Title: **New Approaches for Efficient People Transportation in Both Dimensions – Vertically and Horizontally**

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Subject: Vertical Transportation

Keywords: Elevators
Energy Efficiency
Transportation
Vertical Transportation

Publication Date: 2016

Original Publication: Cities to Megacities: Shaping Dense Vertical Urbanism

Paper Type:
1. Book chapter/Part chapter
2. Journal paper
3. **Conference proceeding**
4. Unpublished conference paper
5. Magazine article
6. Unpublished

New Approaches for Efficient People Transportation in Both Dimensions – Vertically and Horizontally | 在垂直和水平两个维度实现效乘客运输的新方法

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Joerg Mueller 研究电气工程，于1993年加入蒂森克虏伯电梯集团。他在研发部的测试分部就职，负责管理现代化部门。自2005以来，Joerg先后担任过德国工厂的高级工程师及主要项目咨询主管。他负责支持新安装及现代化的主要项目。他已和他的团队共同开发了针对高层建筑垂直交通的新概念，这个概念考虑到了空间效率规划、电梯系统服务质量及使用现代模拟系统的能耗。

Abstract | 摘要

The trend of growing cities with permanently increasing populations will require new and visionary solutions for mobility in urban areas. Moving people as we are used to do today – either by individual cars, buses, taxis, etc., will lead to chaotic traffic conditions, high environmental impacts and a poor quality of life. This paper will show new approaches in technology to improve connections and network links to and between public transportation systems like metros, etc. Increasing the height of buildings demands an increasing number of vertical transportation equipment, requiring more elevators with more vertical hoistway with more demands on space in the building's footprint. New innovations in technology, like thyssenkrupp's MULTI® as a the first rope less elevator system and TWIN®, would allow for better transportation and building efficiency by means of multiple car systems in reduced hoistway space. We will explore different possibilities of vertical transportation in high-rise buildings. In the end, the right combination of elevator systems will be the key for an efficient solution.

Keywords: Energy Efficiency, High Rise Elevator, Multiple Car Systems, Shaft Space Optimization, Urban Mobility, Vertical & Horizontal Transportation

由于人口数量长期增长的趋势，城区发展需要全新的、富有远见的移动解决方案。 流动人口（通过私人汽车、巴士、出租车等等）将导致越来越糟糕的交通状况、恶劣的环境及大幅降低的生活质量，我们现在已经对此习以为常了。本文将展示新技术方法，这些方法旨在改进公共交通系统（诸如地铁等等）之间的联系及网络连接。 增加建筑物高度将导致垂直交通设备数目的增加，这意味着要配备更多垂直电梯井的电梯，这就需要增加覆盖面积。 第一个无绳电梯系统 thyssenkrupp's MULTI®及TWIN®等技术创新，将通过在更少的电梯井空间中放置多个电梯轿厢系统来提高交通及建筑效率。本文内容将包括在高层建筑中规划垂直交通的不同可能方法。电梯系统的正确组合将成为高效解决方案的关键。

关键词：能源效率、高层电梯、基础设施、电梯通道空间优化、城市流动性、垂直和水平城市主义

Extension Vertically, but Not Only…

Considering severe restrictions on space and limitations in infrastructure expansion, the most economical and environmentally viable way to accommodate rapid urban development is to build buildings higher and higher. This will allow cities to occupy less soil and to secure essentially green areas, and it will finally help create a strategy for the centralized intelligent control of energy.

Increasing the height of buildings consequently requires an increasing number of vertical transportation units. Based on today's common state-of-the-art, this means a higher number of elevators in more vertical hoistway (Figure 1). Logically this requires more and more space of the buildings footprint, which has direct impacts on the Facility Net Ratio in building efficiency. For high-rise and supertall buildings, more than 50%–60% of the footprint needs to be provided for transportation and service facilities.

垂直延伸，但不仅如此...

考虑到对城市空间的严格限制和基础设施扩展的局限，能够适应城市人口迅速增长的最经济、环境可行性最高的办法就是建造更高的建筑。这样不仅能减少占用土地，保障城市绿地，还有助于实现集中智能控制能源的战略。

随着建筑高度的增加，需要的垂直运输单元也更多。以目前常见的先进技术计算，这意味着需要更多垂直井道和更多部电梯（图1）。逻辑上，占用的建筑空间也会越来越大，因此会对建筑可用面积的净比率产生直接影响。对于高层甚至超高层建筑，应当认识到，超过50%–60%的空间需要用于交通运输和服务设施。

这不仅是因为在这些建筑中工作和生活的人数更多，还因为人们需要越来越多的内部设施来改善生活质量，例如会议区、咖啡店、餐厅、水疗中心、健身房和医疗服务等等。

This is not only caused by the higher numbers of people working and living in those buildings – more and more internal facilities to make living worthwhile are required, like meeting areas, coffee shops, restaurants, spas, gyms and medical services, and so on.

So, from this point of view (beside of others) in the eyes of real estate developers and architects: *Elevators are the bottlenecks in regards to growing building heights.*

Reduces Core Area by Organizing Hoistway Structures

Common concepts to reduce the required space are planned with transfer floors [1]. This allows stacking of local zone elevator shafts, particularly in the upper part of the building. The shaft arrangement is organized more economically as there are then less shafts going through the whole building. The transfer floors (sky lobbies) are served by express shuttle elevators from the ground floor. These elevators can operate at high speeds and provide a well performing handling capacity by minimizing the number of intermediate stops.

With this arrangement, fewer elevators will start at the main lobby (Figure 2). The footprint for shafts at the ground floor can be reduced, not only because of the smaller hoistway area but also due to the lesser access area in front of the elevators.

Increase Transportation Capacity

Another common method is based on the application of Double Deck elevators (Figure 3), by which the numbers of needed shafts can be reduced accordingly [2]. A two-level dispatch lobby is required to allow the loading of the upper and lower cabins at the same time.

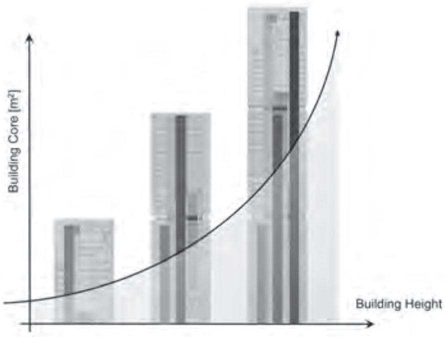

Figure 1. Building space requirements with low-, mid- and high rise lift groups (Source: thyssenkrupp Elevator)
图1. 低、中、高层建筑电梯群的空间要求（来源：蒂森克虏伯电梯集团）

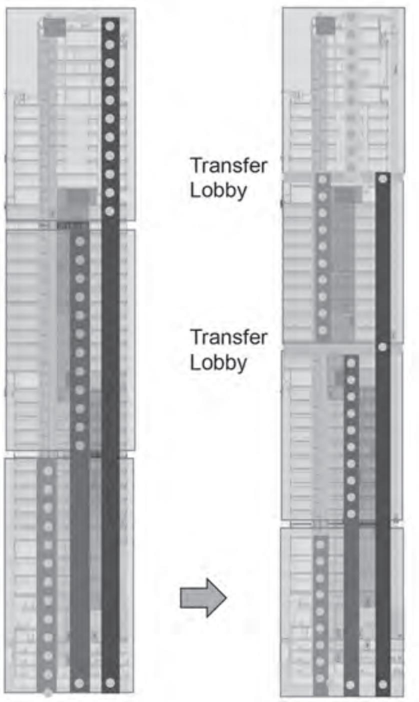

Figure 2. Lift arrangement with stacked shafts and shuttles (Source: thyssenkrupp Elevator)
图2. 叠置井道和电梯的空间布置（来源：蒂森克虏伯电梯集团）

Figure 3. Double Decker (Source: thyssenkrupp Elevator)
图3. 双层电梯（来源：蒂森克虏伯电梯集团）

所以，从房地产开发商和建筑设计师的这个角度来看（不考虑其他角度）：***电梯是建筑物高度增长的瓶颈***

通过组织优化井道结构减少核心区面积

采用转移层减少占用空间的概念计划[1]。这样可以实现区间电梯井道的堆叠，特别是在建筑的上部。井道配置更加经济，因为贯穿整个建筑的井道更少了。转移层（高空大厅）通过快递往返直达电梯与一楼连通。这些电梯可以高速运行，由于减少了中间停靠次数，所以具有良好的吞吐量。

采用这种配置，设置在主大厅的电梯变得更少（图2）。一楼电梯井道的空间可以减小，不仅是因为井道面积更小，还因为电梯前面的通道区域也有所减小。

提高运输能力

另一种常见的方法是采用双层电梯（图3），这样可以相应地减少所需井道的数量[2]。建筑需要采用一种双层调度门厅，可以同时装载上下两个轿厢。

然而，对于双层电梯系统，必须通过清楚明确、合理组织的人流量概念对建筑入口区域的人流进行协调。要前往偶数楼层的乘客必须通过上层门厅进入上轿厢。要前往奇数楼层的乘客必须通过下层门厅进入下轿厢。

通常乘客可以乘坐两个楼层之间的自动扶梯前往需要的楼层，或者也可以通过错层式的建筑环境将人流引导至两个楼层。

由于在上行人流高峰期间能够同时运送乘客到达两个楼层，所以平均往返行程中的停靠次数有所减少。这样就能减少上下客时间的损失。

双层电梯既可以用于停靠每个楼层的区间组，也可以作为通往转移层的往返直达电梯。使用常规的双层系统时，建筑师通常必须保证相同的楼层间距，这会限制建筑结构和建筑设计方面的灵活性。

由于双层电梯的运行会消耗大量能源，所以减少井道面积带来的益处会在很大程度上被经年累月的高能耗所抵消。由于设计的原因，双层电梯具有很大的质量和惯性。轿厢本身的重量就超过10000 kg（图3），而配重则可以轻松达到甚至超过12500 kg（例如用于两个1600kg吞吐量的轿厢的配重）。此外，机器、滑轮、缆绳和补偿装置也会产生很大的惯性。通过新材料减少缆绳重量的尝试才刚刚开始。

所有这些质量都必须经过加速和减速，即使电梯轿厢内只有几名乘客。这会产生很高的加速电流，消耗大量能源。

最新的灵活双层电梯允许对跨楼层流量进行有限的调整，从而使楼层间距可以略有

However, with Double Deck elevators the traffic flow in the entrance area of the building has to be coordinated by a clear organized people flow concept. Passengers who want to reach an even numbered floor must enter the upper cabin via the upper lobby. Passengers who want to reach an odd numbered floor must enter to the lower cabin via the lower lobby.

Usually this is served by escalators between both lobby floors, or the split level building environment provides incoming traffic on both levels.

By serving two floors at the same time during up peak traffic, the number of stops in an average round trip is reduced. This results in less loading time losses. Double Deck elevators can be applied in local groups with destinations at every floor as well as shuttle elevators to transfer floor destinations. By using conventional Double Deck systems, the architects typically have to plan for the same floor-to-floor distances, which will limit the flexibility in the building structure and in the architectural design.

Due to the high demand on energy consumption of Double Deck elevators during operation, the benefit of reduced shaft areas has to be compensated by a high amount of operational energy costs over the years. By way of their design, Double Deck systems contain heavy masses and big inertias. Car weights of more than 10,000 kg (Figure 3) and counterweight masses of 12,500 kg and more can be reached easily (e.g., for capacity of two x 1600kg cars). Additionally, there are large inertias associated with the machine, the sheaves, ropes and compensation means. Opportunities to reduce ropes weights by means of new materials are just beginning to be applied. All these masses have to be accelerated and decelerated, even when only a few passengers are using the car. This causes high acceleration currents and a high amount of energy consumption.

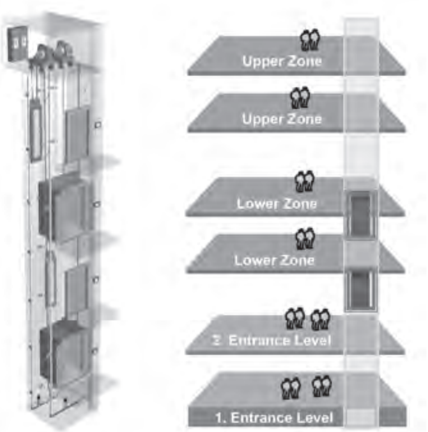

Figure 4. Lift arrangement with stacked shafts and shuttles (Source: thyssenkrupp Elevator)
图4. 叠置井道和电梯的空间布置（来源：蒂森克虏伯电梯集团）

The latest Flexible Double Deck elevators allow a limited adjustment for inter-floor traffic to slightly different floor distances. They require additional mechanical devices, which results in significantly more mass that must be moved.

Multiple Car Systems Using Same Hoistway

New innovation in technology like thyssenkrupp's TWIN® and now MULTI® (as the first rope-less elevator system) would allow increasing transportation and building efficiency by means of multiple car systems in reduced numbers of hoistway shafts. Compared with other solutions, the benefits for building design are not only space savings, but much higher flexibility and significantly reduced energy consumption.

The TWIN system of ThyssenKrupp Elevator (Figure 4) – actually the only available one in the market - runs with two cars independently within one shaft [3]. So the number of elevator shafts can be reduced by up to 30%. The flexibility of the system allows arranging the main lobby on one or two floor levels. Planning with a two-level lobby gives the best performance by enabling the loading and unloading of the upper and lower car at the same time.

For up-peak traffic, ideally the upper lobby is the entrance level to an upper zone within the lift group; the lower lobby is then the entrance level to a lower zone within the lift group. The zones are set up so that the upper and lower cars will serve the same number of passengers or floors, e.g., lower zone: floors 3 to 15; upper zone: floors 16 to 30.

During off-peak traffic, the lifts can run without limitation, serving calls in both zones The flexibility of having two independent cars in a shaft is particularly evident during inter-floor traffic. In buildings where tenants use multiple floors, more cars can be used for inter-floor traffic compared to a Double Deck system. The optimum in performance for traffic flow is organized by the controller. The inertias and masses of TWIN-cars are identical with conventional elevator cars (Single Deck).

Optimizing the system for energy efficiency in a bank of multiple car elevators, only the number of cars needed for service will be moved to provide the required quality of service.

Of course, the technology is certified on the highest safety level and is well proven to

不同。它们需要额外的机械装置，而这又大大增加了需要移动的质量。

使用同一井道的多轿厢系统

类似于蒂森克虏伯的双子®和MULTI®（第一套无缆绳电梯系统）这样的技术创新能够通过多轿厢系统的方式提高运输能力和建筑可用面积。

与其他解决方案相比，对建筑设计的益处不仅在于节省空间，还大大提高了灵活性，显著降低了能耗。

蒂森克虏伯电梯（图4）的双子系统，实际上是市场上唯一一种两个轿厢能够在一个井道中独立运行的系统[3]。所以电梯井道的数量可以减少最多30%。该系统的灵活性允许在一或两个楼层上设置主大厅。通过规划双层门厅，能够同时在上、下轿厢上下客，从而实现最佳性能。

对于上行人流高峰，理想的情况是，上层门厅是电梯组内高区的入口层；下层门厅则是低区的入口层。这些区域经过设置，使上部和下部轿厢能够运送相同数量的乘客或停靠相同数量的楼层，例如低区：3至15楼；高区：16至30楼。

在非人流高峰时，电梯可以不受限制，两个轿厢都可以响应两个区域内的呼梯需求。一个井道内两个独立轿厢的灵活性在楼层间交通时特别明显。在租户使用多个楼层的建筑中，与双层系统相比，可以使用更多的轿厢于楼层间交通。最佳人流量由控制器控制。双子电梯轿厢的惯性和质量与传统电梯的轿厢（单层）相同。

对系统进行优化，以提高一组多轿厢电梯的能效，只启动所需数量的轿厢，以提供需要的服务质量。当然，该技术具有最高安全水平的认证，已经在全球各地的多个项目中成功运行，非常成熟。

将两套具有类似吞吐量和同等服务质量的电梯组进行比较可以发现，双层解决方案的电负荷是多轿厢系统的近两倍。通过100米建筑项目（图5）的全天办公人流量模板[5]，基于行业标准的人流量模拟模型[4]，对两个系统的能耗进行比较，即可证明这一结论。在模拟软件中已经运行了一个复杂的能耗模型[6]。

双层电梯组的能耗高出约20–30%。但是要注意，这两套电梯系统都依据VDI 4707获得了相同的能效等级认证[7]。这背后的原因是，该规范所讨论的能耗仅限于上下一个行程，不考虑日常运行中电梯组的总体性能。双层系统在非人流高峰时需要移动更多的轿厢，而且实际上非人流高峰占据了一天中的大部分时间。

因此，为了获得最佳性能，尽量减少能源浪费，必须根据实际建筑运行模式对每个系统进行规划。因此，双层系统不仅需要

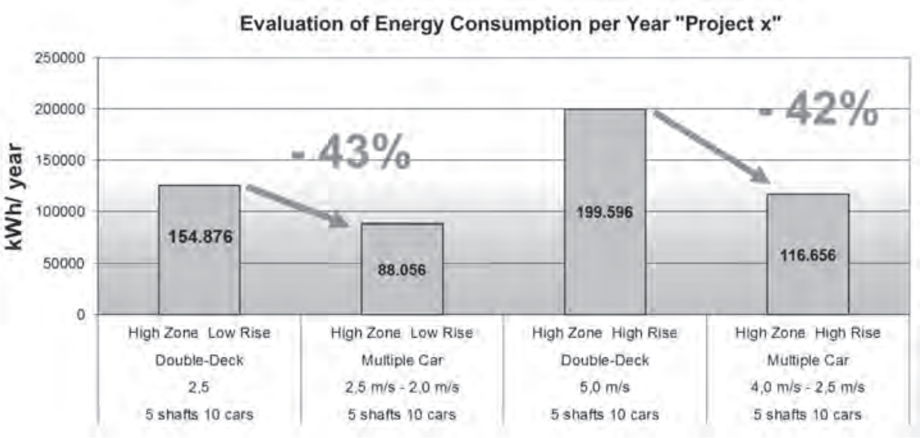

Figure 5. Comparison of energy consumption: Double Deck – Multiple Car (Source: thyssenkrupp Elevator)
图5. 能耗对比：双层电梯––多轿厢电梯（来源：蒂森克虏伯电梯集团）

operate successfully in multiple projects all over the globe.

When comparing two lift groups with similar handling capacity and comparable quality of service, the electrical loads of the Double Deck solution are nearly twice of that of an installation with the Multiple Car system. This can be demonstrated, comparing the energy consumption of both systems, based on an industry standard traffic simulation model [4], with the application of an all-day office traffic template [5] for a 100m high building project (Figure 5). A sophisticated energy model [6] has been implemented into the simulation software.

The energy consumption is approximately 20–30% higher for the Double Deck elevator banks. But it is worth noting that both elevator systems are certified with the same energy efficiency class according to VDI 4707 [7].The reason behind this is that the norm refers to the energy consumption just during one trip up and down, and does not consider the behavior of the elevator bank during daily operation. The Double Deck system moves more cars during off-peak-traffic, which is most of the time in a day. Therefore, for the best performance and least wastage of energy resources, it is necessary to plan each system according the realistic building operation modes.

Consequently, the Double Decker system requires not only requires more operational power consumption, but also much bigger electrical equipment, e.g., transformer, electrical cables, generators, etc.

Multiple Car Concept with More Than Two Cabins

So far, all described elevator systems are still equipped with hoist ropes. This technology has been used since elevators were first developed and is the crucial limitation of travel height.

The most important impacts are the following:

- Because of given safety factors from all worldwide codes the number and the diameter of the ropes have to be increased according to the height of travel. Hence, the total mass of the ropes will increase up to a limit, where they are not able any more to carry their own weight. Now, ThyssenKrupp's new MULTI Concept – announced to be developed two years ago, uses a Linear Motor technology to eliminate rope suspension, so the vertical hoisting limits are eliminated.
- According to the state-of-the-art technology of elevators, to follow non-vertical shapes of a building via inclined hoistways is restricted with some exceptions. With the MULTI concept, inclined hoistings are not limited by the behavior of the suspension means.
- Supertall and megatall buildings are subject to building sway, wind, sunshine and seismic effects. Elevators with rope suspension are directly affected by the buildings behavior and can cause operational breakdowns or damages. Moving without ropes, MULTI does not cause distinctive rope sway effects in tall and supertall buildings
- Up to now, elevators are not designed for horizontal movement. Direct horizontal links between elevator shafts, between buildings and to public facilities are thus limiting urban mobility. The MULTI concept supports passenger transportation in vertical and horizontal directions.

更多运行功耗，而且需要大型的电气设备，例如变压器、电缆、发电机等。

两个以上轿厢的多轿厢概念

到目前为止，我们描述的所有电梯系统仍然配备钢丝缆绳。自从电梯被发明以来，始终采用的就是这套技术，现在它已经成为限制运行高度延伸的关键因素。

最重要的影响包括：

- 由于世界各国的法律规定的安全系数，缆绳的数量和直径必须随着运行高度的提高而增加。因此，缆绳的总质量终将提高到极限，以至于它们无法再承受自身的重量。现在，蒂森克虏伯在两年前开始研发的MULTI概念已经问世，它采用直线电机技术以取代悬挂缆绳，从而完全避免垂直曳引带来的限制。
- 即使是目前最先进的电梯技术，除了少数情况外，也很难适应非垂直建筑内的倾斜井道。而MULTI概念却并不存在悬挂缆绳对于倾斜曳引的限制。
- 由于静定原因，高层和超高层建筑受风力、日照或地震的影响，不可能完全避免建筑摇摆。采用悬挂缆绳的电梯会直接受到建筑性能的影响，并且可能造成运行故障或危险损害。MULTI不采用缆绳，在高层和超高层建筑内不会导致缆绳剧烈摆动。
- 到目前为止，所有电梯都无法进行水平运动。因此，电梯井道之间、建筑之间以及通往公共设施的水平连接都限制了城市交通。MULTI概念支持垂直和水平方向的乘客运输。

因此：使高层建筑继续提升高度的关键就是通过突破性的新技术消除这些限制。

其功能原理基于这样的想法，在最少两个井道构成的环路中使轿厢循环运行，提供连续的载客流（图6）。两个或更多井道将由所谓的交换设备连接起来，从而使轿厢能够从一个井道水平转入另一个井道。

这些电梯将不再配备钢丝缆绳，而是采用线性马达系统。这一技术不但广为人知，而且已经在蒂森克虏伯的磁浮列车系统中得到充分验证。可以保证高度的安全性和舒适性。

为了控制轿厢的独立运动，它采用了一套基于SIL3标准的最高级别安全程序，并在此基础上运用了双子系统可靠、成功的技术。先进的目的地调度算法可以实现最优交通管制。

如前所述，高层和超高层建筑越来越像是在运行一座城中城。因此，毫不奇怪的是，这些建筑中的垂直交通解决方案将会越来越接近现代化水平公共交通基础设施的概念。

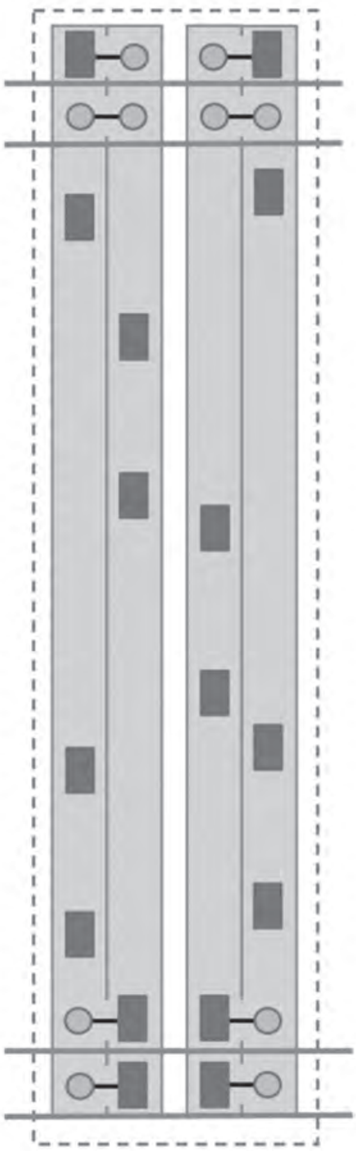

Figure 6. MULTI - transportation in a loop with vertical and horizontal movement (Source: thyssenkrupp Elevator)
图6. MULTI——垂直和水平方向的运输系统（来源：蒂森克虏伯电梯集团）

Therefore: The challenge to enable the growth of tall buildings is to eliminate these limitations with new ground breaking technology.

The functional principle of MULTI follows the idea that circulating cabins for passengers in a loop of at least two shafts will provide a continuous traffic flow (Figure 6). Two or more hoistways will be linked by a so called exchanger device, which enables the cabin to change from one shaft to the other horizontally [8]. By means of a linear motor system, those elevators will not be equipped with hoist ropes. The technology is well known and proven in ThyssenKrupp's Maglev Train systems. A high degree of safety and comfort is guaranteed. To control an independent movement of the cabins, the reliable and successful technology of the TWIN system is applied on a highest level of safety procedures according to the SIL3 standard [9]. An advanced destination dispatch algorithm will ensure optimal traffic control.

As mentioned before, supertall and megatall buildings are developed more and more to operate like cities within cities. Therefore, it's no surprise that solutions for vertical traffic concepts in those buildings will develop more and more in a comparable way to the modern horizontal public traffic infrastructure concepts. Fast trains in long distance service, with only few stops bring passengers from hub to hub, where they change to local transportation systems, like metros, buses or even auto-services. This concept is considered in the focus of MULTI (Figure 7).

Use MULTI as a "long distance" transportations system from main entrance to transfer lobbies and change to local elevators with short distance service.

There might be certain concerns in regards to a general concept, based on transfer lobby traffic. However, efficiently operating transportation systems in such buildings cannot remain a concept, where any individual passenger will be able to reach his final destination directly just in one journey.

The handling capacity of MULTI is constant and independent from travel height. Further, due to the new possibility of sky lobby arrangement (e.g., occurring every 50m), the local group will get shorter travel distances, which will increase the handling capacity of the local lifts and allows optimization of the required numbers of elevator shafts.

快速列车提供长途运输服务，仅设有几个站点，将乘客在各个枢纽中心之间运输，然后，乘客将在交通枢纽改乘当地交通系统，如地铁、公交车，甚至是汽车服务。这个概念同样在MULTI中得到了重视（原因与其他应用不同）（图7）。

使用MULTI作为一个“长途”运输系统，从正门抵达转移门厅，然后换乘短距离的区间电梯。

对于这个基于转移门厅的整体概念，人们可能会存在某些疑虑。但是，毫无疑问，在这种建筑中，运输系统的高效运行不能固守使任何乘客都能够一次性直达最终目的地的概念。

MULTI的吞吐量是恒定的，与运行高度无关。此外，由于高空大厅配置（例如，每50米）带来的新的可能性，区间电梯组的运行距离将变得更短，从增加区间电梯的吞吐量，优化所需的电梯井道数量。

与区间电梯组的单层或双子系统相结合（图8），这一概念将总共节省最多40–50%的井道面积。

将双层往返电梯与MULTI往返电梯进行比较可知，MULTI概念在井道数量较少时最有优势，特别是在运行高度超过200米时（图9）。

一个已经投入使用的真实建筑项目采用了两套具有类似吞吐量和同等服务质量的电梯系统，比较这两种垂直运输配置，MULTI应用比双层应用减小的井道面积相当可观。

关于能耗问题，正如第1.3节中所述，情况也非常类似。除VDI 4707［7]的定义以

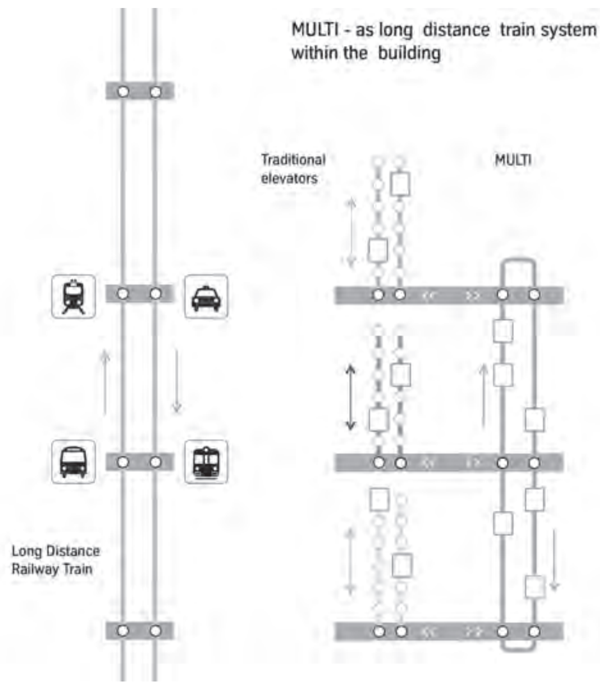

Figure 7. MULTI – traffic concept according to public traffic (Source: thyssenkrupp Elevator)
图7. MULTI—— 参考公共交通的交通概念（来源：蒂森克虏伯电梯集团）

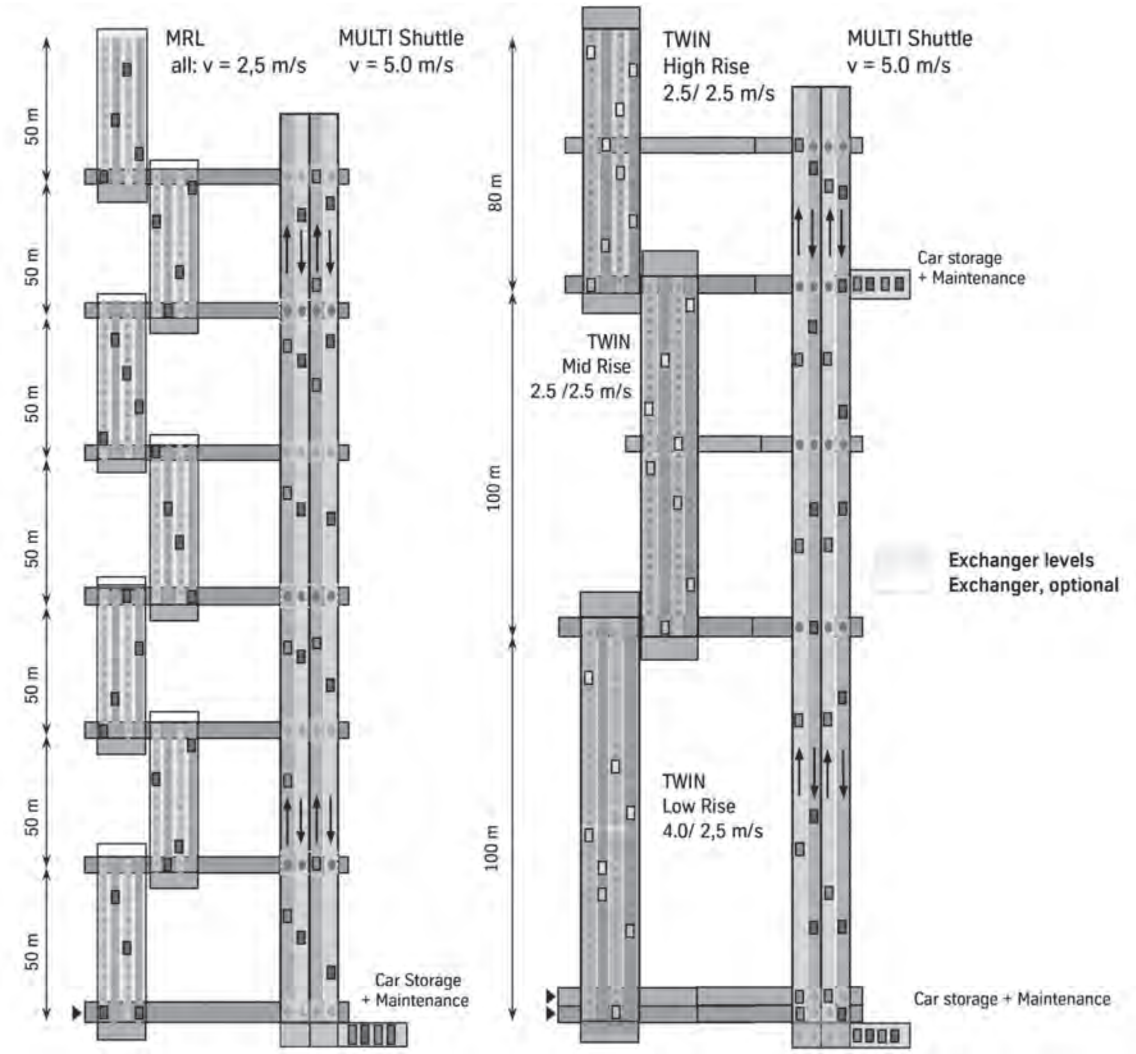

Figure 8. MULTI – project applications (Source: thyssenkrupp Elevator)
图8. MULTI−−项目应用（来源：蒂森克虏伯电梯集团）

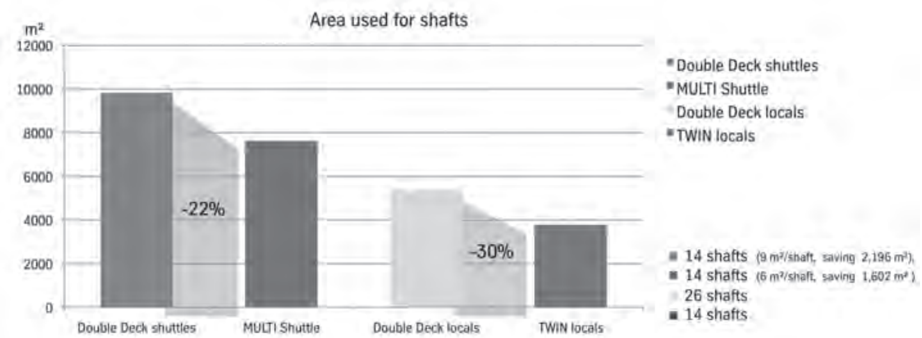

Figure 9. Footprint comparison: Double Deck / MULTI on a real project (Source: thyssenkrupp Elevator)
图9. 占用空间对比：实际项目中的双层电梯/MULTI（来源：蒂森克虏伯电梯集团）

In combination with Single Decks or TWINs in local groups (Figure 8), the concept will allow savings of about 40–50% of shaft area in total.

Comparing Double Deck shuttles with MULTI shuttles, the MULTI concept will be most beneficial with fewer shafts, specifically above 200m travel height (Figure 9).

Comparing two VT configurations, in a realistic and already proposed building project on the base of similar handling capacity and comparable quality of service, the saving in shaft areas is significant between Double Deck and MULTI applications.

In regards to energy consumption, the view is very similar, as mentioned in section 1.3. Beside the definition of VDI 4707 [7], it will be more meaningful to focus on a full-day template or on a week's period record. On one hand, the MULTI system is equipped with lightweight materials for tremendous reduction of masses to be moved. On the other hand, the system is balanced energy

外，考虑全天模板或一周运行记录更有意义。一方面，MULTI系统采用了轻量化材料，大大减少了需要移动的质量。另一方面，该系统在能量运用方面更加均衡，因为向上和向下运行的轿厢直接相互连接，而且配有能源再生装置。到目前为止，新开发的电梯系统完全跟随了现代化驱动系统的趋势。不仅如此，在此概念中，只有需要的轿厢才会移动。

MULTI将成为高层和超高层建筑中实现有效井道配置和最大化可用空间的典范，对于这些建筑来说，如果使用普通的电梯系统，达到同样的吞吐量将需要更多的井道面积和空间。

电梯系统的正确组合将是高效解决方案的关键。

更快的水平移动

正如我们现在习以为常的乘客运输，无论是通过私家车、公交车还是出租车等，都会导致越来越混乱的交通状况、严重的环

wise because of up- and down-traveling cabins with regenerative means, which are directly linked to each other. So far the new development is fully in the trend of modern drive systems. Even more, in this concept only those cabins will move that are in service.

MULTI will be the system for efficient shaft arrangements and the maximization of usable space in tall and very tall buildings, where the handling capacity of common elevators systems will need much more hoistway area and volume.

The right combination of elevators system will be the key for an efficient solution.

Moving Faster Horizontally

Moving people, as we are used to do today – either by individual cars, buses, taxis, etc., will lead to chaotic traffic conditions, high environmental impacts and poor quality of life. We need significantly new approaches in technology to improve connections and network links to and between public transportation systems like metro stations, transportation hubs, links between public buildings, etc. Metros will especially be one of the mass transit options of choice in the future.

But to bring more passengers in the shortest time to metro stations is another challenge. The connectivity of the metro networks has to be improved. It's mandatory to accelerate the transit times dramatically and to improve the comfort of ride on the Metros as well.

With ACCEL, thyssenkrupp Elevator has introduced a new and innovative technology in this field. It is developed as one walkway with two speeds. It combines smooth speed changes and the highest safety requirements for passenger transportation (Figure 10).

Commuters from outlying districts can use it to reach their next metro station or other places quickly and without waiting periods, which dispenses with the need for unprofitable shuttle buses. At airports, this revolutionary technology saves passengers two-thirds of their transit time – which they can spend in on-site stores or restaurants (Figure 11).

The revolutionary is also operated by Linear Motor drives to control every pallet individually. The horizontal speed is accelerated from common 0.6 m/s up to 2 m/s (7.2 km/h) and decelerated again at the end of the line to 0.6 m/s again to be able to conveniently step off.

The length of the high speed walk way is extendable from 100m to 500m per module and can be aligned to bridge variable distances. With a pallet width of 1,200 mm, the capacity can reach an amount of 7,300 passengers /h (Figure 12).

With low demand on footprint, low infrastructure requirements and low operational costs, the concept will increase the influence area of the metro stations and incorporate interesting spots to the metro network within the cities. Connecting times between boarding floor levels are reduced by 30%. The investment is low compared to tunneling, but with high public visibility.

境影响和更差的生活质量。我们需要全新的技术方法来改善通往公共交通系统的连接以及公共交通系统之间的连接，比如地铁站、交通枢纽、公共建筑间的连接等。尤其是，地铁将会成为未来重要的公共交通方式之一。

但是，如何在最短的时间内将更多的乘客送到地铁站又是一个很大的挑战。地铁网络的连通性已经得到改善。大大加快运输时间，改善乘坐地铁的舒适度感非常有必要。考虑到二氧化碳排放，这些目标越快实现越好！

ACCEL是蒂森克虏伯电梯为这一领域推出的创新技术。它是一套具有两种速度的自动人行道。它将流畅平稳的变速与乘客运输的最高安全要求相结合（图10）。

城市外围的乘客可以乘坐它迅速前往附近的地铁站或其他目的地，无需长时间等待免费往返的接送巴士。

在机场，这种革命性的技术可以为乘客节省三分之二的通行时间，这样他们就可以把这些时间花在机场商店或餐厅中（图11）。

这一革命性技术也由直线电机驱动，可单独控制每一个踏板。水平速度可从正常的0.6m/s加速到最大2m/s（7.2 km/h），并在线路末尾再次减速至0.6m/s，以方便乘客迈步走下。

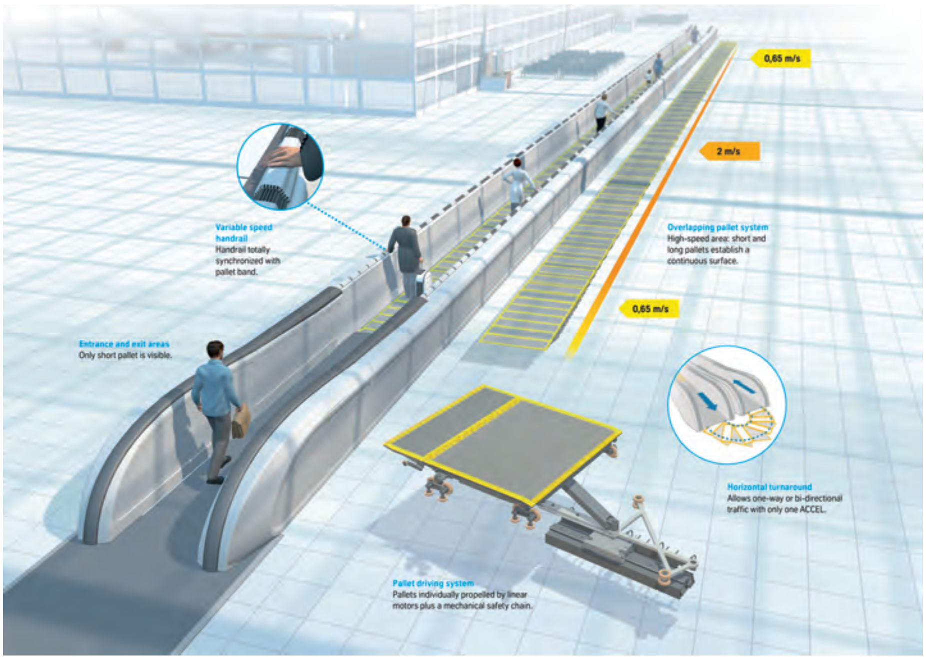

Figure 10. Innovation in horizontal transportation by ACCEL (Source: thyssenkrupp Elevator)
图10. 水平交通的创新技术--ACCEL（来源：蒂森克虏伯电梯集团）

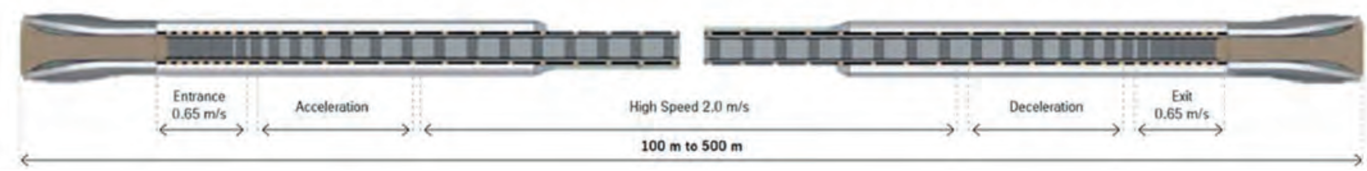

Figure 11. Accelerated and continuous movement horizontally (Source: thyssenkrupp Elevator)
图11. 水平方向的加速和持续运动（来源：蒂森克虏伯电梯集团）

Figure 12. The accessibility challenge – improving connectivity (Source: thyssenkrupp Elevator)
图12. 可到达性的挑战––提高连接性（来源：蒂森克虏伯电梯集团）

Conclusion

Pushing forward to exciting new technologies and being encouraged to go with new concepts in transportation of people and goods, the vertical transportation industry is going to be contributing to a new era of urbanism. Connectivity and urban mobility will make megacities worthwhile to inhabit, complete with tall buildings, public transport links, for living, working, business and leisure: *Connecting areas and places in an exciting way.*

高速人行道的长度可从每个模块100m扩展到500m，而且可以连接起来，提供不同长度。踏板宽1200 mm，载客能力可达每小时7300人（图12）。

由于需要的空间小，对基础设施的要求低，运营成本低，这一概念将增加地铁站的覆盖范围，将城市中的重要节点整合到地铁网络中。 登机楼层之间的交通时间减少30%。投资低于隧道，同时具有更高的公共可见度。

结论

垂直运输行业致力于运用先进的新技术，积极采用新的概念运输人员和物资，为塑造全新城市化的新时代作出贡献。连通性和城市交通将提高大型城市在高层建筑、公共交通设施等各个领域的品质，使其更加适合居住、工作、商务、休闲：*以激动人心的方式连接各个区域和场所*

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