Implementation Plan of

ERTMS

in Hungary

2007. september

Preamble

The rehabilitation of the Hungarian railway network and the implementation of some conditions facilitating an increased speed on certain lines was launched in the 90's. The objective of this rehabilitation is to create a competitive railway infrastructure. Competitiveness in this case means permeable, highly reliable and efficient infrastructure that can provide services to help railway undertakings gain more market share. Simultaneous with the domestic developments great efforts were also made at European level in the field of technical and regulatory harmonization supporting the increased competitiveness of the railway sector. ERTMS (European Rail Traffic Management System) can fulfil the competitiveness conditions of the railway sector simultaneously.

The development projects of the two sub-systems under the ERTMS system, i.e. ETCS (European Train Control System) and GSM-R (**G**lobal **S**ystem **M**obile devoted to **R**ailways*)* have been concluded and installation has been launched at each European railway company. This possibility created the condition of introducing the most state-of-the-art technology in all rehabilitation works.

The installation of the ERTMS system will be a real advantage for the railway undertakings if connected lines and network sections can as soon as possible be built with the new system within the European and domestic railway network. The efficiency of introducing the new system depends on a lot of factors. The selection of the suitable-level system and lines and the definition of the introduction-related tasks represent a fairly complex assignment. Domestic and European advantages will need to predominate simultaneously during the implementation phase.

The **National Implementation Plan** concerning the domestic introduction of the ERTMS system has been drafted. This summary of the Plan is, in pursuance of the relevant EU directive, submitted to the Commission of the European Union as an element to the European Introduction Strategy.

The National Implementation Plan covers the following major chapters:

1) System Selection
2) Target lines
3) Technical Requirements
4) Deployment Strategy and Planning
5) Migration Strategy
6) Potential constrains

1. System Selection

The selection of the system was preceded by the analysis of five scenarios, namely:

Scenario 1

Renewal of the currently operating systems and additionally – to ensure interoperability – installation of the ETCS level 1 during the rehabilitation works.

The telecommunication systems will be partially rehabilitated parallel therewith.

Scenario 2

Renewal of the currently operating systems and additionally – to ensure interoperability – installation of the ETCS level 1 during the rehabilitation works.

Building the GSM-R system for interoperable communication.

Scenario 3

Renewal of the currently operating systems and additionally – to ensure interoperability – installation of the ETCS level 1 during the rehabilitation works.

Building the GSM-R system for interoperable communication and continuous infill.

Scenario 4

Renewal of the currently operating systems and additionally – to ensure interoperability – installation of the ETCS level 2 and the GSM-R system during the rehabilitation works.

Scenario 5

Temporary reservation of the operational capacity of the existing lineside equipments and train control systems with advanced level maintenance and installation of the ETCS level 2 in the corridors undergoing rehabilitation, as well as building the GSM-R system.

The renewal of the various equipments currently in use but getting redundant through the introduction of ETCS can only be avoided in Scenario 5.

The parallel operation of the two systems generates fitting problems and unnecessary chances of error.

Consequent upon the above Hungary has decided to introduce the ETCS level 2 and the GSM-R system.

2. Target lines

In terms of line selection the lines were grouped according to the following, considering a number of criteria:

1.) TEN-T priority projects, their alternatives and the ERTMS corridors
2.) Other Pan-European corridors
3.) Other main lines
4.) Suburban and connected lines
5.) Other lines

The lines of the planned network are shown in Annex 1. The ETCS map in Annex 2 also indicates the schedules. The planned GSM-R network is detailed in Annex 3.

Domestic railway undertakings should be able to use their vehicles equipped with ETCS level 2 and GSM-R in a highly efficient manner, which is another essential criterion in selecting the lines, in addition to the European priorities and the joint letters of intent signed with regard to the ERTMS corridors. There are plans to introduce the so-called low-cost solution in some branch lines where the vehicles used are identical with those running on the main line but where, due to scarce traffic, it is not reasonable to use traditional train control equipment related to either the elements of trackside or to the on-board unit.

Along with the lines the option of equipping the vehicles was also examined. The age of the determinative domestic traction vehicle fleet and the speed limit of these vehicles do not facilitate the utilization of any advantages stemming from an increase in track speed or the enhancement of competitiveness, so the railway undertakings will be compelled to change their vehicle fleet in a short term. The vehicles will have to be replaced and/or supplied with ETCS level 2 equipment according to the development schedules of the individual lines.

3. Technical Requirements

ERTMS is directly related to the railway interlocking (most of the information to be processed comes from them) and the traction vehicles (specifications of the brake system, potential location). The connection points and the information received from the existing systems and equipment must not decrease the security level of the uniform system, therefore the technical solutions, connection surfaces and information packages developed should meet all these requirements. The relatively poor parameters of the existing equipment must not worsen the reliability and operational capacity of the uniform system, which is an essential criterion.

Concluding from the above the ETCS system can be connected to the following interlocking types:

- new and existing electronic interlocking,
- D70, D70V type interlocking
- D55 type interlocking (less than 30 years old), for centralized installation.

The new electronic interlocking will ab ovo have to be developed so that they have a (possibly serial and uniform) interface able to decode the information required by the ETCS system. Individual connection will have to be implemented with the few already existing electronic interlockings.

The existing relay interlocking need to be complemented so as to decode (interface) the information required by the ETCS system. This should expediently be a parallel interface implemented in the frame of ETCS development in the most possible uniform manner.

The out-of-date safety mechanisms excluded from the list are practically inadequate to cooperate with the ETCS system. The equipment that do not satisfy the conditions must be replaced before installing the ETCS system, therefore **the existing equipment will also have to be substituted while introducing the ERTMS system elements**, particularly installing **long-range electronic interlocking** nowadays applied in whole Europe.

Consequent advantages:

- The system developed will be based on a uniform technology and thus facilitate reliable interfaces of the various systems as concerns availability. (When the first electronic interlockings were installed, most of the problems arose from connection to the existing relay system.)

- The interlocking and the ERTMS sub-system can be efficiently interfaced as regards safety. For class A (new, interoperable) systems the permissible value of equipment deficiencies possibly leading to accident reaches the magnitude of 10^{-9}. Still the system can only be required to keep within this value if the reliability of the input information is of a fairly high level for calculations (SIL 4; **S**afety **I**ntegrity **L**evel 1 to 4, where 1 is the lowest and 4 is the highest level). Such an interface with this safety level is a „basic service” in all modern electronic interlockings, while an equal level interface needs to be developed and certified for security for the traditional equipments. This will have to be developed for all types of equipment that cannot or need not be replaced.

- Long-range interlocking can be specifically installed cheaper and remote control of the relatively small stations is easy to solve. This, beyond **savings in headcount**, also facilitates more flexible traffic control and the basic technical network supporting connection to the third component of ERTMS, i.e. ETML (European Traffic Management Layer) is also generated.

- In specific cases long-range interlocking can supply real-time information of a whole line section to other sub-systems. This contributes to state-of-the-art compliance with

the requirements of TAF (**T**elematic **A**pplications for **F**reight services) or TAP (**T**elematic **A**pplication for **P**assenger services) info communication sub-systems and the relevant TSI's.

The ETCS level 2 on-board unit supports the best utilization of the vehicles. The new vehicles may have to be equipped with the so-called STM (**S**pecific **T**ransmission **M**odule) for the transitional period. This module allows the class A on-board unit to communicate with the class B (old, non-interoperable) track-side system as well in the transitional period.

4. Deployment Strategy and Planning

The correct determination of the **deployment strategy** is of fundamental importance for economic and technical efficiency. The „characteristics" of the ERTMS system and the quasi trivial international experience showing that the economic and technical efficiency of parallel systems is the worst should be considered consistently.

The basis of the planning and deployment strategy is that the principle of cost efficiency must proceed in the medium term. This means that the new system should be introduced in a possibly short time and efficient manner. In this case efficiency means that such continuous lines of uniform strength should be realized where **developments in infrastructure harmonize with each other and also with vehicle developments, consequently** fixed assets can be exploited promptly. On the lines where one of the elements of ERTMS, ETCS has already been installed at a certain level or is in process, the strategy should take a direction to the next step. It has to be identified the actions to be taken to reach a homogeneous system in long term at network level. The traction vehicle fleet must also be modernized parallel with infrastructure developments.

In order to promote **future developments**, **conclusions need to be drawn** from the previous projects.

The need to install expensive temporary interlockings can be avoided if in the phase of station reconstructions the **installation of interlocking represents the first step in line rehabilitation** and all track works are initiated with consideration to the time need of interlocking installation. The individual **track building phases** are easy **to follow** with modern electronic interlocking. The method is applied in several railway companies in Europe and only damage to the outdoor parts and cables of the new interlocking entails risk of danger which can however be avoided with orderly work.

Further costs can be cut if the new **interlocking** is built to cover a **large zone** and not by stations. The central control unit of the equipment could practically be built in the biggest station and only the control interfaces of the outdoor elements have to be built in the neighbouring smaller stations. It needs to be emphasized that a state-of-the-art interlocking can nowadays be ordered with an ERTMS interface which increases total integrity and simplifies the costly safety certification procedure.

In case of line-specific interlocking (blocks) the final conditions have to be created after reconstruction. The renewal and relocation of traditional trackside equipments implicates an expensive solution. All block signals remain in their original places in the transitional period. The „virtual" blocks required with regard to the new ETCS level 2 system can be created along with line renewal.

This method **reduces** the **building costs** of the infrastructure and the final performance of line can be reached in a shorter time.

It is easy to understand that the ERTMS system can be really efficient if it is available in a connected structure, possibly on a whole line or on a part of network. The modern vehicle fleet of the railway undertakings can also be utilized the best in this way..

International analyses and examples prove that the introduction of class A systems has a capacity increasing effect, just as any increase in track velocity. This possibility can be exploited in two ways. On lines where capacity shortage would evolve, this problem can be discontinued with increasing speed and with the application of class A systems. On lines with idle capacities today the above modernizations can lead to decreasing the number of some infrastructure elements (station tracks, blocks) and thus the investment and operating costs.

The following criteria must be considered when structuring the projects: the elements of the ERTMS system, i.e. ETCS level 2 and GSM-R are coherent in terms of system technology. Of the existing infrastructure elements the interlocking is the closest to ERTMS as concerns system technology, because it transfers the information to the ETCS system. Consequently these elements must definitely be connected in the project plans. The ERTMS systems can be regarded standard so the market can select the supplier. For operating reasons the interlocking are not recommended to be of different types station by station. It is therefore reasonable to initiate a project covering the interlocking and the installation of the ERTMS system elements.

For strategic considerations the accelerated introduction of the ERTMS technology follows these steps in sequence:

1. GSM-R reference
2. ETCS level 2 reference
3. GSM-R primary
4. GSM-R suburban
5. ETCS level 2 primary
6. GSM-R other
7. ETCS level 2 other

The planning and deployment strategy must reckon with the developments and contracts already in progress and in preparation.

ERTMS installation has already been started in the 90's in the Hungarian sections of the priority projects. The previous projects have all been essentially planned with regard to the ETCS level 1.

Transition to the ETCS level 2 will be managed according to the following scenario:

- putting the ETCS level 1 equipment that have already been installed in the Hegyeshalom-Budapest section into operation
- introducing the GSM-R in the primary network
- developing the other conditions of the ETCS level 2
- installing the ETCS level 2 system.

As concerns the project itself the onboard unit installed in the domestic locomotives is likewise acceptable as a temporary solution.

a) GSM-R Reference Section on the Slovakian border - Szob - Budapest 'Nyugati' railway station – Cegléd - Szolnok section, which allows all current operating processes to be transferred to the GSM-R.
b) ETCS L2 Reference Section on the Budapest 'Nyugati' railway station - Cegléd – Szolnok section to the above GSM-R pilot run. Using this system we will gain

experience not only on a Hungarian corridor of key importance but also on the Budapest 'Nyugati' railway station – Szolnok complex suburban line where international and strong suburban traffic is running on two railway tracks.

c) GSM-R installation on total (approx. 2710 km) primary network consisting of the TEN corridors and the main lines of national network.
d) GSM-R installation on the suburban lines of Budapest. The primary lines already cover most of them but additional approx. 130 km have to be covered, e.g. the heavy traffic single track lines to Esztergom, Lajosmizse and Vácrátót.
e) GSM-R installation on the secondary network, on approx. 220 km total length.
f) ETCS L2 installation on the other lines of the primary and secondary railway network.

The lines described in points a)-e) are planned to be equipped with a ERTMS sub-system between 2007 and 2013.

Equipping the lines selected but not listed above with ERTMS will be scheduled so that continuous sections could be created in a specific line or a region as soon as possible, since this is how railway undertakings can use their vehicles equipped with ERTMS the most efficiently. The class B systems should be removed as soon as possible, which is yet another objective.

5. Migration Strategy

Installations, whether already concluded or in progress, also influence the migration strategy. The most important task in this regard is to regulate the cooperation and side-by-side operation of the two systems (A&B). The fundamental aim is to avoid unnecessary transformations and minimize the parallel operation of the two systems. The renewal of the traction vehicle fleet (renewal of the existing vehicles and acquisition of new ones) and its equipment with system A is a priority element of the migration strategy.

The undertakings will be compelled to operate the currently active analogue line radio system and the GSM-R system parallel within a limited time frame – similar to as described for ETCS –, for the sake of safe course of railway operations. This situation will require that a limited number of locomotives be equipped with dual operation on-board radio if and as much as economic considerations call for such. The other pirority migration task is to assign the sections subject to supervision to the traffic and insfrastructure dispatchers.

Another key task in the migration phase is to assess the extent to which the current railway operating practices and procedures can be applied in the reference section supplied with GSM-R and the ETCS level 2 during the pilot run. One of the most important obligations will be to elaborate the changes of these procedures if and as much as required, and to make certain of the feasibility of these changes during the pilot run.

6. Potential constraints

The observable risk factors are as follows:

- Domestic railway undertakings do not seem to be interested
- Unreasonable development plans
- Extended duration of permission and safety certification procedures accompanying development projects

All interested parties should understand the strategy and the importance of change, the potential advantages of the individual parties and, when necessary, the rules and regulations should be modified in order to reduce all risks.

Annex 1

Name of the line	Length (km)	Type of the line	Planned level of ERTMS	Planned period	Note
Rajka(border)-Hegyeshalom	14	TEN-T ERTMS E	ETCS1/ETCS2 GSM-R	2007-2013	ETCS 1/ETCS 2 subject to transformation works of the Hegyeshalom line and works in Slovakia
Szolnok -Szajol	10	TEN-T PP22 alternative of TEN-T PP6	ETCS 2 GSM-R	2007-2013	
Szajol-Lökösháza(border)	125	TEN-T PP22	ETCS 2 GSM-R	2007-2013	
Bajánsenye(border)-Boba	102	TEN-T PP6 ERTMS D	ETCS 2 GSM-R	2007-2013	ETCS 1 is installed between Bajánsenye-Zalalövő. (System B was not installed.) Conversion to ETCS 2 on the whole length of the line.
Székesfehérvár-Budapest	67	TEN-T PP6 ERTMS D	ETCS 2 GSM-R	2007-2013	
Boba-Celldömölk-Győr	82	TEN-T PP6 alternative of ERTMS D	ETCS 2 GSM-R	2007-2013	
Budapest-Cegléd-Szolnok	100	TEN PP22 alternative of TEN-T PP6	ETCS 2 GSM-R	2007-2013	
Szajol-Püspökladány	67	alternative of TEN-T PP6	ETCS 2 GSM-R	2007-2013	
Püspökladány-Debrecen	44	alternative of TEN-T PP6	ETCS 2 GSM-R	2007-2013	
Pusztaszabolcs-Budapest	53	TEN-T Pan-European V/B/C	ETCS 2 GSM-R	2007-2013	
Szombathely-Szentgotthárd(border)	53	TEN-T	ETCS 2 GSM-R	2007-2013	
Sopron-Szombathely	62	TEN-T	ETCS 2 GSM-R	2007-2013	
Total length between 2007-2013	**779**				

Name of the line	Length (km)	Type of the line	Planned level of ERTMS	Planned period	Note
Hegyeshalom(border)-Hegyeshalom-Komárom-Budapest	178	TEN-T PP22, ERTMS E between Győr-Budapest: alternative of ERTMS D	ETCS 1 GSM-R	2013-2020 2007-2013	Gradual conversion to ETCS 2, subject to the installation of GSM-R and track works
Komárom(border)-Komárom		TEN-T ERTMS E	ETCS1/ETCS2 GSM-R	2013-2020 2007-2013	ETCS 1/ETCS 2 subject to transformation works of the Hegyeshalom line and works in Slovakia
Szob(border)-Budapest	64	TEN-T ERTMS E	ETCS 2 GSM-R	2013-2020 2007-2013	
Budapest-Újszász-Szolnok	100	TEN-T PP6 alternative of TEN-T PP22	ETCS 2 GSM-R	2013-2020 2007-2013	
Boba-Székesfehérvár	114	TEN-T PP6 ERTMS D	ETCS 2 GSM-R	2013-2020 2007-2013	Expensive increasing of speed on hilly sections
Budapest-Miskolc-Nyíregyháza	270	TEN-T PP6	ETCS 2 GSM-R	2013-2020 2007-2013	Expensive increasing of speed on hilly sections
Nyíregyháza-Záhony(border)	84	TEN-T PP6	ETCS 2 GSM-R	2013-2020 2007-2013	
Debrecen-Nyíregyháza	49	alternative of TEN-T PP6	ETCS 2 GSM-R	2013-2020 2007-2013	
Gyékényes(border)-Dombóvár	101	TEN-T Pan-European V/B	ETCS 2 GSM-R	2013-2020 2007-2013	
Dombóvár-Pusztaszabolcs	111	TEN-T Pan-European V/B/C	ETCS 2 GSM-R	2013-2020 2007-2013	
Magyarbóly(border)-Pécs-Dombóvár	107	TEN-T Pan-European V/C	ETCS 2 GSM-R	2013-2020 2007-2013	
Budapest-Kelebia(border)	163	TEN-T Pan-European X/B	ETCS 2 GSM-R	2013-2020 2007-2013	
Győr-Sopron(border)	92	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Zalaszentiván-Nagykanizsa	53	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Nagykanizsa-Murakeresztúr(border)	14	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Püspökladány-Biharkeresztes(border)	53	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Cegléd-Szeged-Szeged rendező-Röszke(border)	132	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Székesfehérvár-Pusztaszabolcs	30	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Murakeresztúr-Gyékényes	15	TEN-T	ETCS 2 GSM-R	2013-2020 2007-2013	
Total length between 2013-2020	**1730**				

Name of the line	Length (km)	Type of the line	Planned level of ERTMS	Planned period	Note
Szombathely-Celldömölk	45	TEN-T	ETCS 2 GSM-R	after 2020 2007-2013	
Nagykanizsa-Székesfehérvár	154	TEN-T	ETCS 2 GSM-R	after 2020 2007-2013	Due to the built-up character of the southern coast of Lake Balaton no significant speed increase can be planned
Csorna-Porpác	55	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Szombathely-Zalaszentiván	49	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Ukk-Tapolca	28	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Szabadbattyán-Tapolca-Keszthely	132	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Keszthely-Balatonszentgyörgy	10	Other main line	ETCS 2 GSM-R	after 2020 2007-2013	
Tatabánya-Oroszlány	15	Other main line	Low cost GSM-R	after 2020 2007-2013	
Hatvan-Újszász	52	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Vámosgyörk-Gyöngyös	13	Other main line	Low cost GSM-R	after 2020 after 2013	
Füzesabony-Eger	17	Other main line	Low cost GSM-R	after 2020 2007-2013	
Felsőzsolca-Hidasnémeti(border)	57	TEN-T	ETCS 2 GSM-R	after 2020 2007-2013	To be harmonized with the construction of the Slovakian connection
Mezőzombor-Sátoraljaújhely	41	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Apafa-Mátészalka	70	Other main line	ETCS 2 GSM-R	after 2020 after 2013	
Pusztaszabolcs-Adony	9	TEN-T	Low cost GSM-R	after 2020 2007-2013	
Adony-Dunaújváros	18	Other main line	Low cost GSM-R	after 2020 after 2013	
Pusztaszabolcs-Cegléd		Planned TEN-T	ETCS 2 GSM-R	after 2020	Provide for interoperability of the future long-distance traffic line - planned to bypass Budapest - as early as construction starts.
Komárom-Székesfehérvár	82	Other main line	ETCS 2 GSM-R	after 2020 after 2013	Only in case construction works of Pusztaszabolcs-Cegléd were executed
ETCS total length after 2020	**802**				

Name of the line	Length (km)	Type of the line	Planned level of ERTMS	Planned period	Note
Links of corridors at Budapest	50		GSM-R	2007-2013	
Budapest-Esztergom	53	Other main line	GSM-R	2007-2013	
Budapest-Vácrátót-Vác	41	Other main line	GSM-R	2007-2013	
Galgamácsa-Vácrátót	25	Other main line	GSM-R	2007-2013	
Budapest-Lajosmizse-Kecskemét	73	Other main line	GSM-R	2007-2013	
Kiskunhalas-Kiskunfélegyháza	46	Other main line	GSM-R	after 2013	
Hatvan-somoskőújfalu(border)	65	Other main line	GSM-R	after 2013	
Debrecen-Nyírábrány(border)	30	Other main line	GSM-R	after 2013	
ETCS total	**3311**				
GSM-R 2007-2013	**3064**				
GSM-R total	**3694**				

Abbreviations:

ERTMS: European Rail Traffic Management System

ETCS: European Train Control System

GSM-R: Global System Mobile devoted to Railways

TEN-T: Trans European Network-Transport

TEN-T PP6 or PP22: One of the 30 priority projects of TEN-T

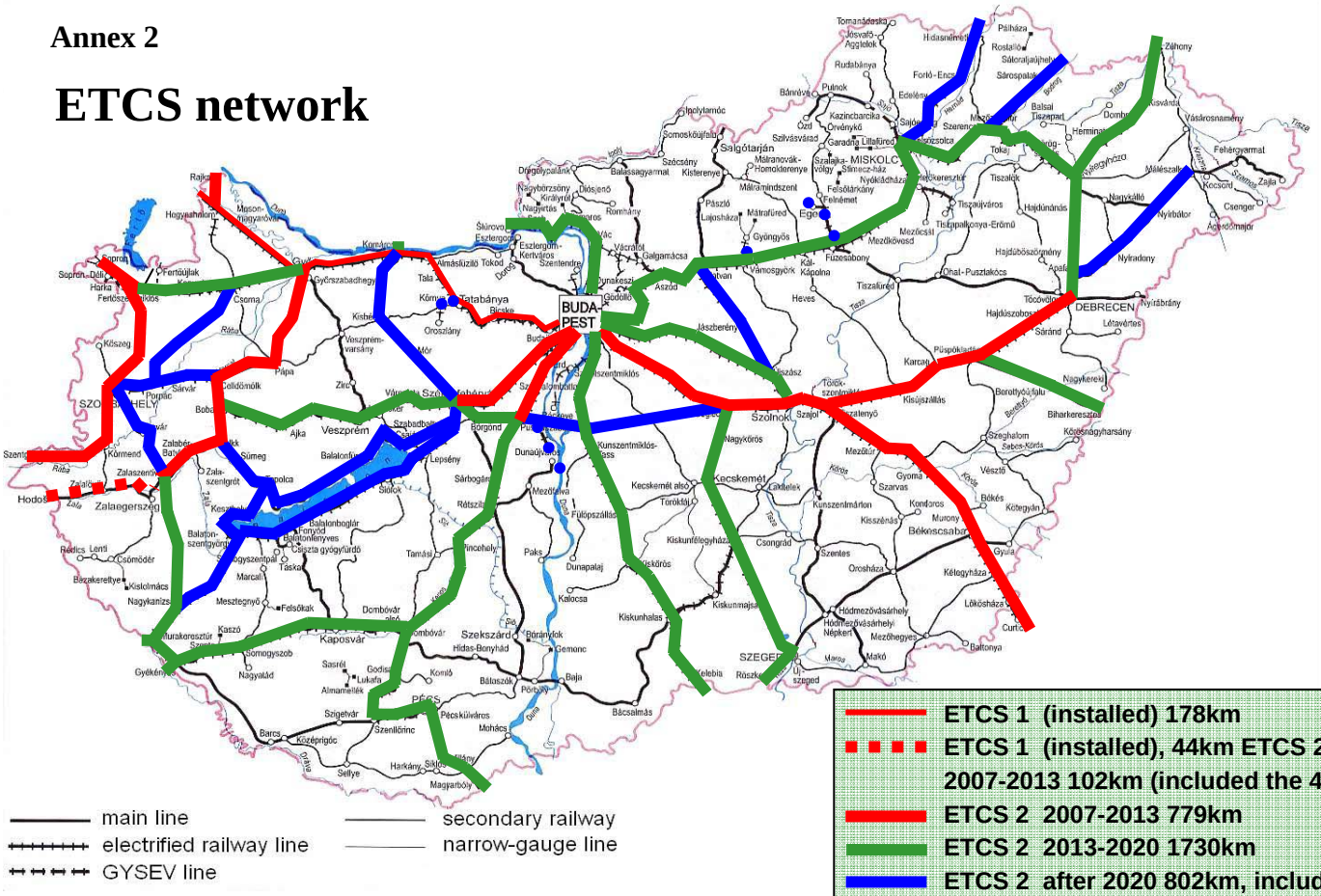
ERTMS D or E: One of the six corridors of ERTMS

Other main line: Lines included the list II of Annex 1 of Railways Act CLXXIII of 2005

LC: Low Cost

Annex 2

ETCS network



Annex 3

GSM-R network