IMPROVING PUBLIC TRANSPORT IN INDIA; PART II

An Overview in Pictures on advisable Rolling Stocks for Light Rail and Regional Rapid Transit - the Future of Mobility in India with Urban Rail

By Dr. F.A. Wingler, Germany, April 2020

INTRODUCTION

With a massive drive, India is on the way to provide **MOBILITY as a SERVICE, MaaS**, and to mitigate its often chaotic Urban Transport Environments. Investing in **METRO-RAIL** alone – although deployed in India in a large scale – does not solve the transport and traffic problems in congested areas.

"**Urban Rail"** is a technical collective term encompassing Metro Rail, Commuter Rail, Light Metro, Light Rail Transit ("Metro-Lite"), Regional Rapid Transit and (Ultra) Very Light Rail Vehicles.

India is proceeding to integrate Metro-Rail, Commuter Rail and Governmental Indian Railways within multimodal urban, suburban, interurban and regional public transport schemes by Hubs with **LIGHT-METRO, LIGHT RAIL TRANSIT, METRO-LITE** and **REGIONAL RAPID (Semi-High Speed) TRANSITS, RRTS**.

With Light Rail Transit/Metro-Lite there is in India the aspect of **INTEROPERABILITY** of Light Rail Transit/Metro-Lite with Metro Rail sharing track, lines and infrastructure as **TRAM-METRO-TRAIN** within a comprehensive **Urban Rail Concept.**

Other affiliated transport modes to be connected and integrated are Rubber Tyred Bus Rapid Transit, **BRT** or **METRO-NEO, WATER-METRO** and Aerial **METRO ROPEWAY:**

Artist`s Concept for Dehradun Metro Ropeway; by F.A. Wingler

The cost effective **METRO-LITE** can be regarded as the *"YOUNGER SISTER OF METRO-RAIL",* and **REGIONAL RAPID TRANSIT** as the *"FASTER BROTHER OF METRO RAIL".*

LIGHT RAIL TRANSIT, LRT, WITH LIGHT RAIL VEHICLES, LRV

The origin for **LIGHT RAIL TRANSIT or "METRO-LITE"** is based on electric City Trams, that started worldwide at begin of the last century. **Light Rail Transit** is becoming a further mainstay for urban and suburban public transport in India. A relict we find in India in Kolkata:

With Low Capacity City Tram on the Streets of Kolkata in the 21st Century, India

LIGHT RAIL TRANSITS, LRT, including City Trams, experience worldwide a renaissance. LRT is currently the fastest-growing passenger rail mode, employing a full range of technologies and operational practices. Around the globe, light rail systems, or LRT, have become increasingly popular in recent years due to their lower capital costs and increased reliability compared with heavy rail systems.

In Central European countries, LRT/city trams remained operating since hundred years uninterrupted as the backbone for urban, suburban interurban and regional public transport.

Be it the tram in the classical sense or the suburban and interurban railways, that combine features of underground railways and trams, the global future of urban transport is on the rail with Light Rail Transits. While the construction and running of underground or elevated systems incur a huge cost, tram and light rail transit systems can be constructed and integrated into the cityscape at a comparatively lower cost.

Light Metro Rail (LMR) or Light Rail Transit (LRT) is now regarded as feasible for India:

Animation of Light Metro Rail, LMR, for India`s smaller Cities

Artist`s Impression for Mauritius and Delhi Phase IV LRT Projects

Representative Image with CAF URBOS articulated Tram in Canberra, Australia, for Delhi Metro-Lite Project

Representative Image: CAF "*URBOS 3*", Overhead Catenary free Battery City LRV at Zaragoza, Spain; delineating Image for Bangalore Metro-Lite Project;
Source: Rail UK

Reference Image of Low Floor, 75 kmph, articulated Tatra Yug Tram, Ukraine, for Visakhapatnam Light Metro Rail

Reference Image of articulated Adtrans Incentro Tramway (Nantes, France) for Jammu-and-Shri-Nagar Metro**-Lite** System

Artist`s Concept for articulated LRT in Jammu

Shelter Platform for LRT with Alstom Citadis X05 LRV; Caen, France – an Example for an economical Solution for Indian Towns with less Ridership for much lower Costs?

LIGHT RAIL TRANSITS show a wide spectrum/range from low capacity over medium capacity to high capacity.

With high Capacity Light Metro Rail through the City of Los Angeles, USA

High Capacity LRT Ottawa, Canada; Turney's Pasture Station

High Capacity LRT Santa Clara, California, USA

Global Activities with Trams and Light Rail Transits; Source: Plasser&Theurer

Light Rail Transits are not only more cost effective than **METRO RAIL**; they have a higher versatility in adapting to local and environmental conditions. LRT can run interoperable and compatible with METRO RAIL tracks and on Governmental Main Line Rail-tracks as Tram-Trains or regional Rapid Transit. They can undergo a symbiosis with Metro Rail, City Street Tram, Regional Rapid Transit, Commuter Rail and Main Line Railways. They can run underground, on streets, on dedicated or reserved lanes/ corridors at grade or on elevated structures. Thanks modern thyristor technology, the LRV can run seamless and smooth under different voltages and DC/AC systems.

City Tram/Light Rail Transit/Light Metro Rail/interurban Tram-Train Symbiosis at Underground (U-Bahn) Station of Cologne, Germany

City Tram/Light Rail Transit/Light Metro Rail/interurban Tram-Train Symbiosis at Grade on reserved Track at Cologne, Germany

City Tram/Light Rail Transit/Light Metro Rail/interurban Tram-Train Symbiosis on City Road at Cologne, Germany

City Tram/Light Rail Transit/Light Metro Rail/interurban Tram-Train Symbiosis on Main Railway Line between Cologne and Bonn, Germany

Dual Voltage (750 V DC and 15 kV 16 2/3 Hz AC) LRV City-Tram/interurban Tram-Train starting from Karlsruhe Main Railway Station for a run through the City Centre as Tramway and further on the Main Railway Line to the Heart of the 149 km far City Forbach as regional Rapid Transit/Commuter Tram Train

With LRT from City Centre to City Centre as Tram-Train over Governmental Main-Line Rail Track under 15 kV 16 2/3 Hz AC **between Hagen and Dortmund, Germany**

Stadler Tram-Train for Szeged, Hungary

Tram-Trains, Light Rail Vehicles, which can run in cities on the tram-rail networks and outside cities on main-line rail networks, sharing the tracks with passengers and freight trains, are coming increasingly popular in Europe, facilitated by the fact that mostly trams and railways run with the same standard gauge. The change of Voltage systems from 750/1000 Volt DC to 15 kV 16 2/3 Hz or 25 kV 50 Hz AC is nowadays thanks modern thyristor technology no problem.

Since in India, Indian Railways run on 1.676 m Broad Gauge, and since for most of the Metro-Lite projects 1.435 m Standard Gauge is envisaged, the intermodal operation will be hampered. However, since most of the Indian Metro Rail systems use 1.435 m Standard Gauge tracks, intermodal operability of **Metro-Lite** as **Tram-Metro-Trains** with **Metro-Rail** should be possible.

Cadiz, Spain, Tram-Train (right) sharing the Main-Line Railway Line with RENFE with 25 kV, 50 Hz, AC Catenary Feed

ASP Light Rail Tram at Dubai with Shelter Station on reserved Track

The Question of Track Gauge for LRT/METRO-LITE

LRT can use Narrow Gauge (2½ feet, 760/762 mm, 900/750 mm) – Austria, Italy, Greece, Switzerland, Germany - , Meter/Cape Gauge (1000mm, 1067 mm) – Switzerland, Germany, Spain, Austria, Spain, Italy, Japan - , worldwide they run on Standard Gauge (1435 mm) and can operate also on Indian/Iberian/Russian Broad Gauge (1676/1668/1520 mm). Narrow Gauge and Meter/Cape Gauge have the advantage that the Light Rail Vehicles (LRV) can negotiate tighter curvatures and need less space in the landscape.

The major Swiss Cities Zurich, Bern, Basel and Geneva, and as well the second largest town in Austria Graz have decided not to go for Metro Rail and not to dig the City Tramway Lines underground. The cities operate a dense branched City Tram Network. In Zurich, one can find always a tramway line in a perimeter of 300 m. Such a dense areal public transport service will be not possible with Metro Rail, that can serve only special corridors.

Dense and branched public Transport with Meter Gauge City Trams at Zurich, Switzerland

With articulated Meter Gauge LRT Tram trough the City of Geneva, Switzerland

Articulated Cape Gauge (1067 mm) for LRT offers many Advantages: Fukui "Fukuram" LRT, Japan; Pict. by Kansai Explorer

Stadler 950 mm Narrow Gauge Diesel LRV for Appullo Lucane LRT Railway (FAL) on reserved Track; South Italy

Waldenburg 760 mm suburban LRT, Canton Basel, Switzerland

Regional LRV Transit on 760 mm Gauge, St. Pölten, Austria; Pict.: www.Mariazellerland-blog.at

Interoperability of LRT with Metro Rail and Main Line Railway is determined by the Gauge. Some **Metro Rails** in Indian run on Broad Gauge, some on international Standard Gauge. For **METROLITE** Standard Gauge and for the **NCRTC/RRTS** Broad Gauge are envisaged. The different track gauges will make interoperability in India problematic. The swift from 750/1000 V DC to 25 kV AC electric feeding is nowadays no technical problem

Light Rail Vehicles, LRV, can negotiate steep gradients. In Gmunden, Austria, the Meter Gauge tram negotiates a gradient of 1 in 10, only by adhesion:

Gmunden Meter Gauge Tram negotiating a Gradient of 1 in 10; Austria

Light Rail Transit or Light Metro Rail is a feasible solution for cities with low or middle income population, and can be connected with Bus Mass Transit (BRT) and on-Demand private Bus Operation.

Addis Ababa in Ethiopia, which has conditions similar to Indian cities, introduced successfully a Light Rail Transit, which runs at Grade as well on elevated Structure:

Light Rail Transit on elevated Structure at Addis Ababa; Ethiopia

Addis Ababa Light Rail Transit on reserved Track at Grade with Shelter Station, Ethopia; Pict. by Aleksandra Prodan

Shanghai LRT CITADIS City Tram on reserved Right of Way Track and at Shelter Station; China

SIEMENS Low Floor S 70 Type 4 LRV operating on the Portland MAX Light Rail Transit, LRT, Network; USA

Portland in USA most progressive with innovative and smart schemes with integrated multimodal public urban and suburban transport for Urban Mobility as a Service, (MaaS):

Modern articulated Street Car LRV in Portland built in Pennsylvania by Brookville Equipment Corporation, USA

Articulated 9 Car CAF *URBOS*® LRT in Budapest, Hungary

Innovative ALSTOM LRV combined articulated 10 (2x5) Car Citadis Tram for Rabat, Marocco

CAF Design for modern articulated Light Rail Vehicle, LRV, for Light Rail Transit

Public Transport Victoria City with BOMBARDIER *YARRA E CLASS* Tram in Melbourne, Australia

BOMBARDIER *FLEXITY* LRT, Ontario, Canada, on reserved Corridor at Grade

Feeding and Propulsion Technologies for LRT

LRT can be fed with electricity for propulsion by Overhead Catenary (750/1000 V DC, 25 kV 59 Hz, AC or 15 kV 16 2/3 Hz AC) or by Third Rail (750/1000 V DC). LRT running as City Trams are mostly fed with 750/1000 V DC.

Nowadays, Light Rail Vehicles and Light Rail Transits can also run in towns as City Tramways without a catenary. With the **Alstom APS Technology** (**A**limentation **p**ar Aesthetic **P**ower **S**upply), the vehicle takes up the electric supply from a middle third power rail (third rail feeding technology), which switches section-wise on and off according to whether a tram is passing over them with a transponder, thereby eradicating any risk to other road users.

The Catenary-free Tramway and Light Rail Transit operation is service proven. APS is a highly reliable catenary free power system, that reduces the footprint of light rail lines and preserves the aesthetics of urban environments. Cities planning a tramway can today preserve their historical heritage and urban environment by dispensing with obtrusive overhead contact lines. Alstom's APS ground-level power supply system is a proven alternative with equivalent performance, which is currently operating in seven cities on three continents, and which offers safe and reliable electric power to trams and LRV, whether in short catenary-free sections or along the entire line:

The system is currently operating in revenue service in the French cities Bordeaux (2003), Angers (2011), Reims (2011), Orleans (2012), Tours (2013), in Dubai, Emirates, opened Nov. 2014 and in Sydney Australia, (2019).

Doing away with Catenary: ALSTOM Catenary free Citadis APS (Alimentation par Aesthetic Power Supply) City Tram at Bordeaux, France on reserved LRT Rail Track

Shelter Platform Station with horizontal Platform Screen Doors of Dubai`s Catenary free Light Rail Transit Metro; ALSTOM APS Technology

Catenary free Section of City Tram in Sydney, Australia

Eco friendly Propulsion Technologies with electric, battery storage, super capacitor storage, hydrogen fuel cells, bio-fuelling, liquid gas fuelling, hybrid technologies with Diesel-electric, overhead catenary feeding, ground level power supply and intelligent electric charging technologies are also coming to India, enlarging the spectrum of **METRO-LITE**.

New global developments go for LRV with Battery and/or Super-Capacitor power storage whether in short catenary-free sections or along the entire line:

CAF "*URBOS 3*", Catenary free Battery City LRV at Zaragoza, Spain; Source: Rail UK

HYUNDAI ROTEM City Tram with Skeleton Ultra-Capacitor Storage Technology for Warsaw, Poland

The future with low carbon print propulsion will be with Hydrogen-Fuel Cells. Pressure to reduce Carbon-Dioxide emission in transport sector has risen also in India interest in **Hydrogen-Fuel Cell** technology for propulsion-power generation in regional trains on non electrified routes.

“India Railways is working on the development of a Hydrogen-Fuel Cell powered suburban train and has floated an Expression of Interest for industry participation”, Rail Minister Piyush Goyal said: “Hydrogen is planned to be sourced from industry in India. Hydrogen production is not planned by Indian Railways. The decision on deployment of hydrogen-propelled trains for long-distance routes will be based.

Fuel Cell LRVs have mostly in addition Batteries for intermediate storage allowing a steady electricity production by the fuel cells.

CRRC Fuel Cell Tram for Foshan, China

Alstom’s Coradia iLint Hydrogen-Fuel LRT in Germany

The Zillertalbahn in Austria wants to start as a hydrogen pioneer. The world's first narrow-gauge railway with hydrogen fuel cells build by Stadler will run in Tyrol, Austria:

Artist`s Concept for Hydrogen Fuel Cell powered LRV for 760 mm NG Gauge Zillertal Commuter Rail in Austria

On lines, which are only partly electrified with catenary feeding Bi-Mode Multible Units have been developed, which can take the electric power either from a catenary or inbuilt Diesel Generator:

STADLER Bimodal *FLIRT* Regional Rapid Transit running as well with Catenary and with Diesel-Generator Feeding

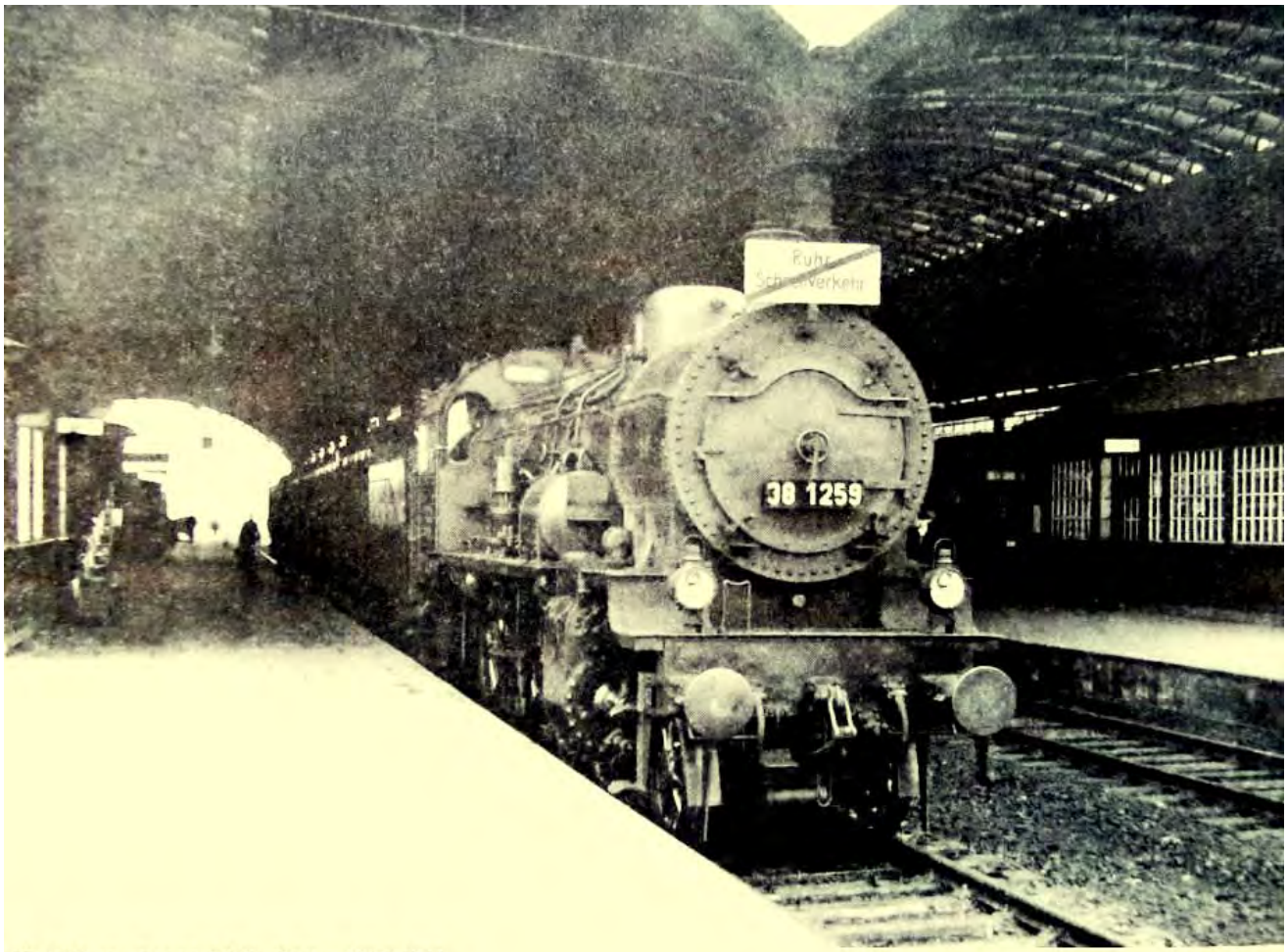
For LRT without Catenary Feeding there are also Diesel-electric or Diesel hydraulic propulsed Light Rail Vehicles:

Mallorca, Spain, CAF build Diesel Meter Gauge LRV

REGIONAL RAPID TRANSIT SYSTEMS, RRTS

RRTS is a modern form of the so-called electric "*Interurbans"* in USA from the last century and resembles the Rhine-Ruhr Express, RRX, - a major transportation project being developed in North Rhine-Westphalia Region of Germany. Latter is considered as the region's 'project of the century' to anticipate the ease of the dense traffic conditions. The forerunner of the RRX had been the last. Century steam powered regional RSV – Ruhrschnellverkehr:

Once upon a Time with *Electroliner* "Interurban" at Chicago, USA b- a Forerunner of modern Regional Transit



38 1259 (ex 'Essen 2402), Borsig 7937/1911
Essen Hbf, 1933 Collection Klaus D Holzborn

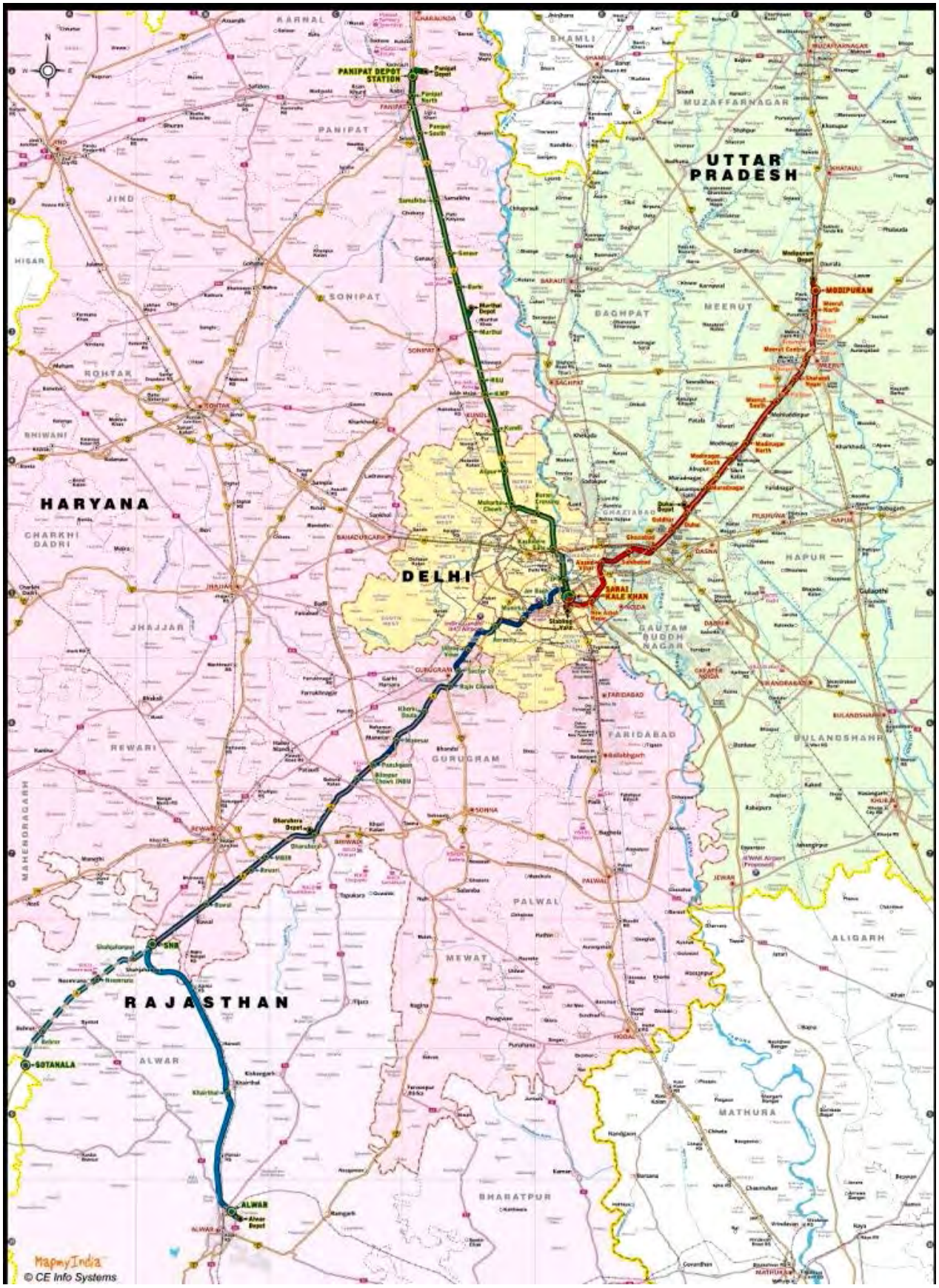
Once upon a Time with rapid Steam powered Regional RSV – "Ruhrschnellverkehr" in Germany of 1933- 1958 – the Forerunner of modern regional Rapid Transit

INDIA has officially launched the **Regional Rapid Transit System (RRTS)** Project, which aims to offer 160 kmph services between New Delhi and Tier-2 cities in adjoining states on Broad Gauge Track. First announced in 2005 as part of a strategy to decongest New Delhi and promote industrial, commercial and regional development in the National Capital Region, the Indian Government is undergoing to construct eight lines.

The real benefit of the RRTS network is that it will provide seamless travel, as the system will have **Multi-Modal Connectivity** by integrating with Indian Railways Network, Interstate Bus Terminals, Airport and Delhi Metro Rail.

A global tender for the acquisition/manufacture of 210 cars at an estimated cost of Rs. 20 bn has also been floated. About 30% of the trains will be imported, while the remainder will be manufactured in India under a technology transfer arrangement.

Rolling Stocks for Regional Rapid Transits differentiate in principle from conventional High Speed Train rolling stocks in design of doors for rapid embarkation and disembarkation and in desgns of interior.



Map of Delhi-Meerut RRTS Corridor

Representative Image for 21st Century Semi-High Speed (160 kmph) Regional RRX with SIEMENS *DESIRO* Train in Germany

Representative Image-Animation with a Siemens *VELARO RUS* High-Speed Train, however less advisable for India`s Regional Rapid Semi-High Speed Transit Projects*;* Animation by Edwin Gramba

Representative Image for India`s RRTS Projects with a SIEMENS *MIREO* 140-200 kmph Regional Semi-High Speed Trainset, German Federal Railway DB

Representative Image with a BOMBARDIER *AVENTRA* EMU, Class 345, build in UK for Elizabeth Line and the regional Thames-Side Commuter Services, (envisaged to become capable of Speeds up to 125 Miles per Hour, 200 kmph) for proposed Pune-Nashik Regional Semi-High-Speed Connection

Representative Image for India`s RRTS Projects with a BOMBARDIER *OMNEO* 140-200 kmph Double-Decker Semi-High Speed EMU with MITRAC Permanent Magnet Traction Motor; French Railway SNCF

Representative Image for India`s RRTS Projects with a STADLER *KISS* Semi-High Speed Double-Decker Regional Intercity Trainset; German Federal Railway DB

Representative Image for India`s RRTS Projects with an Articulated STADLER *GIRUNO* (Semi) High Speed Train for Switzerland

Representative Image for India`s RRTS Projects with an Image of the ALSTOM *METROPOLIS* Regional Transit Train for Sydney, Australia

Representative Image for India`s RRTS Projects with an ALSTOM *CORADIA STREAM* modular Intercity Semi-High Speed 200 kmph EMU

Representative Image for India`s RRTS Projects with a Hyundai-Rotem Regional Intercity EMU for Ukraine

Representative Image for India`s RRTS Projects with a CONSTRUCCIONES AUXILLIAR de FERROCARRILES, CAF, (Spain) CIVITY Regional Commuter Train running in Netherlands

Representative Image for India`s RRTS Projects with an Artist`s Concept for SINARA-SIEMENS *URAL* double Decker Regional EMU, Russia

Representative Picture for RRTS: ALSTOM *X`TRAPOLIS MEGA* Regional Train presented at Cape Town, South Africa

Last not Least

UK sees the Roll-out of a Prototype **Very Light Rail Vehicle, VLRV,** for urban applications. In India, **VLRV** could be of interest as rail bound **People Movers** in emerging smart cities, planned communities, commercial areas and techno parks.

The Future of Urban Rail bound Transport with Battery propulsed Very Light Rail Vehicles, VLRV, People Mover