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MINISTRY OF HOUSING AND URBAN AFFAIRS
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Heavy LRT
or
Light Rail as a Metro (LRM)

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What is Heavy LRT?

Context – "when old technology is new technology

- - Modern light rail has mainly West German origin (1960/70s)
  - Frankfurt U-Bahn turned 50 years old in October 2018
- Viewed as "tram train" or "train tram"
- There are 1050 rail based systems in world
  - From 410 LRT systems, about **100 systems are Heavy LRT**
  - 14 Heavy LRT systems in Germany: 1400km (+4 Metro:400km, 37 LRT: 1850km, 14 Commuter rail: 3950km)

India: 12 Metro: 440km, 1 LRT: 57km, 5 Commuter rail: 1960km

To meet similar urban mobility issues as Indian cities face now

Asia 20 LRTs (90% in China)

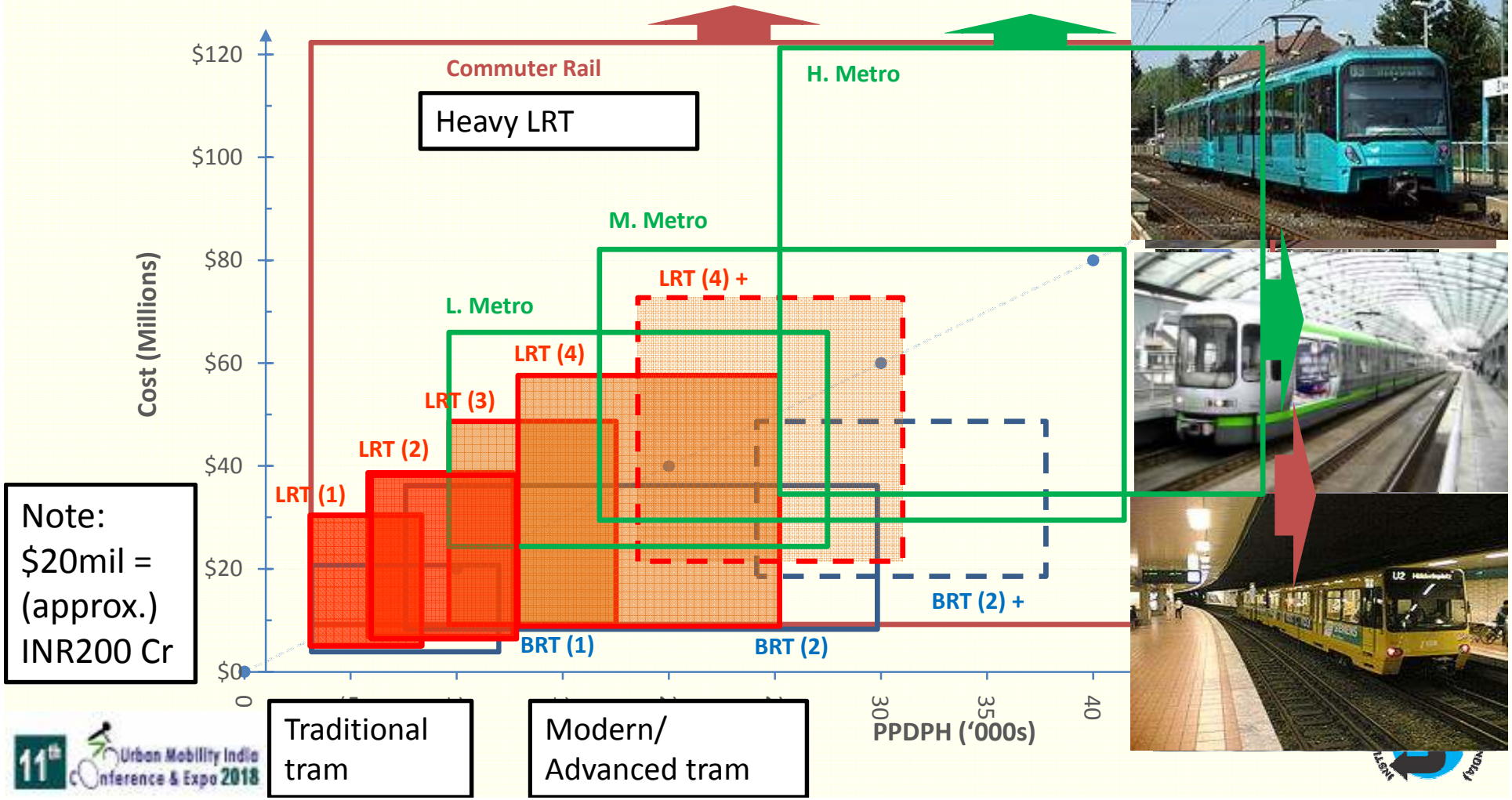
30 new in last 15 years – most in N. America & China

Definition: (Heavy) Light rail

- 1962 (Quinby): Distinct from tradition trams; (i) capacity for more passengers, (ii) appears like a train, (iii) more doors to utilization of space, and (iv) faster and quieter in operation
- Wikipedia: form of urban rail transport using rolling stock similar to a tramway, but operating at a higher capacity, and often on an exclusive right-of-way.

What is Heavy LRT?

How Heavy LRT compares to other Mass Transit Systems



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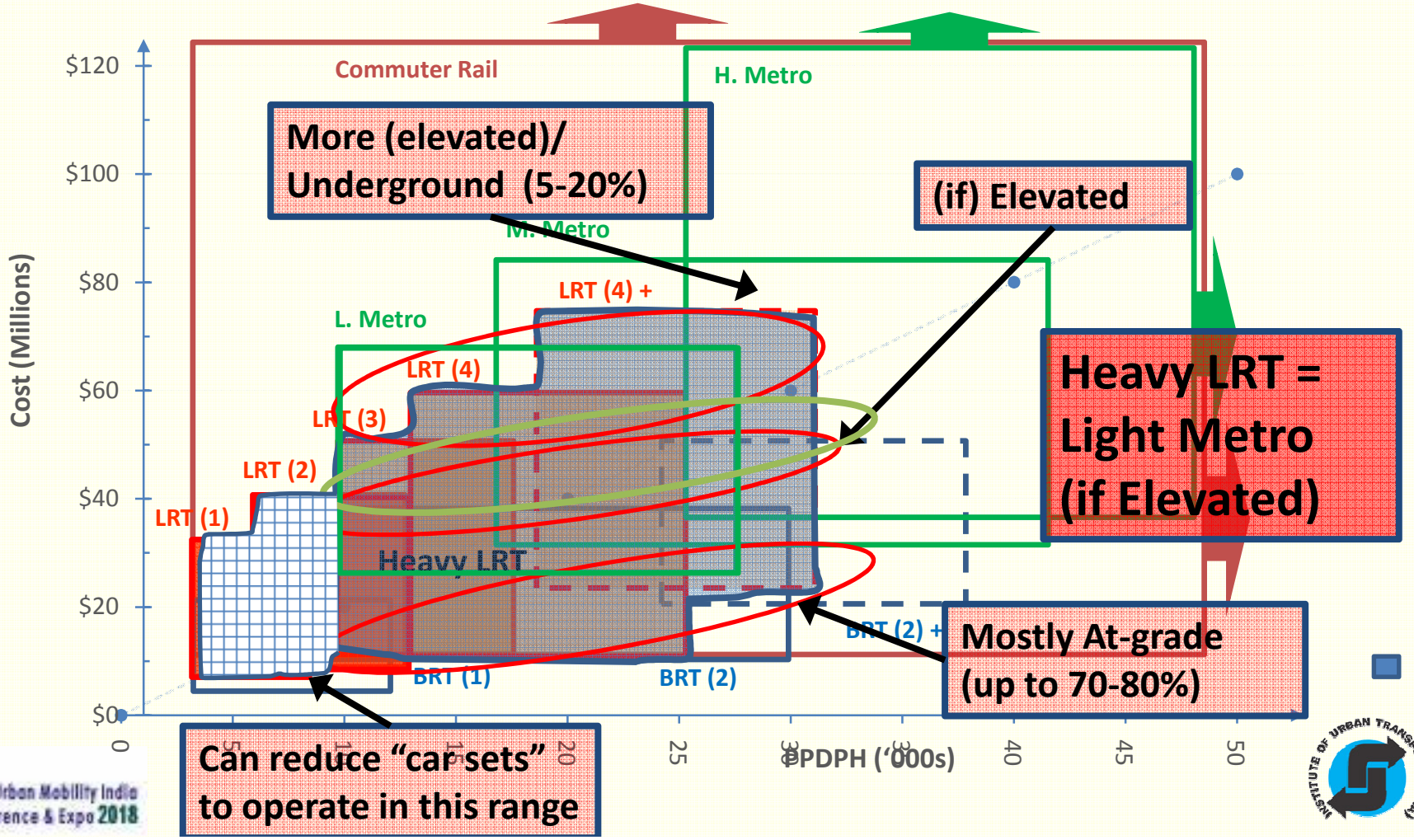


Heavy LRT key features

Degree of segregation with other transport modes

Gives 3 ROW types: (avg. operating speed)

- Separate/Exclusive (30 km/h up to 40 km/h)
- **Segregated (25 km/h up to 40 km/h)**
- Shared (15 km/h up to 25 km/h)

"Typical" Heavy LRT mix

- Separate/Exclusive: <30%
  (elevated/underground <15%)
- **Segregated: >50%**
- Shared: 0-10%

Separate	***Segregated***	***Shared***
		
	Min. ROW 25m (4 lane road) 18m (2 lane road)	Min ROW 12m

Heavy LRT key features

- **Horizontal and vertical alignments**

Horizontal Radii: min 25m (low speed), 50m (norm R

Vertical gradient; maximum 6%, at-grade road in

- **Stations**

Elevated: less complex, smaller, usually lower

At-grade: Far simpler, Access time <5min,, Easy disabled access, less R&R

- **Rolling Stock**

Broadly same physical dimensions/layout as metro (but 2.65m width),

Same operating characteristics, lower axle load, articulated vehicle, modular/sets

- **Systems**

Overhead power (under surface possible), Line of 2) but GoA3/4 being developed, open or closed ticketing

Heavy LRT key features

- **Costs**

Infrastructure: viaduct lower, radius/gradient benefits, axle load: 5-15% savings

elevated stations smaller: 10-30% savings

All at-grade lesser civil: 70-80% savings ($10-15mil/km)

Rolling Stock: vehicle cost similar: +/- 10% (long term)

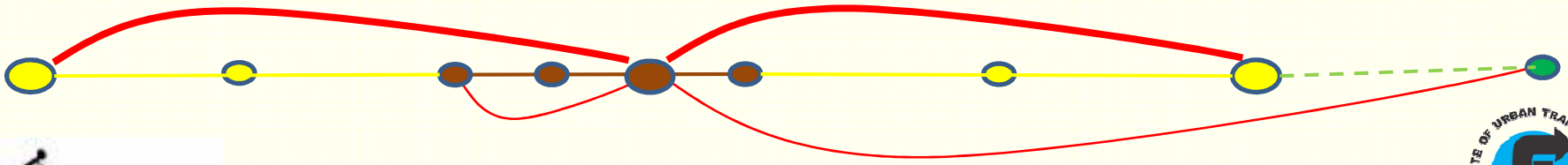
Systems: lesser signalling and communications: 5-10% savings

Other: Land and R&R requirements lower: 10-30% savings

- **Station Planning**

Line operation can be variable

- Central (Inner city/dense urban) - very high frequency, with stops every 300-600 m (tram-like)
- Intra-central (suburban) - high frequency, with stops every 500-1000 m
- Regional (nearby town/smaller urban centres) - medium frequency, with stops every 1.5-3km



Heavy LRT key features

- **Operations**

- Modular – can easily replace defective car from a set.
- Flexible configuration

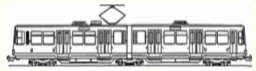
Variability in trainset, from 1 to 4 carriages to meet demand from 5,000 to 24,000 PPHPD

PEAK HOURS (3 or 4 car)

OR

OFF-PEAK HOURS (2 car)

(WEEKENDS: 1 CAR)



- Better access/safety
- Headway of 2min with GoA1 is possible
- Capacity of Intersection crossings
  - Able to handle 1,500-2000 vehicle/lane (75% green time) for LRT at 2 min headway.

M. Metro – smallest size 3 car (65-70m)
L. Metro – smallest size 2 car (40-50m)

More LRT systems (all types) are being established or expanded than new metro systems

Heavy LRT key features

Seeing is believing

Heavy LRT Planning & Design

Poor transport planning (miss options) = sub optimal (costlier) solutions

Ridership of many Metros in India well below forecast (10-40%)

- Theory of demand modelling does not replace reality;
  - Catchment is maximum 1km around station (typical), 0.5km (if access poor)
  - High quality feeder services and NMT connectivity/measures essential to improve catchment area (all parts of user travel must be equal quality)
  - Network coverage and service frequency more favoured over (high) quality
- Typical corridor modelling creates bias in solutions
  - Fewer corridors creates artificial higher demand
- Most medium/large cities (1-3 mil) have 2 or more types of Mass Transit Systems – corridors demand varies
- CMP: should prepare a realistic be long term transport network, not to justify "Phase 1" solution
- When ROW is restricted, elevated/underground should be used!
  - Usually all inner city areas (phase 1?)
  - Do not choose "easy" roads (NH) for elevated if alternative

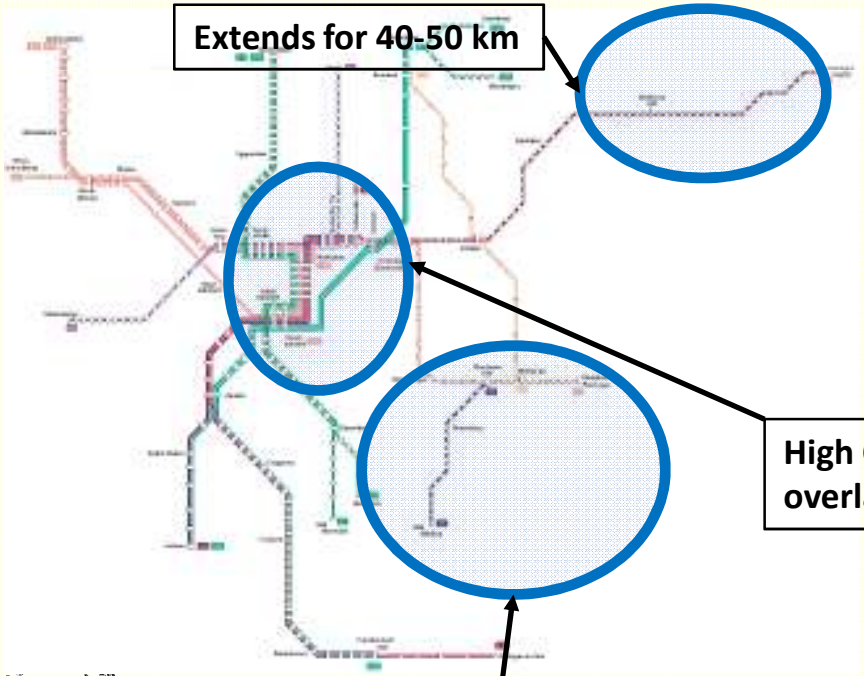
Multiple systems are (slightly) more operational expensive, but cheaper than using wrong system over parts of city

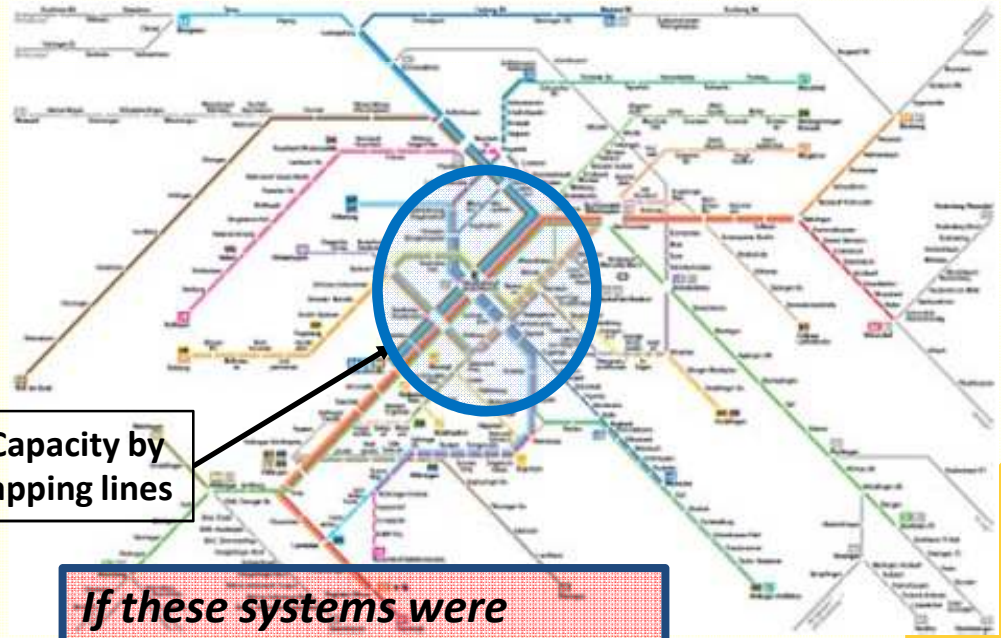
Most Indian cities start at disadvantage: Cannot use existing railway for commuter

Heavy LRT Planning examples

- Usually part of several systems that are integrated (physically and ticketing)
- Overlapping of lines in inner areas to increase capacity, but branch out in outer areas of city

- **KARLSRUHE** **STUTTGART**





If these systems were planned/built like similar India city (1-1.5mil) total length would be 30-40%

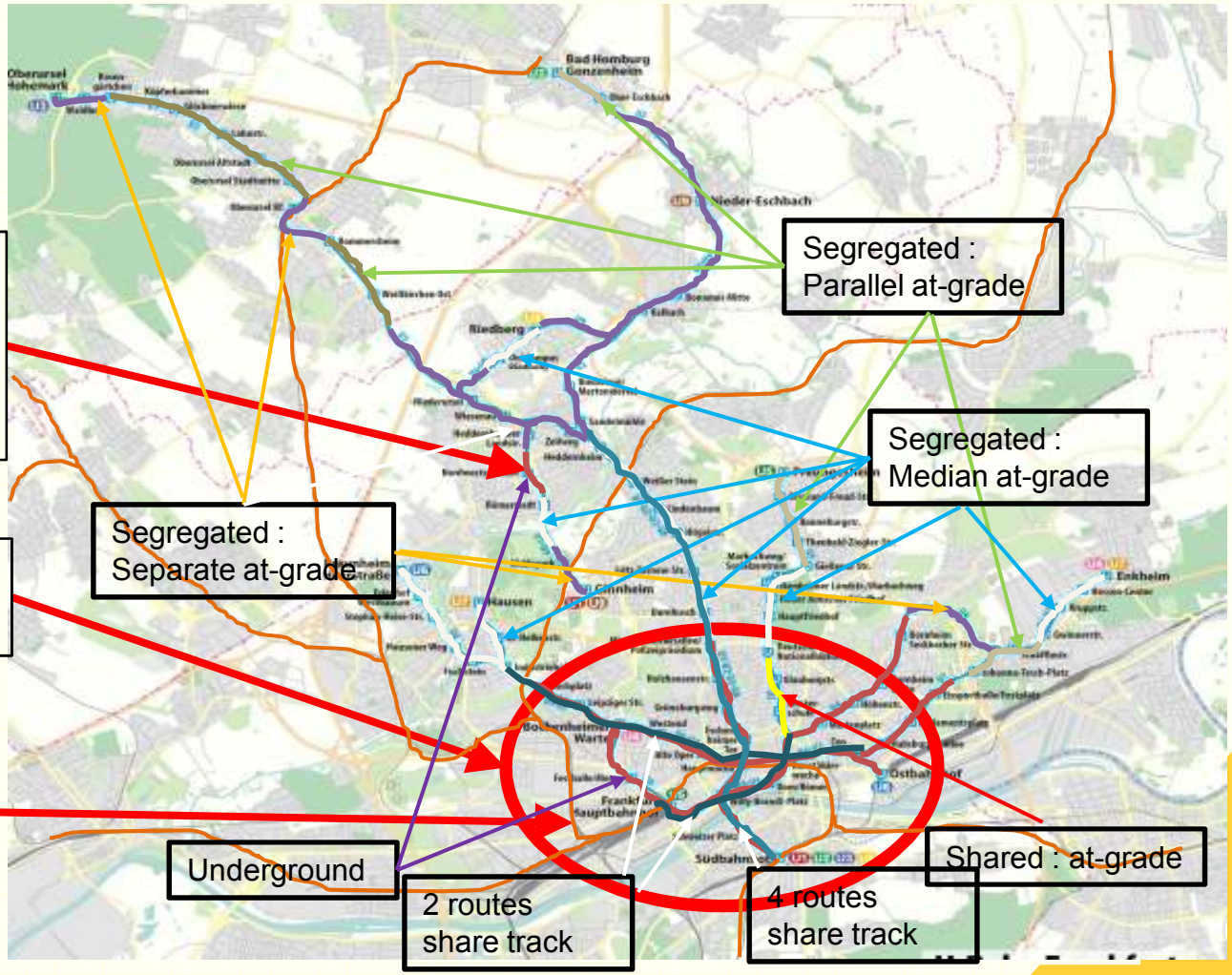
Heavy LRT Planning examples

- Frankfurt (Ubahn)

Heavy LRT (Level III) System
- In most parts of the City
- Connections to Suburbs & nearby towns

Modern Tram LRT (Level I) System
- In Downtown

Suburban/Commuter Rail
- Mainly connecting the Suburbs to Downtown



• Enhancements to Heavy LRT for India

- Gates at road intersection openings (initial 2-3 yrs)
- Higher barrier fence, slight grade difference of running trackway in median
- Intersection breaks only for lower traffic capacity threshold (than developed countries), use of track flyover or underpass for higher
- Stations near intersections/Uturn slots
- Running rails should be open track or greened, not hard surfaced

Example: Guadalajara

If CMP wants >40% public transport road space should be equitably shared. (ROW is for transport, not just roads/private vehicles

Enhancements to Heavy LRT for India

- Anti-Collision Detection systems (available for trams), modified to suit Heavy LRT conditions
- Adaption of developing Autonomous driving system (GoA3/GoA4 capacity)
  [under pilot, available 2021]

Since installed on Frankfurt trams in early 2018 no accidents

- Initial higher enforcement officer presence – and penalization - at "new LRT features" (open road crossings and station) to stop track blockage or poor driver behavior
- Extensive public awareness program – in advance of first line opening

Key Findings for Heavy LRT

- Heavy LRT vehicle allow more flexible and adoptive alignments (due to smaller curves, steeper grades)
- Heavy LRT offer cost savings [over metro] of min. 10-20% but much higher the more at-grade sections are utilized
- Heavy LRT vehicles have significant O&M cost savings (15-20%)
- Cities usually have 2 or more types of rail based systems; for better coverage/frequency >> higher level of service
- At-grade sections increase risk but it is "manageable" and gives 70-80% cost savings and better user accessibility
- Heavy LRT reduces need for few high demand corridors and allows to have more lines with larger coverage area
- Use of Heavy/LRT vehicle on Phase 1 inner city areas on "metro like" separated lines offer more options for future expansion.

Proven cost savings in Indian DPR:

- ***Converting to Heavy LRT vehicle saved 10% (stage 2will be 40%)***
- ***Use of feasible at-grade LRT (35% length) saved 40% total cost***

At-grade problems more complex, solutions more difficult but not unsurmountable – It has been done in many developing countries (why not India?

- ***If not, it will cost 2-3 times to establish same network (= INR 10 Lakh Crore for 150 cities)***

Niti Aayog three year action plan quote (7.39)

"…..Unlike western cities, motorized vehicles in India change lanes with high frequency and in unpredictable ways. This creates unnecessary traffic jams and delays. It may be worth running pilots to see if strict enforcement of traffic rules through fines in case of violations can induce behavioural change and persuade drivers to the benefits of obeying all rules.'…."
"

HEAVY LRT NOT ONLY SOLUTION BUT IT (AND LRT) SHOULD BE PART OF MIX

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THANK YOU

Institute of Urban Transport (India)