The World of Urban Transport; a Picture Kaleidoscope - from the Once-Upon-a-Time Bullock-Sulky to the modern Low-Speed Urban and Regional Maglev Transit

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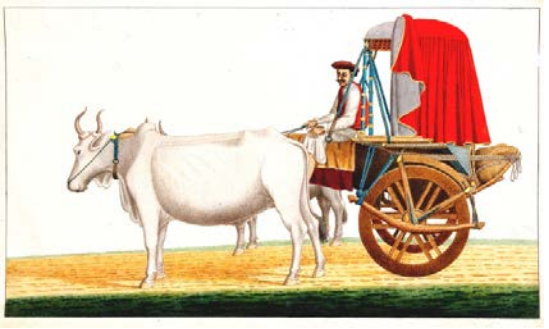
We start our Transit Kaleidoscope in India with a once–upon-a-time privileged Bullock-Sulky personal Transport:



Once-Upon-a-Time Transport in India

The transition from the nineteenth to the twentieth century marked the birth of **Mono-Rail guided Transport Technology** in India. The Kundala Valley Railway in India, a road borne railway system, was built in 1902 and operated in the Hills of Kerala, built to transport tea and other goods:

Mono-Rail guided Bullock Cart Transport in Kerala, India 1902

The second mono-rail in India had been the **Patiala State Monorail Tramway (PSMT)** hauled by a steam engine, and it was running from 1907 to 1927 in south-east Punjab. A steam locomotive and a coach of PSMT have been restored and are exhibited in the Indian National Rail Museum, New Delhi, in running condition:

Patiala State Mono-Rail Tramway, National Railway Museum, New Delhi

The evolution of Light Metro Rail (LMR) or Light Rail Transit (LRT) for public passengers had its origin in Austria:

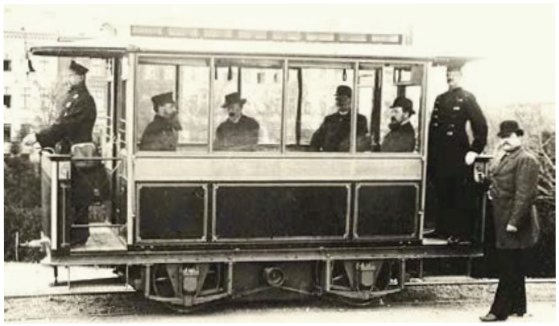
1827 regional Horse drawn public Rail Transport in Austria

The public passenger transport service opened

1827 as a regional horse drawn light railway from Budweis to Linz and further to Gmunden in Austria, on a length of 196 km. The first Horse drawn City Tramways appeared in European Cities around 1860:

Heidelberg Horse City Tramway 1896, Germany

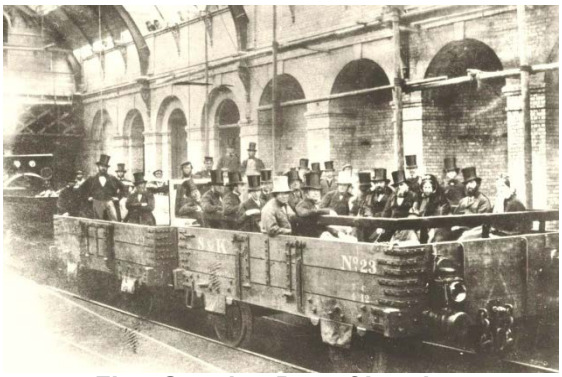
1881 appeared the first electric Tramway build by Siemens in Berlin, Germany:



Electric Tramway by Siemens, Berlin Lichterfelde 1881, Germany

City Steam Tramway Brühl 1900, Germany

The London Underground, which opened in 1863, as a Steam Railway, was the world's first Underground Metro Rail. More than 30,000 Passengers tried out the 'Tube' on the opening Day:



First Opening Day of London Underground on 10.01.1863; pictured by William Gladstone

The electric City Tramway started in Kolkata, India, in 1902 and is still operating:

Kolkata City Tram still in Operation

Electric City Tramways have become in the last century popular all over the world. In many cities they declined, however in the last few decades they have come back in many towns. 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:

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

The cities operate dense branched City Tram Networks. 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:

Begin of the 20st century City Trams expanded to regional tramways. Famous had been the so-called ***"Interurbans"*** in USA:

"Electroliner" Chicago, USA

After Second World War, in several Central European Cities the Tramways went partially underground:

Cologne Underground City Tram U-Bahn, Germany

With the Tram-Train from one City Centre to the next City Center over the Governmental Railway Line in the Karlsruhe Region, Germany

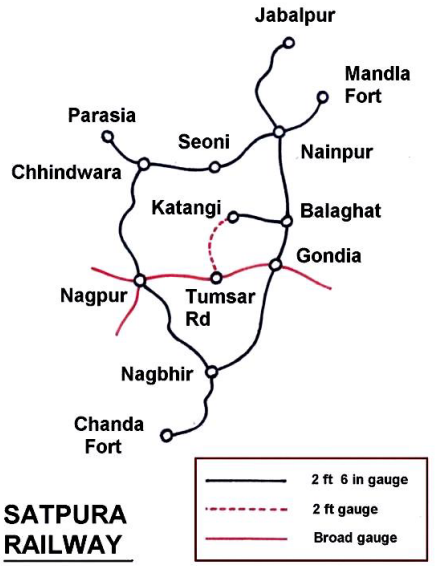
In recent years Tram-Trains have become popular in France, Spain, Hungary and Germany They can run multimodal as Street Trams, Underground and as well as regional intercity trains on governmental railway main lines; switching from one electric feeding system to the other is nowadays technically no problem anymore. Leading is the public transport system at Karlsruhe, Germany, with a 503 km network:

City Tram running on Governmental Main Railway Line to cross River Rhine near Karlsruhe, Germany

Maha Metro, Nagpur, is currently most progressive amongst India`s Metros and is planning to use also Indian Railway Lines for expansion of Metro Rail Services with socalled ***"Metro Trains"*** running up to 120 kmph. Metro-Train is a combination of METRO RAIL with COMMUTERRAIL/REGIONAL RAPID TRANSIT (RRT), as it has come now under focus for the Nagpur Region. Nagpur is embedded in a denseIndian Railways network:

Nagpur embedded in a dense Network of Railway Lines; map by S. Roychoudhury

Most sections of the **SATPURA** NG network, 1005 km, has been already converted to Broad Gauge or is under Gauge Conversion. After completing the Conversion, the new lines are envisaged for electrification and can also be used for Metro Rail:



Satpura 2 ½ ft Narrow Gauge Railway Network before Gauge Conversion

Once implemented, Metro-Train Rolling Stocks would run in the Nagpur Region intermodal on Metro Network as well on Indian Railways' Tracks.

In India in the recent decades, **Traffic Congestion** has increased dramatically. Congestion and the associated **Slow Urban Mobility** had a huge adverse impact on both the quality of life and the economy:

Chaotic Traffic Situation in Indian Cities

India has developed its own style of self organizing Para Transit:

Public Para Transit in India

It is national policy to easy the often chaotic traffi in Indian Cities by deploying modern, world class standard modes of urban, suburban, interurban and regional public transport. It is part of India` strategic planning and regime. The government looks to make sustainable urban transport a priority. Aim is to improve the Economy and the Living Standards of the People/Population by developing Urban Transport Infrastructure with **URBAN MOBILITY as a SERVICE (MaaS) IN INDIA** boosting the socioeconomic development for building a strong and prosperous Indian Nation.

The fast paced implementation of **METRO RAIL** in several mega cities has become a main constituent within the Governmental Transport and Traffic Policy for urban development. **METRO RAIL** has become in several cities the main backbone or "lifeline" for **URBAN MOBILITY IN INDIA** as a Service boosting socio-economic development. The **Kolkata Metro** was for 18 years the only Underground Metro Rail in India, opening for commercial services from 1984:

Kolkata Metro, first Metro in India

Only after 18 years, **Delhi** was the second city to get Metro Rail. The construction started in 1998, and the first elevated section on the Red Line opened on 24th December 2002. Within only 18 years the network expanded to 392 km serving over 250 stations. Metro Rail in India is a **Success Story** for its fast paced implementation. The leading eminent personality behind this success story is Mr. E. Sreedharan:

However, **METRO RAIL** in India serves mostly only certain corridors. To make **METRO RAIL** viable and to operate economically, it needs affiliated supplements, complements and accessories. **FEEDER SYSTEMS** and multimodal **CONNECTIVTY HUBS** link **METRO RAIL** with the other modes of transport: **Railway, Commuter Rail, Mono-Rail Light Rail Transits, Bus Rapid Transit, Water Metro, aerial Ropeway, Pod Cars, Metrinos and Para-Transits**.

In recent decades, Light Rail Transits, LRT, so-called ***"METRO LITE"***, evolved worldwide from City Trams/Regional Trams and are regarded in India as a cost efficient supplement to Metro Rail:

Light Rail Transit in Addis Ababa, Eritrea

The more cost effective **METRO-LITE** can be regarded as the "***YOUNGER SISTER OF METRO-RAIL***" and ***REGIONAL RAPID TRANSIT*** as the "***FASTER BROTHER***". Light Rail Transits, LRT, with Light Rail Vehicles, LRV, show a wide spectrum from Heavy Capacity, to low Capacity LRT:

High Capacity LRT in Los Angeles, USA

Nowadays, Light Rail Vehicles and Light Rail Transits can also run in towns as City Tramways without a catenary. With the Alstom APS Technology (Alimentation par Aesthetic Power Supply), 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:

Catenary free City Tram, Sydney, Australia, Alstom APS Technology

Eco-friendly Propulsion Technologies use electric Battery/Super-Capacitor Storage or Hydrogen Fuel Cells:

Stadler, Switzerland, designed Regional Narrow Gauge Transit with Hydrogen Fuel Cell Propulsion on Zillertal-Bahn, Austria

Metro Rail is not always the most economical solution. Nashik in India is going to implement a **Rubber Tyred Bus Mass Rapid Transit System "*Metro Neo*"** with bi-mode Diesel and electric Propulsion, latter with Battery and Catenary Feeding, on dedicated lanes:

Metro Neo BRT System for Nashik, India

Amritsar dedicated Right-of-Way Bus Corridor Lane

Mono-Rail, running with inflated Rubber Tyred Wheels on an elevated Concrete Trajectory Beam, is an alternative to Metro Rail. A Prototype for this new technology had been implemented under the name ***"Alweg-Bahn"*** in the 1960-ties near Cologne, Germany:

Mono-Rail Proto Type in the 1960-ties at Cologne-Fühlingen, Germany

Mono-Rail at Disney Park, Orlando, USA

In India, Mono-Rail had been installed at Mumbai, however with less economical success. Kerala in India is in the possession of plenty of waterways, the so called ***"Backwaters"***. Kochi/Ernakulum is integrating **Water Metro** in its public transport system with battery operated water barques:

Water Metro for Kochi/Ernakulum, India

Aerial or "Sky" transport modes are indicated for densely build Cities. In **1901 a suspended aerial Mono-Rail** opened in the narrow valley of Wuppertal, Germany:

Suspended aerial Mono-Rail with "Corona Mask" at Wuppertal, Germany

Another suspended "***Sky-Train***" technology uses a Steel Box Trajectory, in which Rubber Tyred running Wheels are guided, with the Vehicle hanging below:

Shonan Sky Transit, Japan, 1970, System SAFEGE

The **Goa Skybus Metro** was a prototype suspended railway system by Indian technologist B. Rajaram with the Konkan Railway. The system consisted of an elevated concrete trajectory or guideway box, carrying two parallel rails without cross bars and with a railway carriage drive with flanged steel wheels running on the rails. The cars are suspended below in the gap between the two rails

Konkan Railway scrapped the project in 2013 after a fatal accident. There had been also problems in keeping the trajectory box stable, to keep the gauge with no cross ties and to provide turnouts:

Goa Sky Bus Guideway Trajectory

Aerial Ropeways are suitable for public transport in difficult, densely populated and build terrain. The Austrian Ropeway manufacturer Doppelmayr/Garaventa is worldwide successful in engineering aerial ropeways. In La Paz, Bolivia, they have installed a 30 km public Ropeway Metro System:

"Mi Teleférico" public Ropeway Metro System in La Paz, Bolivia

In India, for several cities public aerial ropeway transport has been proposed as a more cost efficient mode; f.e. for Varanasi and Dehradun:

Artist`s Concept for Dehradun Ropeway Metro

Ground borne variants are **Bottom pulled Cable-Liners.** The most famous Cable-Liner is the 1877 San Francisco Cable-Car, USA:

San Francisco Cable Car, USA

The Bottom Cable-Liner and Cable-Liner Shuttle is a range of Automated People Mover (APM) products designed by DCC Doppelmayr Cable Car for use at Airports, in City Centers, as intermodal Passenger Transport Connections, Direct Air to Rail Transit (DART), in Techno Parks, Park and Ride Facilities, Campuses, Resorts and Amusement Parks:

CLS Cable-Train "Bolivariano" in Caracas; Bolivia

Animation of Bottom Rope pulled Cable-Liner for Luton Airport, UK, under Construction

Funicular Railways are Mountain Railways, where up and down running Trolleys are counterbalanced by a cable running on the top station over a driving wheel. Most famous in India are the Saptashrungi Funicular near Nashik:

Saptashrungi Temple Funicular; India

and the Joginder Nagar Funicular for Material Haulage climbing in 4 sections 1300 m:

Joginder Nagar Material Haulage Funicular

Centre Rail guided Automated and Driverless People Mover, APM, running on Rollways, we find as shuttle services at several airports. Leading global player for APM is Bombardier:

Centre Rail guided Bombardier APM automated People Mover on elevated Right-of-Way Roll-Way

San Francisco INNOVIA APM 100 Air Train;
pict. www.mousetroop.com

Ultra (**U**rban **L**ight **T**ransit) is an automated personal rapid transit **PODCAR** People Mover developed by the British engineering company Ultra Global PRT. The automated and driverless public system opened at Heathrow Airport in London May 2011. It consists of 21 vehicles operating on a 3.9 km route connecting Terminal 5 to its business passenger car park:

Automated Personal Pod Car Transit at Heathrow Airport, London, UK

ULTra Fairwood, an engineering company in India, reached an agreement with the Punjab Government to build a Pod Car Personal Rapid Transit in Amritsar, an Indian city of 1.5 million:

Pod Car People Mover for Amritsar

The system would be based on the pod-car technology of ULTra Global PRT, for Heathrow Airport in London.

With the worldwide evolution of automatic driven cars and buses Feeder **Shuttle Taxis** will also run autonomous and driverless:

German Railway Driverless automated People Mover (APM) *"LOKI"* for first- and last-Mile provided by SIEMENS

Naya Raipur, a well-planned new Community waiting for innovative Transport Modes

Test vehicles are already in operation. Such automatic people movers are a viable and feasible option for emerging Indian "***SMART CITIES" and "Planned Communities***" from the drawing board to bring commuters at Metro-, Railway-, Bus-Stations or multimodal connectivity Hubs fro and back to offices, homes and shopping centres.

In 2015, India's Prime Minister Narendra Modi created the Smart Cities Mission Program, which is an urban improvement initiative. 100 Indian cities were selected to participate in the project after a competitive process, that compared funding with each city's individual ability to comply with the program and reach its goals.

The super-speed **Maglev Train Transrapid** does not roll on wheels; rather, hit hovers above a track guideway using the attractive magnetic force between two linear arrays of electromagnetic coils - one side of the coil on the vehicle, the other side in the track guideway, which function together as a magnetic dipole. During levitation and travelling operation, the Transrapid maglev vehicle floats on a frictionless magnetic cushion with no mechanical contact whatsoever with the track guideway:

Transrapid Maglev on Test Track, Germany

The system had been developed in Germany and marketed by Transrapid International from 1969 onward, a joint venture of Siemens and ThyssenKrupp. In 2002, the first commercial implementation was completed with the Shanghai Maglev Train, which connects the city of Shanghai's rapid transit network 30.5 km (18.95 mi) to Shanghai Pudong International Airport. On 22th September 2006, a Transrapid train collided with a maintenance vehicle at 170 kmph on the test track in Lathen, Germany. This ended the development of the system, that proofed as un-economical.

The German Construction Company Max Bögl launched a new maglev concept for local public transport: Instead of a high speed application, the company envisages low or medium speed, 80 kmph, operation over distances up to about 30 km.

Following the demise of Transrapid maglev technology in Germany Max Bögl later revised the concept and decided to explore its potential. The company built a short test guideway in Sengenthal, not far from Nürnberg, with a view of refining the infrastructure, vehicle and control technology:

M. Bögl low Speed Maglev for Urban Transport

M. Bögl Maglev Trainset ready for Air Lift to China

Worldwide there is great potential for the lowand medium-speed local maglev trains, that can negotiate curves and up- and down gradients. The initial target is China, where the company has found a partner business with a project to build a 3.5 km test installation in Chengdu:

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