Business Plan

Of

X Limited

For

Procurement & Manufacture of

TPS & Ancillary Products for Railway & Metro Rail

Confidentiality Agreement

Executive Summary

Company Description

Management & Organisation

Products & Services

Market Research

SWOT, Porter's 5 Forces & PESTEL Analysis

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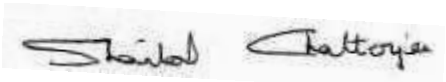
Confidentiality Agreement

The undersigned reader acknowledges that any information provided by SHAIBAL CHATTERJEE in this Business Plan, other than information that is in the public domain, is confidential in nature, and that any disclosure or use of same by the reader may cause serious harm or damage to SHAIBAL CHATTERJEE. Therefore, the undersigned agrees not to disclose without express written permission from SHAIBAL CHATTERJEE.

Upon request, the undersigned reader will immediately return this document to SHAIBAL CHATTERJEE.

Mr. SHAIBAL CHATTERJEE acknowledges that the information being provided in the Business Plan is for the sole use of Company X Limited (hereinafter referred to as "XL") and the information shall be freely shared within the organisation and its stakeholders for internal purposes. Mr. SHAIBAL CHATTERJEE undertakes that the Business Plan shall be kept confidential by him, as the plan formulates part of business strategy of XL and shall not disclose the plan without express written consent from XL or its assigns.



Signature	**Signature** SHAIBAL CHATTERJEE
(FOR & ON BEHALF OF XL)	(FOR & ON BEHALF OF SHAIBAL CHATTERJEE)
	SHAIBAL CHATTERJEE
NAME	**NAME**

Date: 18th February 2019

This is a business plan. It does not imply an offering of securities.

Executive Summary

1. Business Overview

With an Annual Turnover of Rs 20,950 Cr & PAT of Rs 1,435/- Cr, major consumers located in India & Overseas having equipment installed by XL, a vast R&D centre, an exclusive Employee Training Centre, XL is one of the largest employers in the Indian Capital Goods Industry

2. Products & Services

Covers almost all major systems & Equipment in the Capital Goods Industry.

3. Business Goal

Take XL to the next level and move towards the Vision of becoming a Global Engineering Enterprise, with continued focus on Globalisation & Diversification.

4. Target Market

The Target Market is two-fold:

- To Procure & Manufacture High & Low End TPS [Train Protection System] systems
- To Procure & Manufacture Ancillary Products
- To export these equipment & systems

5. Competition Landscape

XL has a long standing relationship with the Indian Railway & Metro Rail industry. Over a course of time, some Global Technology Majors have had a head start insofar as hi-tech TPS equipment & systems are concerned. However, supported by indigenous alternatives and the Make in India thrust, it will be possible to function efficiently in this environment

6. Management Team and their Expertise

During 32 years of its existence, XL has developed a strong & enviable team of Technocrats, adept in all facets of technology and capable managers as well

7. Financial Outlook for the Target Market

The financial outlook is encouraging, with an estimated 18 months for start-up and a break-even achievable in the 4th year thereafter

Company Description

Business Name	X Limited [XL]
Company Mission Statement	**"Providing in-depth, researched & sustainable business solutions in the fields of Energy, Industry & Infrastructure"**
Company Philosophy/ Values	**1. Committed to reducing Global Warming** 2. **Active contributor to Nation Building**
Company Vision	**"A Global Enterprise providing solutions for a better tomorrow"**
Goals & Milestones	Company's strategy framework consists of two themes: • Consistently Move forward • Consistently invest in Technology & Human Capital
Target Market	TPS & Ancillary Products for Railway & Metro Rail
Legal Structure/ Ownership	Public Limited Company

Management & Organisation

[MANAGING DIRECTOR]

⬇

[DIRECTOR]	[DIRECTOR]	[DIRECTOR]	[DIRECTOR]	[DIRECTOR]
[HR & PR]	[R&D]	[Engineering]	[Marketing]	[Finance]

⬇

Senior Executive Directors

⬇

Executive Directors

⬇

General Managers

⬇

Management Staff

⬇

Employees

Products & Services

- Desalination and Water Treatment Plants
- Systems & Services: For various industrial equipment & their requirements.
- Industrial Systems: Coal & Ash Handling Plants, Mine Winder Systems etc.
- Boilers: Steam Generators for Utilities, Fuel Flexible Boilers etc.
- Emission Control Equipment: Electrostatic Precipitators, Fuel Gas Desulphurisation etc.
- Valves: High & Low Pressure Turbine Bypass Valves, High & Medium Pressure Valves etc.
- Seamless Steel Tubes: Hot-finished & Cold-drawn Seamless Steel Tubes with varying ranges as required
- Castings & Forgings: Sophisticated Heavy Castings & Forgings of Creep Resistant Alloy Steel, Stainless Steel etc.
- Condensers & Heat Exchangers: Surface Condenser, Feed Water Heaters etc.
- Pumps: Pumps for Various Utility Power Plant Applications Up To 1000 MW capacity
- Compressors: Multi Stage Centrifugal Compressors & Auxiliary System for various applications
- Rail Transportation: Equipment & Systems for Locomotives, Coaches etc.
- Transportation Equipment

A . M A R K E T R E S E A R C H R E P O R T

Economic Viability for Manufacture & Procurement

Of

Train Protection System [TPS]

&

Ancillary Products [AP]

For Use In

Railway & Metro Rail

A.1 PREAMBLE

A.1.1 As per a press release on "**Initiatives & Achievements of Ministry of Railways in the year 2018**" by Press Information Bureau, Government of India, Ministry of Railways dated 29th December 2018, **Safety** continues to be the foremost priority of Indian Railways [IR] and is accorded the greatest consideration. As a result of efforts put in by IR, train accidents decreased from 104 to 73 during 2017-18 in comparison to the corresponding period of the previous year. In the year 2018-19 (from 1st April, 2018 to 30thNovember, 2018) train accidents decreased further from 51 to 44 in comparison to the corresponding period of the previous year. Category-wise break-up of accidents is given in the following table:-

Type of Accident	(April to March) 2016-17	(April to March) 2017-18	(1st April to 30th November) 2017-18	(1st April to 30th November) 2018-19
Collision	5	3	3	0
Derailments	78	54	39	35
Manned Level Crossing Accidents	0	3	1	3
Unmanned Level Crossing Accidents	20	10	8	3
Fire in Trains	1	3	0	2
Miscellaneous	0	0	0	1
Total	**104**	**73**	**51**	**44**

A.1.2 The Ministry of Railways has accorded the highest priority to passenger safety and has undertaken several initiatives such as the deployment of various signalling components such as train detection systems, point machines, on-board train protection, and LED signals, among others to augment S&T systems across the railway network.

A.1.3 This Research focuses on the Domestic Market in India and explores the Economic Viability of [a] harnessing advanced but costly Foreign Technology [b] Manufacture of low cost alternatives with indigenous technology and [c] Manufacture / Procurement of Ancillary Equipment with indigenous technology

A.2 INDIAN MARKET

A.2.1 Overview

India operates the world's third-largest railway network, with over 115,000km of track, 131,200 railway bridges and 7,112 stations. Every day over 23 million passengers travel by train and operator Indian Railways (IR) carries over eight billion passengers annually.

The demand for TPS in IR has grown substantially in recent years. This is primarily due to an increasing number of accidents on its network and the need for upgrade & modernisation. IR has laid emphasis on deploying modern TPS Systems and Signalling & Telecommunication [S&T] equipment and systems in order to modernise the railway network, improve efficiency in operations and address the issue of safety. IR's telecommunication infrastructure has also improved significantly in the past five years. While there is a framework for **Make in India** and indigenisation, the pace of technology adoption is still quite slow.

Given the poor safety record and low budgetary allocations for TPS and S&T, IR had envisioned an investment requirement of Rs 10100 crores to meet the TPS and S&T targets for the period 2017-18 to 2019-20. It was estimated that funding of Rs 15230 crores will be required for S&T over the next five years (2017-18 to 2021-22) to replace obsolete mechanical S&T systems and install automatic TPS to enhance safety across the IR network. Of this amount, Rs 10140 crores (66.57 per cent) will be allocated under the Rashtriya Rail Sanraksha Kosh (RRSK) and Rs 5090 crores from the Depreciation Reserve Fund/Special Railway Safety Fund. Of the total fund allocation under the RRSK, 27.12 per cent will be allocated towards the installation of Train Protection Warning Systems (TPWS) / Train Collision Avoidance Systems (TCAS), 25.05 per cent towards replacing existing signalling equipment, 18 per cent towards the provision of mobile train radio communication devices, and 16.07 per cent towards the up-gradation of interlocking systems. Taking cognisance of this requirement, an amount of Rs 2505 crores had been allocated for S&T in Union Budget 2018-19, which was marginally lower than the revised estimates for 2017-18.

A.2.2 Recent Initiatives

The Ministry of Railways has accorded the highest priority to passenger safety and has undertaken several initiatives such as the deployment of various signalling components such

as train detection systems, point machines, on-board train protection, and LED signals, among others to augment S&T systems across the railway network.

In line with the Make in India directive to produce TPS and S&T technology domestically, the Cross Approval Policy has mandated that all imported products, approved so far by the Research Designs and Standards Organisation [RDSO], be indigenised. IR offers an opportunity to Indian original equipment manufacturers (OEMs) to collaborate with the carrier in developing and indigenising modern signalling equipment with low failure and system hanging rates, especially those that are more suited to India's tropical climate. Currently, key modern signalling equipment such as Electronic Interlocking (EI) and Digital Axle Counters (DACs) of foreign OEMs has been indigenised.

Recently, IR selected two companies that could install TCAS in order to prevent accidents in the Vikarabad-Bidar section, a 200 km long track. It is one of their pilot projects. **Y (India) Ltd** and **Z Pvt. Ltd** were selected among the top six contenders, consisting of a few multinational companies also, by RDSO on behalf of the Railway Board.

IR has deployed new technologies such as TPWS, TCAS and anti-collision services with the aim to prevent accidents caused due to over-speeding and negligence by providing automatic train protection. At present, TPWS is under implementation on about 10,000 Rkms. TPWS has been made operational on the Chennai-Gummidipundi sub-urban section of Southern Railway (50 route km), the Hazrat Nizamuddin-Agra section of Northern/North Central Railway (200 route km) and the Dum Dum-Kavi Subhash section of the Kolkata metro (25 route km). TCAS is a safety device that is designed to prevent train accidents. It is a combination of railway signalling data with radio communications, radio frequency identification devices, global positioning, software, and logic. "TCAS is developed in RDSO and it is very cost effective for us. While TPWS costs about Rs 70 lakh per km, TCAS is just about Rs 10 lakh," a railway official said.

In a bid to modernise TPS and S&T systems, signalling infrastructure is being automated from semaphore mechanical to Route Relay Interlocking (RRI) and EI. An EI and a massive yard remodelling project were commissioned on the busiest section of the Delhi-Howrah section at Dadri railway station in Uttar Pradesh in April 2017. India's largest EI system of 800 routes has been commissioned at Kharagpur station in West Bengal, replacing the old RRI system of 423 routes. For deployment of TCAS, trials are being undertaken in sections spanning 250 km with 40 locomotives. For real-time monitoring, a web-enabled track management system has been launched across railway divisions to manage all track maintenance-related activities, enabling planned maintenance.

India had recently announced to deploy European Train Controlling System (level II) over 60,000 Km broad-gauge railway network in the country. This advanced signalling system will use wireless technology to continuously update controlling authority in loco cab.

A.2.3 Key Issues and Challenges

Even though there has been a push towards the domestic production of TPS and signalling systems through different policies, several issues still persist. At present, there are very few vendors manufacturing modern signalling systems such as EI, DACs, and Universal Fail-Safe Block Interface (UFSBI), resulting in a limited scope for competition, which could help

introduce more efficient, successful products. There are currently only two indigenous OEMs approved for the manufacturing of UFSBIs.

On the technology side, a major challenge faced in the case of DACs is adapting them to IR's operating environment. The equipment is unable to withstand tropical weather conditions. There have also been difficulties in isolating train failures and system hanging cases. System hanging failures are common and need to be eliminated.

On the workforce side, there is a dearth of computer and systems savvy workers; intelligent mass to efficiently operate the latest systems like TPWS & ETCS2 are few. As per a press release on "**Initiatives & Achievements of Ministry of Railways in the year 2018**" by Press Information Bureau, Government of India, Ministry of Railways dated 29th December 2018, India's first **Rail and Transportation University** namely, **National Rail and Transportation Institute (NRTI)**, Vadodara has begun its first academic session with two under-graduate programmes from 5th September, 2018. A total of 103 students (17 girls and 86 boys) have joined the two courses (62 in B.Sc. and 41 in BBA). The Courses are:-

- B.Sc. in Transportation Technology
- BBA Programme in Transportation Management

NRTI was dedicated to the nation on 15th December, 2018.

A massive training programme named as '**Project Saksham**' has been launched for giving 5 days on the job training to all 12 lakhs employees of Indian Railways. This will help in competence building of employees and thereby productivity and efficiency of the organization. More than 12 lakhs employees have been imparted this training, which is a record in itself

With regard to telecommunication issues, IR still uses traditional means of extracting data from information systems and the use of such systems makes it difficult to address modifications in data and demand "software spaghetti" solutions, which are very expensive to support and maintain.

A.2.4 Automatic Train Protection System [ATPS]

IR's Action Plan 2022 focuses on the urgent need of ATPS systems. ATPS system is provided to avoid train accidents / collisions on account of human error of Signal Passing At Danger [SPAD] or over speeding. There are two versions:

- TPWS based on European Technology ETCS Level 1, a tested & proven ATP system in India
- TCAS developed indigenously by RDSO for collision prevention and protection against SPAD

By 2022, ATPS systems will be provided on more than 10000 Rkms of High Density Network [HDN] routes

A.2.5 Competition Landscape in India

The competition landscape in India can be divided into 2 categories:

- Technology already developed or developable by RDSO in which dedicated vendors have been / will be appointed, trained and asked to deliver to IR / Metros. Here, the competition will be among such vendors. As stated in Para B2 above, **Y (India) Ltd** and **Z Pvt. Ltd** have already been appointed by RDSO

- Competition among Global players vying for a frontal position of domination. However, with gradual indigenisation and the government's focus on Make in India, the size of the pie will reduce and this will pave the way for Large Indian Industrial Houses to collaborate with these Global players and pitch in to the Make in India Team.

Over time, these collaborations will compete among themselves and the ones with economies of scale shall be in the forefront. In India, for the Manufacturer & IR/Metros it will be a Win-Win situation

A.2.6 Implementation of Technologies in India

Recently, India initiated its first high-speed railway project to connect its major cities Mumbai and Ahmedabad. "Virgin Hyperloop One" signed an agreement with Maharashtra State Government to initiate first Hyperloop train project between Mumbai (financial capital of India) and Pune (major IT and manufacturing hubs in India). Similarly, more than 20 metro train projects have been initiated in major cities in India. All these factors, represents a positive outlook for Railway Signalling Systems providers in the country

Although the current widely used signalling system Continuous Automatic Train Control [CATC] allows monitoring of train location and speed, emergency braking and door supervision, and can run trains with minimum intervention by train operators, the new CBTC system goes a few steps further, that is, the frequency of trains can be safely increased, with the interval reduced from 2 minutes to less than 90 seconds, thereby increasing train frequency [more trips by the same number of trains] AND it will also help bring down costs because of less maintenance and fewer wayside signalling equipment.

Civil Construction cost has been the single largest cost in Metro Rail installation, but it is quickly followed by the cost of metro cars, signalling etc. Other compelling issues are: [a] Unbearable passenger load [b] the need to reduce pollution by reduction of private cars in use with large parking facility near the station [c] the need to reduce the increasing pressure on existing road infrastructure. Accordingly, increase of train frequency without increasing the number of trains available is a cost efficient means of tackling the aforesaid issues.

In December 2012, Larsen & Toubro appointed Thales India for providing India's first Signalling System with Communications Based Train Control (CBTC) and Integrated Communications and Supervision (ICS) systems for Hyderabad Metro Rail Project. It is the world's largest public private partnership mode venture for an elevated metro rail, which was inaugurated by PM Modi

on 28 November 2017. It covers over 30 km from Miyapur-Ameerpet (13 km) of corridor-I and Ameerpet-Nagole (17 km) of corridor-III.

Under the terms of the contract awarded by Mumbai Metro Rail (MMRCL) in 2018, Alstom will supply and equip the Mumbai Metro Line 3 with Urbalis 400, the latest generation of CBTC signalling technology, designed specifically for heavy ridership metros, the deployment of Urbalis 400 will support in alleviating Mumbai's commuter congestion. It will also enable the operator to improve headway and average speed performance of the metro system. The contract also includes the delivery of an unmanned train operation (UTO) and computer-based interlocking with centralised train supervision, as well as electrical and mechanical supervisory control and data acquisition system (E&M SCADA) services.

As per "Rail Analysis India's post-dated 5th February 2019, RailTel Enterprises ltd, a wholly owned subsidiary of RailTel Corporation of India Ltd., has been awarded the work of replacement of old mechanical signalling equipment with state-of-the-art electronic interlocking system at 13 stations of Northern Railway. The existing mechanical signalling systems are using lever frames to both lower the signal and change the tracks. The new electronic interlocking signalling system will now enable lowering the signal and changing of tracks by click of a mouse. There are total 13 stations which have been assigned to REL, out of which 3 are in Delhi Division and 10 are in Ambala Division. The stations of Delhi division are Kalayat, Kaithal and Pehowa Road. The 10 stations of Ambala Division are Anandpur Sahib, Nangal Dam, Ropar Thermal Plant, Balluana, Giddarbaha, Malout, Pakki, Panjkosi, Hindumalkot and Fatuhi. The anticipated cost of this project is approximately Rs. 87 crores.

A Memorandum of Understanding (MoU) was inked between REL and Northern Railway to execute the work. Elaborating on the utility of this new system, Sh. T.P Singh, GM/ Northern Railways, said "These state-of -the-art signalling systems will go a long way in improving safety and efficiency in train operations. We need to expeditiously complete these stations." This is the first Railway Signalling project being executed by REL.

A.2.7 The Way Forward

Indian Railways witnessed a huge jump in capital expenditure from Rs. 0.96 trillion in 2015-16 to Rs. 1.58 trillion in the Interim Budget for 2019-20 presented by Finance Minister Piyush Goyal, which saw the highest ever capital expenditure allocation for IR. According to a **PTI report of May 2016**, IR had identified the need for safe running of trains in High Density Railway network by the way of implementation of TPWS in accordance with ETCS-1. Accordingly, Thales, a major player, installed TPWS on a 68-km long rail line in the Chennai - Gummidipondi section (MAS-GPD) in Southern Railway on a Pilot Project basis and Ansaldo STS did likewise in the Delhi - Agra section in Northern/North Central Railways. These projects were successfully commissioned and TPWS system became a proven safety supervision system. Simultaneously, a study of Vendor Interoperability among different makes of TPWS On-board and Trackside Train Protection Systems was conducted with respect to System Requirement Specifications [SRS] between the On-Board system of Analdo and newly introduced Track Side System of Thales in the Automatic Signalling Section [Chennai – Arakkonam] and it was found to be successful. With this, TPWS system was accepted and a number of TPWS projects for 3330 Rkms were sanctioned for suburban sections provided with Automatic Signalling Arrangement. IR intends to install TPWS on approximately 7,900 km of main lines**.** According to a **PTI**

report of March 2018, in order to improve speed and line capacity, IR also plans to implement an advanced version of ETCS Level II on its entire broad gauge network of 60,000 route km.

However, according to a **PTI report of April 2018**, PM Modi blocked IR's ETCS plan of Rs 78000 crores ($US 12bn) to install ETCS Level 2 across its entire 67,368km network, on cost grounds**.** At a meeting with Railway Board officials on March 26 2018, he is understood to have argued that the mass rollout of ETCS **Level2** on the Indian rail network was not feasible, considering that the technology had not proven its efficacy in Indian conditions. His view was that ETCS-2 should first pass performance tests in **heavy traffic density sections.**

According to a **PTI report of June 2018**, PM Modi wanted IR to execute Rs 78,000 crore signalling project with 'Make in India' in focus, Railway Minister Piyush Goyal said. "Keeping in mind the Make in India initiative and the fact that three Indian companies are already trying to develop the signalling system PM Modi suggested that we should consider indigenous technology also and in case it is found suitable, we should give preference to it,". He said there was also an option to involve international as well as domestic players and use the former for urgent requirements. "We will simultaneously support the indigenous manufacturers to come up to the level of the international players. In any case, any project with international technology will largely be made in India for it to be cost-effective," the minister said. The initial plan of the railways was to roll out the signalling system, based on the ETCS2, across its network and sources said that global suppliers like Siemens, Thales, Alstom, Bombardier, Ansaldo, STS, CAF, and the Memec Group could be considered for it. The ETCS2 installation will enable continuous updating of Movement Authority (distance to travel) in driver's cab through wireless network. Until now, IR has implemented the Automatic Train Protection (ATP) system conforming to ETCS Level 1 on 342 Rkms in which Movement Authority (distance to travel) displayed in the driver's cab is updated, whenever the locomotive passes over a balise fitted on track. This enables train driver to know the condition of signals ahead even when the visibility of signals is poor due to fog or any other reasons. This will provide technological aid to train drivers for avoiding Signal Passing at Danger (SPAD). At the end of 2017, the Board of Indian Railways approved the proposal to equip 6,000 electric locomotives with **ETCS Level 2**, a project estimated at EURO 1.45 billion; however, PM Modi is learnt to have raised the cost factor as well as the wisdom of rolling out en masse a technology that is untested for Indian conditions and is mainly commissioned in high-speed systems in some global railways. He asked the Railways to carry out extensive trials in a section with heavy traffic density first, and take a call depending on its success.

Lastly, according to a report of September 2018 IR is all set to install a modern signalling system on the 850-km long section between Mathura and Vadodara. The project is expected to cost around Rs 2,000 crore. According to sources quoted in an IANS report, the proposal to introduce an automatic train protection (ATP) system, which is a state-of-the-art ETCS level 2 is being firmed up and will shortly be sent to the Cabinet for approval. This modern signalling system prevents the collision of two trains on the same railway track.

The Railway Board has been evaluating a project report prepared by Ernst and Young detailing the benefits of ETCS-Level 2. As per the report, which also gave the estimated cost of Rs 78,000 crore, there are eight potential global suppliers who could vie for this contract: Siemens, Thales, Alstom, Bombardier, Ansaldo, STS, CAF, and Memec Group

At present, India is at a nascent state with regard to the adoption of advanced S&T systems used by developed railway systems globally. However, in the next two to three years, IR plans to undertake several initiatives to move towards modernised S&T infrastructure. Accordingly, the future seems to be bright!

A.3 GLOBAL MARKET

A.3.1 Overview

The key players in the Global Train Collision Avoidance System market include companies like Hitachi, RSSB, Mors Smitt, Hytera, HBL Power Systems Ltd., Kernex Microsystems, Thales Group, Intelligence on Wheels GmbH, Siemens AG, Bombardier Inc. and Honeywell International Inc., with Siemens, & Thales Group Dominating.

The market was valued at US$ 8.0 billion in 2017 and is expected to grow at a CAGR of 10.5% over the next 5 years, out of which TPWS & ETCS 2 Market is expected to be US$ 1.03 billion. It is expected to witness considerable growth with increasing investments particularly in railway network expansion projects in emerging markets such as India, China, Southeast Asia, and other countries across the world.

Developed markets are increasingly investing in upgrading their existing signal controlling systems for more efficient and safe railway operations. Emerging countries are investing in expansion of their railway and other transportation networks in order to support their economic growth. In addition, major cities are also investing in metro rail expansion due to rising numbers of commuters. All these factors are expected to increase the demand for railway signalling systems throughout the next 5 years.

In 2017, communication based train control system accounted for the largest revenue share in the global railway signalling systems market. However, European Train Controlling System (ETCS) is steadily gaining popularity in the global market and is expected to witness the fastest growth throughout the forecast period. As of 2017, more than 20 countries across the world have deployed European Train Controlling System (ETCS) for their major railway networks in the country. Some major countries which are currently using this technology include Australia, Germany, France, United Kingdom, China and Italy among others.

North America and Europe represent established markets for advanced railway signalling systems and most of the railway routes in these countries are already equipped with advanced signal controlling systems. The market for railway signalling systems in these regions is expected to witness a steady growth with new railway network expansion projects. Asia Pacific and Middle East is expected to witness significant growth with both expansions of railway network projects and deployment of advanced signalling system on existing railway networks. China is the most attractive individual market for railway signalling systems as it has planned to expand its railway network to 150,000 Km by 2020 which is a 24% increase over 2015. Around 58% of this total expansion is expected in high speed rail network.

Global manufacturers are feeling the heat from Chinese manufacturers with introduction of advance solutions and consistent recognition by end-users on the global platform.

Recently, China's state owned company China Railway Signal and Communication Co, Ltd was awarded projects in Gulf and Africa to develop high speed railway networks in these regions.

A.3.2 Scope for Indian Manufacturers

Due to the absence of Indian Manufacturers there is presently no scope globally. However, once the hurdles of RDSO [Research Design & Standards Organisation] enlistment, technology procurement and manufacturing infrastructure have been completed, there will definitely be opportunities to export Equipment & Services, particularly to Asia Pacific, Middle East and Africa.

A.4 MARKET SEGMENTS

There are and will continue to be 2 Essential Market Segments viz. Railway & Metro Rail, flanked by much lesser requirement from Mono Rail, Circular Rail etc. Additionally, Connected Rail Market by Service (Passenger Mobility, PIS, Train Tracking & Monitoring, Automated Fare Collection System, and Predictive maintenance), Rail signalling system (PTC, CBTC & ATC) & Rolling Stock is a Related Segment. The global connected rail market is estimated to be USD 77.27 Billion in 2017 and is projected to grow at a CAGR of 6.42% from 2017 to 2022, to reach USD 105.44 Billion. The major factors behind the growth of connected rail markets is the continuous need for safety and security in railways, commuter convenience, growing economy, and increasing population. The CBTC technology is estimated to account for the largest share in the global connected rail market.

A.5 TECHNOLOGIES AT PLAY

A.5.1 As per a Handbook on "**Global Bench Marking of Indian Railways Signalling System**" prepared by Hitachi & Siemens, under the Corporate Safety Plan & Indian Railway Modernisation Plan, Discrete Signalling Systems are being replaced with Modern Signalling Systems such as:

- Electrical/Electronic Interlocking [EI]
- Block Proving Axle Counter [BPAC]
- Track Circuiting
- Train Protection Systems such as Train Protection and Warning System (TPWS) / European Train Control System - Level 1 [ETCS1], European Train Control System - Level 2 - [ETCS 2], Train Collision Avoidance Systems (TCAS) etc.

A.5.2 TPWS/ETCS1 is the more used but older technology being gradually outrun by the latest ETCS-Level 2 technology which is of recent advent. A standard TPWS installation consists of an on-track transmitter placed adjacent to a signal and activated when the signal is at `danger' point. Any train that tries to pass the signal will have its emergency brakes activated. If the train is travelling at speed, this may be too late to stop it before the point of collision, therefore a second transmitter may be placed on the approach to the signal that applies the brakes on trains going too fast to stop at a signal, and this is positioned to safely stop trains approaching at up to 120 km/h. TPWS is an additional safety protection & warning system that works in tandem with other signaling products. The purpose of TPWS is to stop a train by automatically initiating a brake demand, where TPWS track equipment is fitted, if the train has:

- passed a signal at danger without authority
- approached a signal at danger too fast
- approached a reduction in permissible speed too fast
- approached buffer stops too fast.

A.5.3 ETCS-2 is a complex system of electronic devices installed along tracks to convey train signals to a computer fitted in the locomotive, doing away with the need for track-side signal indicators and it negates the possibility of collision as trains are electronically prevented from jumping signals and, even if they do, the locomotive comes to a halt automatically. The main feature is that the devices fitted in the tracks get synced continuously to reflect the current signals on the route and to update that information in a running locomotive via wireless frequency. In December 1989, the European Transport minister decided to formulate a strategy to develop a single Train Control System standard to apply across Europe. A group of railway experts started to develop the requirements specification of **European Train Control System (ETCS)** as the base for industrial development. The project framework included new on-board equipment, a new discontinuous and a new continuous data transmission system. At the end of 1993, the EU council issued an Interoperability Directive and a decision was made to create a structure to define the Technical Specification for Interoperability. In 1996, the EU decided that **European Rail Traffic Management System (ERTMS)** would become the standard for all high-speed lines. The EU Council Directives 96/48/EC and 1001/16/EC with respect to the interoperability of the trans-European high-speed rail system and conventional rail system were developed. ETCS was developed as part of the ERTMS initiative. ETCS is the train control system and GSM-R (Global System for Mobile Communications–Railways) is the new radio system for voice and data communication. The two subsystems together form **European Railway Traffic Management System** [**ERTMS]** that was developed and specified by the European Signalling Suppliers (UNISIG), European Railways and the GSM-R industry acting together under the guidance of the EC. The major members of UNISIG are Alstom Transport, Ansaldo STS, Bombardier Transportation, Invensys Rail Group, Siemens Mobility and Thales, the new signalling and traffic management system which enables interoperability throughout the European railway network. Signalling component of ERTMS has basically four components - European Train Control System (ETCS) with Automatic Train Protection System, Global System GSM-R, European Traffic Management Layer (ETML) and European Operating Rules (EOR). ETCS is not a signalling itself, but provides a layer over existing signalling. It has 5 application levels and 16 operating modes. Each application level defines level of protection to trains. GSM-R is though a separate element; ETCS makes use of GSM-R for its voice and data communication. ETCS has two components - Line side Equipment (LSE) and On board Equipment (OBE). Basic ETCS Application Level is Level 0 where locomotives have been fitted with OBE and no LSE has been provided. In Level 0, ETCS will do limited monitoring - monitoring of Max Speed. Level 1 is where OBE on Locomotives and LSE are provided. In Level 2, GSM-R over a fixed network is required in addition to OBE and LSEs and Line side signals are not mandatory. Level 0, 1, and 2 work on fixed block concept where train sections have been demarcated with signals or signages. In Level 3, moving block in place of fixed block will be mandated. Level STM is meant to provide interface to trackside existing national protection systems AWS, TPWS &TPWS+ (UK) and OBE

A.5.4 TCAS is an indigenous production with technology provided by Railway Design & Standards Organisation [RDSO] and is a serious competitor to TCWS & ETCS 2 because of its low unit cost as compared with the many times more costly TCWS & ETCS 2 systems.

Its salient features are:

- Prevention of SPAD
- User friendly cab signalling
- Speed Supervision & Indicate Movement Authority
- Multi-Vendor Interoperability – free from monopoly
- Communication based signalling
- Indigenous technology

Its additional features are:

- Collision prevention
- SOS from Loco & Station
- Blowing horn when approaching a level crossing or gang of workmen

A.5.5 Electronic Interlocking [EI] system ensures safety of train movements by monitoring & controlling train movements as per the operational requirements of IR. Intricate wiring in Relay Based Interlocking system is replaced by Electronic Logic Circuit Cards. EI systems are completely preassembled and tested as per Interlocking Design Requirements. This plays a key role in cutting down on time and costs for installation & commissioning. EI systems have been provided at more than 1200 stations on IR as on 31st March 2017. By 2022 EI systems will be provided at more than 3000 stations of IR

A.5.6 **Communications Based Train Control [CBTC] & other Signaling Systems for Metro Rail**

A CBTC system as defined in the IEEE 1474 standard as: A continuous, automatic train control system utilizing high-resolution train location determination, independent from track circuits

Continuous, high-capacity, bidirectional train-to-wayside data communications; and Train-borne and wayside processors capable of implementing **ATPS** functions, as well as optional **Automatic Train Operation (ATO)** and **Automatic Train Supervision (ATS)** functions

The main objective of CBTC is to increase capacity by reducing the time interval (headway) between trains. Traditional signaling systems detect trains in discrete sections of the track called 'blocks', each protected by signals that prevent a train entering an occupied block. In a moving block CBTC system the protected section for each train is a "block" that moves with and trails behind it, and provides continuous communication of the train's exact position via radio, inductive loop, etc.

Bombardier opened the world's first radio-based CBTC system at San Francisco airport's **Automated People Mover (APM)** in February 2003. A few months later, in June 2003, Alstom introduced the railway application of its radio technology on the Singapore North East Line.

CBTC had its origin in the loop based systems developed by Alcatel SEL (now Thales) for the Bombardier **Automated Rapid Transit (ART)** systems in Canada during the mid-1980s. These systems, which were referred to as Transmission-Based Train Control (TBTC), made use of inductive loop transmission techniques for track to train communication, introducing an alternative to track circuit based communication.

CBTC systems can mainly be used in urban railway lines (either light or heavy) and APMs, although it could also be deployed on commuter lines. For main lines, a similar system might be the **European Railway Traffic Management System ERTMS Level 3**

CBTC is not a synonym for "driverless" or "automated trains" although it is considered as a basic enabler technology for this purpose.

A.5.7 CBTC System implementation - Globally

A study of fully-automated driverless metros conducted by the International Association of Public Transport (UITP) says that the length of such lines is expected to increase from 789km today to 2200km by 2025. “In the 40 years since the first automated lines, the growth rate has doubled each decade and is set to quadruple in the coming decade,” the UITP says. The study only covers metro lines operating at the GoA4 grade of automation which means unattended operation. The UITP says there are currently 53 fully automated metro lines operating in 36 cities around the world, with 42% in Asia, 34% in Europe and 13% in North America. Half of the world’s fully-automated (GoA4) metro lines are in France, the United Arab Emirates, Korea and Singapore, with the three largest systems in Singapore which has 82km, Dubai with 80km, and Vancouver with 68km. While fully-automated metro lines represent just 6% of the world’s total metro infrastructure, nearly a quarter of the world’s 157 metro cities have at least one metro line operating in fully-automated mode

The global railway signalling systems market is valued at US$ 8.0 Bn in 2017 and is expected to grow at a CAGR of 10.5% from 2018 to 2022. The global market for railway signalling systems is expected to witness considerable growth with increasing investments particularly in railway network expansion projects in emerging markets such as India, China, Southeast Asia, and other countries across the world. Developed markets are increasingly investing in upgrading their existing signal controlling systems for more efficient and safe railway operations.

The global connected rail market is estimated to be USD 77.27 Billion in 2017 and is projected to grow at a CAGR of 6.42% from 2017 to 2022, to reach USD 105.44 Billion. The major factors behind the growth of connected rail markets is the continuous need for safety and security in railways, commuter convenience, growing economy, and increasing population. The CBTC technology is estimated to account for the largest share in the global connected rail market.

A.6 Grades of Automation

Modern CBTC systems allow different levels of automation or **Grades of Automation (GoA)**, as defined and classified in the IEC 62290-1. The grades of automation available range from:

- A manual protected operation GoA 1
- A Semi-automated GoA 2
- A driverless GoA 3 (**Driverless Train Operation, DTO**)
- A fully automated operation, GoA 4 (**Unattended Train Operation, UTO**). It operates without a driver in the cabin, but requires an attendant to face degraded modes of operation as well as guide the passengers in the case of emergencies

A.7 Risks

The primary risk of an electronic train control system is that if the communications link between any of the trains is disrupted then all or part of the system might have to enter a failsafe state until the problem is remedied. Depending on the severity of the communication loss, this state can range from vehicles temporarily reducing speed, coming to a halt or operating in a degraded mode until communications are re-established. However, the evolution of technology and the experience gained in operation over the last 30 years has made the CBTC system more reliable and less prone to failure than older train control systems. CBTC technology is evolving, making use of the latest techniques and components to offer more compact systems and simpler architectures. For instance, with the advent of modern electronics it has been possible to build in redundancy so that single failures do not adversely impact operational availability

A.8 Other Systems

As per a press release on "**Initiatives & Achievements of Ministry of Railways in the year 2018**" by Press Information Bureau, Government of India, Ministry of Railways dated 29th December 2018, a lot of focus had been made on other systems as under:

a. Trial of **Ultrasonic Broken Rail Detection System** for detection of Rail/Weld breakage has been started on NR and NCR on 25 km track length each. After successful completion of trials, the system will be utilized over IR for timely detection of Rail/Weld fractures
b. **GPS based trackers** have been provided to Key men and Patrolmen to get real time information of any untoward incidents/emergencies to avert derailments
c. **High output BCM (HOBCM)** with double the output of present machines along with stabilizer and ballast regulating system is planned for commissioning by March, 2019 for the first time ever in IR. This will improve safety and economy in track maintenance along with better utilization of maintenance slots on busy routes.
d. **Leveraging technology for reducing reliance on human interface:** Selected best available technology to improve safety by reducing reliance on human interface and efficient allocation of resources. Induction and proliferation of following new technologies have been decided for improved track inspection, maintenance and

monitoring:

- **Ground Penetration Radar (GPR**) for monitoring health of track ballast bed (Clear ballast cushion, Caked up ballast & ballast penetration in formation) and to prioritize deep screening of track in place of present practice of periodic screening every 500 GMT or 10 Yrs.
- **Axle Box Mounted Accelerometers** on pilot basis in 40 rakes in fastest train on selected high density trunk routes to monitor track requiring urgent attention and generate alerts to maintain organization on daily basis.
- **Track Component Condition Monitoring System with Machine vision** is planned to be fixed on 16 LHB based OMS Coaches for intermediate inspection by Zonal Railways to get defect list of track components to reduce reliance on human inspection.
- **Rail Grinding Machines** with complementary Switch Grinding Machines and RIV are planned to cover entire Indian Railway track for maintenance of rails to control fracture due to rolling contact fatigue. It will improve reliability of asset by reduction in fractures. Order for 2 nos. Switch rail Grinding Machine (SRGM) & 2 nos. Rail Inspection Vehicle (RIV) has been placed for the first time on IR.

A.9 Summing Up

If the current thinking of the Indian Government were to continue, insofar as domestic market demand is concerned, the Thrust Areas are likely to be:

a. There will not be an en-masse purchase of TPWS & ETCS Level 2 costly systems from Global Players. Small quantities will be bought but with an insistence to Make in India

b. Much greater focus will be on encouraging the usage of indigenous technology like TCAS, EI etc. on the surmise that Global Best Technology is not required for all Train/Metro routes in India but rather, only for the High Density Routes and High Speed Train routes. The rest can live with indigenous technology for some time

c. Indigenised equipment & systems such as - Electronic Interlocking (EI), Digital Axle Counter (DAC), Traffic Collision Avoidance System [TCAS], Ground Penetration Radar (GPR), Axle Box Mounted Accelerometers, Track Component Condition Monitoring System with Machine vision, Rail Grinding Machines with complementary Switch Grinding Machines and RIV etc. will be the largest component of purchases by IR & Metro Rail and accordingly, this is where the manufacturing activity should be focused.

d. Procurement should be focused on foreign technology items such as TPWS, ETCS Level 2 etc. The process may be through importing in SKD [Semi Knocked Down] condition with final assembly in India or through Technology Sharing.

e. There will be a constant upgrade & expansion of Indigenous Technology for the manufacture of Low Cost TPS & Ancillaries for the Railway and Metro Rail

f. Enlisting of more but limited number of Engineering Enterprises, that can ensure High Quality of Manufacture, will be encouraged

g. The Government will continue to encourage Foreign Technologies to Make in India through Transfer of Technology and ensure that this stipulation comes with an assurance of continued association

B. SWOT Analysis

STRENGTHS

- Existing strong commercial relationship with IR/Metros is a COMPETITIVE ADVANTAGE
- The sheer magnitude of XL's Product line, Manufacturing Infrastructure and Geographical Spread of its offices in India is a COMPETITIVE ADVANTAGE
- Being an Indian Company, it will get preferential treatment from IR/Metros, RDSO & Indian Government
- Being an Indian Company, it will benefit from the Government's Make in India focus

WEAKNESSES

- Many TPS & S&T Equipment & Systems technology will have to be acquired
- TPS & S&T Equipment & Systems have never been sold by XL to IR/Metros even as bought-out items
- Some Global Majors have already demonstrated their technological superiority by the successful installation & commissioning of ATWS in IR

OPPORTUNITIES

- Indigenously manufactured TCAS is a strong competitor of ATWS & ETCS, especially in the lower train density routes, because of relatively much lower cost. XL stands a very good chance to acquire this technology from RDSO and become a dedicated vendor of IR/Metros
- There is a strong demand for other TPS & S&T products manufactured indigenously, in which XL can be an active partner of IR/Metros and thereby reap a substantial turnover
- There should be an export market in SE Asia, Bangladesh & Sri Lanka for TPS & S&T products manufactured locally by XL
- Because of its size and the patronage it is likely to get from the Government & IR/Metros, XL has a head-start in acquiring/benefiting from advanced technology from the Global Majors who might collaborate with XL rather than look at their depleting fortunes in India

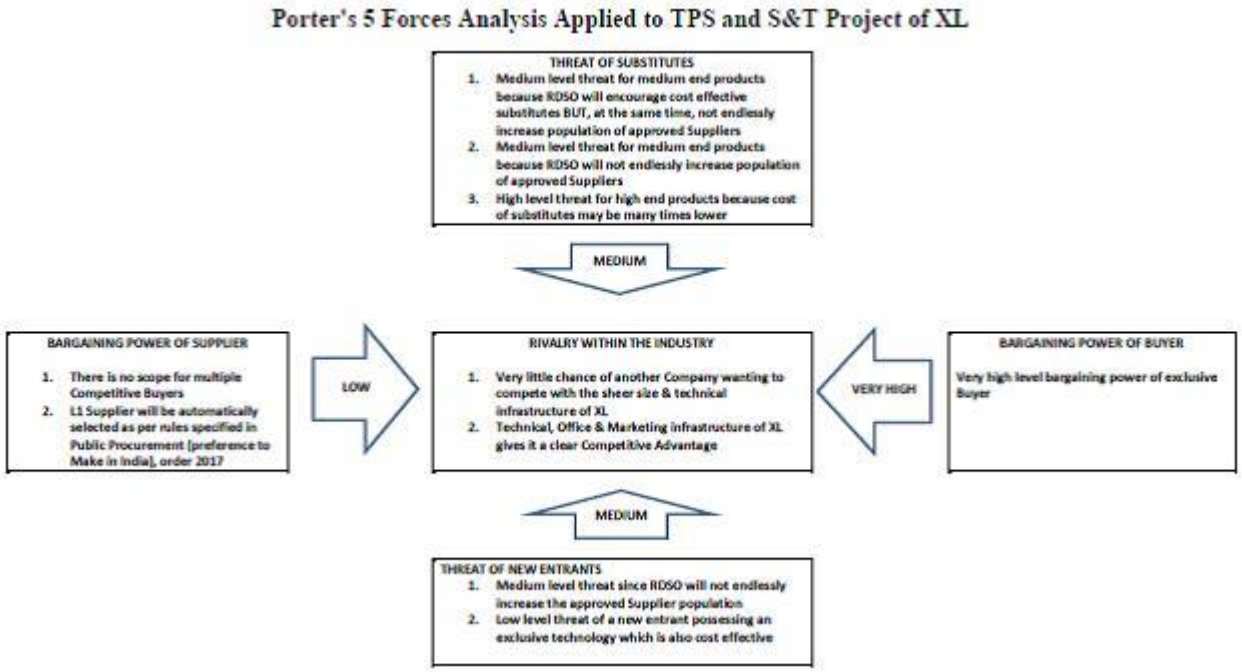
THREATS

- In case ATWS & ETCS 2 requirement goes up due to [a] conversion of low train density to high train density routes and [b] pace, size & quality of economic development increasing substantially, then demand for TCAS may drop down to uneconomic levels
- Contribution from XL's TPS & S&T business will be negative for some time. However, if this gestation period exceeds budget OR does not show a minimum acceptable contribution growth, then, in view of the Management time involved, it may be wiser to close operations

C. PESTEL Analysis Applied to TPS and S&T Project of XL

Political Factors	Continuation of "Public Procurement (preference to Make in India), order 2017" is vital to promote indigenous technology and enterprise Continued focus on "Modernisation of Transport Infrastructure in India" is primal The current policy of welcoming FDI in India BUT with Make in India pre-condition needs to continue
Economic Factors	XL has a huge Product & Customer Base with matching Office & Marketing Infrastructure It has an existing commercial relationship with Indian Railways & Metro Rail It has the financial capability to reap the advantages of "Economy of Scale Reduced overseas procurement and promotion of lower cost indigenous technology adds to the economic health of India
Social Factors	Indigenous procurement directly influences manufacturing and resultant employment generation Promotion of indigenous technology leads to skilled manpower and resultant increased earnings Installation of modern TPS and S&T system and equipment results in fewer train accidents and resultant decrease in mortality rate
Technical Factors	Make in India practice enhances growth of Indigenous Technology It gives a fillip to R&D
Environmental Factors	Technological up-gradation leads to environmental friendly means of travel Technological inputs result in an increase of skilled manpower who enjoy better living conditions, better amenities for their children who grow up to become responsible Citizens and thus positively influence the environment
Legal Factors	TPS and S&T products supplied to IR/Metro Rail must adhere to stringent quality standards lest they cause train mishaps which will invite the Law to step in

D. Porter's 5 Forces Analysis Applied to TPS and S&T Project of XL



E. **Marketing Strategy**

[DELETED ON GROUNDS OF CONFIDENTIALITY]

F. Operational Plan

[DELETED ON GROUNDS OF CONFIDENTIALITY]

G. Financial Plan - Forecast of Operating Income from TPS&AP Project

[Figs. In Rs Cr]

	Year 0 [18 months]	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
TURNOVER							
ETCS Level 2 & similar advanced systems from overseas Vendors		0.00	88.87	291.75	971.77	1,442.04	**2,794.43**
TCAS, EI & Other High-end systems indigenously manufactured		160.00	679.13	1,892.25	5,179.72	7,892.23	**15,803.32**
METRO Rail CBTC GoA4 & other ATP Systems		48.00	230.40	655.20	2,153.02	3,266.99	**6,353.61**
TOTAL Turnover		208.00	998.40	2,839.20	8,304.51	12,601.26	**24,951.37**
MANUFACTURING & PROCUREMENT COST							
ETCS Level 2 & similar advanced systems from overseas Vendors		0.00	-79.99	-256.74	-855.16	-1,268.99	-2,460.88
TCAS, EI & Other High-end systems indigenously manufactured		-142.40	-590.84	-1,589.49	-4,350.96	-6,629.47	-13,303.16
METRO Rail CBTC GoA4 & other ATP Systems		-43.20	-202.75	-563.47	-1,851.60	-2,809.61	-5,470.64
TOTAL		**-185.60**	**-873.58**	**-2,409.70**	**-7,057.72**	**-10,708.08**	**-21,234.68**
Gross Margin		**22.40**	**124.82**	**429.50**	**1,246.79**	**1,893.18**	**3,716.69**
OPERATING EXPENDITURE							
CAPEX + DR Expenditure [Rs 3,000 Cr] pro-rated over 10 years equally	3000.00	-300.00	-300.00	-300.00	-300.00	-300.00	**-1,500.00**
Marketing & Other Expenses		-7.17	-33.70	-111.67	-286.76	-435.43	**-874.73**
Notional simple interest @ 10% pa on CAPEX with notional repayment of Rs 300 Cr pa		-300.00	-270.00	-240.00	-210.00	-180.00	**-1,200.00**
Operating Expenditure		**-607.17**	**-603.70**	**-651.67**	**-796.76**	**-915.43**	**-3,574.73**
OPERATING INCOME		**-584.77**	**-478.88**	**-222.17**	**450.03**	**977.75**	**141.96**

	Year 1	Year 2	Year 3	Year 4	Year 5	TOTAL
TURNOVER PERCENTAGE						
ETCS Level 2 & similar advanced systems from overseas Vendors	0%	9%	10%	12%	11%	11%
TCAS, EI & Other High-end systems indigenously manufactured	77%	68%	67%	62%	63%	63%
METRO Rail CBTC GoA4 & other ATP Systems	23%	23%	23%	26%	26%	26%
	100%	**100%**	**100%**	**100%**	**100%**	**100%**
GROSS MARGIN AS % OF TOTAL TURNOVER						
ETCS Level 2 & similar advanced systems from overseas Vendors	8%	10%	12%	12%	12%	**1%**
TCAS, EI & Other High-end systems indigenously manufactured	11%	13%	16%	16%	16%	**10%**
METRO Rail CBTC GoA4 & other ATP Systems	10%	12%	14%	14%	14%	**4%**
	11%	**13%**	**15%**	**15%**	**15%**	**15%**
GROSS MARGIN AS % OF TOTAL GROSS MARGIN						
ETCS Level 2 & similar advanced systems from overseas Vendors	0%	7%	8%	9%	9%	9%
TCAS, EI & Other High-end systems indigenously manufactured	79%	71%	71%	67%	67%	67%
METRO Rail CBTC GoA4 & other ATP Systems	21%	22%	21%	24%	24%	24%
	100%	**100%**	**100%**	**100%**	**100%**	**100%**

NOTE:

X Limited intends to retain the project under this Company and not a SPV [Special Purpose Vehicle]. Overheads will be prorated, existing manufacturing infrastructure will be used and existing marketing offices & staff will be used to the fullest extent. The actual costs will therefore be estimated much later. Accordingly, the above financials was prepared with the intention to provide an approximate Break Even Period.

H. Appendices

References – Internet Search

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