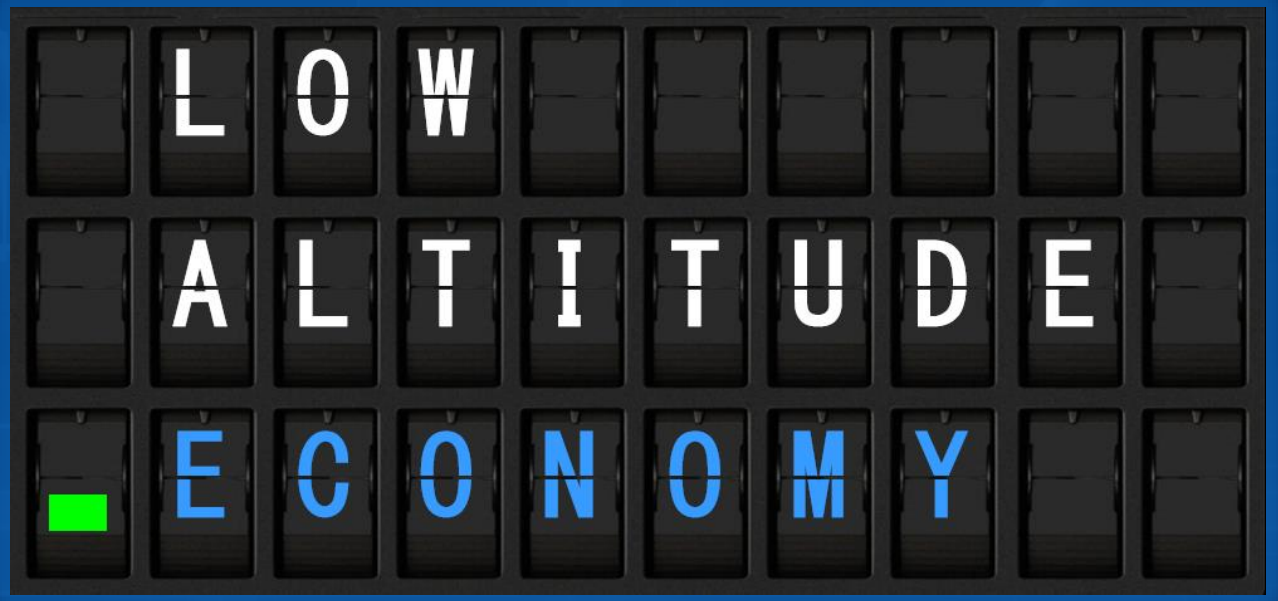

A new driver for economic growth ready for take-off ?

- 低空经济 -

蓄势待发的经济增长新动力

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Low Altitude Economy

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Do not expect...

- *THE* solution or *THE* idea
- Easy answers

请勿期待.....

- *可直接套用的解决方案或想法*
- *轻松的答案*

You can expect...

- Comprehensive view
- Asking the right(?) questions
- Some examples
- Ideas for a way forward
  (avoiding mistakes made elsewhere...)

将会分享.....

- *全面的观点*
- *引导提出正确的问题*
- *可供参考研究的案例*
- *一些推进方法（避免在其他地方犯先验经历者犯过的错误）*

My background...

- Air Traffic Control (Tower)
- Radar Intercept Control
- Airport Operations

- Technological Feasibility Studies
- Business Model Design
- Safety & Security, Resilience

Setting the Scene 场景配置

Some food-for-thought

Key Takeaways

Low Altitude Economy

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"Shanghai is planning to have at least 400 low-altitude flight routes by the end of 2027 to help achieve the city's ambition of building a "city of sky" featuring a complete low-altitude industry with its expected core industrial scale exceeding 50 billion yuan ($6.9 billion) by 2027."
[english.shanghai.gov.cn]

"The size of China's low-altitude economy as of t… stimated at more than 500 billion yuan (about 69.52 bil… pec… d to rise to 2 trillion yuan by 2030, accordin… *[english.shanghai.gov.cn]*

"By 2030, th… the drone…

PREPARATION FINISHED BY 2024
FULLY OPERATIONAL BY 2025
OPTIMIZED BY 2027
BILLIONS OF YUAN BY 2027
TRILLIONS OF YUAN BY 2030

WOW!

…e low-altitude flight

…ed by 2025)
…ation management system across the Yangtze …imum of 150 low-altitude flight routes will be built.

3. **…inished by 2027)**
L… …ude public air route network structure of Shanghai will take shape with at least 400 low-altitude flight routes planned and established.

- 深远的计划已在实施中……
- 相关方的理解是否保持一致?
- "规模"是否等同于 "经济增长"?

It is not just about "Low Altitude"

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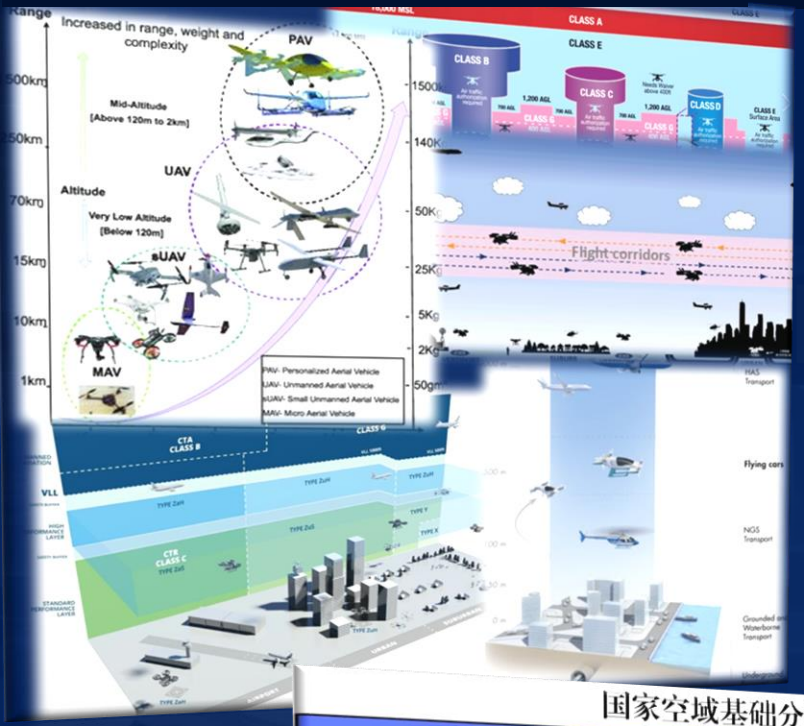
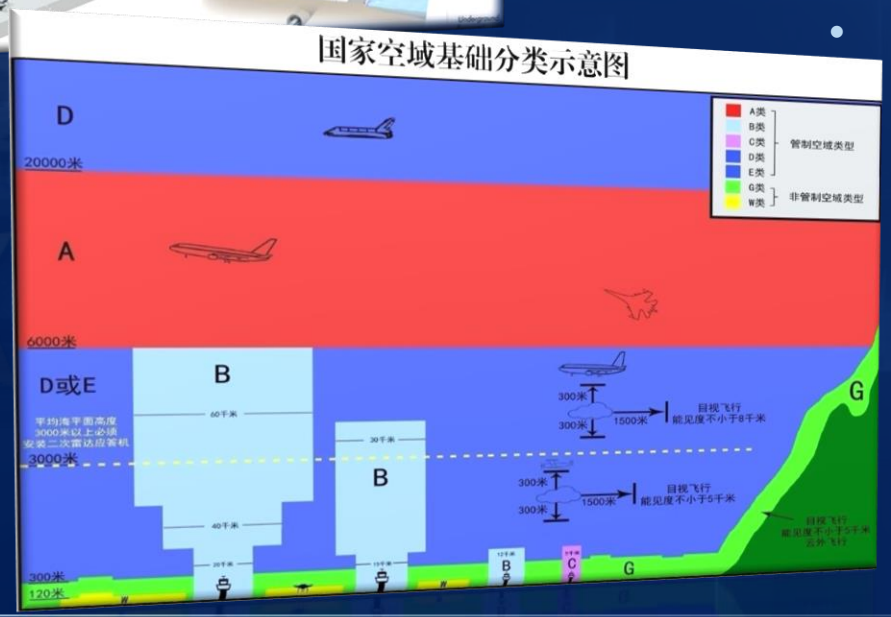




Altitude 海拔高度

- from 0 to <300 meters
  (up <6000m GND or transition to FL system)

0至300米高度，或6000米以内高度，或过渡高转换飞行高度层

Aerial Vehicle 空中飞行器

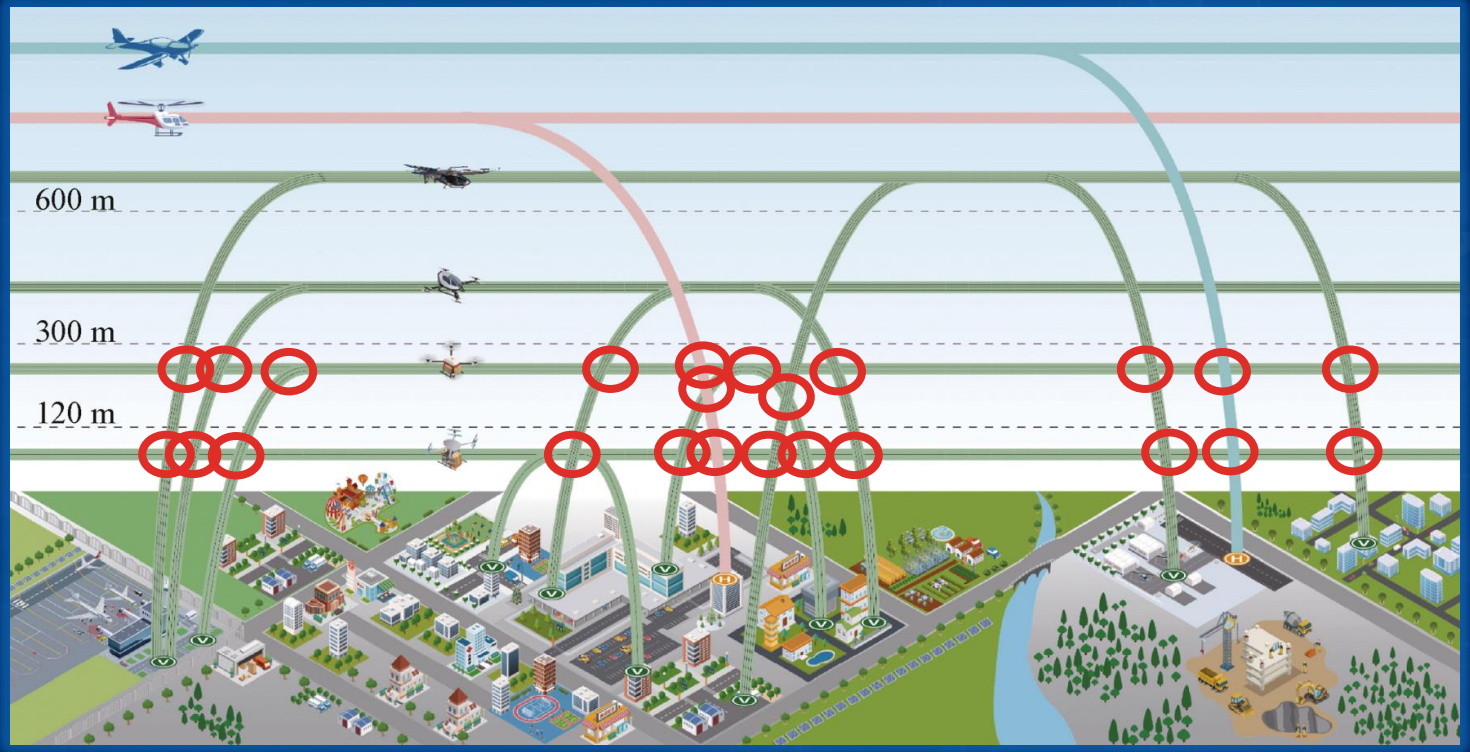
- Weight (50g / 2 Kg / 25 Kg / ...) 重量
- Speed / Manouverability 飞行速度/机动能力
- Range 飞行范围
- Max. altitude 极限高度
- (Un-)Manned 无人机（既无飞行员也无乘客）
- (Un-)Piloted (onboard/remote) 有人驾驶（机上驾驶/远程遥控）或无人驾驶（程序自动）

Airspace 空域

- Class/category 分类/类别
- Controlled/Uncontrolled 受控/不受控
- Flight rules (IFR, VFR) 飞行规则

China status? 7 classes (5 reg. / 2 unreg.)?
中国现状？7类空域（5类管制/2类非管制）

It is not just about "Low Altitude"



Source: Xiangmin Guan et al. 2024, Green Energy and Intelligent Transportation 3 (2024) 100149 (additional markings (○) by the presenter)

CAAC Key Laboratory of General Aviation Operation ● China Academy of Civil Aviation Science and Technology ● Phoenix Wings Technology (Shenzhen) Co. Ltd. ● Shenzhen Highgreat Innovation Technology Development Co. Ltd. ● Queen Mary University of London

Operations in Low Altitude require more than corridors...

低空飞行需要的不仅仅是划定空中走廊.....

- TakeOff & Landings 起飞和降落
- Vertical crossings 垂直交叉
- Lateral separation of vehicles with different capabilities & different mission priorities

  针对不同功能和不同任务优先级的飞行器的横向分隔
- Change from controlled to uncontrolled flight and vice versa.

  从空中管制飞行至非空管飞行的变化（例如空域变化），反之亦然

Economy – Which economy?

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经济——哪种经济?

Growth for whom, and at the cost of other (growth) sectors?

哪一部分能够实现经济增长？是否以牺牲其他领域的增长为代价?

Growth at which level: Local, regional, national?

哪个维度的经济增长——本地的、区域的还是全国的?

A new driver for economic growth or just "flogging a next dead horse" ?

经济增长新动力或者只是费力做无用功?

"经济增长"需要从多方面考虑.....

When and for how long? Sustainable? Foreseeable substitutes?

何时实现？持续多久？是否可持续?是否有可预见的替代品?

As an aspect of the "*new quality productive forces*" you may want to consider ...

作为"新质生产力"之一您可能要考虑一些可能潜在的低于预期的结果

Economy – Which Scope?

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经济——哪个范畴?

“Jumping” on specific use cases early …

跳过其他维度的研讨
直奔具体的用例研究是否明智?

Economy – Which Scope?

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不同行业

Growth across verticals along the supply / value chain

供应链/价值链

	R&D 研发	Production 制造	Service Provisioning 服务供给	Maintenance Provisioning 维护配给	Infrastructure Provisioning 基础设施配给	ATM/ATC Provisioning 空管配给	Data Provisioning 数据服务供应
Urban Air Mobility 都市空中运输	✓*	✓				✓	
Logistics 物流		✓	✓		✓		✓
Tourism 旅游观光			✓			✓	
Agriculture 农业	✓				✓		✓
Surveillance & Inspection 监督检查		✓	✓	✓		✓	
Public safety (incl. medical transport) 公共安全（包括医疗转运等）		✓	✓			✓	
...							

* filled for demonstration purpose only

European Perspective – EASA

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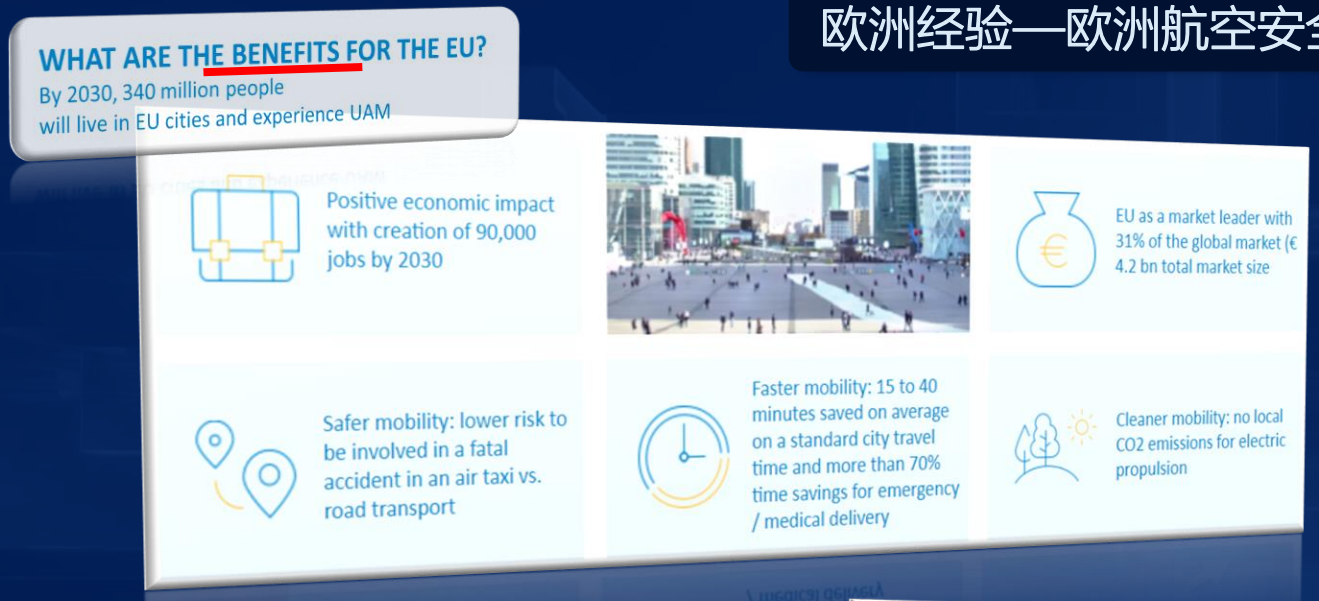
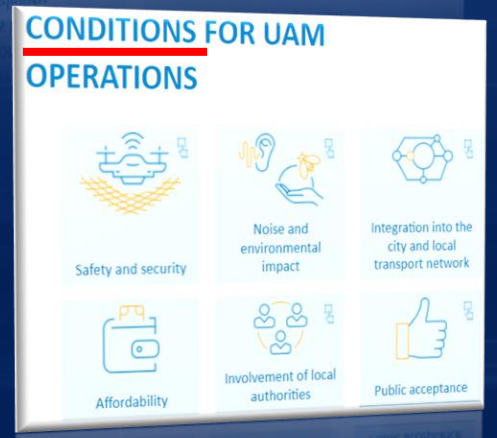
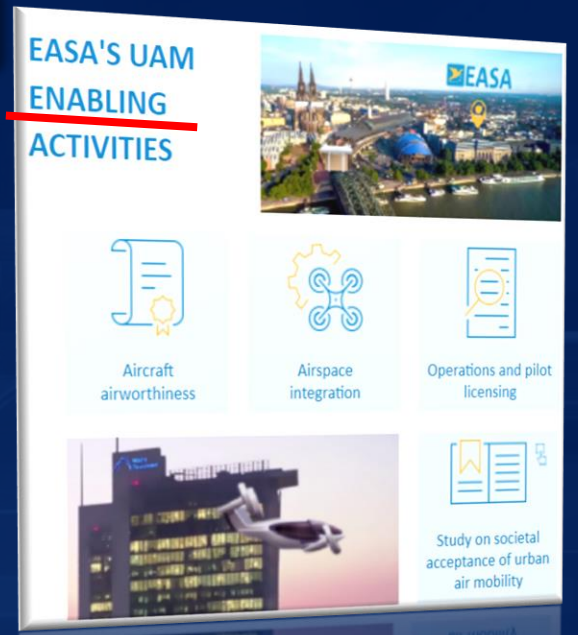
欧洲经验—欧洲航空安全局EASA







欧洲航空安全局EASA已从以下四方面推动都市空中运输UAM的发展：

(1) 经济效益
(2) 授权活动
(3) 作业条件
(4) 试点项目

Source: https://www.easa.europa.eu/en/what-is-uam (accessed 2024-Nov-19)

European Perspective – EASA

欧洲经验—欧洲航空安全局EASA

KEY POINTS 要点

1. Safety & security	安全与安保
2. Medical / emergency services	医疗/急救服务
3. Aircraft airworthiness	飞机适航性
4. Licencing	许可
5. Social acceptance	大众接受度
6. Integration in transport networks	交通网络一体化
7. Value add (provider & consumer)	增值（提供者和消费者）
8. Trials / pilot projects	试验/试点项目

Source: https://www.easa.europa.eu/en/what-is-uam (accessed 2024-Nov-19)

European Perspective – Example Projects

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欧洲经验—项目案例

Droniq (DFS & Deutsche Telekom)

Based on (EU) EASA U-Space concept

Droniq公司—实际上由DFS实施欧空安全局的U-SPACE概念服务

- Network Identification Service
- Geo Awareness Service
- Flight Authorization Service
- Traffic Information Service
- Conformance Monitoring Service
- Weather Information Service

HHLA Sky (Port of Hamburg)

汉堡港—通过多架无人机在不同用例中测试U-Space概念

- Crane maintenance (visual inspection)
- Inspection of complex structures
- Environmental monitoring
- Fast delivery of repair parts
- U-Space, real-world 10 km² testing site
- Integration into public ATM
- Max. 100 drones simultaniously

Schleswig-Holstein (North Sea Cost)

北德石荷州（北海海岸）—医疗服务、离岸风电场用例

- UAM-InnoRegion-SH / testbed
- Medical services for small coastal islands
- Off-shore wind-parks (inspection)
- Water rescue (Univ. in Heide)
- UAVs & birds

Cranfield University (Bedfordshire)

英国Cranfield克兰菲尔大学—共享空域程序和系统的测试

- TRA sandbox trial / shared airspace
- Elaborate knowledge, processes and systems
- ATM and FlightOps procedures
- Partners: CAA, Thales, Saab, ...

European Perspective – Insights

欧洲经验—深刻见解

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Some “(not so) stupid questions” as lessons learned …

一些“（不那么）愚蠢的问题”作为经验教训……

1. What if a drone leaves the **customs-free-zone**? How to inspect for goods? 无人机飞离码头免税区，货物检查?
2. What about **liability** questions (especially, when flying autonomously) … ? 自主飞行时的责任划分问题
3. Passenger **safety & security** vs. convenience & time-saving? 乘客安全与安保 vs. 便利与省时
4. Who determines **risk-based flight paths** and updates in **real-time**? 谁评估风险以确定飞行路线并实时更新?（例如无人机在载有危险品的船只上空飞行）
   (take a drone over a vessel, which has dangerous goods loaded)
5. A pilot of a light aircraft or helicopter flying in VMC according to VFR:
   → Still feasible in dense “**drone-populated**” airspace?
   If not: Is **switch to IFR** feasible considering ATC’s workload? 根据目视飞行规则VFR在目视气象条件VMC中飞行的轻型飞机或直升机的飞行员：在密集的“无人机”空域仍然可行吗？如果没有：考虑到空管的工作量，切换到仪表飞行规则IFR是否可行?
6. **Road traffic jams** must not be tackled by flying cars / eVTOLs! 采用飞行汽车或eVTOLs并不能从根本上解决道路交通堵塞的问题!
7. …
8. The business case! … **Which business case** ?!? 某些用例/应用场景可能没有实际的商业案例

欧洲经验

Transferable to China ?

欧洲经验是否可在中国直接复制/借鉴?

Setting the Scene

Some food-for-thought 值得思考的问题

Key Takeaways

European Approach For China?

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欧洲方法适用于中国么?

Why would you want to do that?
想这么做的出发点?

用例? /目标市场?	Use cases? / Target Markets?
研发环境?	R&D environment?
生产环境?	Production environment?
监管环境?	Regulatory environment?
综合空域管理?	Airspace integration / integrated airspace management?
社会环境?	Socio environment?
经济环境（国家、个人）?	Economic environment (national, individual)?

Economic Growth – Aspects to Consider

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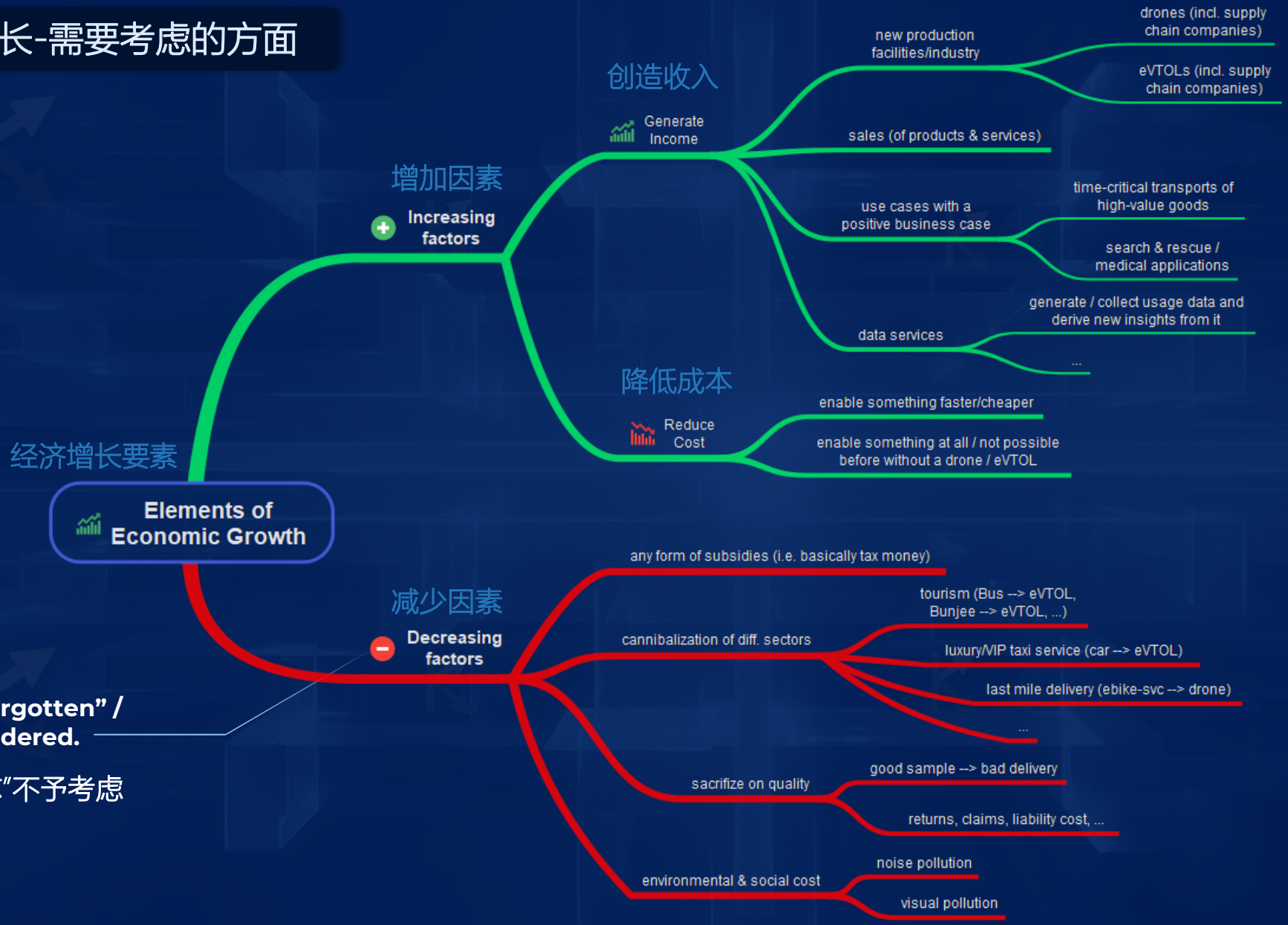
经济增长-需要考虑的方面



Often "forgotten" / not considered.

常被"遗忘"不予考虑

Market
Inside China?
Outside: for how long?

Take for example
German eVTOL companies ...
(not the best approach)

Economic Growth – Aspects to Consider

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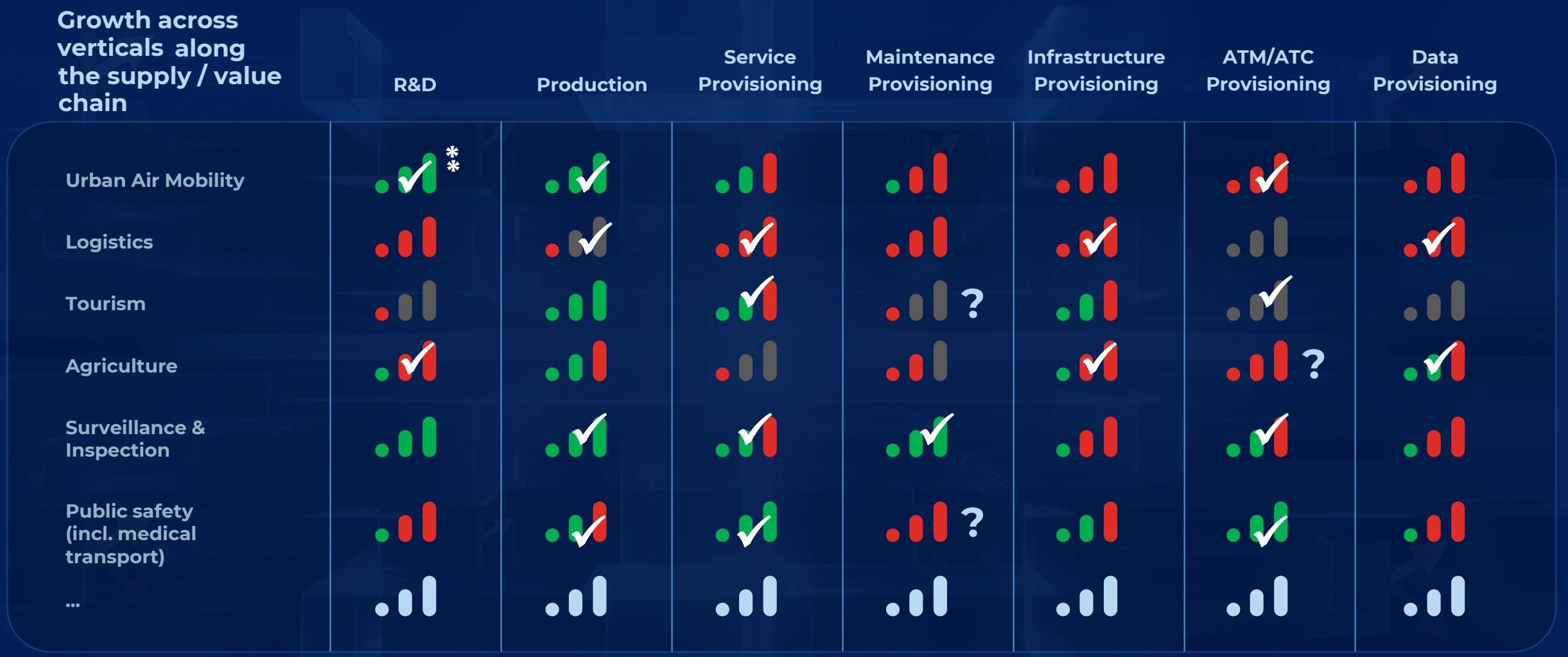

* filled for demonstration purpose only

制定一个清晰的蓝图（路线图），阐明参与时机、投入方面、参与广度和深度，然后监控执行情况。

Economic Growth – Questions to Ask

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经济增长-需要回答的问题

Wise policy-makers would want to ask some questions…

明智的政策制定者会想问一些问题……

- Is there an **integrated roadmap** (what?, when?) considering pre-conditions (what needed for it?)
  是否有一个清晰完整的综合路线图？怎样的？该何时具备？需要考虑哪些先决条件？
- Are **inter-dependencies** being monitored in a causal model over different target time-horizons?
  是否在不同目标时间范围内的因果模型中监测相互依赖关系？
- Is a target **market** segment ready for being harvested? What needs to be done to develop it?
  是否已有目标细分市场并做好准备以优势抢占市场和获利？需要采用哪些方法策略来开发细分市场？
- Which **substitutes** are there / will be there for a service/product offering?
  一项服务/产品在目前或将来是否存在替代品？（被替代性/非可持续发展）
- Is there a clear **value-add** for the consumer and/or the wider public? (use case ≠ business case)
  对消费者和/或更广泛的公众来说，是否有明显的增值？（用例≠商业案例）
- Is the value-add offset by any **hidden cost / side-effects** (economically, ecologically, socially, …)?
  附加值是否被隐藏的成本/副作用（经济上、生态上、社会上……）所抵消？

一种可能的推进方法 A Potential Way Forward...

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KEY OBJECTIVES 关键目标

1. Safety & Security 安全和安保
2. Comprehensive & Balanced Approach 综合&平衡的方法
3. Viable In The Long-Term 长期可行
4. Contribution To Economic Growth 对经济增长的贡献
5. Aligned With National Development 与国家发展战略接轨

WORKSTREAM	KEY ACTIVITY
Comprehensive Framework	• ... • ...
Dependency Model	• ... • ...
Benefit Assessment	• ... • ...
Trials, Pilot Projects	• ... • ...
Implementation Portfolio	• ... • ...
Policy alignment	• ... • ...

TO BE DONE IN A COLLABORATIVE APPROACH BY INDUSTRY, ACADEMIA, GOVERNMENTS, CITIZENS

行业、学术界、政府、公民以协同工作方式参与和定义以下工作流程中的关键活动：
全面的框架，依赖模型，效益评估，试点项目，组合项目实施，政策颗粒度对齐

A Potential Way Forward...

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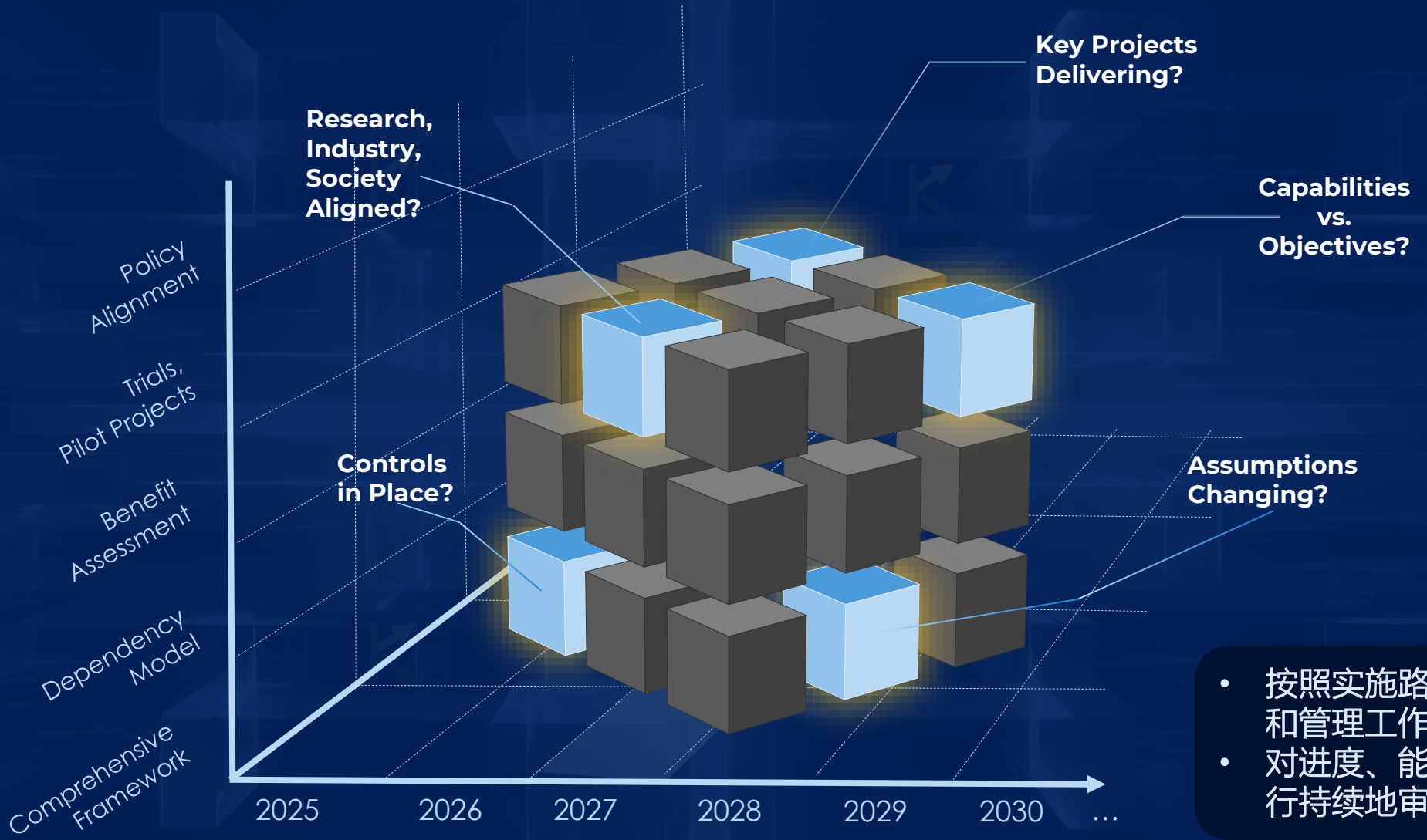

- 按照实施路线图积极推进和管理工作流活动。
- 对进度、能力和有效性进行持续地审查。

Setting the Scene

Some food-for-thought

Key Takeaways 关键要点

Low Altitude Economy

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Do **not** expect **easy** questions or answers.
(If too easy, someone might trick you.)

不要期望简单的问题或答案。（如果一切都显得轻巧容易，必然存在隐藏某处的坑。）

Manage **expectations** regarding economic growth.
(Use a comprehensive framework.)

使用综合框架来管理经济增长预期。

Integrated **airspace management** is key!
(Address stakeholders' concerns as early & open as possible.)

综合空域管理是关键！（尽早着手解决利益相关者的担忧，并尽可能开放。）

Imagine a future **20 years from now**...
(Is your approach scalable? Side-effects? Hidden costs?)

想象一下未来20年.....(您的方法可有效扩大规模吗？有副作用吗？是否有隐性成本?)

Low Altitude Economy – A Promising Future?

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低空经济-未来可期

Traffic jams gone? 交通拥堵消失了?
Accidents decreased? 事故减少了?
Economy grown? 经济增长了?
Pollution reduced? 污染减少了?
Quality of life improved? 生活质量改善了?

Helicopters? 直升机?
Light aircraft? 轻型飞行器?
Kites? 风筝?
... .

Let's have a fruitful discussion for a future, which we all would like to be a part of ☺

让我们就未来进行一次富有成果的讨论，我们都热切期待成为低空经济发展的先行者、践行者和见证人。

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