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ET3 Global Alliance *'Space Travel on Earth'* TM SM

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Ms. Cynthia Brown
Chief, Section of Administration
Office of Proceedings
Surface Transportation Board (STB)
395 E Street, S.W.
Washington, D C. 20423-0111
Re: California High Speed Rail Project, Your Reference Number- FD-35724-0

Dear Ms. Brown,

We request that the Surface Transportation Board (STB) recognize that the California High-Speed Rail Authority's
(CHSRA) request **is inconsistent with the public convenience and necessity**, and accordingly the STB must deny CHSRA's request for an exemption from STB's oversight during construction and operation of high-speed rail (HSR) in Merced, Madera and Fresno Counties California. We further request that the CHSRA not be granted expedited consideration of any application for for a Certificate from the STB as required by 49 USC, Section 10901.

There are many reasons that HSR is inconsistent with "the public convenience and necessity":
1) Passenger trains are moribund, surviving only because of gross government subsidy.
2) Gross government subsidy for passenger trains chills private investment in cleaner, faster, and lower cost modes such as Evacuated Tube Transport Technologies (ET3)tm (see comparison).
3) Government owned and subsidized monopolies such as Amtrak and the proposed CA HSR are much more anti-competitive than private monopolies. One reason is that HSR's tax footprint is far bigger than the service footprint (proven by the inadequacy of HSR funding plans).
4) No HSR system in the world is capable of recovering any of the train or track construction cost, and most HSR systems must also subsidize operating expense too.
5) Because over 90% of the cost must be subsidized by government, each "high paid HSR job" touted is actually a net drain on resources as it takes the entire tax output from 6 to 10 average Americans to fund each HSR job. [By contrast, privately funded modes produce net income for government.]
6) Professor Kemp of Lancaster University in UK shows that todays fuel efficient cars and jets use less energy per passenger mile than trains or HSR when compared along the same routes, and at the same load factor. http://www.telegraph.co.uk/news/uknews/1465041/Cars-are-more-fuel-efficient-than-trains-claims-study.html
7) Most of the land that the proposed HSR route is prime agricultural land that is more productive than virtually anywhere else in the world. HSR will at once take thousands of acres of this land, and also cut it into small and odd shaped parcels that are difficult (or impossible) to competitively farm. In addition the air blast raises dust and harms crops. HSR is not proposed to offer any cargo service that could offset at least a little of the harm. HSR train sets are likely to be produced outside the US, so in effect CA tax to pay for HSR will produce oversees jobs for foreigners.

There are many reports that cast doubt on the claims of the FRA record of decision. For instance section 4.0 (Alternatives) does not mention that several viable technologies (like ET3) were 'thrown under the train' with no analysis or discussion in the public record. The air quality assessment and measures in 5.2 are totally undefined. Section 5.3 admits "noise will be significant" and most of the

(continued on other side)

route will not get barriers. Section 5.4 is in conflict with Prof. Kemp's study. This is confirmed by Federal Government data at: http://cta.ornl.gov/data/index.shtml . Section 5.5 is false because at grade sections pose grave threat to children playing, and wild or domestic animals that may climb or cross fences. If a truck is so dangerous that it is not allowed to exceed 55mph in CA, why allow 200+mph trains at grade? In section 5.7 -- "full grade separation" is only possible if underground or elevated; however most of the track will be at grade posing risk to ag traffic. Section 5.8 social-economics, communities and environmental justice impacts are highly negative. HSR will create foreign jobs increasing trade imbalance, 100% guide-way and rolling stock subsidy and likely operating subsidy means every HSR generated job will be a tax sink for 6 to 10 average tax payers. 5.9 seeks to displace cars and jets (It is fact that cars and aircraft displaced passenger trains from 90% intercity passenger market share in 1910 to less than 1% today due to vastly higher market value offered by cars and jets). 5.10 brags about low land use, however modes like ET3 would convert less than 1% as much ag land to exclusively transportation use than HSR. Section 7 shows that the vast majority of comments for HSR from the central valley are negative.

Best regards,
Daryl Oster CEO, ET3 Global Alliance
The ET3 Team

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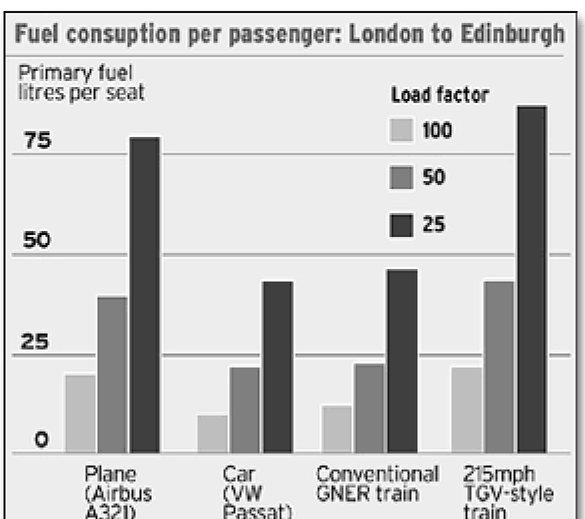
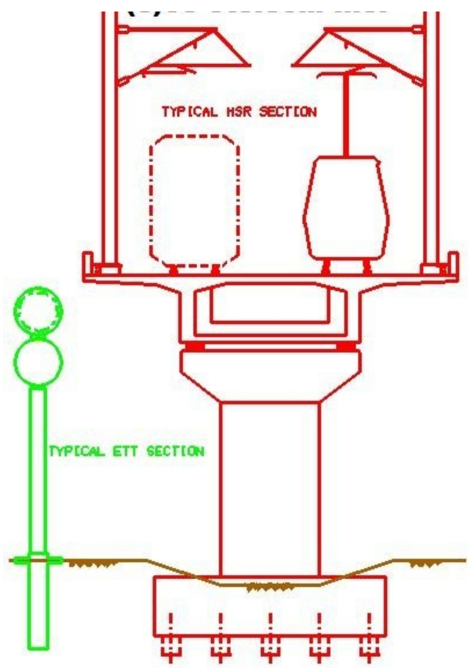
See appended peer reviewed paper contrasting ET3 with other modes.

Graph from Prof. Kemp, Lancaster University





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Evacuated tube transport technologies (ET3)^{tm}: a maximum value global transportation network for passengers and cargo

Daryl OSTER[1*], Masayuki KUMADA[2], Yaoping ZHANG[3]

1. ET3.COM INC., Crystal River Florida 34423-1423, USA
2. Feynman Co. Ltd., 4-5-11 Azuma Tsukuba 305-0031, Japan
3. Institute of Evacuated Tube Transportation, Xijing University, Xi'an 710123, China

Abstract: Evacuated Tube Transport Technologies (ET3) offers the potential for more than an order of magnitude improvement in transportation efficiency, speed, cost, and effectiveness. An ET3 network may be optimized to sustainably displace most global transportation by car, ship, truck, train, and jet aircraft. To do this, ET3 standards should adhere to certain key principals: maximum value through efficiency, reliability, and simplicity; equal consideration for passenger and cargo loads; optimum size; high speed/high frequency operation; demand oriented; random accessibility; scalability; high granularity; automated control; full speed passive switching; open standards of implementation; and maximum use of existing capacities, materials, and processes.

Key words: evacuated tube transport; energy-savings; high speed; cargo; passenger; optimization; global; network

1. Introduction

Think about this: No Form of transportation in our universe is older, more proven or more efficient than what we are proposing. Our planet itself has been traveling this way for all of recorded history, and it works successfully. Average world citizens travel at least 300 billion km in orbit during their lifetimes without expending any fossil energy to do so.

2. Overview

The scientific principals of ET3 are highly proven. ET3 is literally "Space Travel on Earth" where car sized passenger capsules travel in 1.5 m (5') diameter tubes on frictionless maglev (magnetic levitated vehicle). Air is permanently removed from the two-way tubes that are built along a travel route. Airlocks at portals allow transfer of capsules without admitting air. Linear electric motors accelerate the capsules, which then coast through the vacuum for the remainder of the trip using no additional power. Most of the energy is regenerated as the capsules slow down where kinetic energy is converted to electric power through electromagnetic induction. ET3 can provide 50 times more transportation per kWh of electricity than the most efficient electric cars or trains.

ET3 is networked like freeways, except the capsules are automatically routed from origin to destination. Speed in initial ET3 systems is 600 km/h (370 mph) for local trips. This will be developed to 6 500 km/h (4 000 mph) for international travel that will allow passenger or cargo travel from New York to Beijing in 2 h. Velocity may even extend to that of a rocket in future.

ET3 capsules weigh only 183 kg (400 lbs), yet like an automobile, can carry up to six people or 367 kg (800 lbs) of cargo. Compared to high-speed-rail (HSR) trains, ET3 needs less than 1/20 as much material per passenger because the capsules are so light.

Automated passive switching at the full design speed allows a 600 km/h ET3 route to exceed the capacity of a 40 lane freeway thus producing further economy. This exceptional capacity can be leveraged to carry water, sewer, oil, gas, and garbage, etc., all in special capsules. For cargo, the capsule can accommodate up to three Euro pallets (0.8 m wide, by 1.2 m long, by 1.0 m high). The ability to consolidate different utility needs into the same right-of-ways creates great economy of scale. ET3

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*Corresponding author. E-mail: et3@et3.com (D. OSTER)
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Table 1 Evacuated Tube Transport and Transrapid Comparison

	CATEGORY	ETT	TR	UNIT	Factor
Performance	Operating Speed used to compare	500	500	km/h	1.0
	Switching Speed	500	200	km/h	2.5
	External Sound Level	20	90	dB	128.0
	Time to top speed	20	256	seconds	12.8
	Distance to accelerate	1.13	22.6	km	20.0
	running resistance per seat	1.05	200	Newton	190.5
	Specific Energy Consumption	0.98	52	Wh/seat-km	53.1
	Carbon dioxide emission	0.622	33	g/seat-km	53.1
	Min suspension gap	6	10	mm	1.7
	Min radius at 500km/h	1950	6200	m	3.2
	Safe Headway	0.125	147	seconds	1,176.0
	Switch cycle time	0	30	seconds	
	Maximum power required	1	12	MW	12.0
	Kinetic Energy	1.45	329	kW-h	226.9
	Specific KE per seat	0.242	1.79	kW-h/seat	7.4
	Life-support Recharge / seat	50	N/A	Wh/seat	
	Pumping Energy /seat / km	0.72	N/A	Wh/seat/km	
	Cooling Energy / seat	50		Wh	
Vehicle	Empty weight- passenger service	0.2	106	ton	530.0
	Passengers	6	184	seats	30.7
	Empty wt / seat	0.033	0.576	ton	17.5
	Gross weight	0.6	136	ton	226.7
	Height	1.3	4.2	m	3.2
	Gross mass / length	0.15	2.52	ton/m	16.8
	Seat pitch	1.5	1	m	1.5
	Seat width	0.6	0.5	m	1.2
Guideway	Tunnel Crossectional area	12.6	225	m^2	17.9
	2-way width	1.8	7.9		4.4
	Mass of 24m span	13	350	ton	26.9
	Mass of typical support	2	90	ton	45.0
	Land use	525	2100	m^2/km	4.0
Cost (cost study in 2003 $)					
	Guideway cost per km	$1.25	$17	$M/km	13.6
	Guideway maintenance	0.12	0.53	cents/seat-km	4.4
	Vehicle cost per seat	$4,700	$61,000	$/seat	13.0
	Vehicle maintenance	0.07	0.27	cents/seat-km	3.9
	Station and Switch Cost	7.3	175	$millions	24.0
	Station Capacity	700	14400	person/hr	20.6
	Station Cost / capacity	$10,429	$12,153	$/person/hr	1.2
Ticket Cost at 6000 rnd trps/day use 800km trip					
	Guideway cost for 800km	$1,000	$13,600	$millions	
	Vehicle cost 1200 seats needed	$5.64	$73.20	$millions	
	Station cost (2 minimum)	$14.60	$350.00	$millions	
	Total	$1,020	$14,023	$millions	
	10%of capital cost/trips per year	$47.23	$649.22	per round trip	
	Plus energy cost	$0.21	$8.68	per round trip	42.3
	Plus Maint Cost	$0.68	$2.69	per round trip	
	Plus misc. operating expense	$1.00	$1.00	per round trip	
	Total Round trip Ticket Price	$49.12	$661.59	Ticket price	13.5
	Total cap cost for 12000 trips / day	1025.88	14096.4		
	10%of capital cost/trips per year	23.747222	326.30556		
	Total ticket price	$25.63	$338.67		13.2
	Total cost for 24000 trips / day	1046.12	14169.6		
	10%of capital cost / trips per year	12.10787	164		
	Total ticket price	$13.99	$176.37		12.6
	per km cost	$0.0087	$0.11		12.6

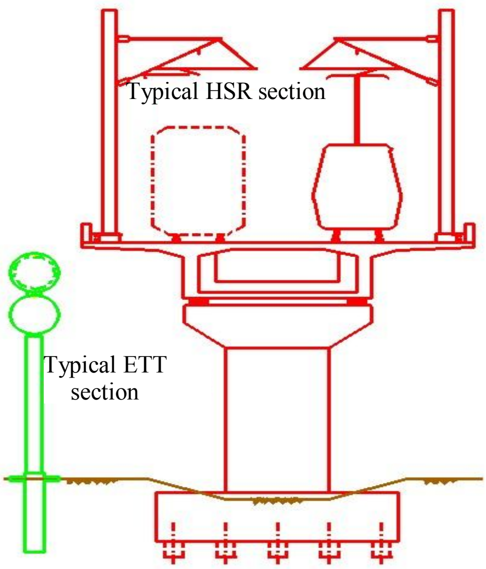

Fig. 1 ET3 compared with HSR

can be built for 1/10 the cost of high speed rail (HSR), or 1/4 the cost of a freeway.

The performance comparison of ET3 with a maglev train is shown in Table 1, section view in Fig. 1.

A studious review of ET3 will reveal that the environmental impact is a quantum level improvement over status-quo modes in almost every measure. ET3 technology represents obvious environmental advantages. For example:

• ET3 will be virtually silent (sound cannot be transmitted in a vacuum).

• ET3 will not cause ground vibration like trains (an advantage of the light weight).

• The path of ET3 capsules is fully isolated within the tube guideway, and therefore it is impossible for birds, animals, or people to be in conflict with the path of the capsules.

• ET3 power supply requirements are advantageous by several orders of magnitude. Once the ET3 capsules reach top speed, they coast without further power application. By contrast, HSR requires 12 MW power supply along the entire guideway.

• Much of the electrical energy used to accelerate the capsules can be recovered when the capsules slow down (Energy Recovery System), the energy may be used to accelerate outbound capsules, stored in a flywheel, or used in the power distribution grid.

• Because ET3 uses electrical energy and the consumption per passenger/mile is less than 1% of an electric train at the same speed, ET3 will not have a negative impact on air quality if renewable sources are used.

There will be a positive effect from reducing automobile and aircraft pollution and Green House Gas (GHG). In fact, ET3 can play a key role to meet Kyoto Protocol by eliminating over 90% of fossil energy use for transportation.

3. Safety

Transportation safety is a matter of controlling all travel variables. Only ET3 offers the ability to tightly control them. Conditions inside the guideway tubes are absolutely governed at all times so that optimal conditions for efficient travel always exist. By comparison, trains, cars and aircraft travel in the natural environment where the existence of adverse weather conditions, obstacles to travel (like animals or pedestrians, etc.), cause frequent safety problems.

The US government website www.bts.gov shows that flying in a commercial airline is about 18 times safer than driving the same distance by car. Let's compare the safety of ET3 with jet aircraft. The greatest risk factor of aircraft accidents is human error.

ET3 virtually eliminates this problem through automation. The second largest safety issue with aircraft is bad weather, also mitigated by ET3. The third major cause of air accidents is mechanical failure. Some of the more common causes are: engine malfunction, fuel system problems, fouled controls, structural and landing gear failure, instrument errors, and loss of pressurization. Because ET3 is less complicated by several orders of magnitude, mechanical failures are virtually eliminated.

The most significant risk that applies to ET3 and aircraft is pressure loss in the capsules. Sudden loss of pressure in an aircraft will cause loss of consciousness of the crew within a few seconds. This is known to have been the cause of at least two aircraft accidents. Aircraft are at far greater risk of sudden pressure loss than ET3. Aircraft pressure-holding structure has many points of likely failure, such as: extreme and variable aerodynamic forces, temperature extremes, vibration, air turbulence, bird strikes, hail storms and ice formation, high G force loading, hard landings, etc. By contrast ET3 operates in controlled conditions at all times, and has much less opportunity of failure. ET3 is also built to 3 times higher margin of safety than aircraft. In the rare event of cabin pressure loss, aircraft must descend thousands of feet before enough air is available for survival. In the rare event of catastrophic emergency with ET3 the affected branch can be isolated with gate valves and, air can be admitted along the entire section. This can occur in a fraction of the time it takes an aircraft to reach safe conditions. This air is metered to quickly slow the capsules and cushions any collisions, as well as provide a breath of fresh air.

In non-failure emergency stop, a capsule experiencing a problem may exit at any access portal or be diverted to an appropriate place equipped to deal with the emergency.

4. Enabling technologies

4.1. Magnetic levitation (maglev)

ET3 can use any type of maglev. The cost will be less than 1/10 the cost of using maglev to levitate 100-ton trains. ET3 capsule weight per unit of length is less than 1/15 that of a train so much less material is needed for ET3.

The High Temperature Superconductive Maglev (HTSM) invented by Professor Wang at Southwest Jiaotong University (SWJTU) [1] and preferred for use in ET3 has safety and cost advantages compared with other maglev systems. HTSM is not reliant on motion, external or internal power, or electronic control to maintain stable levitation. The capsule will levitate indefinitely as long as the HTS bulks are kept in a superconductive state by coolant. The record holding Japanese superconductive maglev system relies on liquid helium temperatures of only a few degrees above absolute zero. By contrast HTSM requires only common (and safer) liquid nitrogen temperatures. Liquid Nitrogen is less than 1/100 the cost of liquid helium. The cooling requirements for ET3 are met by carrying enough coolant to keep the HTSM cold enough to levitate during the entire trip, plus a reserve for safety.

The first passenger HTSM developed at SWJTU in China is safely carrying thousands of passengers without failure. The prototype will maintain levitation for more than 6 h on a single coolant charge. It takes less than $5 worth of liquid nitrogen to charge the prototype. Because ET3 operates in a vacuum, the HTS material will absorb less heat and require less coolant than the first prototype HTSM developed in China.

To reduce the vehicle cost of HTSM some of the HTS material can be replaced with permanent magnet (PM). Tusada [2] shows the levitation force in a PM-PM system is three times larger than the force in the HTS-

PM system, so the levitation force in the hybrid system was larger than that of the HTS-PM system. Stable levitation was achieved in the hybrid system because repulsive force in the PM-PM system against horizontal displacement was much smaller than restoring force in the HTS-PM system. To reduce guideway PM cost; the HTS (and hybrid PM) should be along the entire length of the capsule to reduce the PM section in the guideway. The PM configured in a Halbach array [3] optimized to focus the magnetic field such that less PM is used in the guideway. There might be a possibility that even permanent magnet can be cooled at low temperature by a metal conductor cooling in vacuum. Its temperature coefficient is about 0.1%/degree of Br and 0.5% of Hc. This means At -75 degree C, the Br increases by 10%, and Hc increases by 50%. Finally, the levitation height is optimized to minimize the sum of PM cost and alignment system cost.

4.2. Automation

Automation has been largely responsible for most of the labor productivity and quality gains made in telecommunications during the last 30 years. Consider the electronic control system - used to levitate the world's first maglev train in revenue service In Shanghai China. The system turns an inherently unstable magnetic attraction into a stable one. Controlling the position of the train within a millimeter in mid air (by rapidly changing the magnetic force) is something no human could manage for a few seconds, let alone for an entire trip. Many aircraft also rely on ultra-fast sensing and decision making computer capabilities to achieve stability (also impossible for human operators). Technology capable of controlling ET3 is a commodity.

The ET3 control system is very simple by comparison and can be implemented without computer control (although computers will be used to enhance safety and add functionality). ET3 functions like an industrial or amusement park conveyor system on a larger linear scale. The system will be wired so that out-of-time launch of capsules is not possible. Our computer simulations operate reliably. There is little reason to expect that the actual system will function differently. ET3 can be viewed as a simple conveyor inside a tube with maglev replacing the rollers, and linear motor replacing the drive belt.

4.3. Vacuum systems

Vacuum production is a well developed industry. Vacuum flask insulation bottles that keep liquids hot or cold for long periods of time have a thin shell containing a medium grade vacuum; they function for years if not damaged by abuse. Televisions and CRT screens require much higher vacuum quality than ET3. If all the TVs, CRTs and vacuum flasks in the world were lined up in a row, they would circle the globe and be able to function for years without additional evacuation pumping. The ET3 tube structure has a more favorable volume to surface area ratio than vacuum flasks or TV tubes. The optimum vacuum level for ET3 is selected to minimize transportation cost, at some point the reduction in aerodynamic drag energy is offset by vacuum production energy. This optimum varies according to use factor and design speed. Minimizing leaks minimizes vacuum energy requirements. Coating and sealing technologies have developed to the point that leakage is virtually eliminated. A vacuum level in the range of 10 microbars down to 100 nanobars is estimated to be a sufficient range for most ET3 branches. Particle accelerator experts agree that the vacuum requirements for ET3 are easy to achieve and maintain compared with the high grade vacuum needed by linear accelerators or cyclotrons/synchrotrons [4].

ET3 capsules carry no propulsion fuel and have no lubrication needs. The chance of an ET3 derailment is virtually zero since the guideway is fully constrained. In the unlikely event that cargo contaminants are released from a capsule, the tube guideway structure provides a secondary containment barrier. Compared to typical HSR, the contamination possibilities of ET3 should prove 2 or 3 orders of magnitude less.

5. Maximizing ET3 value

Transportation value is maximized through efficiency of: materials, energy, labor, and time. This is ensured by finding the ideal balance where the benefit/cost ratio is maximized. Simplicity of low parts count, fault tolerant systems (with appropriate redundancy in critical areas), result in great safety and low cost too.

5.1. Size really matters, it is the most important thing to optimize to maximize value

The main reasons trains and aircraft are so big is to minimize labor cost, and aerodynamic drag per passenger (or ton). If one does not have to pay an operator, most of the advantage of large vehicles (like buses, jets and trains) vanish. ET3 is automated, so labor cost is minimized without the necessity of using large vehicles.

ET3 cost is very sensitive to tube diameter. The material use varies with the diameter squared, and the tooling cost increases rapidly with scale factor so that the cost is roughly according to the diameter cubed. If ET3 capsules and tubes are built too large they will cost too much to achieve maximum transportation market share.

If ET3 is too small it cannot haul large enough cargo items or achieve comfort levels required to reach maximum network expansion. If several sizes of ET3 systems are built, they cannot be effectively networked together under one global standard offering seamless point to point service.

The optimum size is such that the ultimate global market share of ET3 will be maximized. Cargo and passenger movement have equal importance. About half of the \$8.65T that is spent globally on transportation in a year is to move people, the other half to move cargo. ET3 gives equal consideration to efficiency and effectiveness of passenger and cargo movements. Our studies show that about 94% of cargo can be hauled in an ET3 capsule having about the same volume as a van, pickup or large SUV, happily it turns out that this size vehicle is the most popular conveyance for people too.

The automobile has won the global transportation market. Cox [5] Shows over 80% of passenger travel in the USA is automobile, over 70% in the EU, and over 60% in Japan. In China auto use is growing twice as fast as the economy, and is rapidly taking market share from trains and buses. The size of the automobile is highly optimized by hundreds of years of market forces. People vote on the optimum balance of vehicle utility and cost with the money they spend to purchase and operate the vehicles [6]. The US EPA shows that automobile volume of all cars sold in the USA is 108.3 ft^3 with a standard deviation of 16 ft^3. Fig. 2 shows load capacity rank.

Our studies of cargo show that most goods shipped in containers are palletized or in cartons. If an ET3 capsule were a few cm smaller than optimum it would not be able to accommodate very common cargo items. Sheets of building materials, refrigerators, ovens, and furniture items that people commonly move would not fit. The cargo utility (measured as a percentage of all cargo items) increases rapidly with diameter. At about 1m diameter over 70% can be accommodated, and by 1.3 m, about 94%. Our research shows that an automobile sized ET3 capsule of 1.3 m (51″) diameter and 4.95 m (16.2') long accommodating up to 6 adults, (or 3 pallets) can displace over 90% of present global transportation of people and goods. Cost studies show that the cost to make ET3 capsules and tubes large enough to accommodate standard 40' shipping containers would increase the cost by a factor of 30, but the utility would only increase from 94% to 98% of cargo accommodation

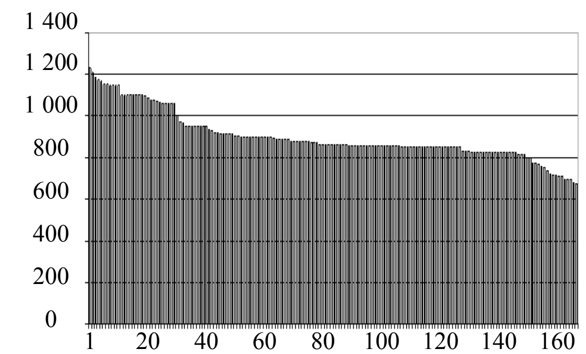

Fig. 2 US automobile load capacity ranking, mean = 858 lb, sd=114 lb for the 200 models sold in the USA

5.2. Fast is better than slow

For inspiration we recognize that friction free travel conditions of galactic orbit is proven. ET3 is 'Space Travel on Earth' ™. As soon as 2020 the average person will be able to travel between almost any major city on earth in less than 4 h. In addition, the average time to get to an access portal will quickly drop to about 15 min., and eventually to less than one minute. According to US based Walmart, 90% of the population of the USA is within 15 minutes of one of their stores. Fast also relates to capacity. A fast vehicle can carry make more trips than a slow one. Small (and low cost) vehicles at high frequency and speed can carry more than massive (and expensive) ones.

Speed is also costly, but less so for ET3 than other modes. Unlike human controlled cars on freeways, ET3 capacity increases with speed, this capacity improvement offsets much of the cost increase associated with higher design speeds. Fig. 3 shown demand for speed, Table 2 shows several speed related variables and constraints.

5.3 Demand oriented transport

Dense urban living has high costs for inhabitants and environment. The footprint of cities extends far beyond the official city limits (as countless military sieges have proven). Urbanites depend on long haul cargo. Food

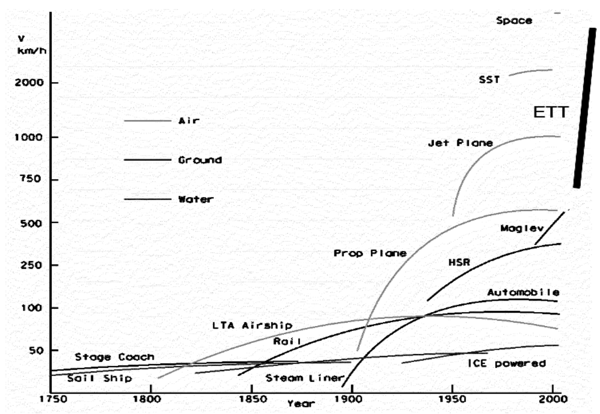

Fig. 3 The history of speed demand

movement depends on speed to ensure consistent quality and minimize spoilage. ET3 will allow people to efficiently and sustainably live and work where they want to, (instead of where the train tracks are). This is what we call "Demand Oriented Transportation" or (DOT)–the opposite of Transit Oriented Demand (TOD) [7] a set of codes forcing people to live at unhealthy high densities so they may be served by trains.

The US interstate highway system only represents

Table 2 Evacuated tube transport (ETT) energy and accelerations for 550 kg gross capsule mass

Design speed		1 *g* acceleration		Curve radius	Kinetic energy		Maximum capacity	
(kph)	(m/s)	Time (s)	Distance (m)	(m)	(kWh)	40 t truck @ 115 kph	Passenger (person/h)	Cargo (t/h)
200	56	6	157	315	0.2	5%	80 000	5 333
225	62	6	199	398	0.3	6%	90 000	6 000
250	69	7	246	492	0.4	7%	100 000	6 667
275	76	8	297	595	0.4	9%	110 000	7 333
300	83	8	354	708	0.5	11%	120 000	8 000
350	97	10	482	964	0.7	15%	140 000	9 333
400	111	11	629	1 258	0.9	19%	160 000	10 667
450	125	13	796	1 593	1.2	24%	180 000	12 000
500	139	14	983	1 966	1.5	30%	200 000	13 333
550	153	16	1 190	2 379	1.8	36%	220 000	14 667
600	167	17	1 416	2 832	2.1	43%	240 000	16 000
650	181	18	1 662	3 323	2.5	50%	260 000	17 333
700	194	20	1 927	3 854	2.9	59%	280 000	18 667
750	208	21	2 212	4 424	3.3	67%	300 000	20 000
800	222	23	2 517	5 034	3.8	76%	320 000	21 333
900	250	25	3 186	6 371	4.8	97%	360 000	24 000
1 000	278	28	3 933	7 865	5.9	120%	400 000	26 667
1 100	306	31	4 759	9 517	7.1	145%	440 000	29 333
1 200	333	34	5 663	11 326	8.5	172%	480 000	32 000
1 300	361	37	6 646	13 293	10.0	202%	520 000	34 667
1 400	389	40	7 708	15 416	11.6	234%	560 000	37 333
1 500	417	42	8 849	17 697	13.3	269%	600 000	40 000
1 750	486	50	12 044	24 088	18.1	366%	700 000	46 667
2 000	556	57	15 731	31 462	23.6	478%	800 000	53 333
2 250	625	64	19 910	39 819	29.8	605%	900 000	60 000
2 500	694	71	24 580	49 159	36.8	747%	1 000 000	66 667
2 750	764	78	29 741	59 483	44.6	904%	1 100 000	73 333
3 000	833	85	35 395	70 789	53.0	1 076%	1 200 000	80 000
3 500	972	99	48 176	96 352	72.2	1 464%	1 400 000	93 333
4 000	1 111	113	62 924	125 848	94.3	1 912%	1 600 000	106 667
4 500	1 250	127	79 638	159 276	119.4	2 420%	1 800 000	120 000
5 000	1 389	142	98 319	196 637	147.4	2 988%	2 000 000	133 333
5 500	1 528	156	118 966	237 931	178.3	3 615%	2 200 000	146 667
6 000	1 667	170	141 579	283 158	212.2	4 303%	2 400 000	160 000
6 500	1 806	184	166 159	332 317	249.0	5 050%	2 600 000	173 333
7 000	1 944	198	192 705	385 409	288.8	5 856%	2 800 000	186 667
7 500	2 083	212	221 217	442 434	331.5	6 723%	3 000 000	200 000

Remark: 1*g* lateral acceleration = 45 degree bank angle. Capacity calculated at 6 persons per capsule, or 0.4 t/capsule at a capsule pitch of 15 m (3:1 safety factor). The clearance for fixed maglev components limits curve radius (shown in red) to 600 m UNLESS vertical load is reduced. Federal Aviation Regs state bank angle under 60 deg is non-aerobatic.

2% of the kilometers of paved road, yet it carries about 60% or road based cargo and passengers. ET3 is analogous, a global "backbone" (Fig. 4) of less than 50 000 km operating at a design speed of 6 500 km/h could connect national ET3 branches, and eventually carry at least 20% of global travel, and likely over half.

Control should not require continuous effort. Wouldn't you rather interface with a 24 inch HD touch screen while kicking back in a posh recliner, than driving in heavy traffic while trying to see what is on a cell phone screen? We plan to fuel greater innovation through free, open source platforms provided by big name brands that most of us already trust and use. Not only will this benefit consumers with relevant timely information and more choice, it opens up revenue opportunities for advertisers, carriers, manufacturers and developers along every route. Unlike in an airliner, or train, if we see something interesting en-route via ET3, we are in control and can stop to check it out. This control factor is one of the reasons cars use is growing so much faster than train or bus use.

6. Business model

Creating a reasonably high Return on Investment (ROI), and an easy pathway for participation are the keys to attracting international investment and cooperation around a global standard. Proof of this is the $billions invested in the global Internet system – accessible anywhere because it is built on the same set of standards. We must invest the limited global resources and time to yield the greatest long term benefits for ourselves, our families, our nations and our world.

Another way to reduce costs is to maximize the use of past investments that have already recovered their cost. This may be accomplished with an open consortium business model where stakeholders collaborate on planning, production, and standards, using parallel processes, existing capacities, and leveraging past investments. For instance many companies have collectively invested billions of dollars in production capacity and technology that are already used to produce parts that can be directly used in ET3 systems.

A consortium business model that is fair and transparent, and allows private ownership incentives, will be competitive, whole and balanced. The competitive measurements and comparisons must focused on value. An open philosophy facilitated with universally accessible web-based tools for community cooperation is proven in many fields such as open source software developments.

All of us can make money through serving the greatest good. ET3 can accomplish 50 times more transportation per kWh than the most efficient electric car or train. Also, ET3 can reduce infrastructure cost up to two orders of magnitude. And transportation is the biggest growth market in the world. This ensures there will be plenty of profit potential as ET3 displaces present transportation. ET3 can be built mostly with existing production capacity, processes, technologies, and materials. Those who have the capacities, and make the investments will at once: lower consumer costs, increase jobs, increase revenue and ROI for much greater profits, and greatly stimulate the global economy with the cascading benefits.

Growing Two Long Tails [8]. Everyone in the world has potential to contribute to ET3 (much like "open source" software development, either as developers or consumers) to achieve ET3 implementation for mutual benefit. The ET3 consortium is open (similar to "open source"), to leverage the "long tail" (see Fig. 5) of modest contributions from many; and also recognizes that there is another "long tail" to leverage–past investments made for other purposes. Much of the long tail of past investments cannot be captured with typical "open source" or "chaordic" principals [9]. To leverage the best commercial inventions, IP rights must be respected, and profit motives incentivized.

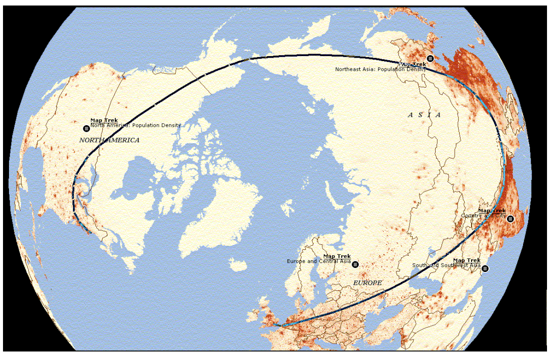

Fig. 4 Population and production centers connected by a global ET3 "backbone"

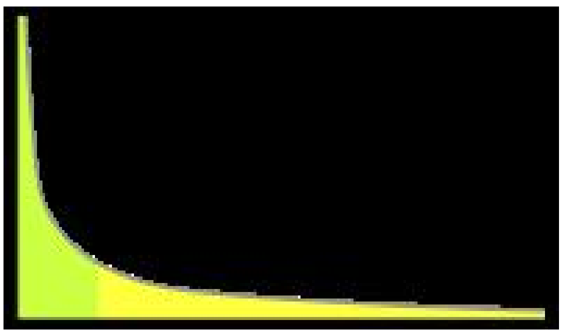

Fig. 5 Power law: the long tail to the right, to the left the few that dominate. The areas of both are the same

7. Some impacts of ET3

7.1. Adding value to a national capital

Think of Tokyo in Japan. It holds 1/10 of the population of whole nation in a radius of only 15 km or so. The center of Tokyo is the Tokyo station. The Emperor's Castle is just a hundred meter away from it. The shinkansen (bullet train) starts in Tokyo and extends to Aomori up north, Kyusyu down south, and Niigata to the west. Shinkansen is the safest and fastest (250 km/s or so) train of conventional transportation. Tokyo is the safest mega city in the world. The land cost is so expensive that most people can not afford to live in the city center. So people commute mostly by train. The commuting range is about 70 km or so. It takes about 2 h from door to door. It is not a big distance. NIRS where I used to work was 60 km away from my home. I took a car. It took more than 2 h one way. I spent 4 h a day for commuting. I worked such a way for 17 years.

With ET3 we will have a revolution in our lives. When ET3 connects Tokyo Station and Tsukuba science city where I live, I can reach Tokyo in 10 min. Tsukuba will become a backyard community of Tokyo Station. This means that Tokyo can extend its backyard to 60 km distance to west, to the north, to the east.

It is not just about a backyard of Tokyo. Hokkaido is a vast land. Rich nature is reserved. Land is vast, plenty of fresh water, delicious seafood. With ET3, Hokkaido can be a residential area to Tokyo station of within 20 min range. The whole nation of Japan can be connected within a hour. That is a true revolution in transportation. Only ET3 can enable such a revolution of life style. This revolution could happen in major cities of other countries, like Paris, London, Madrid, or Rome.

7.2. A new silk road in Eurasia continent

A mega highway project is proposed between China, the Mid-East, and Europe called "the new silk road" to connect them. The concept is right but the transportation method is obsolete and not environmentally responsible. It consumes oil in vain. It would create a traffic jam all along the super-long silk road as the economy grows. Nature will be destroyed. Our civilization is in crisis. Only ET3 can bring a resolution of sustainability in the three critical areas of economy, ecology, and energy. See Fig. 6 as a global extension of the 'silk road' concept, but with ultra clean ET3 technology.

7.3. Fresh ice and water transportation

Natural resources are not evenly distributed. The scorching hot desert nations have oil to burn, but there is little fresh water to sustain life. Fresh water supply is the critical factor limiting city growth. Enormous quantities of fresh water (mostly in the form of ice) are in the most remote and inhospitable places like Greenland, the north pole or south pole. ET3 can carry them in a flash of time. Fresh ice can be served to Beijing or Arabic countries on demand. Japan has a lot of fresh high quality water all over the country. ET3 can provide high quality fresh water on demand to parched cities.

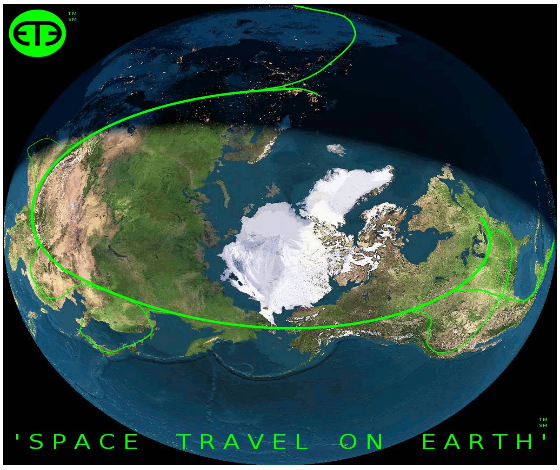

Fig. 6 A world connected by ET3

8. Conclusions

Great just isn't good enough. Dissatisfaction with the way things are, and knowledge of the perpetual motion transportation example proven in planetary orbits becomes the driving force behind optimizing 'Space Travel on Earth' to achieve the ET3 vision. We can profit, for ourselves, our children, our nations, and world. Adopting the best transportation practices and methods like ET3 (and letting the status-quo "following" modes fall away) will ensure the advancement of global prosperity.

ET3 will create expanding potentials for several generations. The first nations to implement ET3 will invigorate their economies, then the focus will shift to the enormous opportunity of accelerating the sustainable development of nations now in poverty. ET3 will allow sustainable prosperity to take root in developing nations at a much faster rate. This will improve peace, green the earth, arrest population explosion, and create an age of global prosperity.

The need for transportation crosses all borders. To facilitate ultra efficient and effective transportation for the entire world, we must employ open standards that may be continuously improved, and not encumbered by old ways that are no longer sustainable. We should never restrict ET3 based on: sex, age, race, religion, nationality. We aim to provide the ET3 IP and standards in as many languages and accessible formats as possible. We believe that ET3 will greatly increase the present peace that more than 99% of the world's population enjoys more than 99% of the time.

Acknowledgements

There are presently more than 95 licensees who have contributed to or support the ET3 body of knowledge.

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(Editor: Dongju CHEN)

Evacuated Tube Transport Technologies (ET3) ™ Energy and Accelerations for

550 Kg Gross Capsule Mass

Design Speed			1 G Acceleration			curve radius @		Kinetic Energy		Maximum Capacity		#Airlocks
			time	distance		1 G lateral			40t truck	passenger	cargo	820
kph	mph	m/s	sec	m	mile	m	mile	kWh	@70mph	person/hr	Ton/hr	each end
200	124	56	6	157	0.1	315	0.2	0.2	0.05	80,000	5,333	98
225	140	62	6	199	0.1	398	0.2	0.3	0.06	90,000	6,000	110
250	155	69	7	246	0.2	492	0.3	0.4	0.07	100,000	6,667	122
275	171	76	8	297	0.2	595	0.4	0.4	0.09	110,000	7,333	134
300	187	83	8	354	0.2	708	0.4	0.5	0.11	120,000	8,000	146
350	218	97	10	482	0.3	964	0.6	0.7	0.15	140,000	9,333	171
400	249	111	11	629	0.4	1,258	0.8	0.9	0.19	160,000	10,667	195
450	280	125	13	796	0.5	1,593	1.0	1.2	0.24	180,000	12,000	220
500	311	139	14	983	0.6	1,966	1.2	1.5	0.30	200,000	13,333	244
550	342	153	16	1,190	0.7	2,379	1.5	1.8	0.36	220,000	14,667	268
600	373	167	17	1,416	0.9	2,832	1.8	2.1	0.43	240,000	16,000	293
650	404	181	18	1,662	1.0	3,323	2.1	2.5	0.50	260,000	17,333	317
700	435	194	20	1,927	1.2	3,854	2.4	2.9	0.59	280,000	18,667	341
750	466	208	21	2,212	1.4	4,424	2.8	3.3	0.67	300,000	20,000	366
800	497	222	23	2,517	1.6	5,034	3.1	3.8	0.76	320,000	21,333	390
900	560	250	25	3,186	2.0	6,371	4.0	4.8	0.97	360,000	24,000	439
1000	622	278	28	3,933	2.4	7,865	4.9	5.9	1.20	400,000	26,667	488
1100	684	306	31	4,759	3.0	9,517	5.9	7.1	1.45	440,000	29,333	537
1200	746	333	34	5,663	3.5	11,326	7.0	8.5	1.72	480,000	32,000	585
1300	808	361	37	6,646	4.1	13,293	8.3	10.0	2.02	520,000	34,667	634
1400	871	389	40	7,708	4.8	15,416	9.6	11.6	2.34	560,000	37,333	683
1500	933	417	42	8,849	5.5	17,697	11.0	13.3	2.69	600,000	40,000	732
1750	1088	486	50	12,044	7.5	24,088	15.0	18.1	3.66	700,000	46,667	854
2000	1244	556	57	15,731	9.8	31,462	19.6	23.6	4.78	800,000	53,333	976
2250	1399	625	64	19,910	12.4	39,819	24.8	29.8	6.05	900,000	60,000	1,098
2500	1555	694	71	24,580	15.3	49,159	30.6	36.8	7.47	1,000,000	66,667	1,220

2750	1710	764	78	29,741	18.5	59,483	37.0	44.6	9.04	1,100,000	73,333	1,341
3000	1865	833	85	35,395	22.0	70,789	44.0	53.0	10.76	1,200,000	80,000	1,463
3500	2176	972	99	48,176	30.0	96,352	59.9	72.2	14.64	1,400,000	93,333	1,707
4000	2487	1111	113	62,924	39.1	125,848	78.3	94.3	19.12	1,600,000	106,667	1,951
4500	2798	1250	127	79,638	49.5	159,276	99.0	119.4	24.20	1,800,000	120,000	2,195
5000	3109	1389	142	98,319	61.1	196,637	122.3	147.4	29.88	2,000,000	133,333	2,439
5500	3420	1528	156	118,966	74.0	237,931	147.9	178.3	36.15	2,200,000	146,667	2,683
6000	3731	1667	170	141,579	88.0	283,158	176.1	212.2	43.03	2,400,000	160,000	2,927
6500	4042	1806	184	166,159	103.3	332,317	206.6	249.0	50.50	2,600,000	173,333	3,171
7000	4353	1944	198	192,705	119.8	385,409	239.6	288.8	58.56	2,800,000	186,667	3,415
7500	4664	2083	212	221,217	137.6	442,434	275.1	331.5	67.23	3,000,000	200,000	3,659
10000	6218	2778	283	393,275	244.5	786,549	489.1	589.4	119.52	4,000,000	266,667	4,878
15000	9327	4167	425	884,868	550.2	1,769,736	1100.4	1326.2	268.91	6,000,000	400,000	7,317
20000	12436	5556	566	1,573,099	978.2	3,146,197	1956.3	2357.7	478.06	8,000,000	533,333	9,756
25000	15545	6944	708	2,457,967	1528.4	4,915,933	3056.7	3683.9	746.97	10,000,000	666,667	12,195
30000	18654	8333	849	3,539,472	2200.8	7,078,944	4401.7	5304.8	1075.64	12,000,000	800,000	14,634
35000	21763	9722	991	4,817,615	2995.6	9,635,229	5991.2	7220.4	1464.06	14,000,000	933,333	17073

1G lateral acceleration = 45 degree bank angle. Federal Aviation Regs state bank angle under 60 deg is non-aerobatic.

Capacity calculated at 6 persons per capsule, or 0.4Ton / capsule at a capsule pitch of 15m (3:1 safety factor)

The clearance for fixed maglev components limits curve radius (shown in red) to 600m UNLESS vertical load is reduced.

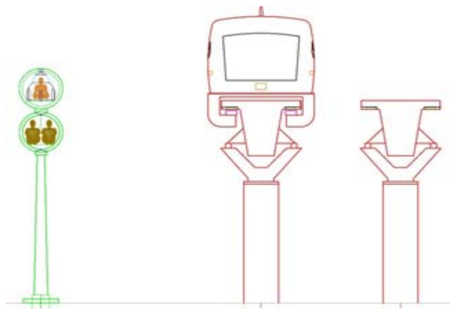
Airlock capacity of 820 passengers per hour (cell M5) (55.4T/hr) is based on cycle time of 26 seconds and 6 passengers (0.4T) per capsule.

Acceleration time and distance do not include transition time (0.5g/sec max jerk adds 2sec time and 1sec distance).

Capsule inside diameter = 1300mm, length = 4950mm Tube inside diameter = 1500mm, 13mm “Ductal” concrete wall.

Vertical sag and crest curve radius limit is half the horizontal limit (does not apply to orbital velocities used for space launch (in magenta)).

A typical coal train hauls 120 cars with 120T/car = 14,400T, 4 unit trains/hr max rail capacity, 3 trains / day / mine.



ET3 and Transrapid Maglev sections drawn at same scale
ET3 in Green, TR in Red

Evacuated Tube Transport and Transrapid Maglev Train Comparison
Two - Way System

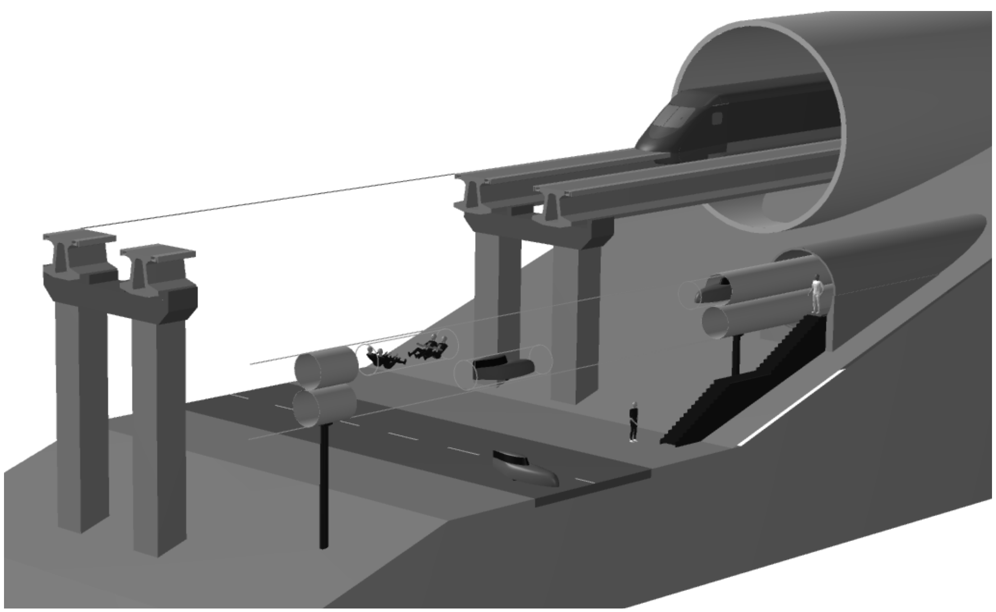
Daryl Oster, CEO responsible for content.

CATEGORY	ETT	TR	UNIT	Factor	Comment
formance					
Operating Speed used to compare	500	500	km/h	1.0	Design speed fixed for comparison
Switching Speed	500	200	km/h	2.5	Full speed switching allows high vehicle frequency for ET3
Top Speed Potential	6000	600	km/h	10.0	
External Sound Level	20	90	dB	**128.0**	The train is 128 times louder than et3
Max Grade	30	10	%	3.0	Maximum grade for et3 limited by passenger comfort – not et3 physical limits
Time to top speed	20	256	seconds	12.8	ET3 passengers seated and restrained - like in a car
Distance to accelerate	1.13	22.6	km	20.0	Less linear motor elements needed for ET3
Time to stop	20	147	seconds	7.4	means ET3 can maintain speed longer for faster trip time
Distance to stop	1.13	10.4	km	9.2	
running resistance per seat	1.05	200	Newton	190.5	The huge benefit of resistance elimination!
Specific Energy Consumption	0.98	52	Wh/seat-km	**53.1**	TR is for 400km speed - number for 500 not available
Carbon dioxide emission	0.622	33	g/seat-km	**53.1**	
Magnetic field	1 to 1000	1	microTesla	1,000.0	Depends on maglev tech used by ET3
Ice thickness buildup limit	n/a	5	mm		
Min suspension gap	6	10	mm	1.7	
Minimum Curve radius at 200km/h	312	1000	m	3.2	
at 300km/h	705	2250	m	3.2	
at 400km/h	1250	4000	m	3.2	
at 500km/h	1950	6200	m	3.2	
Safe Headway	0.125	147	seconds	1,176.0	For ET3 de For TR determined by ability to stop for a failed switch
Switch cycle time	0	30	seconds		No switch limits for vehicle frequency Some TR literature shows 120 sec, 30 sec is from Larry Blow, former director of TRI USA
Passenger capacity	172,800	29,300	persons/hour	5.9	Uses 1200 person capacity trains for TR on 147 sec intervals
Cargo capacity	3.6	1.02	ton / sec	3.5	TR based on maximum 10 section train = 150t/147 seconds
Maximum power required	1	12	MW	**12.0**	Big cost savings for ETT this is minimum for TR, 2 section train full of 75 kg people to 500km/h in 256 sec plus 1/2 running resistance at 500km/h
Kinetic Energy	1.45	329	kW-h	226.9	
Specific KE per seat	0.242	1.79	kW-h/seat	7.4	
Airlock Time	30	N/A	seconds		all the other factors in favor of ET3 more than compensate for the time lost in airlock cycling
Airlock Energy per seat	10	N/A	Wh/seat		
Life-support Recharge / seat	50	N/A	Wh/seat		ET3 uses well proven technology developed for submarine and spacecraft
Pumping Energy /seat / km	0.72	N/A	Wh/seat/km		this is for a use of 25000 passengers per day - this number goes down for higher usa, and up for lower use.
Cooling Energy / seat	50		Wh		UNKNOWN for TR - said to be greater than levitation energy
Vehicle					
Empty weight- passenger service	0.2	106	ton	530.0	The May 2002 TR brochure, says weight is 53t/section, (no distinction for end or mid) the minimum is 2, for 106t
Empty weight- cargo service	0.15	96	ton	640.0	The May 2002 TR brochure, says weight is 48t/section, (no distinction for end or mid) the minimum is 2, for 96t
Cargo payload	0.45	15	ton	33.3	one advantage for TR is the ability to move very large items up to 15t
Passengers	6	184	seats	30.7	Minimum vehicle size is two sections, each seating 92 passengers according to May 2002 brochure
Empty wt / payload	33	320	%	**9.7**	Big cost savings for ET3 cargo movement
Empty wt / seat	0.033	0.576	ton	**17.5**	Big cost savings for ET3 for materials - and energy too
Gross weight	0.6	136	ton	226.7	
Length	5	54	m	10.8	Minimum vehicle size is two sections of 27m each as per May2002 TR publication
Width	1.3	3.7	m	2.8	outside capsule diameter of 1.3m and inside tube diameter of 1.5m
Height	1.3	4.2	m	3.2	
Gross mass / length	0.12	2.519	ton/m	**21.0**	Big cost savings for ET3 maglev components due to low loading
Vehicle stowage volume /seat	1.408	4.561		3.2	
Seat pitch	1.3	1	m	1.3	first class comfort seating -- (4 seat ET3 vehicles offer 1.9m pitch)
Seat width	0.6	0.5	m	1.2	ET3 offers the comfort of a living room recliner.
Guideway					
Tunnel Crossectional area	12.6	225	m^2	**17.9**	Underground ET3 in a 4m diameter bore tunnel is big cost savings when tunnels are needed
min width	1.8	2.8	m^2	1.6	TR cannot exploit the minimum width dimension due to air blast and drag limitations
2-way width	1.8	7.9		4.4	
Mass of 24m span	13	350	ton	**26.9**	material savings for ET3 results in much lower construction costs
Mass of typical support	2	90	ton	**45.0**	Big weight savings for ET3 results in much lower foundation costs
Land use	525	2100	m^2/km	4.0	

	ET3	TR	Unit	Ratio	Comment
Cost					
Guideway cost per km	$1.25	$17	$M/km	**13.6**	Use of higher cost material for ET3 still produces big cost savings
Guideway maintenance	0.12	0.53	cents/seat-km	4.4	Cost savings not as large due to maint of vacuum equipment
Guideway cost per km / capacity	7	580.20	($/km)/(p/hr)	80.2	Much better material utilization for ET3=huge reserve capacity for future growth
Vehicle cost per seat	$ 4,700	$ 61,000	$/seat	**13.0**	Use of small vehicle size pays off big - much lower tooling and production cost
Vehicle maintenance	0.07	0.27	cents/seat-km	3.9	Cost savings not as large due to maint of life support equipment
Station and Switch Cost	7.3	175	$millions	24.0	From China cost estimate reports
Station Capacity	700	14400	person/hr	20.6	12 trains per hour for TR (1200seats each)
Station Cost / capacity	$10,429	$12,153	$/person/hr	**1.2**	ET3 station cost advantage not as significant as other savings, ET3 stations will be used closer to capacity due to 20 times better granularity of capacity
Ticket Cost at 6000 rnd trps/day use 800km trip					
Guideway cost for 800km	$1,000	$13,600	$millions		6000/day 360 days/year=2,160,000
Vehicle cost 1200 seats needed	$5.64	$73.20	$millions		vehicles make 5 round trips per day
Station cost (2 minimum)	$14.60	$350.00	$millions		
Total	$1,020	$14,023	$millions		Seats needed for 6000/day = 6000/5= 1200
10%of capital cost/trips per year	$47.23	$649.22	per round trip		
Plus energy cost	$0.21	$8.68	per round trip	42.3	
Plus Maint Cost	$0.68	$2.69	per round trip		
Plus misc. operating expense	$1.00	$1.00	per round trip		
Total Round trip Ticket Price	$49.12	$661.59	Ticket price	13.5	
Total cap cost for 12000 trips / day	1025.88	14096.4			
10%of capital cost/trips per year	23.7472222	326.3056			
Total ticket price	$25.63	$338.67		13.2	
Total cost for 24000 trips / day	1046.12	14169.6			
10%of capital cost / trips per year	12.1078704	164			**87% of the ticket price is capital cost – after recovery this represents profit**
Total ticket price	$13.99	$176.37		12.6	**(eg. Tampa – Atlanta round trip ticket price ET3 vs Maglev train**
per km cost	**$0.0087**	**$0.11**		12.6	**less than one cent per passenger km for ET3**
Some Questions					
Is a system in operation yet?	N	Y			
Snow clearing required?	N	Y			
Bird Strike Danger?	N	Y			
Can Debris Blow onto guideway?	N	Y			
Power need on entire guideway?	N	Y			
Are scheduled needed?	N	Y			
Can Passengers walk around?	N	Y			
Vacuum required?	Y	N			
Airlocks required?	Y	N			
Life-support required?	Y	N			
Is operation always non-stop?	Y	N			
Offline stations?	Y	Y			
Is mass production practical?	Y	N			
Is the cost low enough for masses?	Y	N			
Is unsubsidized cost < flying?	Y	N			

Capacity cost components		
3,617	290102.00	
4,700	61,000	
10,429	12,153	
18,746	**363254.78**	**19.37817**
for chart 9		

TR cost estimate is from 5/2002 TR publication titled tri_engl.pdf dc
TR data from Chattanooga study using data provided by TRI



Cut away view of TR guideway on left, and ET3 guideway on right

NOTE: Cost study in 2002 dollars, excludes land, tunnels, and bridge spans greater than 100'.

Not shown in this comparison:

- Foundation area and depth in different soils
- cubic capacity comparisons
- disabled person accessibility
- safety and risk comparison
- station area
- station area/station capacity
- emergency escape provisions
- vertical curve radius
- life cycle comparisons
- visibility
- factory and production tooling cost comparisons
- cargo dimensional analysis (what can fit through doors)
- door size
- failure mode analysis
- load factor analysis
- granularity issues
- minimum practical design speed analysis
- physical curve limits (horizontal and vertical)
- dynamic suspension separation in "g"
- suspension load response time
- impervious surface comparisons
- ice load limits
- wind load limits
- snow depth limits
- wind gust response
- earthquake limits
- alignment tolerance
- CG constraints
- infrastructure separation distances
- security factor comparisons
- station dwell time
- station wait time
- passenger load time
- cargo load time
- cargo cube analysis
- cargo utility analysis
- cargo hazard analysis
- water crossing comparisons
- operating temperature limits
- disease exposure comparison
- heat or cool energy use / passenger
- carbon footprint
- minimum population density for break-even