New Critical End Market Requirements: How Can Technology Enable Them?

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Key Topics

Smart Cities and Smart Spaces

Freight Transportation & Logistics

Smart Manufacturing & Industrial

Smart Mobility and Automotive

Smart Cities and Smart Spaces

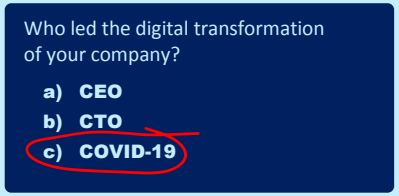
Changing Priorities for City Governments

Focus on Resilience as Top Priority

- Cities extremely vulnerable – loss of life and economic value
- 2019 - Chief Resilience Officers, 100 Resilient Cities (100RC)
- 2020 and beyond
  - New universal smart city requirement
  - Rebalancing efforts and budgets – pandemics *versus* road safety

Leveraging Technologies to Address Demand-Response Challenges

- Scalable IoT Platforms and Digital Twins
- Open Data approaches & Artificial Intelligence (AI)-based predictive analytics
- Robotics – Drones, driverless delivery vehicles
- Sharing and Crowdsourcing Economy
- Smart home and commercial buildings technologies
- Repurposable assets & new use cases



Accelerated and Lasting Digital Transformation and Virtualization

- eServices – eHealth, online education, eWork, eGovernment
- Blockchain – supply chain monitoring & management & Smart contracts for logistics

Regulation and Legislative Frameworks

Role of Cities in Economic (Re)Development

Resilience – Avoidance, Readiness, and Responsiveness

Resilience components and technology tools

Avoidance and Prevention	Early Anomaly Detection and Notification/Alerting	Emergency Response Management and Recovery
▪ Digital Twins ▪ Modeling / Simulation ▪ Generative Design ▪ Physical Protection	▪ IoT Telemetry ▪ Smartphone Data Ingestion ▪ Flood & Earthquake sensors ▪ Air Quality Measurement ▪ Predictive Analytics (AI)	▪ Digital Twins ▪ Robotic Delivery & Surveillance ▪ Repurposing of Assets & Sharing Economy ▪ Manufacturing & Supply Chain Flexibility

"Across 279 top cities, US$546.50 billion is at risk from all 22 threats"

City	GDP@Risk	Leading threat
Tokyo	$24.31bn	Interstate conflict
New York	$14.83bn	Market crash
Manila	$13.27bn	Tropical windstorm
Taipei	$12.88bn	Tropical windstorm
Istanbul	$12.74bn	Interstate conflict
Osaka	$12.42bn	Interstate conflict
Los Angeles	$11.56bn	Flood
Shanghai	$8.48bn	Tropical windstorm
London	$8.43bn	Market crash
Baghdad	$7.91bn	Interstate conflict

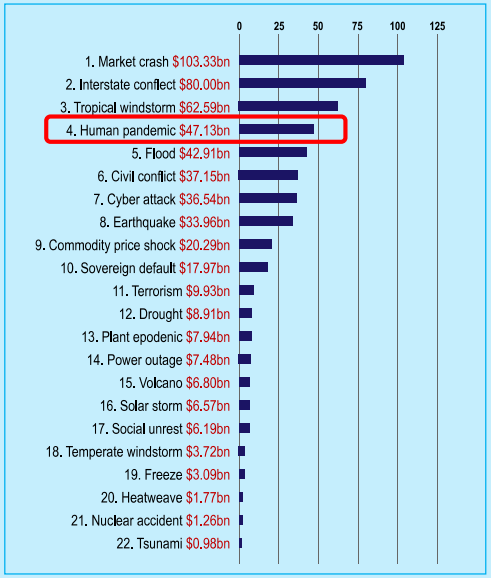
(Source: Lloyd's of London)

Processes and Procedures

Organizational Structure

IT/OT Design Requirements

Risk Assessment



(Source: Lloyd's of London)

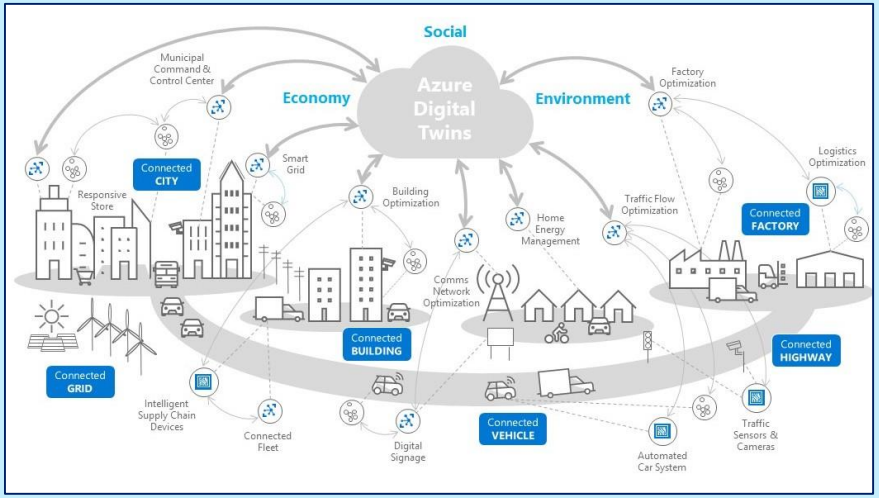
Urban Digital Twins – The Ultimate Smart Cities Tool

- **Spatial 3D modeling of physical structures and assets**
- **Mathematical descriptions of electrical and mechanical systems**
- **Real-time IoT sensor data**

Road Traffic: Vehicles and Micro-mobility Patterns
Parking Spaces and EV Charging Stations
Indoor and Outdoor People Movements and Flows
Weather and Air Quality Levels
Flooding and Water Management
Energy and Utilities: Generation, Distribution, and Usage Patterns
Smart Buildings and Energy Management
(Air)ports, Malls, Venues, Stadium and Campuses
Impact of Natural Disasters
Green Infrastructure and Circular Economy
Cyber Security

OPERATIONAL EFFICIENCIES AND COST SAVINGS
IMPROVEMENTS IN DESIGN AND SERVICE QUALITY
IMPROVED SAFETY, SECURITY, AND RESILIENCE
AUTOMATED, GENERATIVE DESIGN
ECONOMIC GROWTH

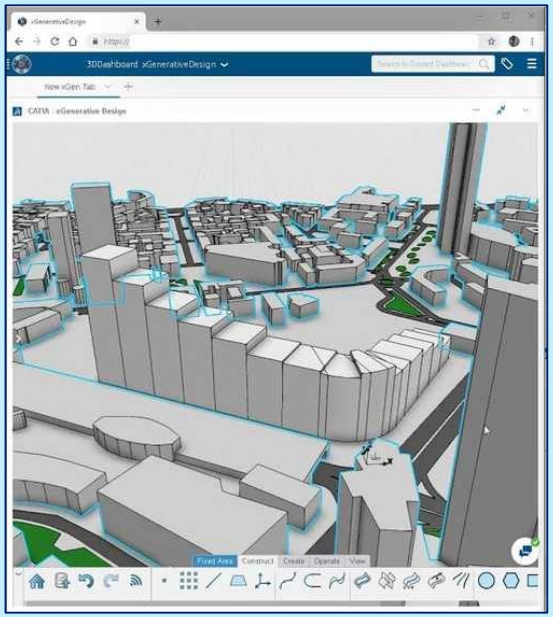
Microsoft Azure Digital Twins	Siradel (Engie)
Dassault Systèmes	IES
ESRI	Autodesk
Bentley systems	Siemens
Ansys	CityGML
PTC	PTV
NTT	CityzenitH
Locis	



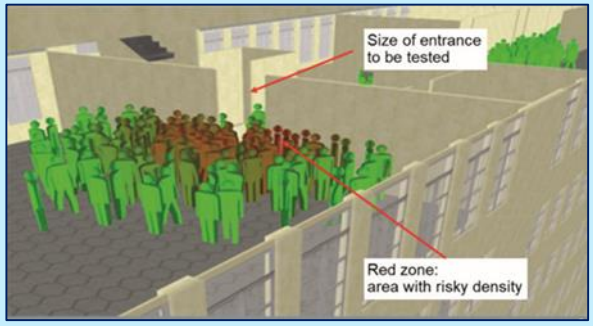
Urban Digital Twins and Resilience – Virtual versus Real

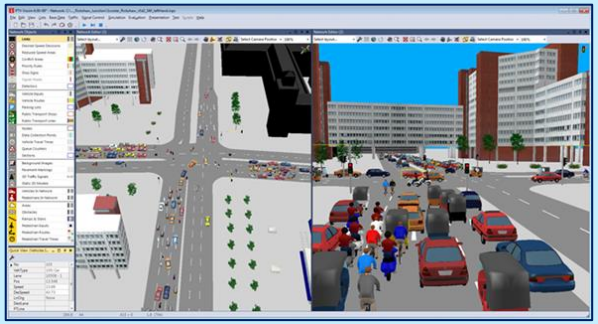
Simulations, demand/response management and generative design

- Transversal, end-to-end, holistic modeling
- Full real-time visibility on assets, utilities, services, and activity levels
- Simulation of stress resistance of systems and assets
- Visualization (dashboards), monitoring and scenario-based planning
- Generative design of new greenfield developments



Emergency Evacuation Simulation
Solar Energy Capacity
Flood Levels Simulation
Impact of Flooding on Traffic Flow
Coverage of CCTV Network
Dynamic Simulation of Public Lighting, Noise, Heat
Impact Demand on Energy and Other Utilities



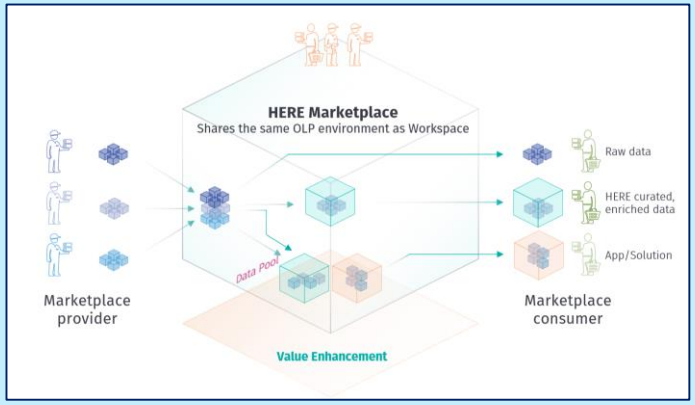


A New Reality

Budget constraints, different priorities, lifecycle management and open ecosystems

- Close Cooperation with Private Companies
- Long Term View
- Lifetime Value Optimization

Govtech Marketplaces
Vendor Acceleration
Open Data Platform
Smart City Standards
Scalable, Modular, Cloud-based Platforms
Cross-vertical Collaboration
Horizontal Organizational Structures
Cooperation Between Cities (Coalitions)



- **Rebalancing Priorities in Short Term**
  - Pandemic, Climate Change
  - Road safety, Air Quality, Micro-mobility, Congestion

- **Shrinking City Budgets due to COVID-19**
  - Lower Tax Revenues
  - Higher Costs

- **Use Technology to Maximize Cost Savings (ROI)**

- **Financial Support from Governments?**

Freight Transportation and Logistics

Industry Snapshot

Will unprecedented volume hit a cliff?

Trucking

- US freight volumes peaked March 23rd, with highest volumes ever recorded
- Poor expected Q2, followed by flat Q3

Maritime

- March to May to fall 17.8% Year-on-Year (YoY) on Asia-Pacific-European Union (EU) route, 15% on the Trans-Pacific West, and 13% Trans-Pacific East (MSI)

Air Freight

- Rates have doubled between the US and Europe.
- Rising use of passenger aircraft and freight forwarders using charters

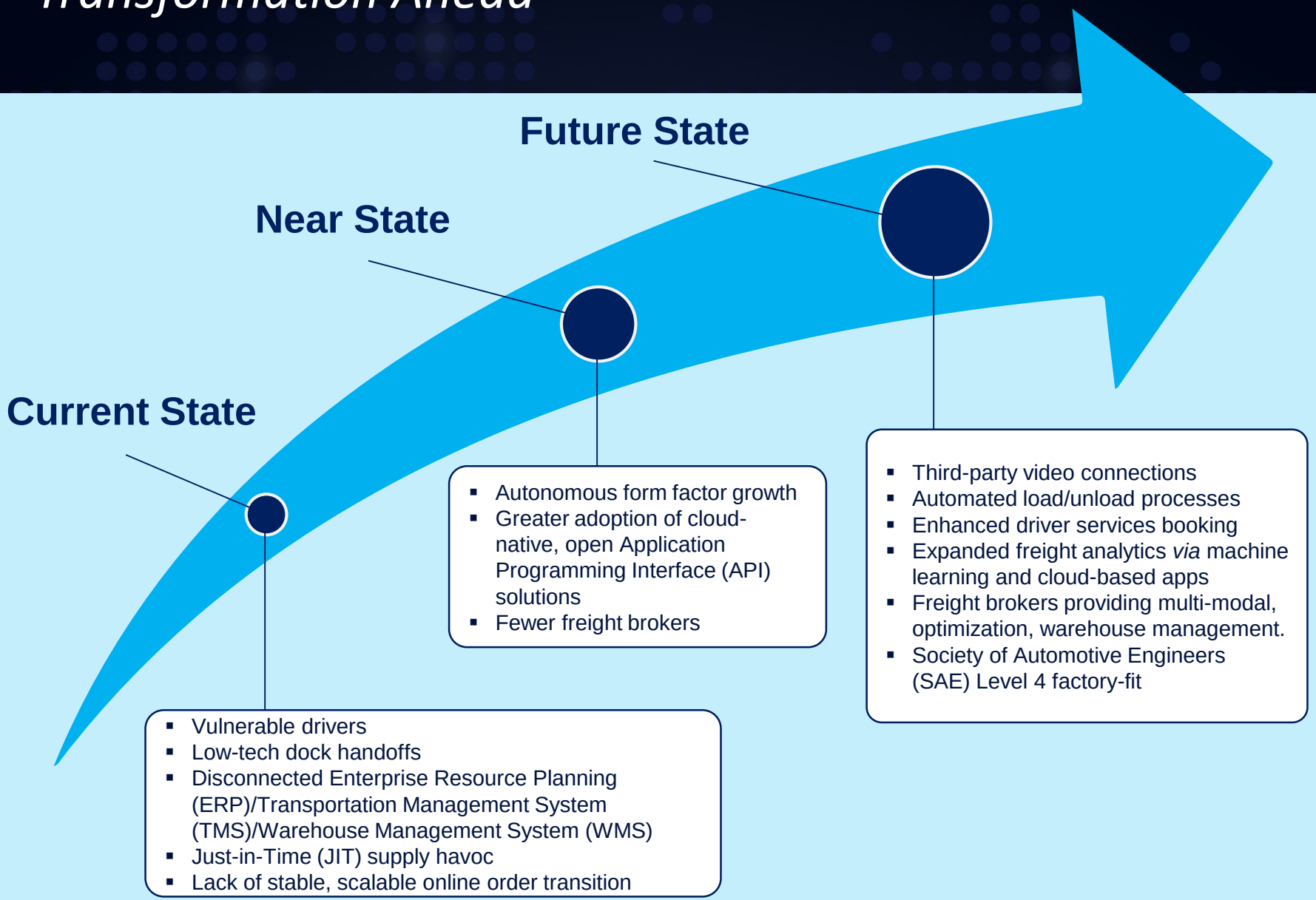
Rail Freight

- Fluid and negative rail carload cycle expected
- First return trip on 03/28 from Wuhan to Europe

Fulfillment

- Need for new hotspot sites. Non-essential 3rd party shipments delayed
- Massive hiring attempts, but demand closely follows economic activity…

Transformation Ahead



Automation, Acceleration and Regulatory Support

- Current conditions will act as an **accelerant for initiatives and the future of work**
- **Automation occurs in surges, intensified in downturns**
- **2020 and beyond** is likely to generate **a new wave of scalable technology applications**
- These will result in **operational changes** as well impact **staffing and skill sets**
- Likely contenders: **robotics, automation, sensors, cameras, machine learning,** and **predictive analytics**

- **U.S. Department of Transportation (DOT)/National Highway Traffic Safety Administration (NHTSA)** gives Nuro first approval to operate 5,000 driverless last-mile delivery vehicles across the United States
- UPS Flight Forward, first to receive Federal Aviation Administration (FAA) approval to partnered with CVS and now with **Wingcopter**
- **Waymo** allowed to continue Phoenix's **fully driverless early rider program, local delivery and truck testing.**
- **Idriverplus's** driverless street-sweeping trucks support disinfection in **China**.
- **Baidu** partnered with **Neolix Apollo** autonomous vehicle to deliver supplies
- **Drone Delivery Canada Corp** in discussion with government ministries to transport supplies

Innovative, Well-Funded Start-Ups

Unicorns to Watch

Convoy

- $2.7B digital automated freight network
- Clients include Unilever/ P&G
- Focus on automation and machine learning

TuSimple

- $298M in VC/$1B valuation
- Camera-based autonomous driving
- Navistar and Paccar, partners & a stake in UPS

Nuro

- $1B in funding
- Self-driving, Electric Vehicle (EV) pod for local goods
- USDOT approved
- Kroger, Walmart and Domino's partners

Flexport

- $1.3B cloud-based, licensed customs broker & forwarder for global trade
- Ocean, air and ground modes Georgia Pacific, Ring, Sonos & Bombas clients

Samsara

- $530M in funding Telematics & Industrial IoT EV fleet services
- Real-time visibility, w/ analytics & AI
- Many municipal clients

Recommendations

- Seek options for greater process automation, predictive analytics via machine learning/AI to drive better freight and inventory visibility and accuracy (virtual and on-site including demand response solutions). Fulfillment will require more flexibility and systems integration (TMS/WMS/ERP and blockchain) across the supply chain.
- Focus on more differentiated and complex value-add services (multi-modal, fulfillment, import/export linkage), that cannot be easily adopted by fast followers. Leverage scale, reduce speed and costs within your organization and for your clients and their clients.
- Look for opportunities to further disrupt the middleman and solve existing pain points from detention time (re-scheduling/re-routing load/unload automation) to parking solutions for interstate. Fulfillment solutions can address both human-machine interaction and minimized contact solutions between pick & pack.
- Identify potential of future mergers and acquisitions, partnerships and investments to go beyond current strengths and offer more comprehensive, differentiated solutions.

Industrial and Manufacturing

550,000 manufacturers in the U.S. in 2019, 6.3 million globally

China, US, Japan, and Germany are largest manufacturing economies

Automotive, consumer goods, and machinery lead in terms of advanced manufacturing technology adoption

Global Purchasing Managers' Index (PMI) deteriorating

COVID-19 highlights **critical need for greater flexibility and agility** in the production chain

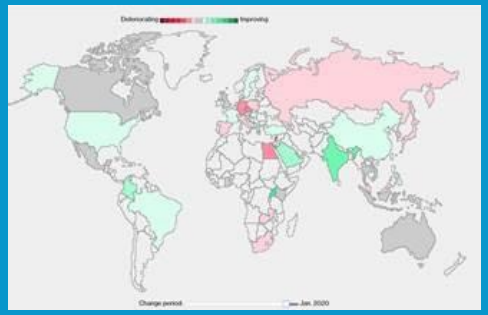
Recent Examples:

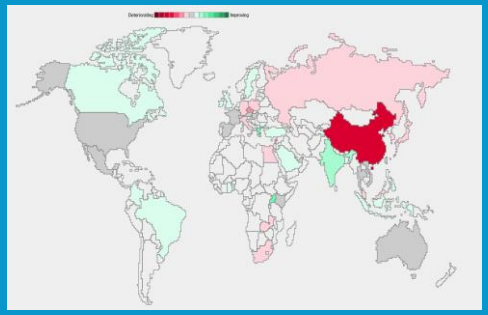
- **Ford** and **GE Healthcare**: 50k ventilators, <100 days
- **GM** and **Ventec**: 10k/month ventilators
- **Dyson**: 15k ventilators run 1, 10 days
- **New Balance**: face masks
- **Distilleries in the U.S. and England**: hand sanitizer
- **Stratasys**: 30k+ 3D-printed Personal Protective Equipment (PPE)

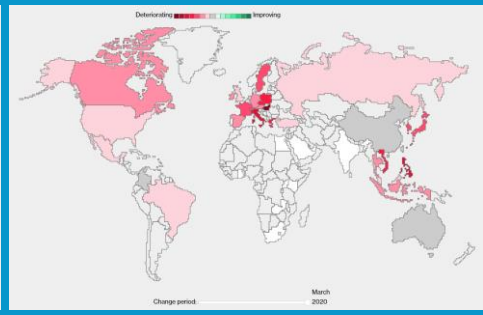
GLOBAL PMI ACTIVITY

Improving — Deteriorating


April 2018


January 2020

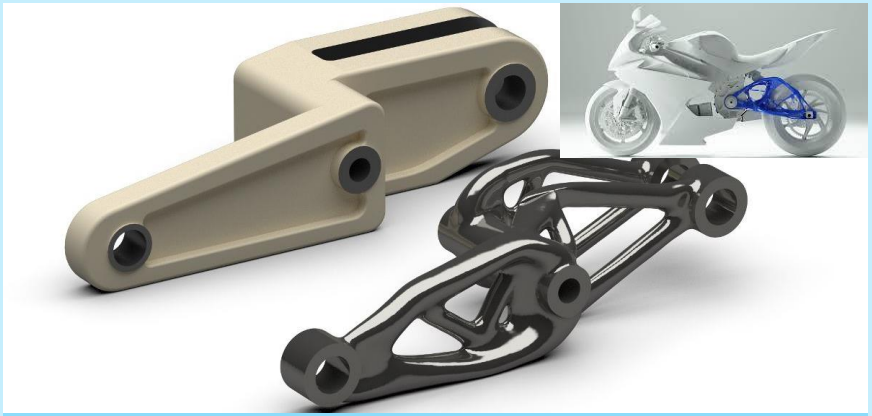

February 2020


March 2020

Source: Bloomberg

Which Technologies Will Gain Additional Momentum, and Which Will be Delayed?

INCREASING



- Cloud
- Remote monitoring
- Digital twins
- Connected tools
- Robotics
- Additive manufacturing
- Generative design
- Augmented Reality (AR)/Virtual Reality (VR)
- Wireless

DECREASING

- 5G
- Autonomous Mobile Robot (AMR) deployments
- Integrated vision systems
- Additive manufacturing
- Smart glasses

Technology 1: Cloud

Cloud improves collaboration and synchronization and is past the point of acceptance

- Cannot leverage key metrics like overall equipment effectiveness (**OEE)** without cloud

- **Enables more flexible management of capital**: 26-29% avg. machine utilization globally

Tailwind from:

- **Dassault Systèmes** 3D Experience Platform – cloud-based simulation and modeling
- **PTC/OnShape** ($470 million) – collaborative Computer-Aided Design (CAD)
- **Siemens/Mindsphere** + **Mendix** ($730 million) – cloud-native low-code app development

Technology 2: Digital Twins

Remote monitoring

Predictive maintenance

Remote collaboration

Enables more flexible management of people

Future: AR-guided work instructions to supplement or supplant pick-to-light, improve "flexagility"

Technology 3: Wireless Connected Tools

Wireless enables mobility and mobility is key for rapid response and greater flexibility and agility US$1,500-$5k per cable drop

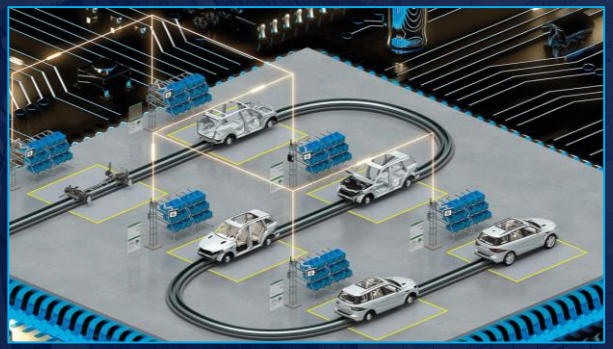
Robotics

Connected forklifts

Torque wrenches

Machine tools, AM

JIT is great for fast cash conversion cycles, but there are times you might need to over-produce – e.g., Ford F-150 program



Smart Mobility and Automotive

Impact of COVID-19 on Automotive and Ridehailing

Auto Sales

- Chinese car sales fall by 80% Year-to-Date (YTD)
- US light vehicle sales fall by 39% in 03/20
- EU car sales fall by 7.5% in Jan. and Feb.
- EU-wide shutdown decreases vehicle production by 1.23 million

Auto Production

- **Original Equipment Manufacturer (OEM)**
  - **Renault** closes global plants, apart from China and SK
  - **Ford** delays restart of production in N. America
  - **Nissan, GM, Ford, FCA** US manufacturing sites remain closed
  - **Mitsubishi** closes 3 Japanese plants
  - **PSA, VW, Ford, Mercedes, Nissan, Toyota, BMW, Volvo, Geely,** close European manufacturing plants
  - **FCA** closes all plants in Italy
- **Tier 1**
  - Knock-on end of production for **ZF, Continental, Bosch, Marelli, Faurecia, Valeo**

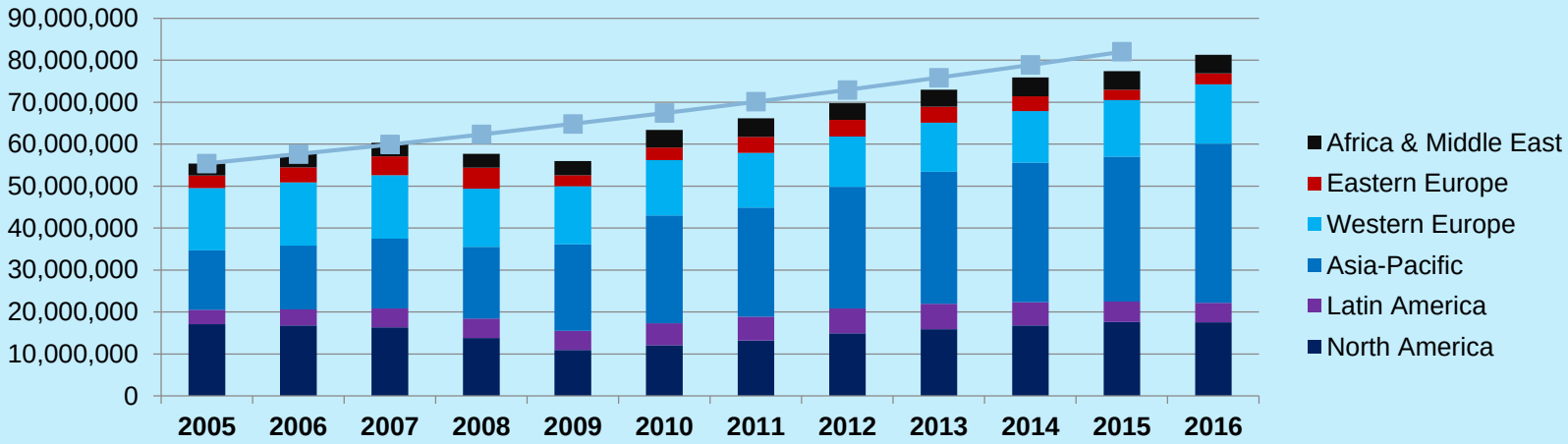
Ridehailing

- Singaporean NTA and NPHVA report 25% decline in ride and 35% earnings decline
- Grab provides free face masks for food delivery drivers in Philippines
- Amazon partners with Lyft to meet delivery demands
- NPD Group (China) reports 20% increase in food deliveries
- Numerous mobility service provide free / discounted services to healthcare providers

Lessons from 2008

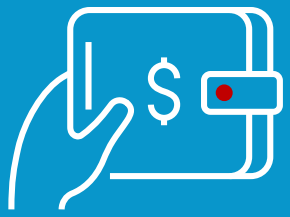
New passenger vehicle sales will return to trend

- **Average market growth rate from 2005 to 2007 was approx. 4%**
- **2008 new vehicle sales drop**
  - Average age of cars on the road grows
  - Consumers put off vehicle renewals
- **2009 – 2010 growth rate accelerates to 13%**
  - Consumers finally begin to update their aging vehicles
- **By 2016, vehicle sales are about one year behind pre-crisis trend**
- **Long-term investments in autonomous vehicle technology, electric batteries and powertrains etc. are secure**



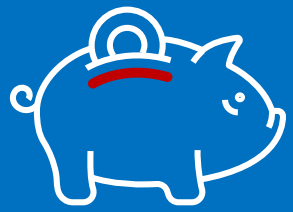
Crises Drive Consolidation

Opportunity for rationalization in technology investment



Short to Mid Term

- **Share EV Platform and Battery Technology Investment Between OEMs**
  - Wind down investments in hydrogen fuel cell technology
- **Coalesce Around a Single V2X Protocol**
  - Avoid costly duplication of effort



Longer Term Investment

- **Rationalize Research and Development (R&D) Investment in Autonomous Vehicle Technologies**
  - Cash Poor Suppliers and OEMs must reduce duplicated effort to ride out economic “pause”
- **Develop Resilient Supply Chain**
  - Learn lessons from 2010/2011 – shuffling factory locations does not add resilience to global crises
  - Invest in technologies that will structurally improve productivity

Which Trends are Delayed, and Which will be Accelerated?

INCREASING

Sensor Data Crowdsourcing

- Real-time, widespread insights are key to combating pandemics
- Connected, ADAS-equipped cars provide unique insight
  - Density
  - Geographic coverage
  - Rich semantic insight

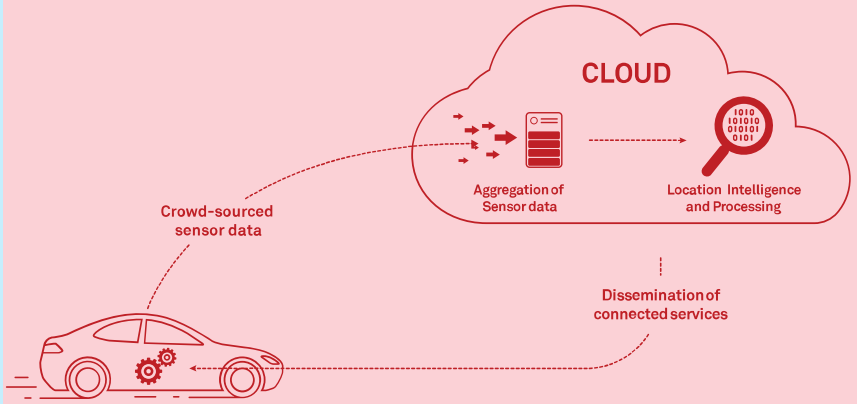
Delivery Services

- Ridehailing platforms accelerate their transition to providers of multiple on-demand services
- Food and Goods delivery

DECREASING

Shared Personal Transit Modes

- Consumer attitudes to shared spaces are likely to evolve
- Shared economy must adopt technologies to minimize spread of contagion



Related Research

SMART CITIES

- **AN-5239**: Digital Twins, Smart Cities, and Urban Modeling
- **PT-2251**: Resilience Technologies and Approaches for Smart Cities
- **White Paper**: 5 Ways Smart Cities Are Getting Smarter

FREIGHT AND LOGISTICS

- **PT-2339**: Commercial Transport and Supply Chain Disruptive Influencers
- **PT-2365**: Supply Chain Trends and Technologies in 2020
- **AN-5191**: Fleet Operations: Trends and Key Drivers

MANUFACTURING

- **AN-5255**: Industrial Simulation Use Cases: How Simulation Software Benefits Manufacturers' Operations
- **AN-5273**: Software Applications in the Manufacturing Setting
- **AN-4904**: 5G and Edge Networks in Manufacturing

AUTOMOTIVE

- **AN-5163**: Cooperative Mobility: Phases, Use Cases, and Forecasts
- **CA-1299**: Connected Car Platforms Competitive Assessment
- **AN-5305**: Camera-Based Driver and Occupant Monitoring Systems

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