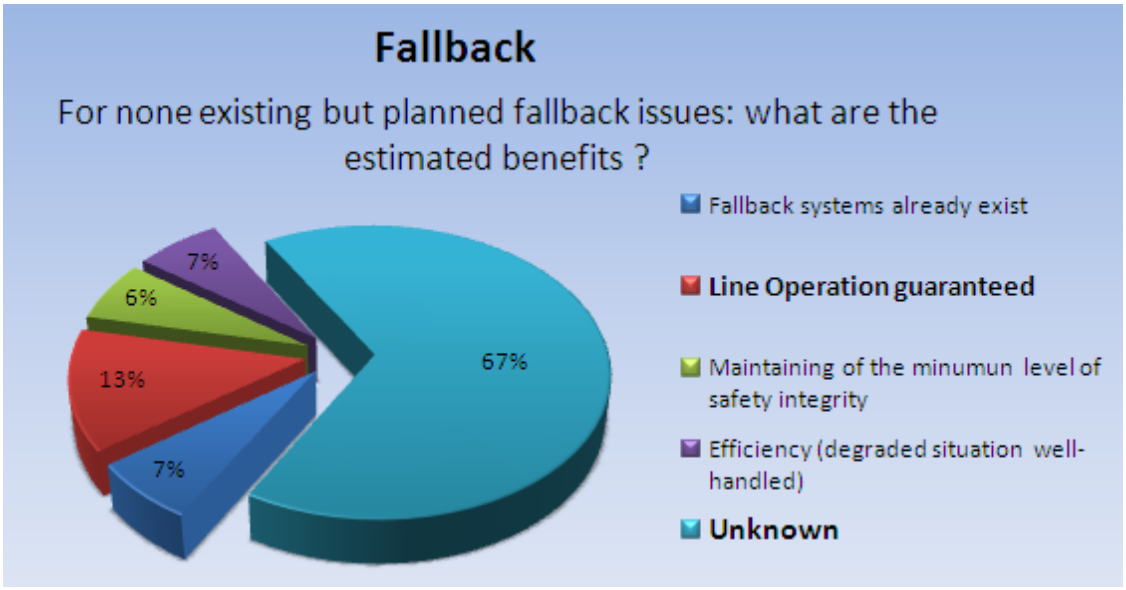


Figure 12 Estimated Benefits

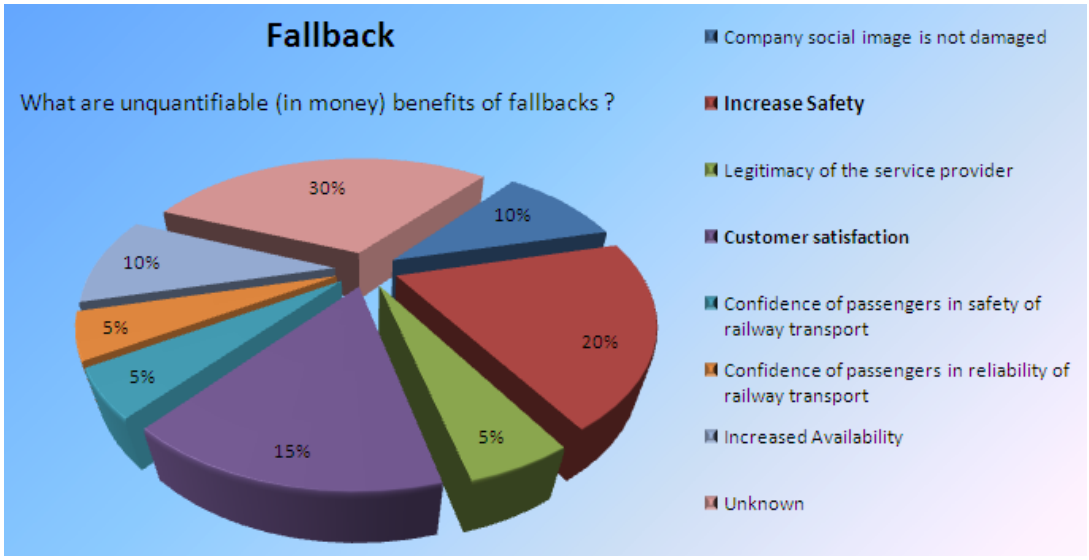


Figure 13 Non quantifiable benefits

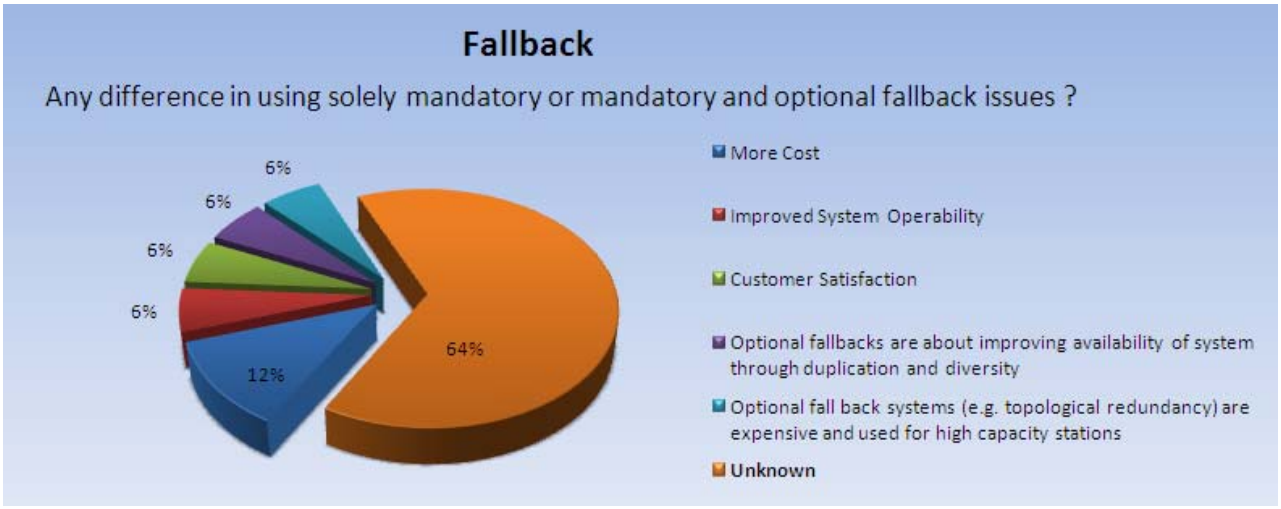


Figure 14 Benefits from M/O Fallbacks

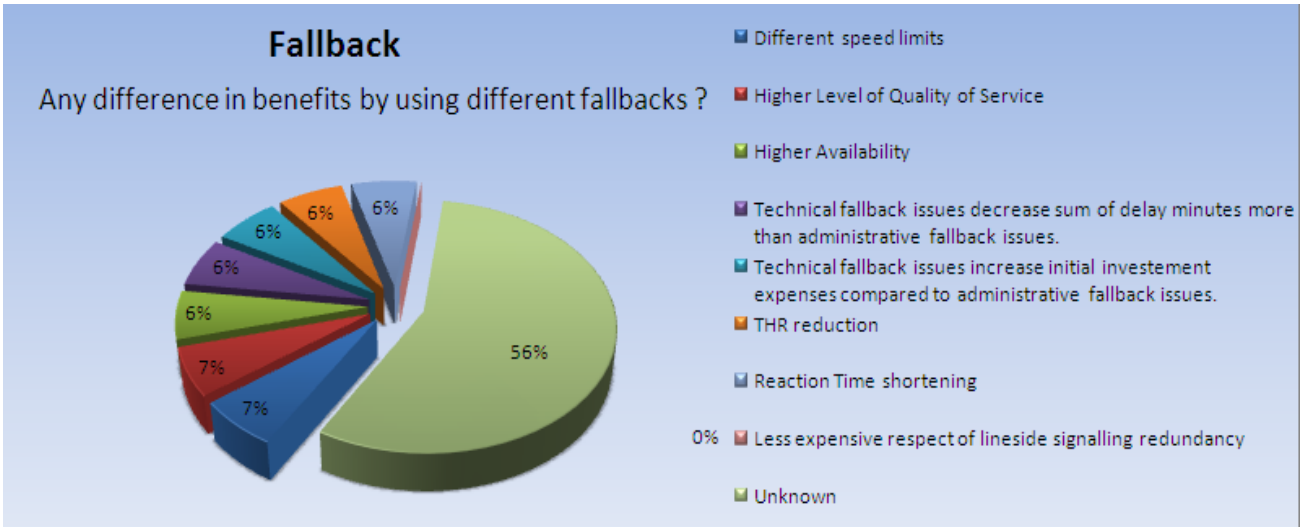


Figure 15 Fallback Strategy Vs Benefits

3.2 Migration

The analysis of different migration strategies is based on the following definitions:

Migration

“The fact of changing from one computer system to another; the act of moving programs, etc. from one computer system to another” (Oxford Advanced Learner's Dictionary – OALD)

To Migrate

“3 (technical) [v] to move from one place to another: The infected cells then migrate to other areas of the body.

4 (computing) [v, vn] to change, or cause sb to change, from one computer system to another

5 (computing) [vn] to move programs or hardware from one computer system to another” (Oxford Advanced Learner's Dictionary – OALD)

“3. to shift, as from one system, mode of operation, or enterprise to another.” (Dictionary.com)

Trackside migration means to bring out new technology into the field and replace old technology (if present). Thus, a new kind of technology can overlay an old one (Brownfield),or there is the possibility to build up totally new infrastructure with new technology from the outset (Greenfield).

So, trackside migration includes:

- overall network wide strategy (priority of lines)
- line wise strategy (priority of line sections/stations)
  - specific line section/station strategy
  - implementation/installation with or without maintaining railway operation
  - track wise with or without several construction stages
  - several constructions/installation methods

3.2.1 General Migration

The migration towards ERTMS is implemented in different ways around Europe. Whilst some railways use a single migration strategy for all their lines, most railways adopt multiple strategies. As an extreme example, one railway stated in their questionnaire that they use five different strategies. Figure 1 illustrates the picture across Europe:

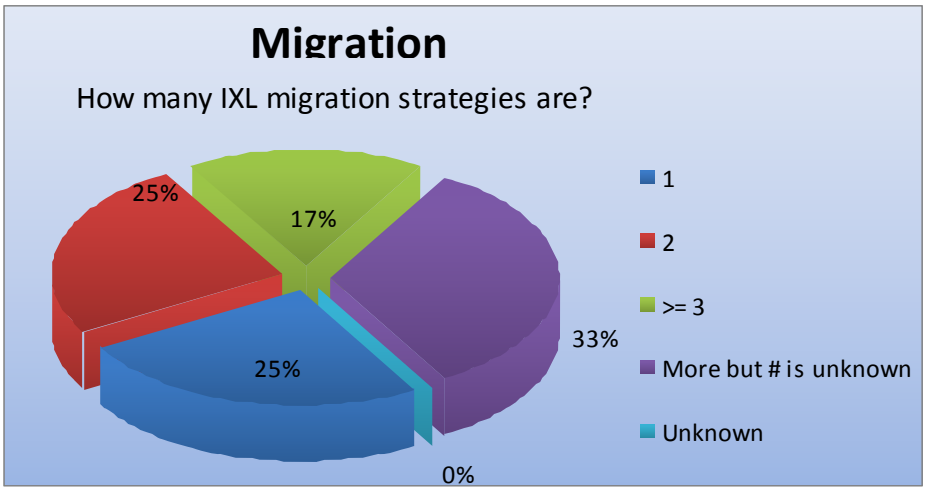


Figure 1: How many IXL migration strategies are there around Europe?

The questionnaire revealed that railways and suppliers base their migration strategy decision almost solely on economic or technological factors. One partner stated:

"The migration strategy is a very complex issue and therefore the reasons are directly determined by the type of project they have to be applied to. So depending if there is a completely new line, a pilot system or an upgrade of an old system the reasons are accordingly economic, technologic."

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Economic		X	X			X	X	X	X	X	X	X	9
Technological	X	X	X	X			X	X	X	X	X	X	10
Methodical		X											1
Other…	X				X								2

Table 7: Reasons for establishing migration strategies

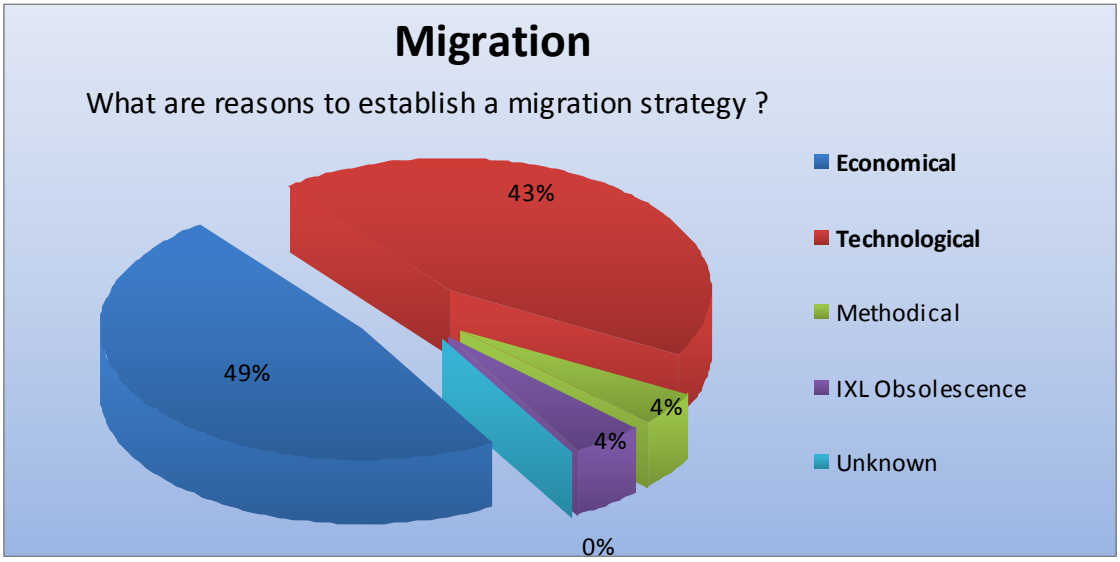


Figure 2: What are the reasons to establish a migration strategy

Table 8 and Figure 3 show that the majority of railways prefer to perform line wise migration, with three partners preferring network wise migration.

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Line wise	X	X	X	X				X	X	X		X	X	9
Network wise			X					X					X	3
Other…						X	X		X		X			4

Table 8: Preferred migration strategies

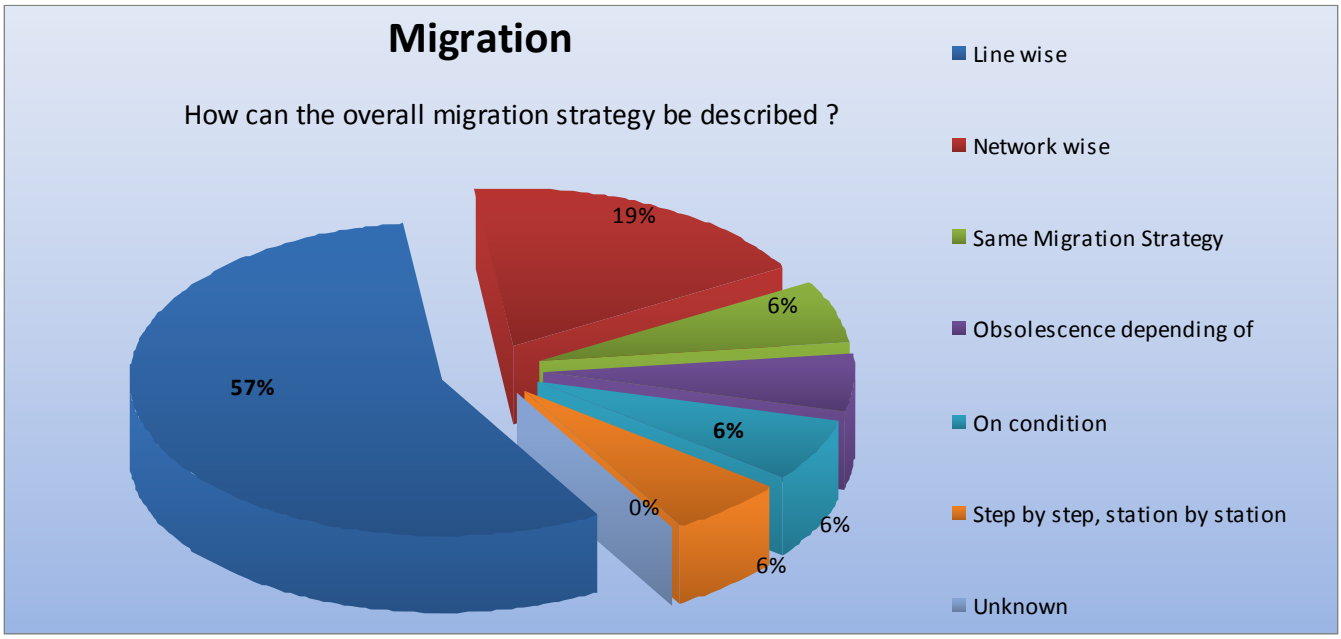


Figure 3: How can the overall migration strategy be described?

Although some partners refer to political reasons, in most cases economic considerations lead to the decision for the chosen migration strategy, as illustrated in Table 9 and Figure 4. In the three cases where partners elaborated on their decision making, the age of the existing interlockings was an important factor. Another explanation was that in Sweden all major renewals must – by law – be ERTMS compliant.

	1	2	3	4	5	6	7	8	9	10	11	12	Total
Economic		X	X			X	X	X	X	X	X	X	9
Technological	X	X	X	X			X	X	X	X	X	X	10
Methodical		X											1
Other…	X				X								2

Table 9: Reasons for decision of a strategy

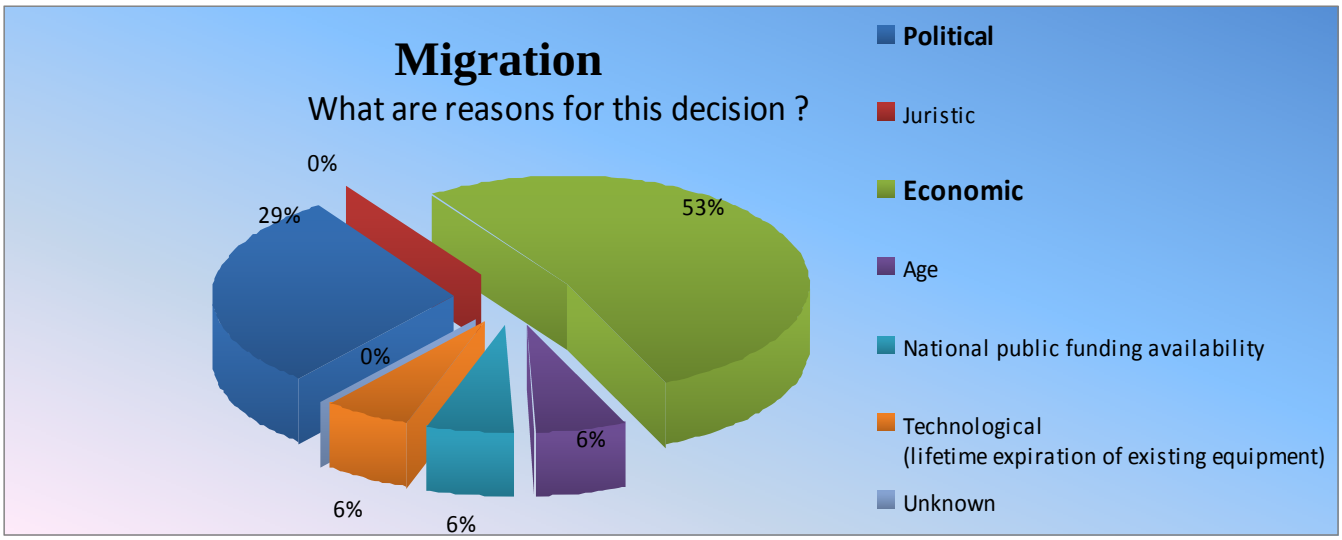
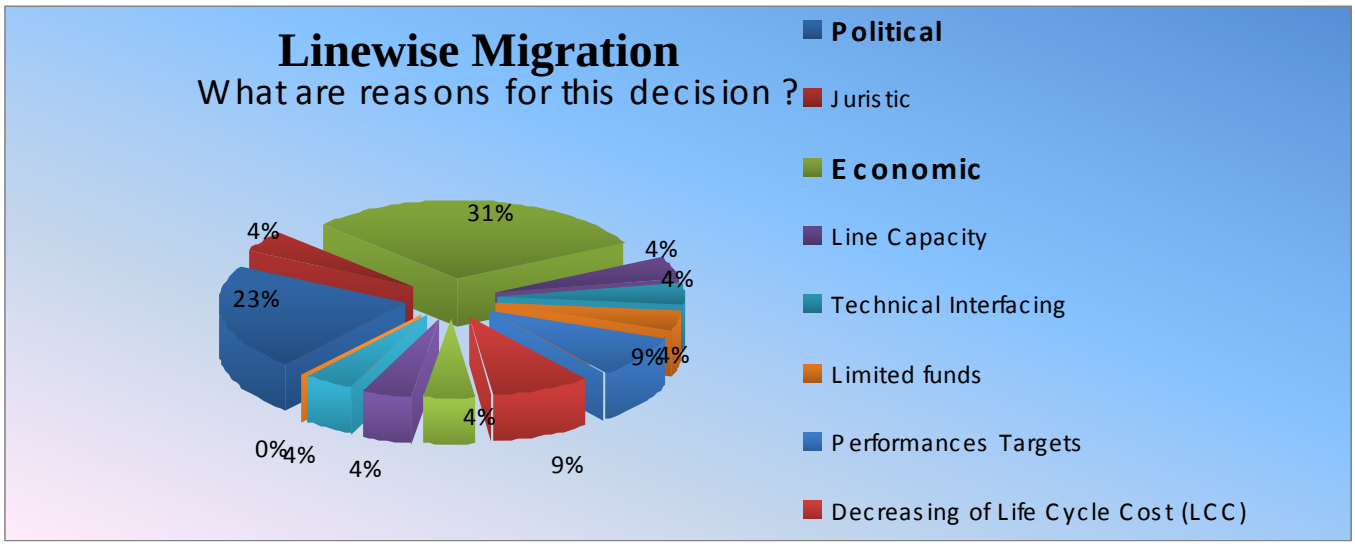


Figure 4: What are the reasons for the chosen migration strategy?



3.2.2 Line Wise Migration

In line wise migration, there was a trend toward a migration priority for each line (see Figure 10 and Figure 5) with the two key reasons being Political or Economic (see Figure 6). However, one railway gives higher priority to the migration of the ERTMS corridors and lines with international traffic. Therefore not every of their lines is part of the national migration plan, and the broad based questions contained in the questionnaire may therefore mask some of the complexities of partners' migration strategies.

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
yes	X	X	X	X		X		X	X	X			X	9
no							X					X		2

Table 10: Is there a migration priority for each line?

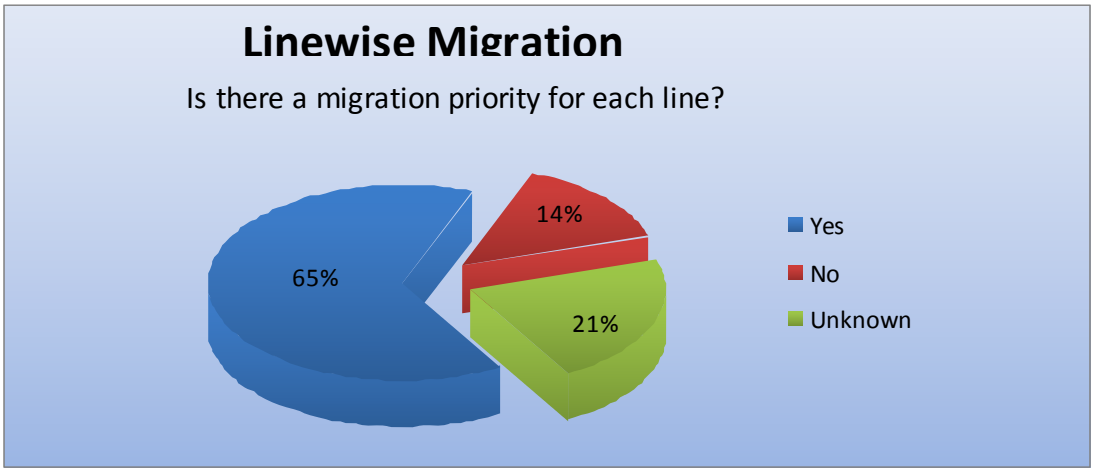


Figure 5: Is there a migration priority for each line?

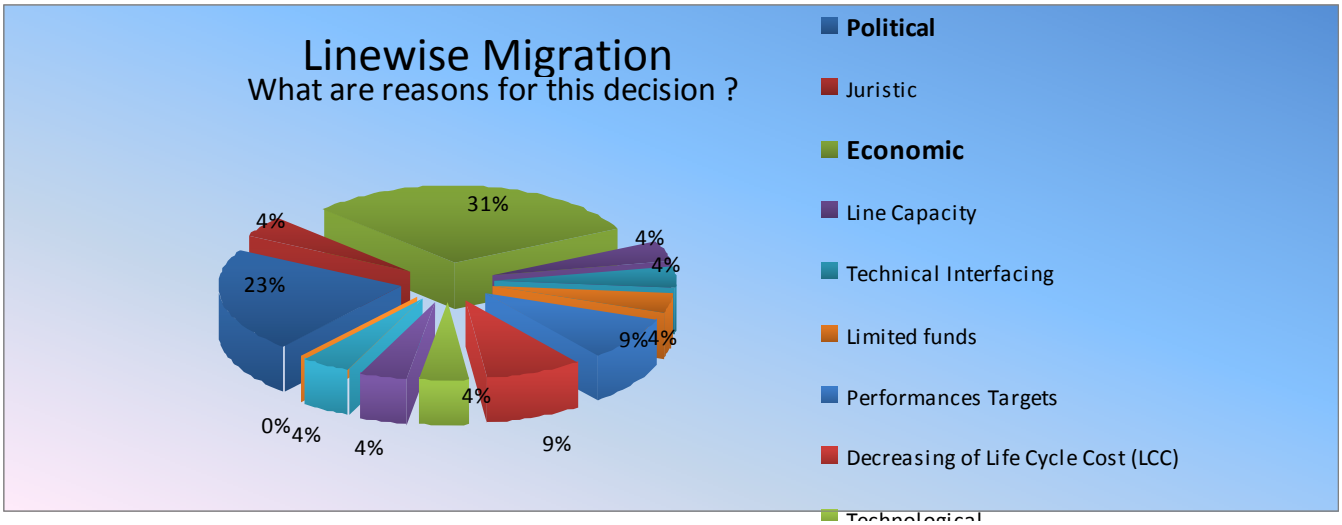


Figure 6: Reasons for migration priority for each line

Within the line wise migration strategies, the majority of partners plan a step by step migration of equipment on the existing tracks, as shown in Table 11 and Figure 7. This is based upon technological and economic reasons (see Figure 8) with partners citing the need for minimal interruption of rail traffic. Furthermore, a step by step migration allows optimisation according to the age of the installed systems, meaning that the renewals can prioritise on the oldest systems. Sometimes the installation and testing is done step by step, but the commissioning is done for the whole line at once.

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
At once	X								X	X				3
Step by step	X	X	X	X			X		X			X	X	8
Other…						X		X				X		3

Table 11: Order of trackside migration

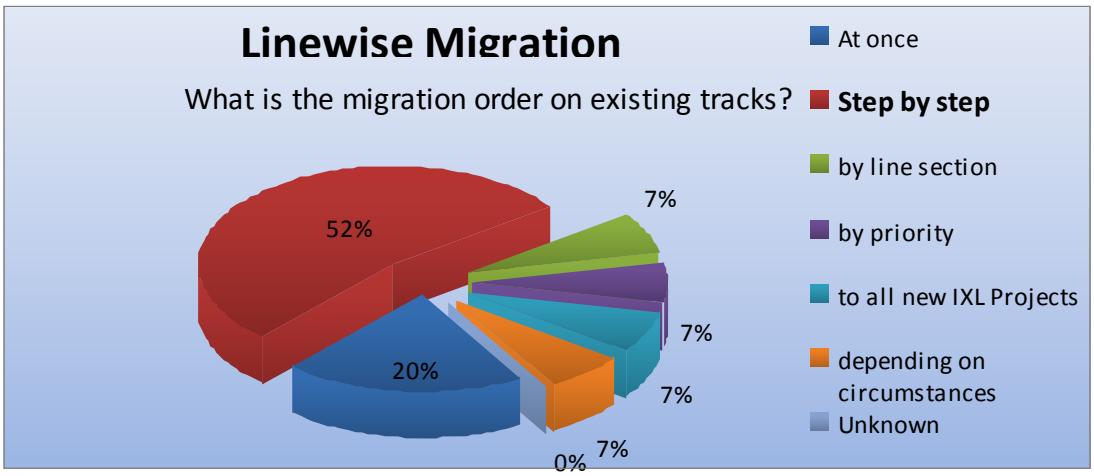


Figure 7: What is the migration order on existing tracks?

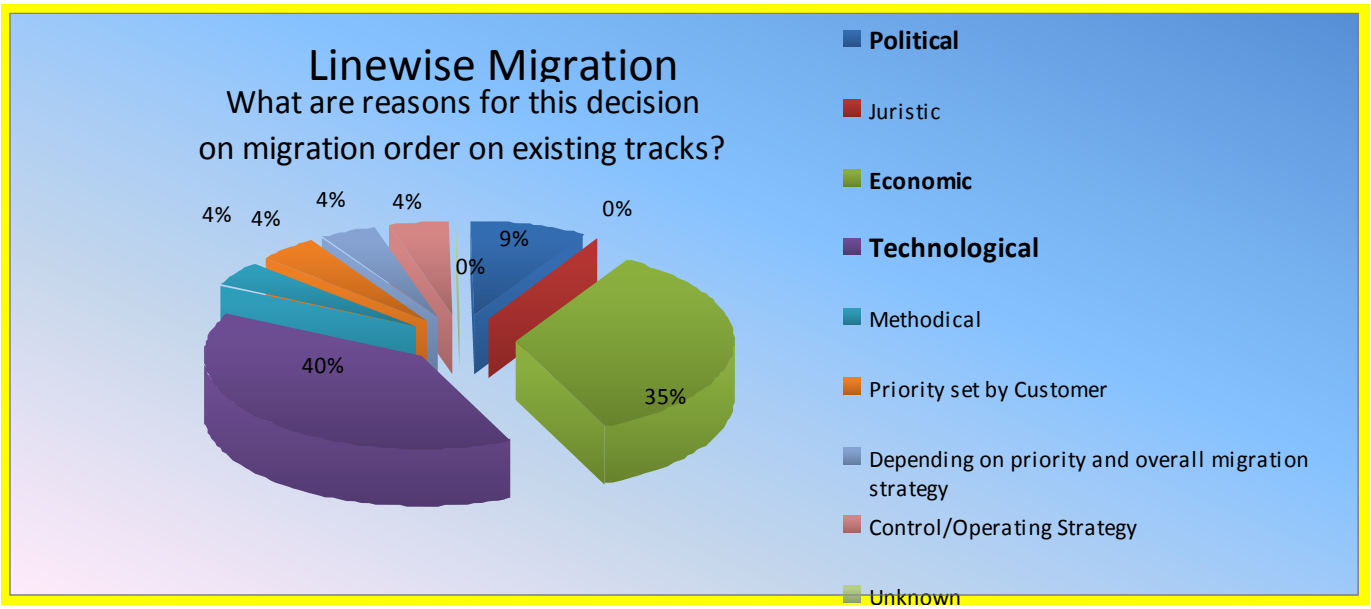


Figure 8: The reasons for the decision on migration order of existing tracks

3.2.3 Step Wise Migration

Within the step wise migration strategies, the results of the questionnaire indicate that, in general, there is a migration plan for step wise migration of the railways, as shown in Table 12 and Figure 9.

	1	2	3	4	5	6	7	8	9	10	11	Total
yes	X	X	X	X	X	X				X		7
no							X	X	X		X	4

Table 12: Is there given a priority for each single step?

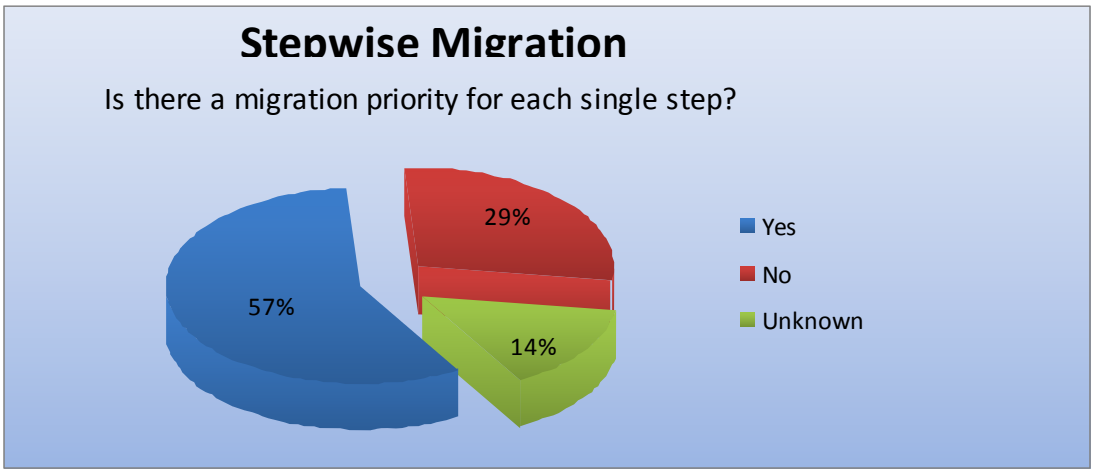


Figure 9: Is there a migration priority for each single step?

The reason for this is often that the existing interlockings are not ERTMS compliant. Therefore the renewal of the interlocking can be a determining factor in the migration path towards ETCS.

As shown in Table 13 and Figure 10, the priority of step wise migration is often part of economic or technological decisions. One railway also stated that the main reasons for the priority are “dependencies from other works in the line (e.g. installation of telecomunications, power, etc)”.

	1	2	3	4	5	6	7	8	9	10	Total
Political						X				X	2
Economic			X	X		X	X		X	X	6
Technological	X	X	X	X			X	X			6
Methodical	X	X		X							3
Other…					X						1

Table 13: What are the reasons for this priority decision?

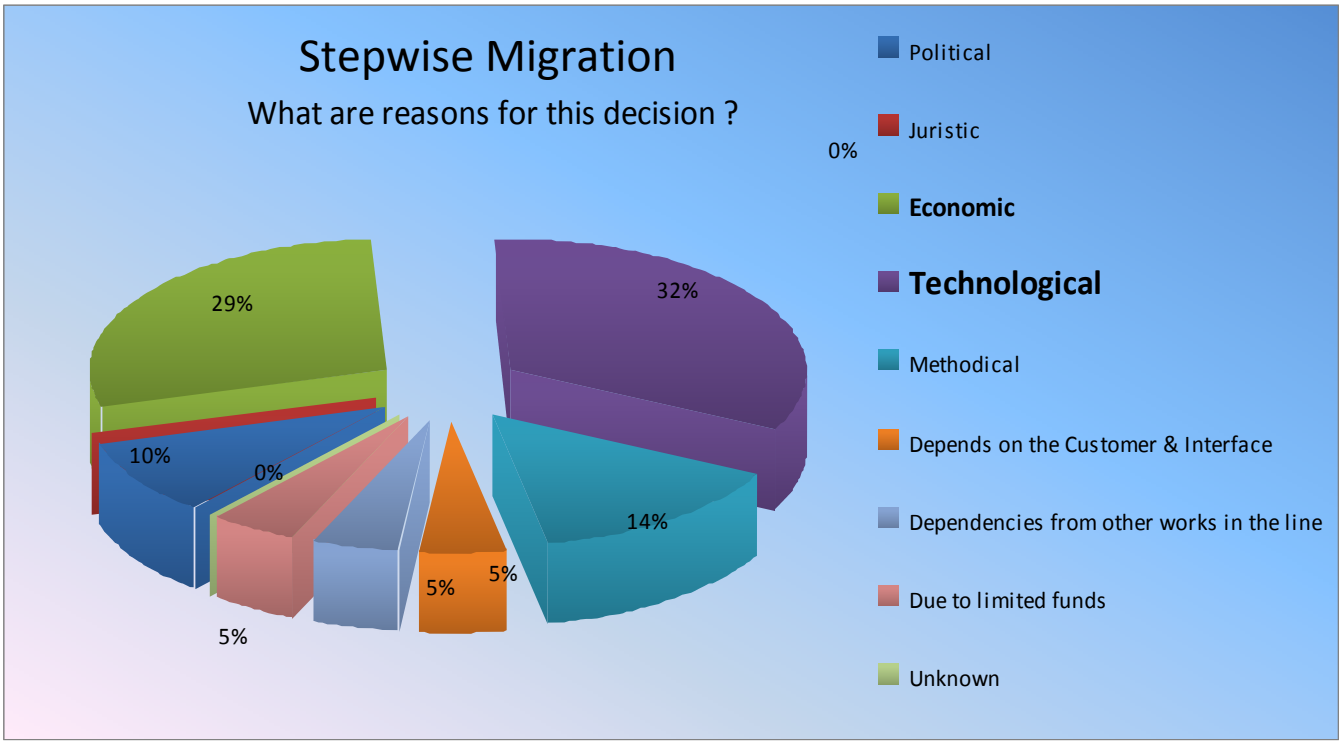


Figure 10: The reasons for the stepwise migration

Different strategies are used to install equipment on a line. Depending on the density of traffic on the line ("Importance"), infrastructure managers decide if traffic can be interrupted (i.e. replaced by busses), or if train operation has to be maintained (see Table 14 and Figure 11).

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
while maintaining train operat	X					X	X	X		X	X	X	X	8
without any train operation			X				X		X	X	X			5

Table 14: How is the equipment installed on existing lines?

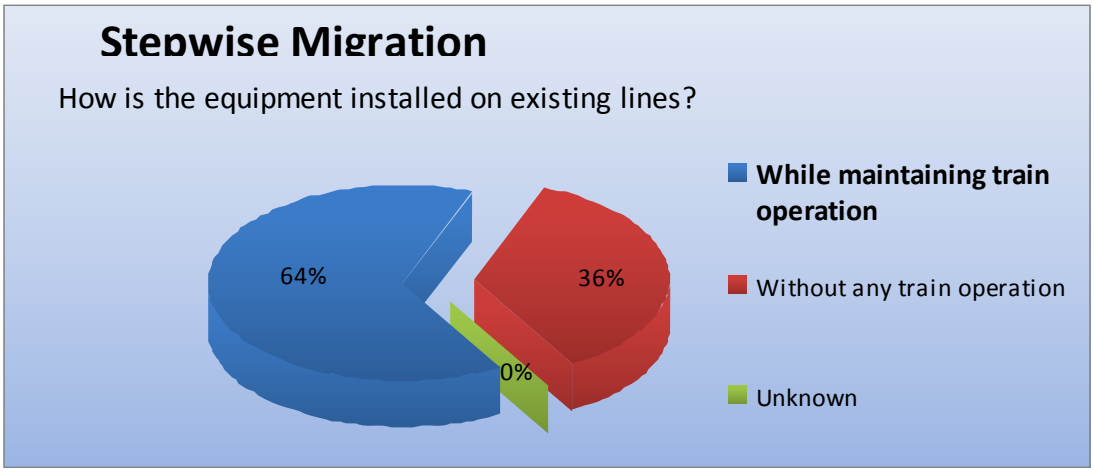


Figure 11: How is the equipment installed on existing lines?

Asked about the circumstances which have to be given for a migration, implementation or installation under "rolling wheel", the following statements were given:

> "The highest possible level of operability has to be maintained. Of course there will be a decrease in the overall customer satisfaction, but this will be less damaging than in the case of "total closure of the service" migration strategy."

> "If no one needs to enter the track and if an approved fallback service is established"

> "Both systems (existing and new) are monitoring the wayside objects at the same time. Control of the wayside objects is switched manually between the old and the new system for test purposes. When the new system is actively controlling the wayside objects, only test vehicles are allowed in the track section under test. The existing level crossings need to be manned under the testing periods. ETCS balises are deactivated when normal traffic is rolling."

> "The equipment is installed usually while maintaining train operation to avoid a replacement by bus operation."

> "Continue to maintain both systems, after commissioning, a total switch to new"

"Train must drive!"

"Parallel installation, pre approval of CAE Data, short switch breaks, Ability to switch back in case of problems"

"The highest possible level of operability has to be maintained. Of course no "overall stop of the service" migration strategy is applied"

These responses, summarised in Figure 12, show that the reasons are fairly eclectic and there is little consensus.

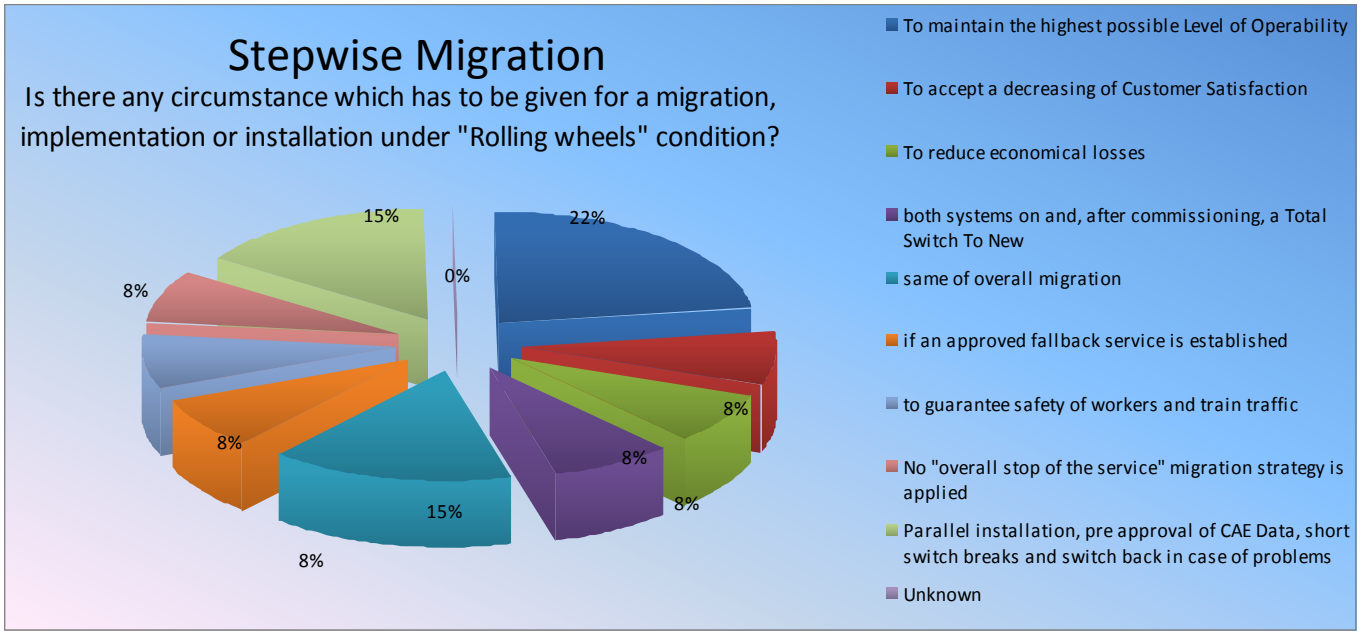


Figure 12: Special circumstances for "Rolling Wheels" condition

It seems that in most cases existing rules and regulations can be used also for ERTMS migration, as shown in Table 15 and Figure 13.

	1	2	3	4	5	6	7	8	Total
yes					1		1		
no	1	1	1	1		1		1	

Table 15: Are there special rules?

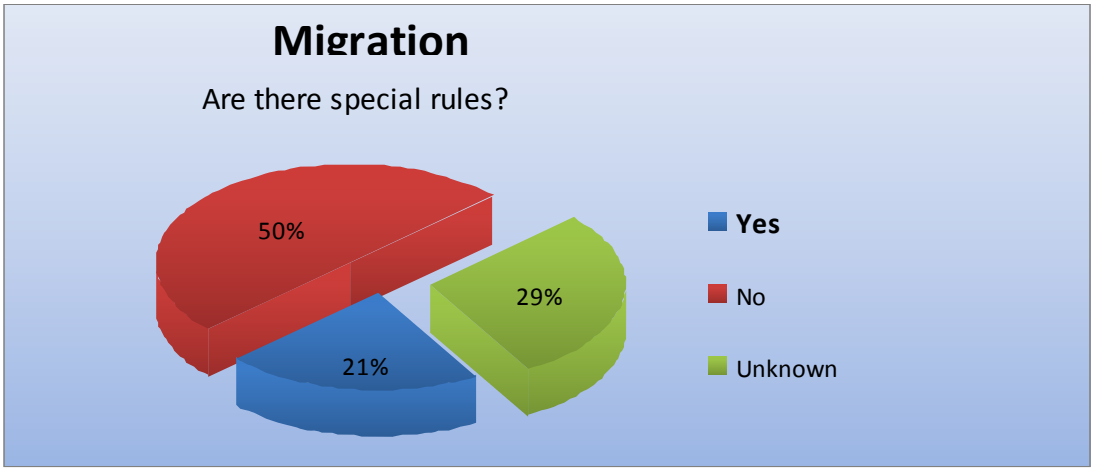


Figure 13: Are there special rules?

Other factors that have an influence on the migration strategy are:

- The supplier of adjacent or actual interlocking
- Type of interface & volume of change & time to test
- To enable the replacement of separate IXL independent of the existing product (IXL supplier)
- Signals technology update / line signalling improvements
- Aligning with other upgrades (e.g. track upgrades and electrification)
- Ability of compatibility has to be designed and shown offline / renewed or new subsystems must have the ability to replace legacy components
- Signal technology update

3.2.4 Comments on the impact and experience of the strategies

The experiences gained so far are (apologies for the poor language):

> “Each migration has to be planed new each migration plan keeps 40 % time space for special services”
>
> “The switch over mechanism (between the old and new system) has been used before by the contractor with very positive experience.”
>
> “Looking to overlay as much as possible and test as much as possible off site to avoid long periods without trains running”
>
> “Ability to replace legacy components decelerates innovation”

Section 4 – CONCLUSIONS

4.1 Conclusions on Fallback

Currently, almost all the suppliers / vendors use fallback systems. The biggest motivations for using them are to maintain the operation of the line and signalling system and to ensure safety.

ERTMS signalling system has helped to harmonise the fallback systems used. Not only at a technical level but also at an operational level (eg running in SR mode when Full Supervision is not possible).

The way forward in a European IXL definition would be to define the different fallback levels in the specification following the path already opened by ERTMS.

Detailed fallback issues are described in section 3.1.

4.2 Conclusions on Migration

There is at least one migration strategy for each railway and sometimes more than one. The drivers for the strategies are primarily Economic and Technical.

Line wise migration is usually the preferred approach to migration but some railways are adopting a step wise approach. The drivers for these decisions are primarily economic and secondarily political.