

# The impact of innovative technologies and business practices on last-mile logistics

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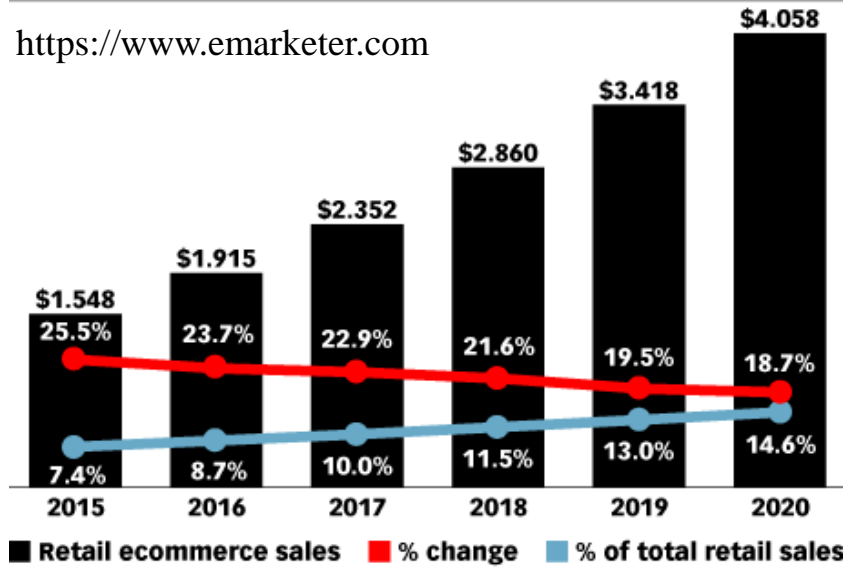
CITYLAB Symposium  
Rome  
20<sup>th</sup> October 2017

# Growth of Online Retailing and Food Delivery Market

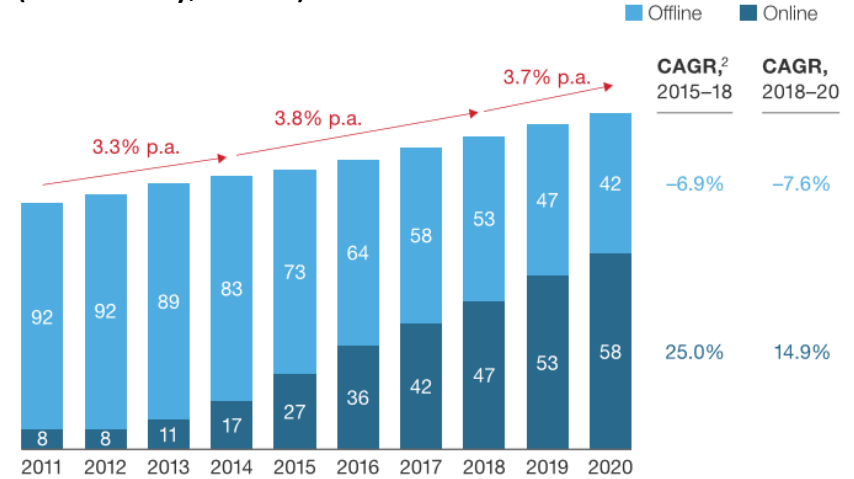
## Retail Ecommerce Sales Worldwide, 2015-2020

trillions, % change and % of total retail sales

<https://www.emarketer.com>

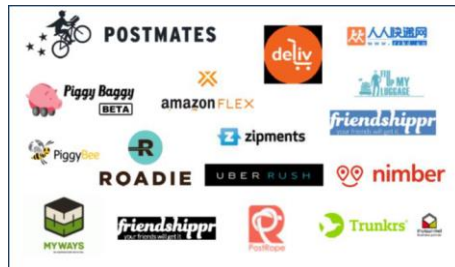


## Value of food delivery market (McKinsey, 2016)



% of US online retailers with same day delivery capability: 2016 16% 2017 51% (Business Insider)

- volume growth
- service enhancement
- delivery fragmentation
- cost pressures
- labour shortages



crowdshipping



drones



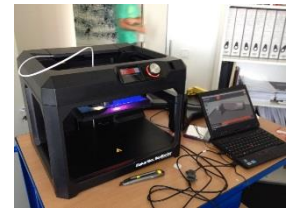
drone-truck



droids



robovan



consumer-based 3D printing

# Crowd Sourcing of Parcel Deliveries: *Crowdshipping*

*'enlisting people who are already travelling from points A to B to take a package along with them, making a stop along the way to drop it off'* (US Postal Service 2014)

- exploiting new spirit of collaboration
- commercialisation of social networking

*'We believe efficient local delivery is critical to a vibrant local economy. Logistics isn't just about moving stuff around. It's a tipping point in helping local economies prosper.'* Zipments website

## *Benefits:*

- accelerates last mile distribution
- more flexible, life-style-adjusted delivery
- fewer failed deliveries
- low marginal cost / improved asset utilisation
- lower traffic levels, emissions and congestion

## *Problems:*

- increased risk of theft, loss and damage
- inadvertant delivery of illicit products
- vulnerable to criminal / terrorist activity



[www.alanmckinnon.co.uk/story\\_layout.html?IDX=729&s=y](http://www.alanmckinnon.co.uk/story_layout.html?IDX=729&s=y)

## redefining passenger / freight interface



Could Amazon plus Uber be the click-and-collect dream combo?

Financial times (15 Oct 2014)

Andrew Hill | Author alerts | Oct 15 2014 11:50 | 2 comments | Share

Amazon and Uber now in the crowdshipping market

Uber Eats accounted for 10% of Uber's global bookings in the last quarter (FT 16 Oct 2017)

# Impact of Crowdshipping on Urban Traffic Levels

## 1. Degree of spatial and temporal matching between personal travel and freight movement:

Probability of matching =  $f$  (number of crowdshippers and receivers)

Initially low probability → longer detours      limited reduction in traffic levels

## 2. Integration of crowdshipping into urban supply networks:

Where do crowdshippers obtain the consignments?

collection from a point on the travel route – no deviation

minimal extra kms

separate parcel delivery to crowdshipper's home – extra trip

significantly more kms

- Net effect on traffic levels likely to be modest at least in the early stages
- Will require substantial reductions in vehicle-kms for system to be viable and socially worthwhile

# Parcel deliveries by drone



China - Alibaba



Switzerland



UK - Amazon



Australia – Google / Dominos Pizza



US – Seven Eleven



France - DPD

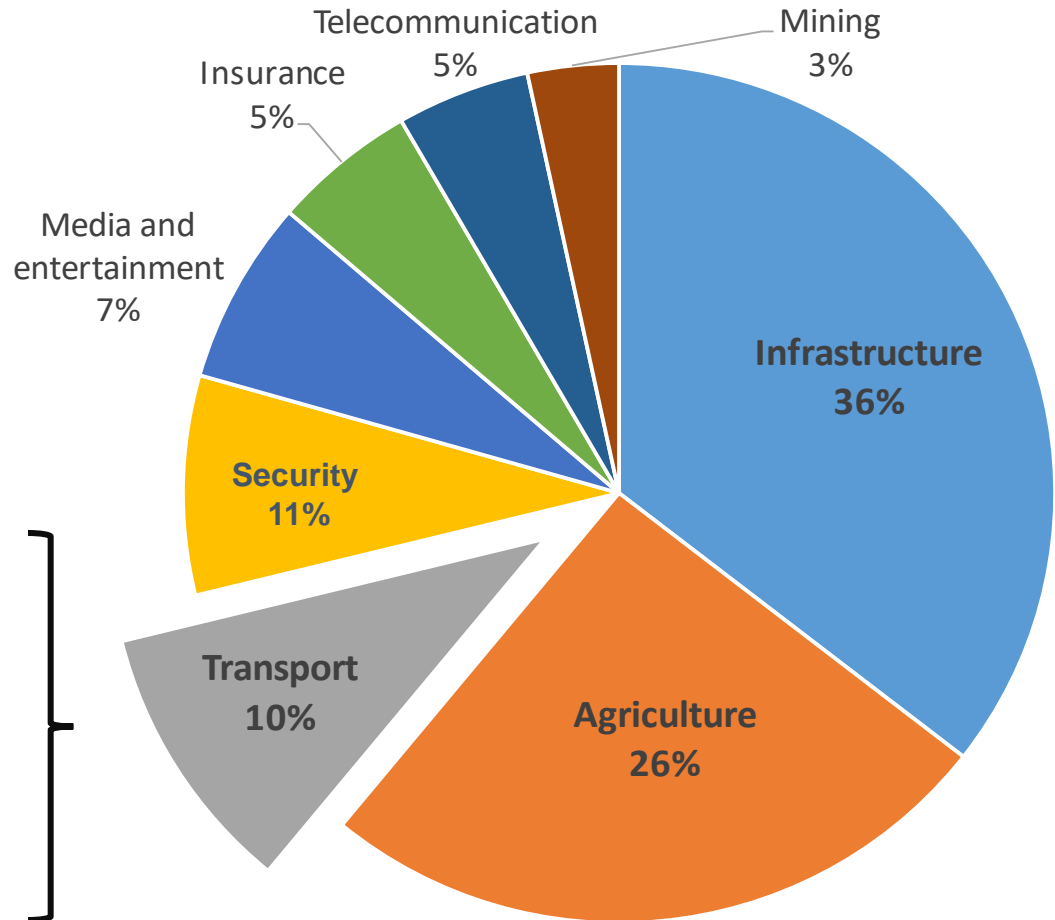
# Global Market Potential for Drones \$127 billion

Data source: PwC (2016)

<https://www.pwc.com/gx/en/communications/pdf/communications-review-july-2017.pdf>



- Parcel delivery
- Spare part delivery
- Food delivery
- Medical logistics



Andreas Raptopoulos CEO of Matternet  
*'..the next big paradigm in transportation'*

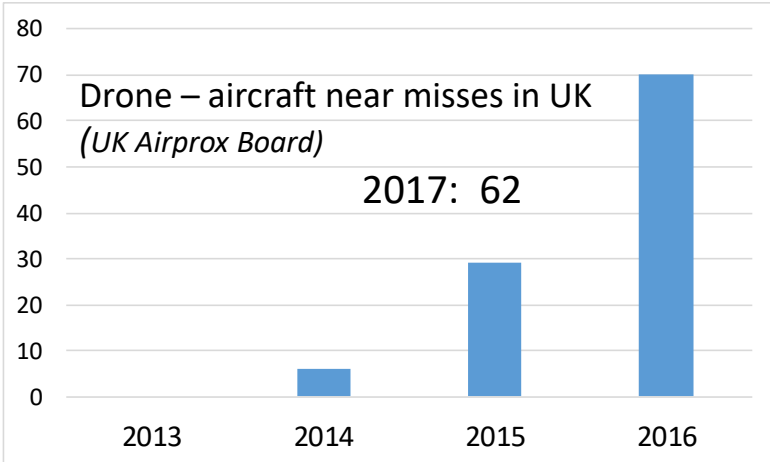
Frank Appel, CEO of DP - DHL  
Drones are *'not a mass phenomenon'*



# Aeronautical Constraints

Line of sight operation – cannot yet operate autonomously  
When autonomous - network of 'skyways' over urban areas – not direct flight

'Pure luck' prevented drone from causing catastrophic central London disaster



European Aviation Safety Agency  
**Notice of Proposed Amendment 2017-05 (A)**

Introduction of a regulatory framework for the operation of drones  
Unmanned aircraft system operations in the open and specific category



MINISTRY OF INFRASTRUCTURE AND CONSTRUCTION

EASA  
European Aviation Safety Agency

CIVIL AVIATION AUTHORITY

WARSAW DECLARATION  
*“Drones as a leverage for jobs and new business opportunities”*  
Warsaw - 24 November 2016

- Airspace up to 150 metres
- Registration, e-identification and geo-fencing
- Unleash full economic potential of drones
- 'Up and running' by 2019

'U-space is a set of new services and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones'

Source: EU U-space blueprint

# Scoping the European Drone Delivery Market



7.2 billion parcels per annum

10% same day premium

60% <2.5kg

15-20% drone share

85 million parcels per annum  
1% of total parcels

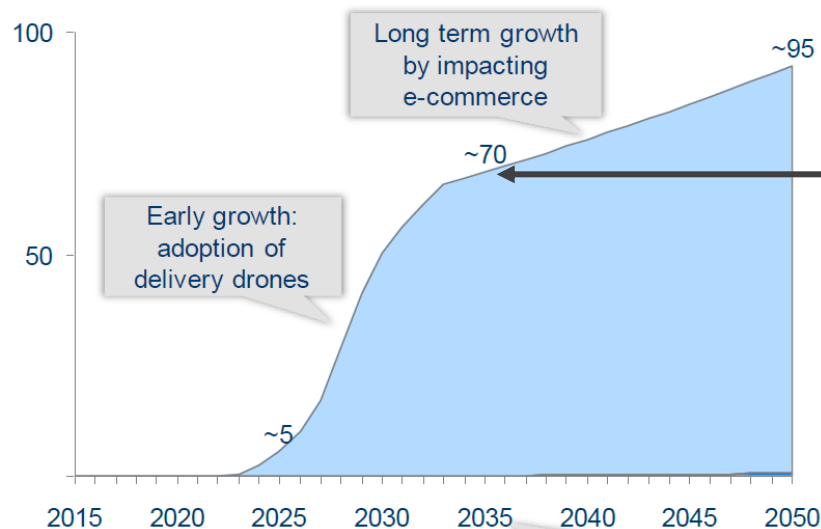
15,000 drones

'Drones are not expected to be viable for standard parcel deliveries'

need €10 per delivery

premium, same day delivery market

Drones used for delivery services ('000)



'Outlook for 70 000 drones to deliver some 200 million light weight parcels across Europe in 2035'



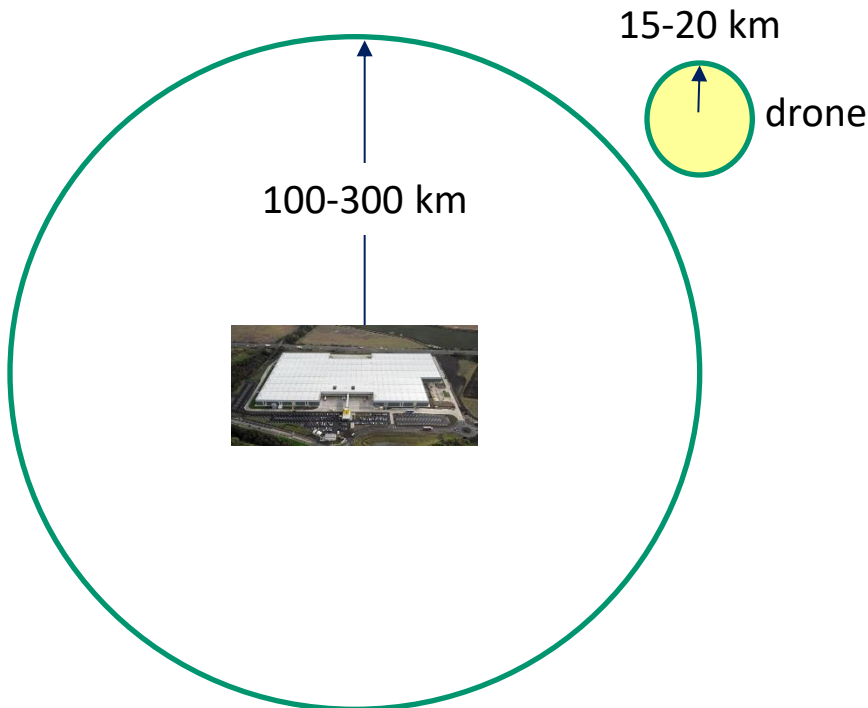
# Critical Logistical Trade-off: *product diversity versus speed of delivery*

Amazon Fulfilment Center network



vast product range:

> 1 million SKUs



cannot replicate huge product range at local level

restrict drone delivery to small range of 'fast movers'

use predictive analytics to pre-position these products

use local depots or shops as 'drone dispatch' points

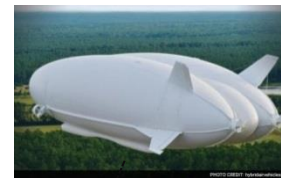
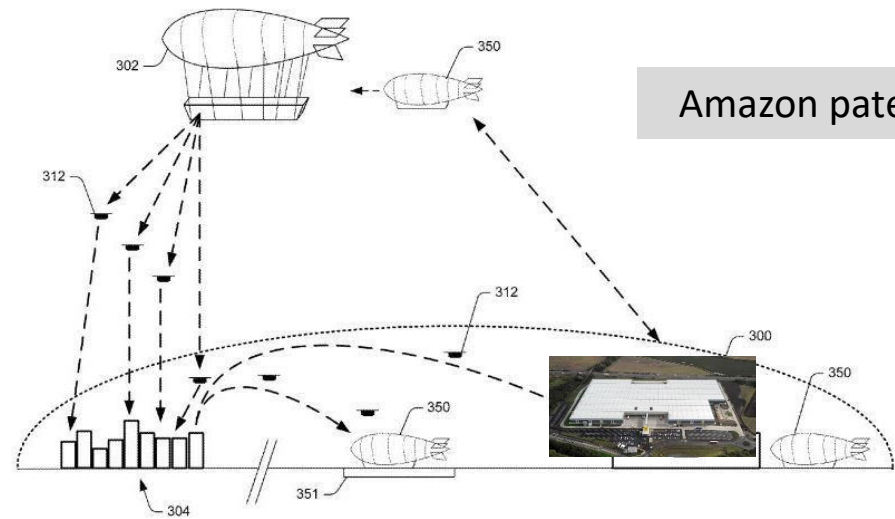
inventory dispersal + local dispatch point inflates costs

# Reinventing the Logistical Trade-off: *Logistical Innovation 1*

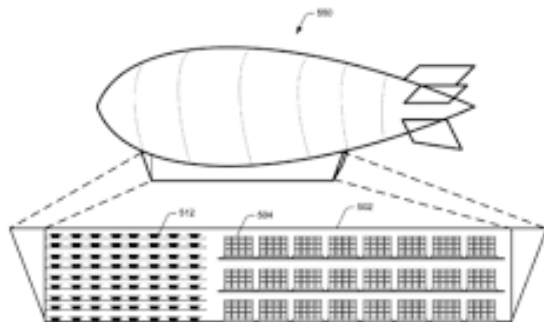
## Aerial Fulfilment Centre (AFC)

Amazon patent

100-300 km



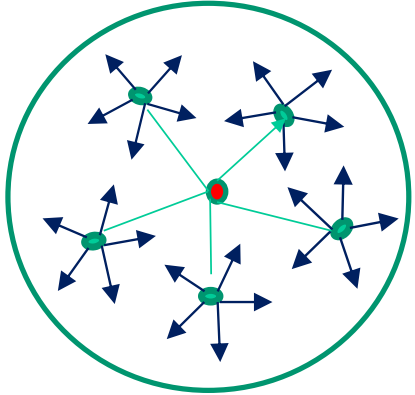
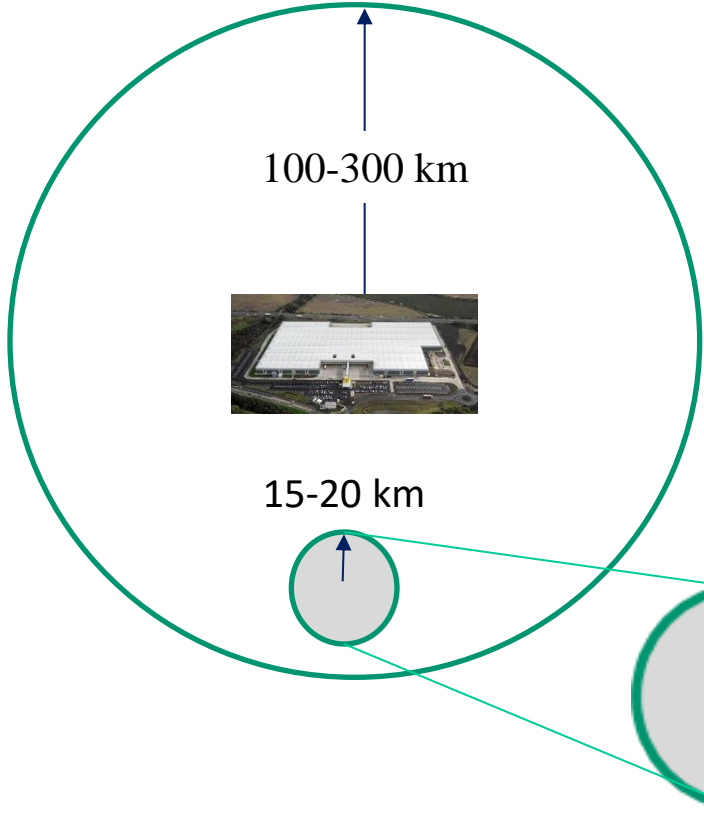
45,000 feet



drones inventory

# Reinventing the Logistical Trade-off: *Logistical Innovation 2*

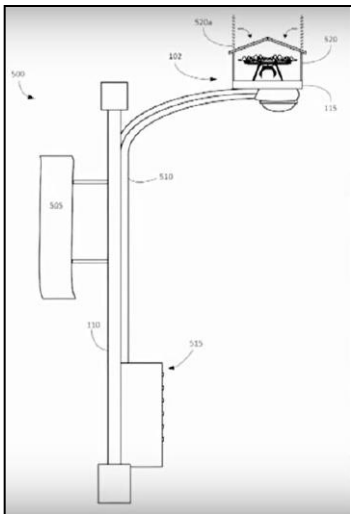
## Drone Truck



- BUT:**
- longer delivery time
  - much higher cost
  - exposed to traffic congestion



# Where will the drones land?



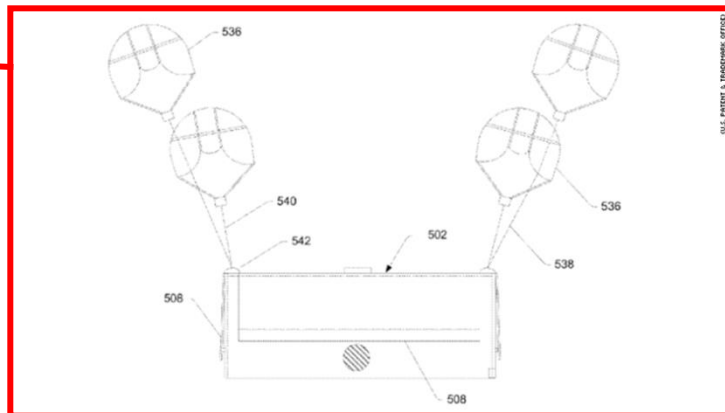
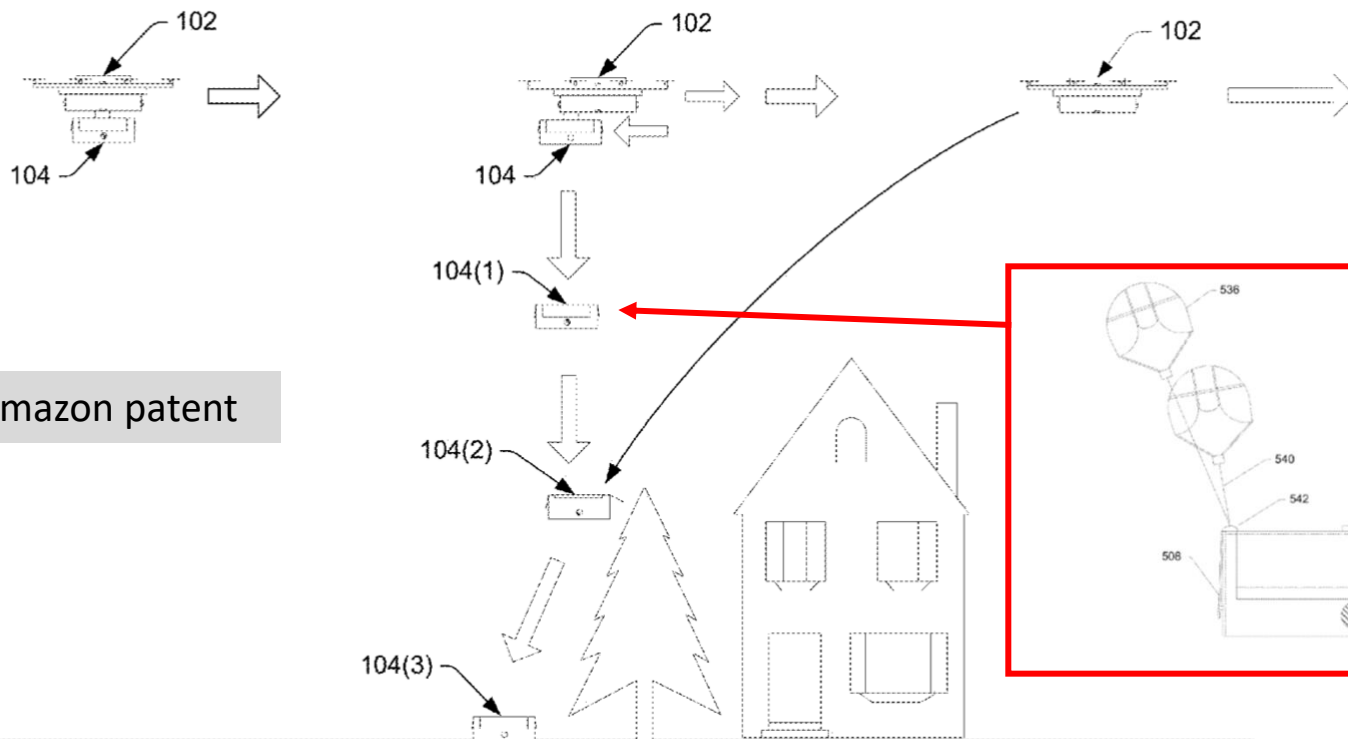
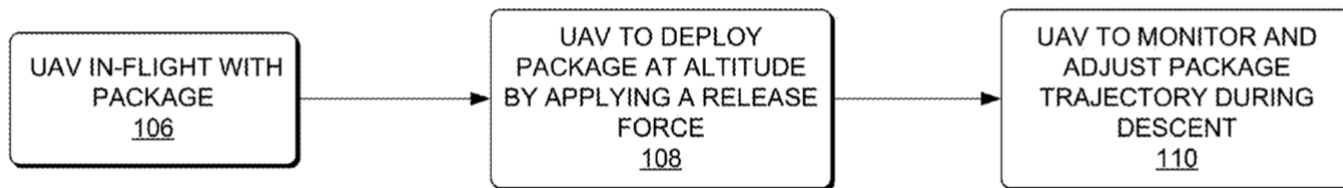
Don't land the drone – *drop parcel by cable*

or by parachute....



Amazon patent

# Parcel dropped by parachute + *inflatable balloons remotely controlled by the drone*



Amazon patent

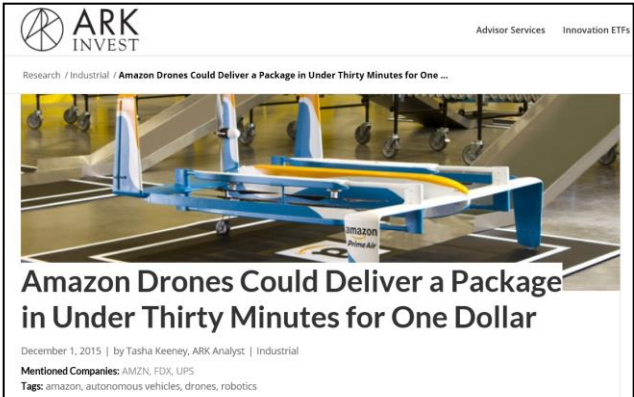
- Damage risk to product
- Damage to property
- Injury to innocent by-standers
- Risk of loss, theft etc

} Liability issues

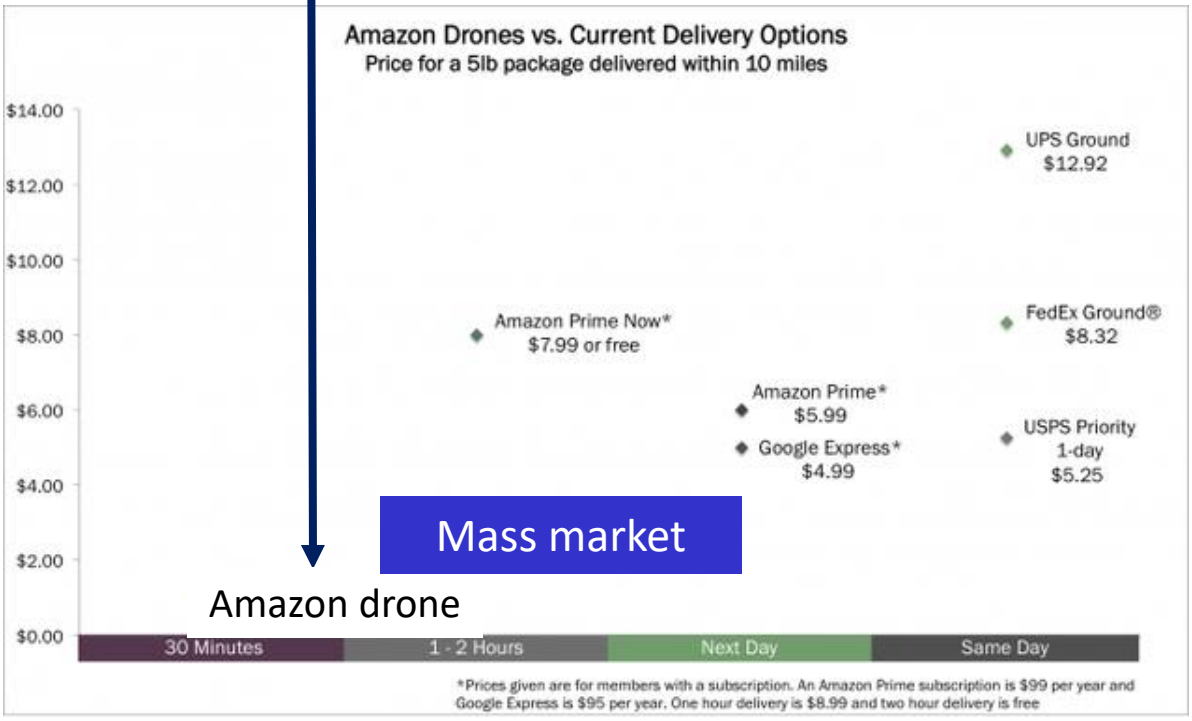
*'As for Amazon, if it wanted press coverage ...well, buying adverts is expensive. But filing sci-fi patents for drones is cheap – and gets acres of publicity.'*  
 Peter Bradford, *Guardian* 16 Feb 2017

# Economics of Parcel Delivery by Drone

Amazon: 10 cents per drone delivery against \$2 - \$8 for surface delivery by van



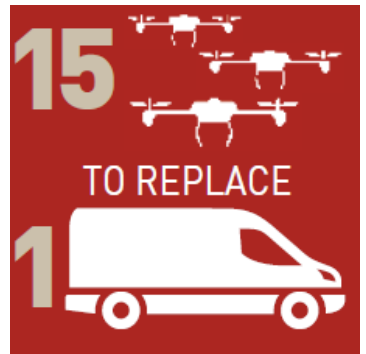
\$0.88 - \$1.00 ← cost per delivery ? → \$9.75 and \$17.44



€10  
SESAR study

Niche premium market

few economies of scale in drone delivery





# Impact of Drone Delivery on Urban Traffic Congestion

DHL Trend Radar report(2016) *'by potentially reducing the amount of vehicle movements, UAVs can provide traffic congestion relief to densely populated cities'*

Number of drones required to cut total urban traffic by 1% in the UK

163.4 billion vehicle kms (2014) by all vehicle classes

1% = 1.63 billion vehicle-kms

drone : van substitution ratio 15:1

drone : van substitution ratio 10:1

average annual kms per van: 13,700

average annual kms per van: 27,400

1.8 million drones

600,000 drones

<http://www.alanmckinnon.co.uk/blog/?p=9>

Drones may also replace cars making shopping trips, collecting /delivering meals etc

SESAR: no. of drones required to meet current delivery market potential in UK: 2000

negligible effect on urban traffic congestion

# Vulnerability of Drone Delivery

Theft of parcels from insecure drone delivery points

target practice



Use of eagles to apprehend drones in restricted locations (Dutch trial)



Hijacking of drones for malicious purposes

# Delivery Robots: Droids

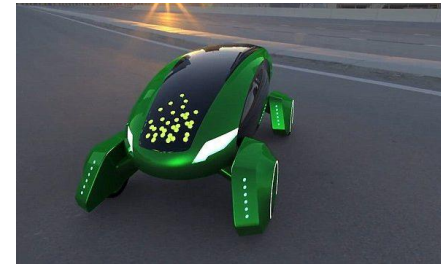
## Twinswheel



## Loom-go



## Kar-go



## Starship Technologies Autonomous Delivery Robot

- 60,000 kms of deliveries
- 100 cities
- 17 countries

- 12-15 kg payload
- 1.5-3 km range
- 6 kms per hour
- parcels, fast food, groceries

Cost per delivery:  
€1.5 – 3.0

Data source:  
<http://bit.ly/2y4i8CD>

[www.npr.org/sections/alltechconsidered/2017/03/23/520848983/hungry-call-your-neighborhood-delivery-robot](http://www.npr.org/sections/alltechconsidered/2017/03/23/520848983/hungry-call-your-neighborhood-delivery-robot)



# Droids



- Much more conspicuous than drones
- More interaction with the public
- Conflict with other pavement / sidewalk users
- Greater security risk
- Onboard video cameras raise privacy concerns
- **Public acceptance is essential**



- Artificial intelligence adapts movements to local environment – *constant AI learning process*
- Very manoeuvrable and slow speed
- Numbers limited – ‘15-20 per neighbourhood’
- Security achieved by:
  - Constant tracking
  - 9 video cameras
  - Siren
  - Secure lock
  - Concealed contents – *mostly low value*

All deliveries are attended – 5 minute time window – consumer tracking of the droid by phone app

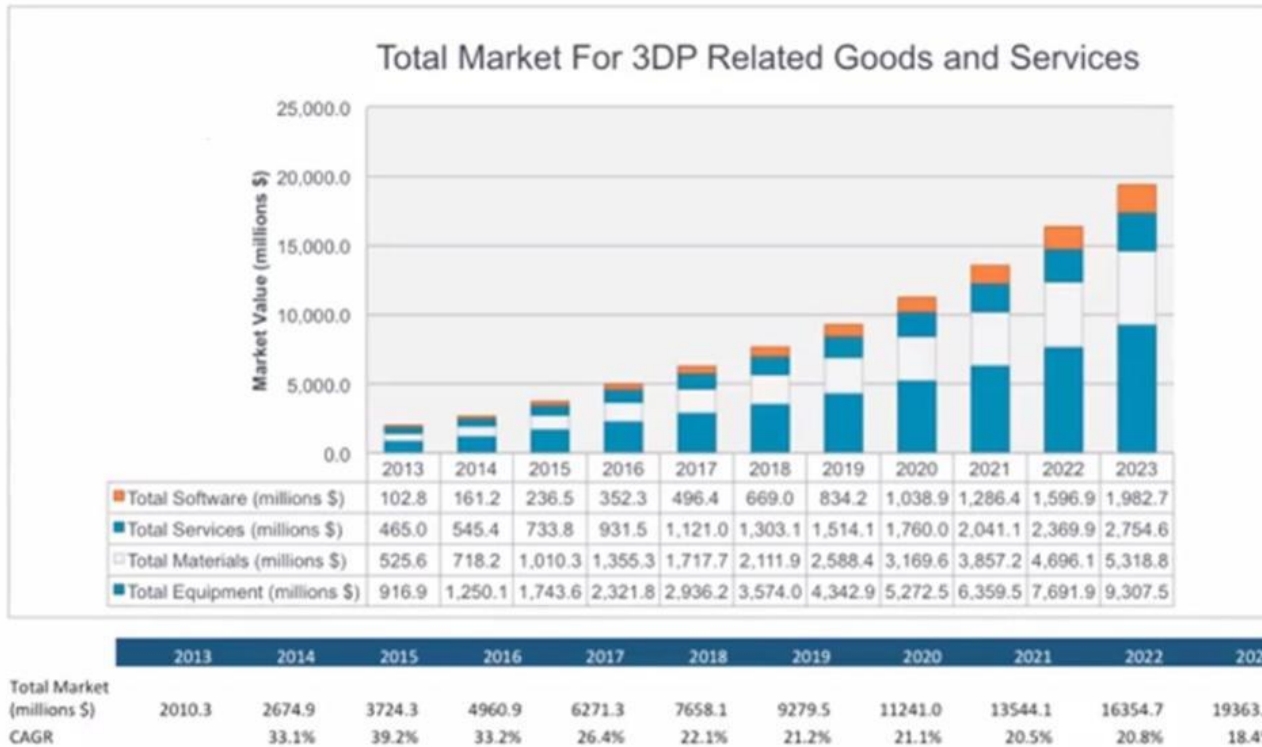
Integration into logistics system:  
-locally sourced meals and groceries  
-parcels from local ‘hub’  
-same parcel constraints as for drones



Robovan: ‘Mothership’

- integration of droids with van deliveries
- extends delivery range
- improves productivity of van delivery?

# Growth in the Global 3D Printing Market



<https://www.forbes.com/sites/louiscolombus/2015/03/31/2015-roundup-of-3d-printing-market-forecasts-and-estimates/#268bd3201b30>

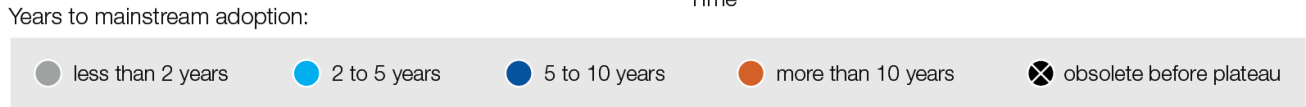
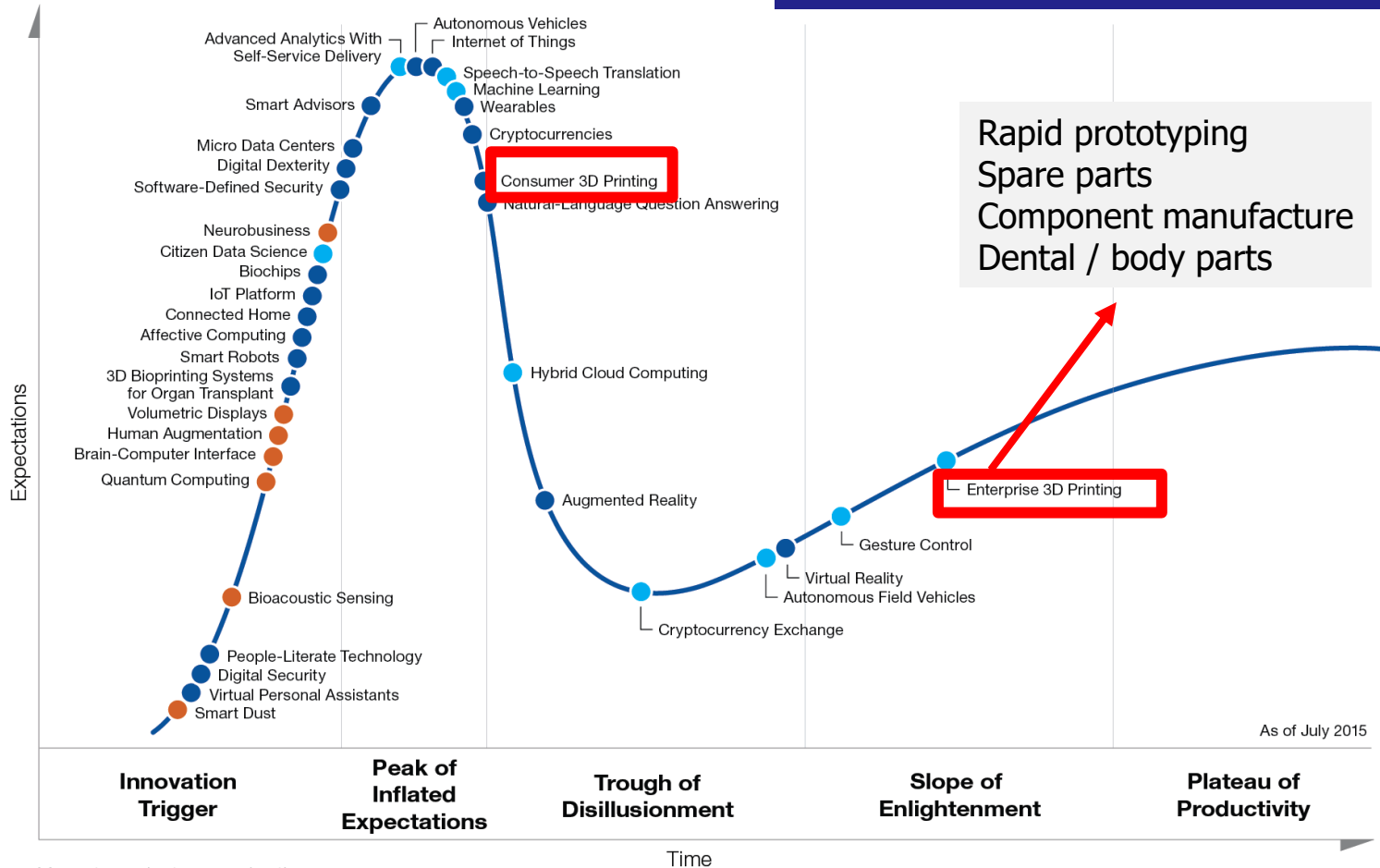
Predominantly 'enterprise' 3D printing

*'Market penetration on the consumer side is extremely low for 3D printing even as the media repeats unproved assertions and overheated projections'*  
*Biederman, 2013*

Large reduction in urban goods movement will require a major uptake of 3D printing at consumer level

# Position of 3D Printing on the Gartner 2015 Hype Cycle

Over-hyping of consumer applications?





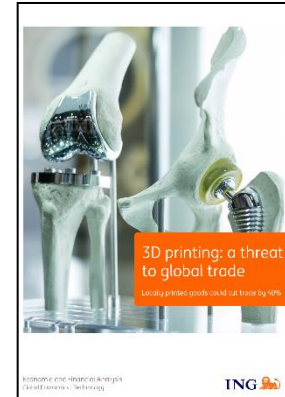
# Constraints on the Development of Consumer-based 3D Printing

1. **High unit costs:** even after forecast reduction in costs €3.14 / cm<sup>3</sup> → €1.1 per cm<sup>3</sup> (2023)

- high capital cost of 3D printers with necessary functionality
- very limited economies of scale: *cannot compete with factory-based batch production for standard products*



Adidas to mass customise soles of training shoes using 3D printing in German factory



50% of manufacturing by 2040 (Scenario 1)  
2060 (Scenario 2)

What proportion of consumer-products will command a large enough 'customisation premium' to justify home-based 3D printing?



2. **Product range limited:** by nature of the process, range of materials, inherent weaknesses in the printed products and affordable functionality of home-based 3D printers

Home-made toys – *entry point for the domestic market?*

News > Technology > 3D printing

Hasbro aims to make 3D printing child's play

3DP may create new generation of personalised products, supplementing rather than replacing existing retail goods - **net increase material consumption?**

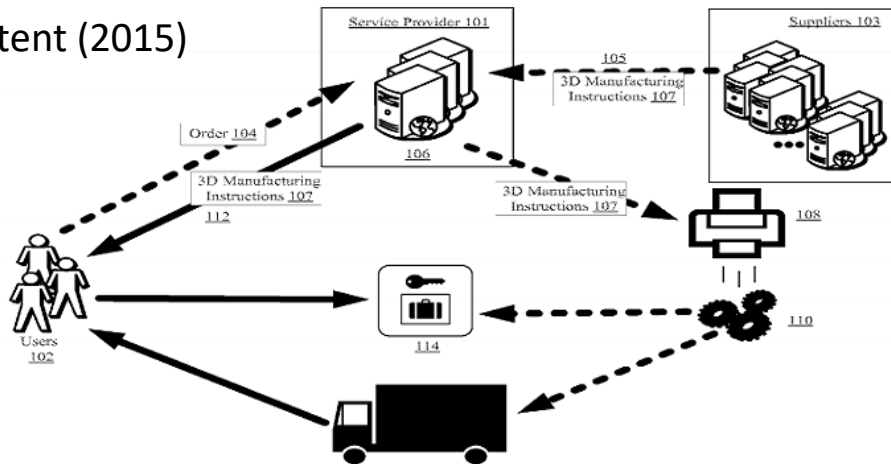
# Provisional Verdict on these Innovations

- Crowdshipping - *significant opportunities if social media, collaborative business models, IT systems and regulatory policy are well aligned*
  - *entry of big players into market increases potential but also changes the original concept from communal to commercial*
- Drones - *rural rather than urban applications*
  - *niche, premium delivery services in urban areas – if regulations permit*
- Droids - *workable if public acceptance secured*
  - *localized, niche and more for suburban areas*
- Consumer-based 3D printing: *-potential for significant reduction in the amount of freight movement in urban areas*
  - *but unlikely to scale up to mass activity in foreseeable future*

Possible synergies between these city logistics innovations?

# Convergence of Last Mile Technologies?

From Amazon patent (2015)



## Amazon Wants to 3D Print Your Purchase in the Back of Its Delivery Van

Jamie Condliffe  
2/27/15 4:30am

7.8K 43



Source: Advanced Tactics Inc

The 'Drone-Droid' ?

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