


*Reference - KPMG*

# 5G, IoT, AI & Industry 4.0

## Impact & Applications in Select Industries

			
<b>Dr Zhu Han</b> Speaker	<b>Dr Tilak Agerwala</b> Panelist	<b>Dr Darukhanavala</b> Panelist	 <b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications

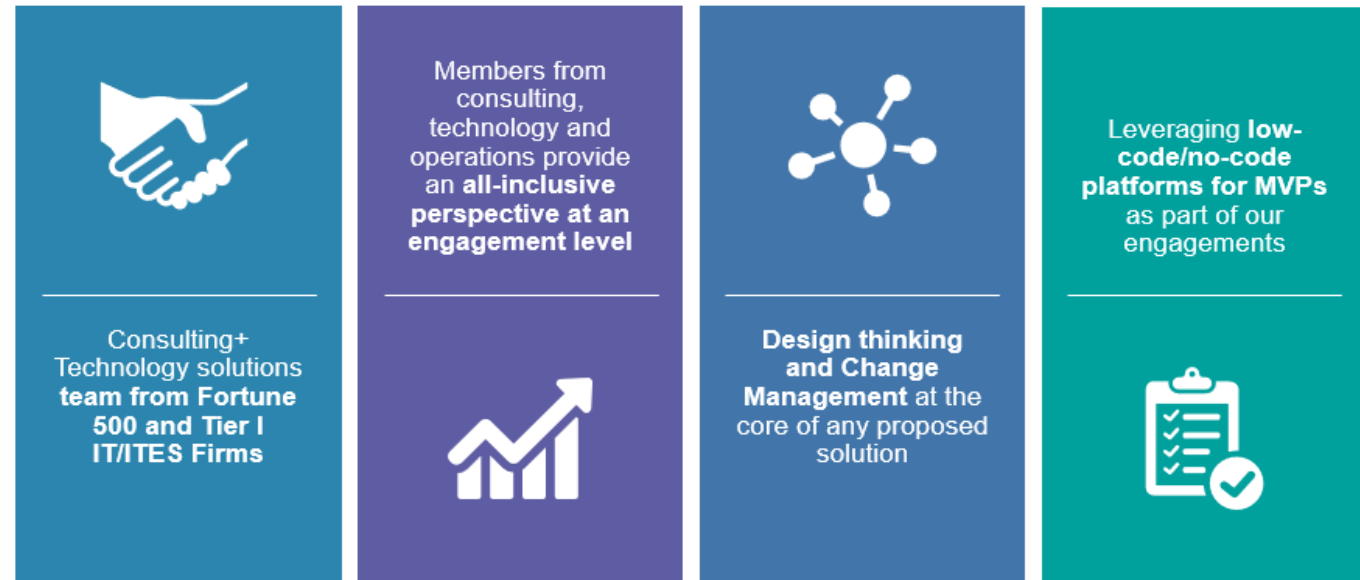
Section	Topic	Speaker/s
 Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
Key Takeaways	Service Models for Industry 4.0	K.S. Rao

## Strategic intent to create industry value

Performatica provides professional & technology consulting services, leadership development, and opportunities to participate in emerging industries that impact and emphasize Environment, Social, and Governance (ESG) values.

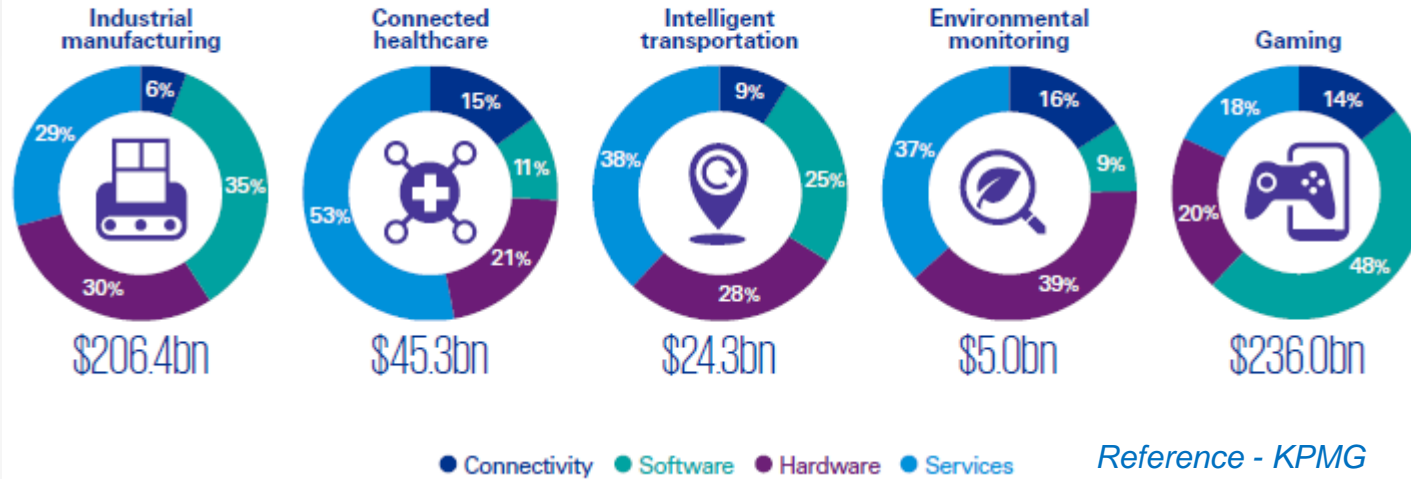
### *Key focus areas -*

- Develop ventures that transform key industries through design thinking, domain expert networks, & digital innovation
- Provide methods and frameworks for business performance, transformation, & program management in a distributed virtual environment
- Develop & demonstrate domain solutions by prototyping using digital transformation tools & process automation

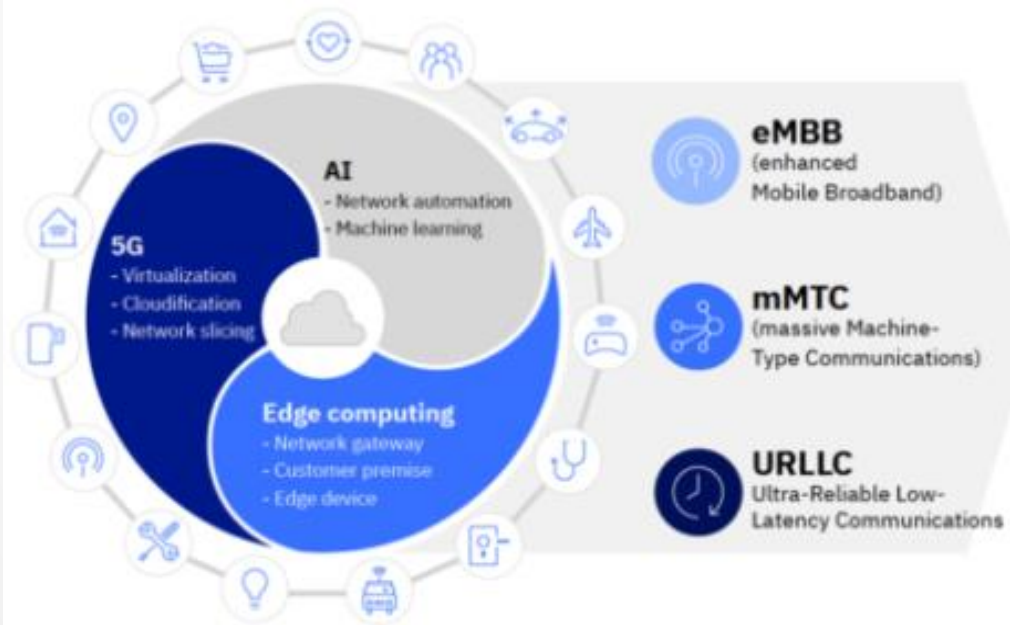


# 5G impacting industry, business & technology models

The US\$517bn 5G+Edge ecosystem across just five industries

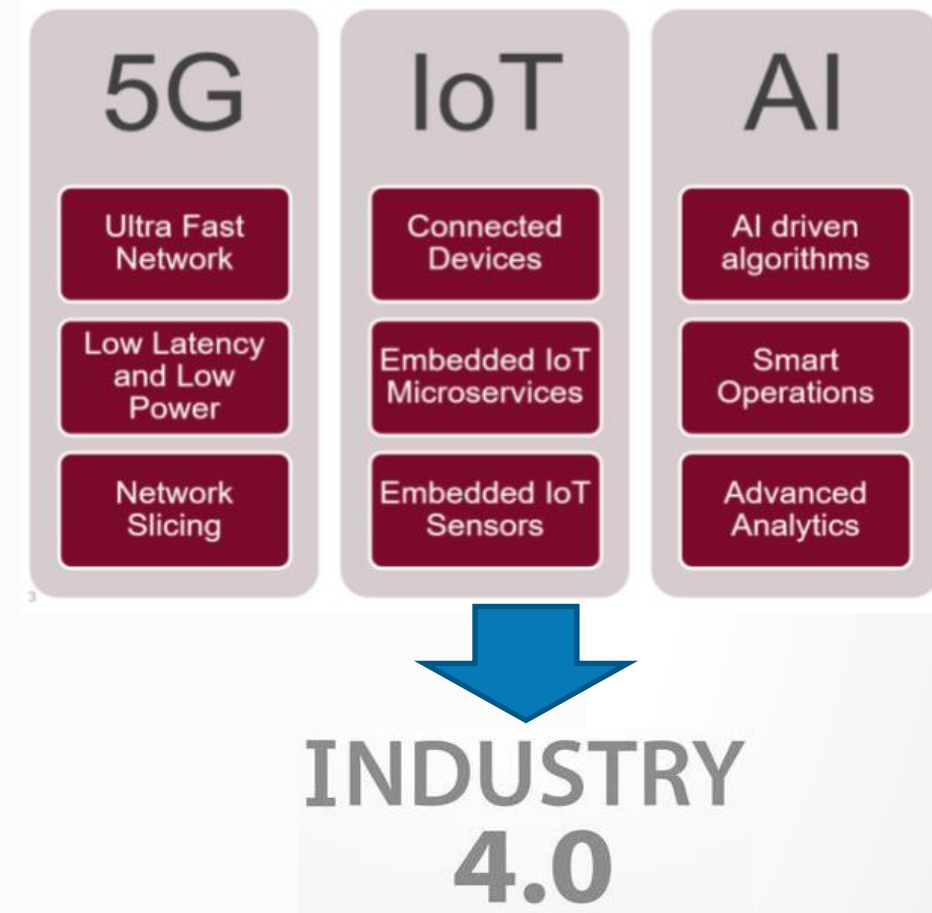


Reference - KPMG

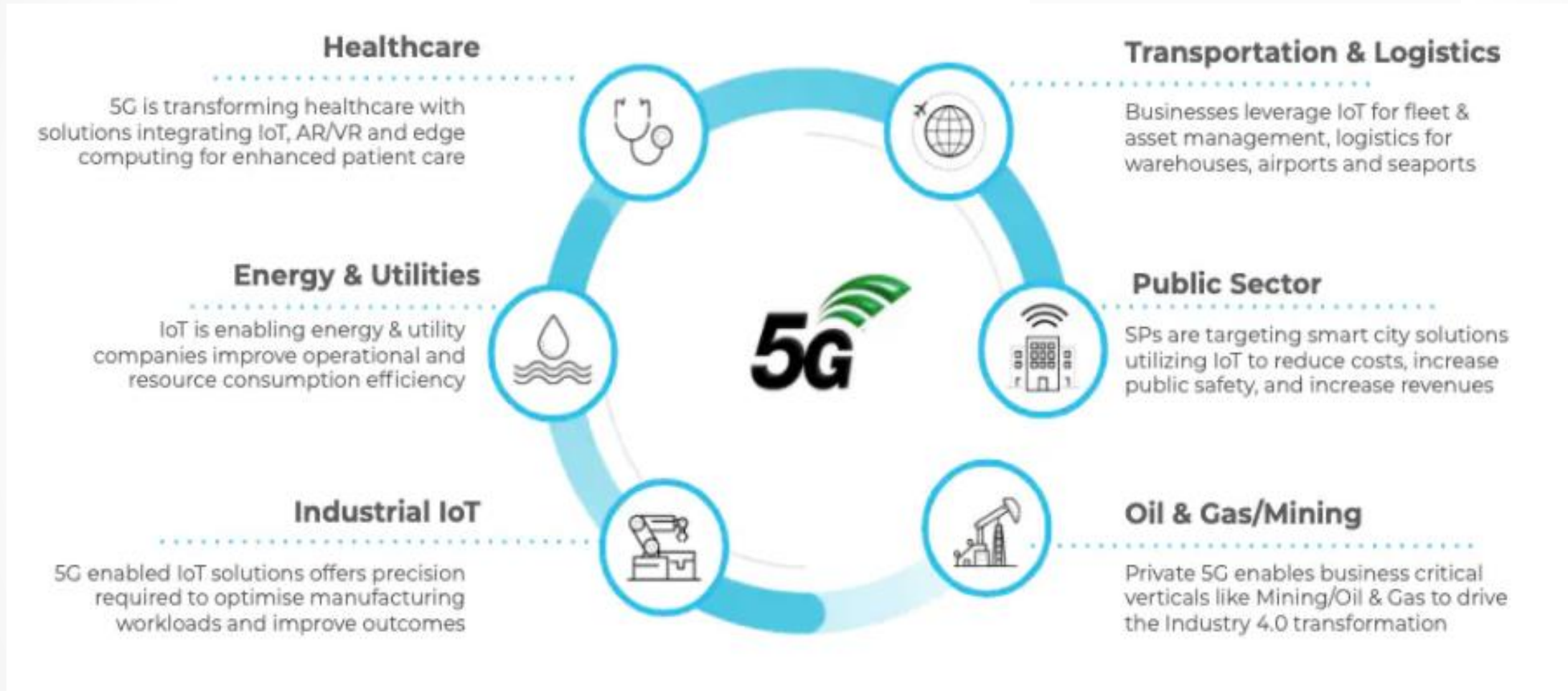


- Examples of 5G applications**
- Smart factories
  - Agricultural drones
  - Robotic surgery
  - Smart homes
  - AR/VR shopping
  - Assistive robots
  - Collaborative gaming
  - Smart cities
  - Autonomous cars

Reference - IBM



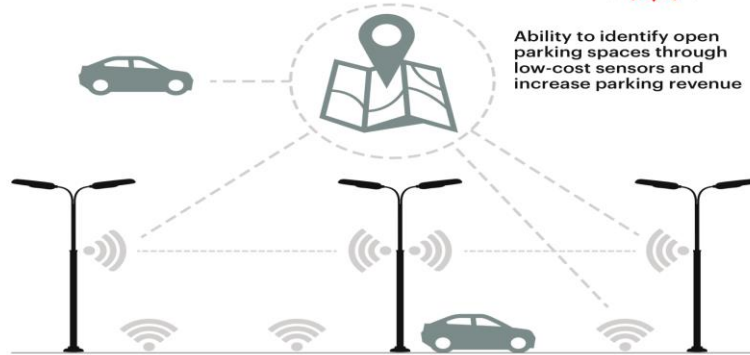
# 5G impacting industries



# 5G Impact on Smart Cities & Healthcare

## Smart Parking + Metering

↑27%  
Parking  
Revenue



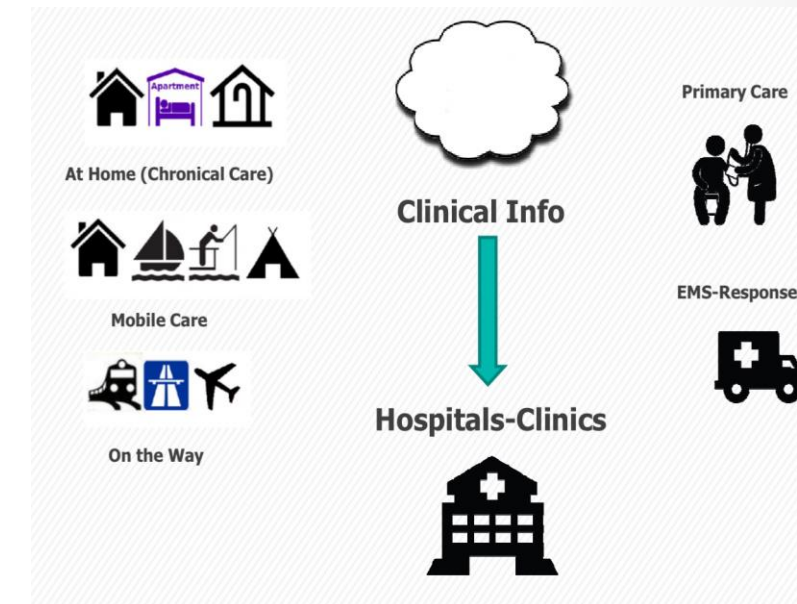
Reduce time to find parking and congestion benefits all commuters and encourages traffic to commercial areas, boosting economic activity.

## 5G: Technology to Meet the Growing Demands of Smart Cities

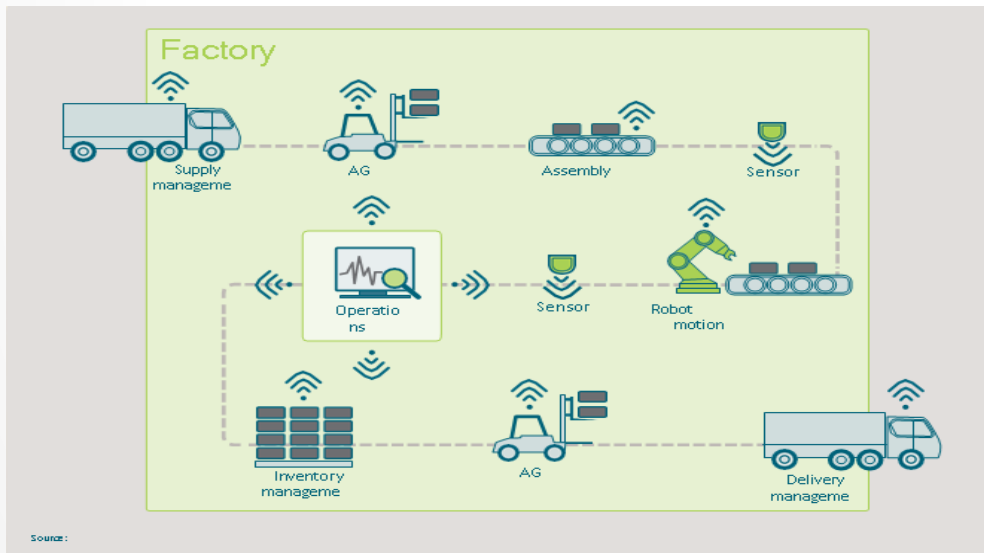
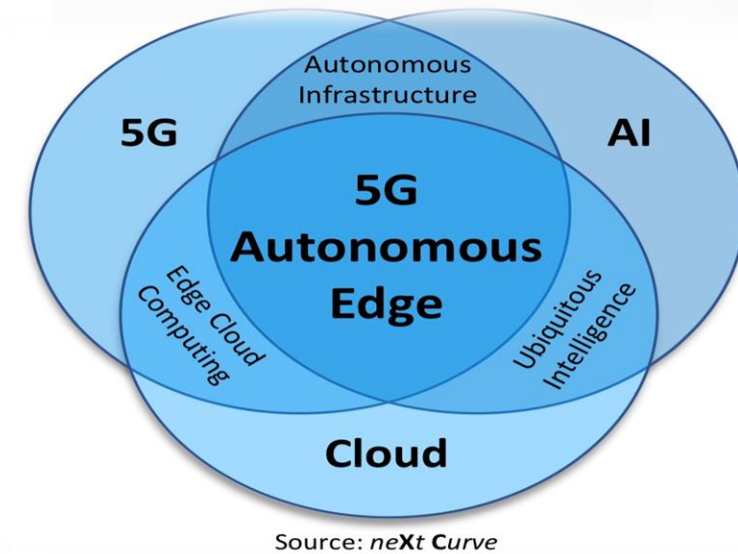
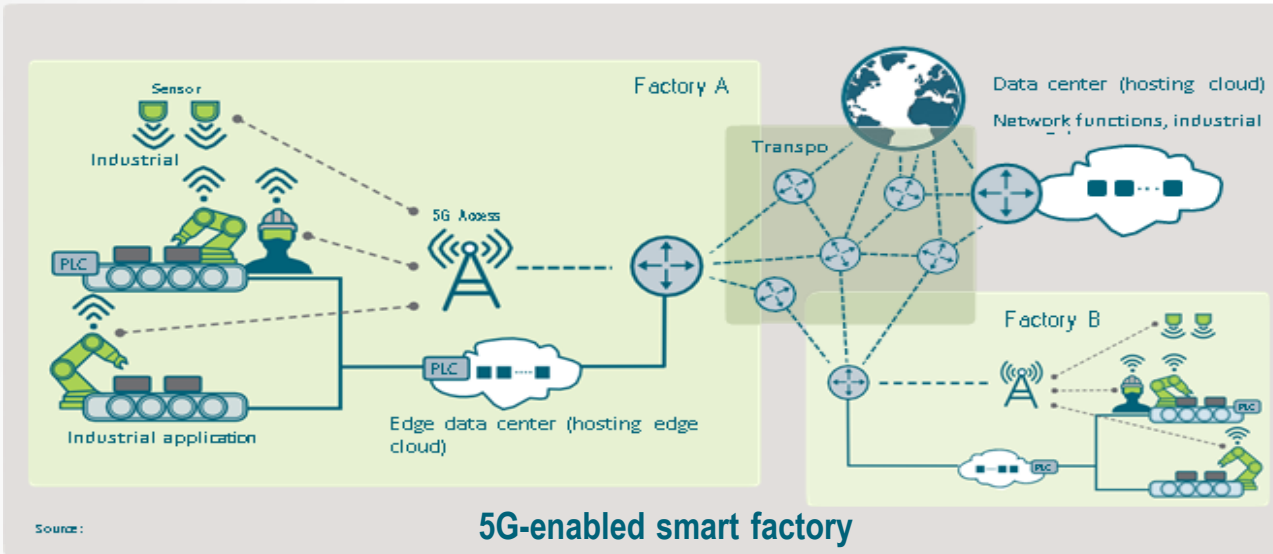


Illustration of an IoT-based Smart City, where all services are connected into the grid.

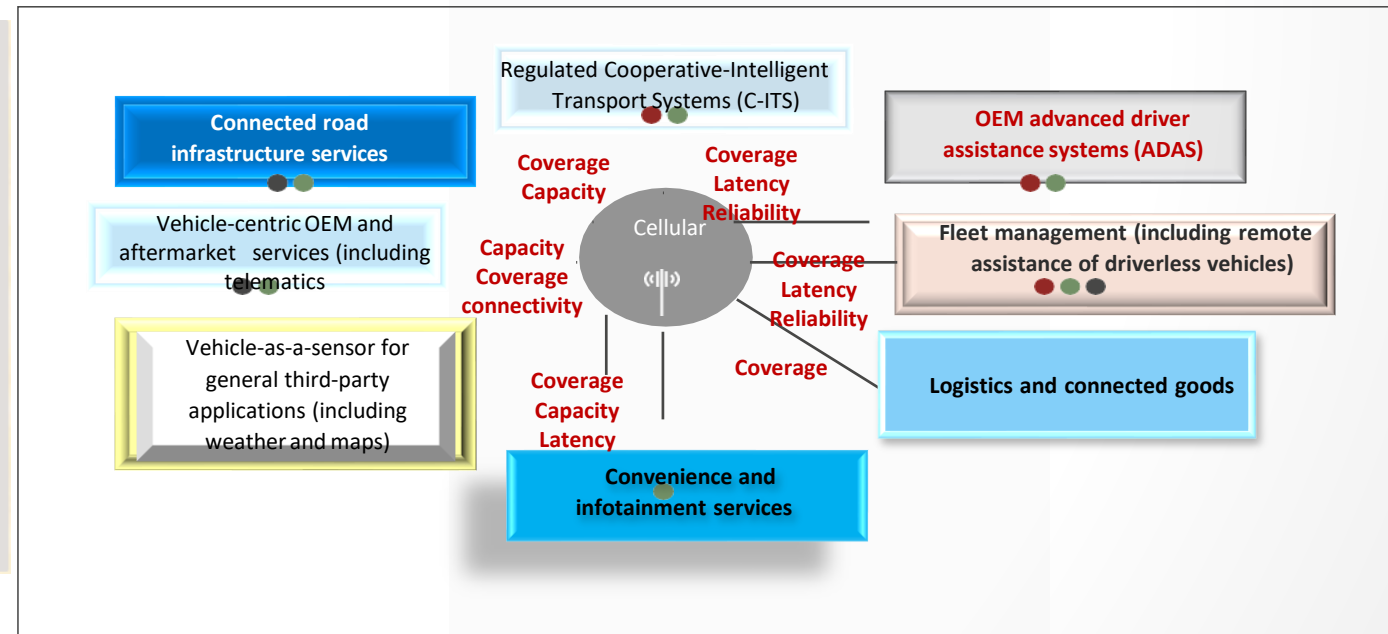
## 4 key evolutions in healthcare: considerations for 5G






# 5G Impact on Digital Manufacturing




**Exemplary application areas of 5G in the factory of the future**

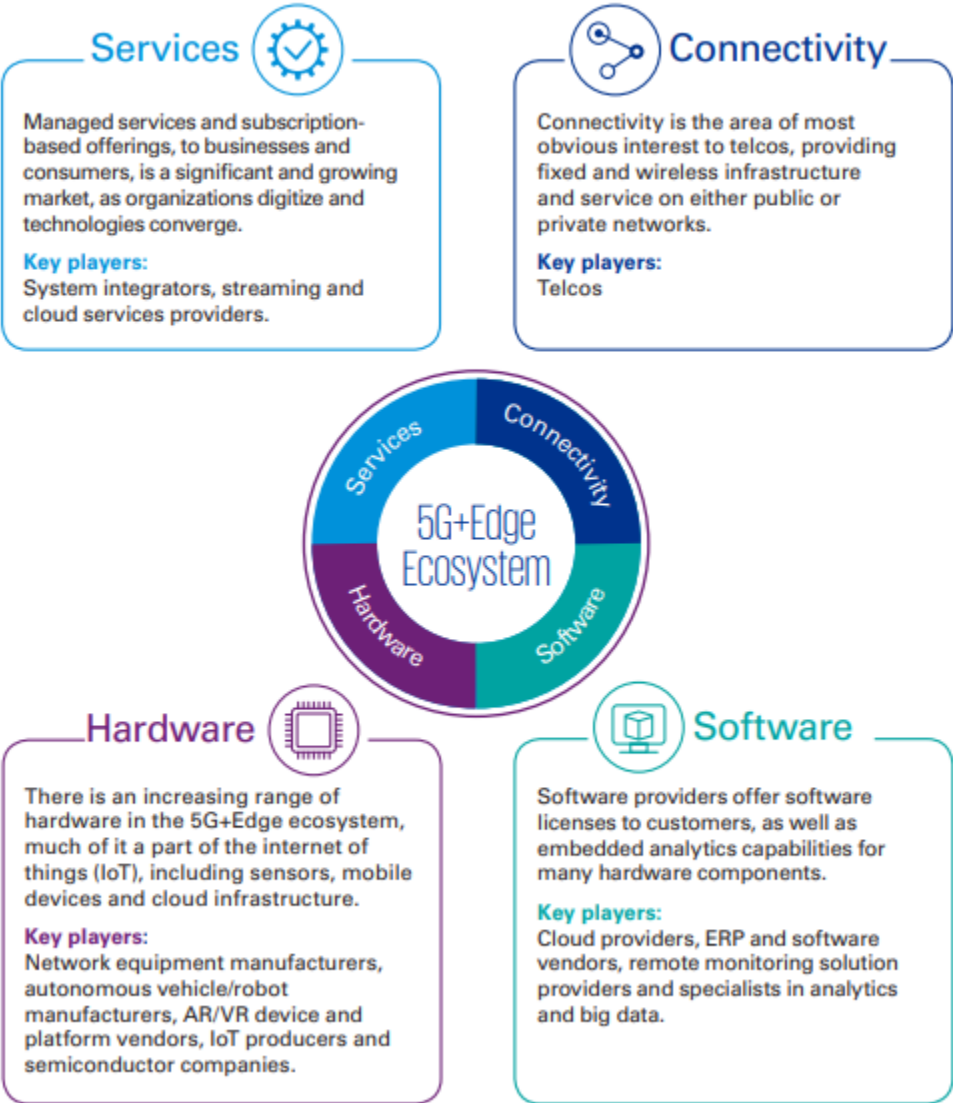


# Agenda

			
<b>Dr Zhu Han</b> Speaker	<b>Dr Tilak Agerwala</b> Panelist	<b>Dr Darukhanavala</b> Panelist	<b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications

Section	Topic	Speaker/s
Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
 Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
Key Takeaways	Service Models for Industry 4.0	K.S. Rao

# 5G+ Edge Ecosystem



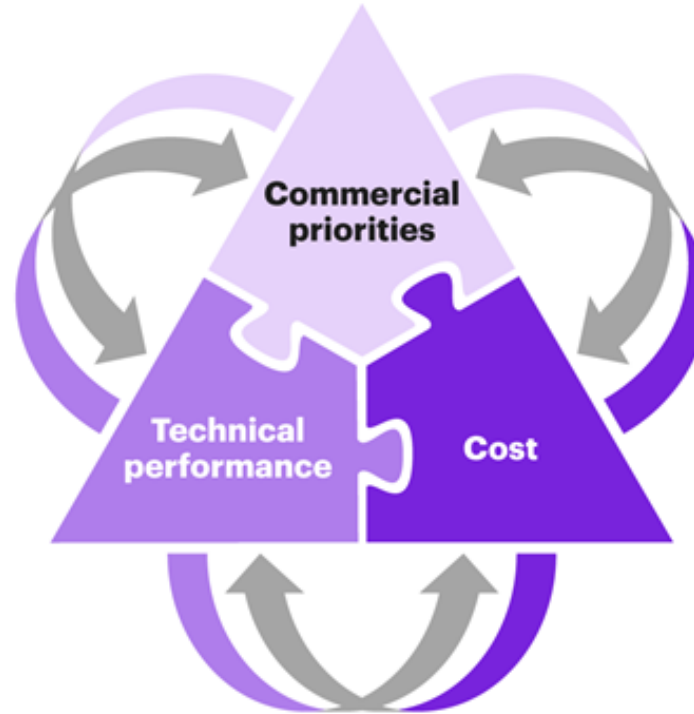
Reference - KPMG

Capacity	Connectivity	Capabilities	Complexity
<b>5x</b> projected mobile data traffic growth by 2024	<b>3-5x</b> increase in radio sites from densification	Latency Synchronization	<b>200</b> new use cases enhanced by 5G
<b>6+x</b> projected growth of video traffic by 2024	<b>10+x</b> increase in next generation core connectivity	QoS Security	<b>Magnitude</b> of new connections due to increase of radio and core sites, interfaces and technologies
Cost of ownership			

Reference - Ericsson

## Key considerations for deciding the extent and pace of a 5G rollout

- **Commercial priorities** need to be matched/timed with technical readiness
- Technical solutions **pushed by vendors** must be matched by commercial viability

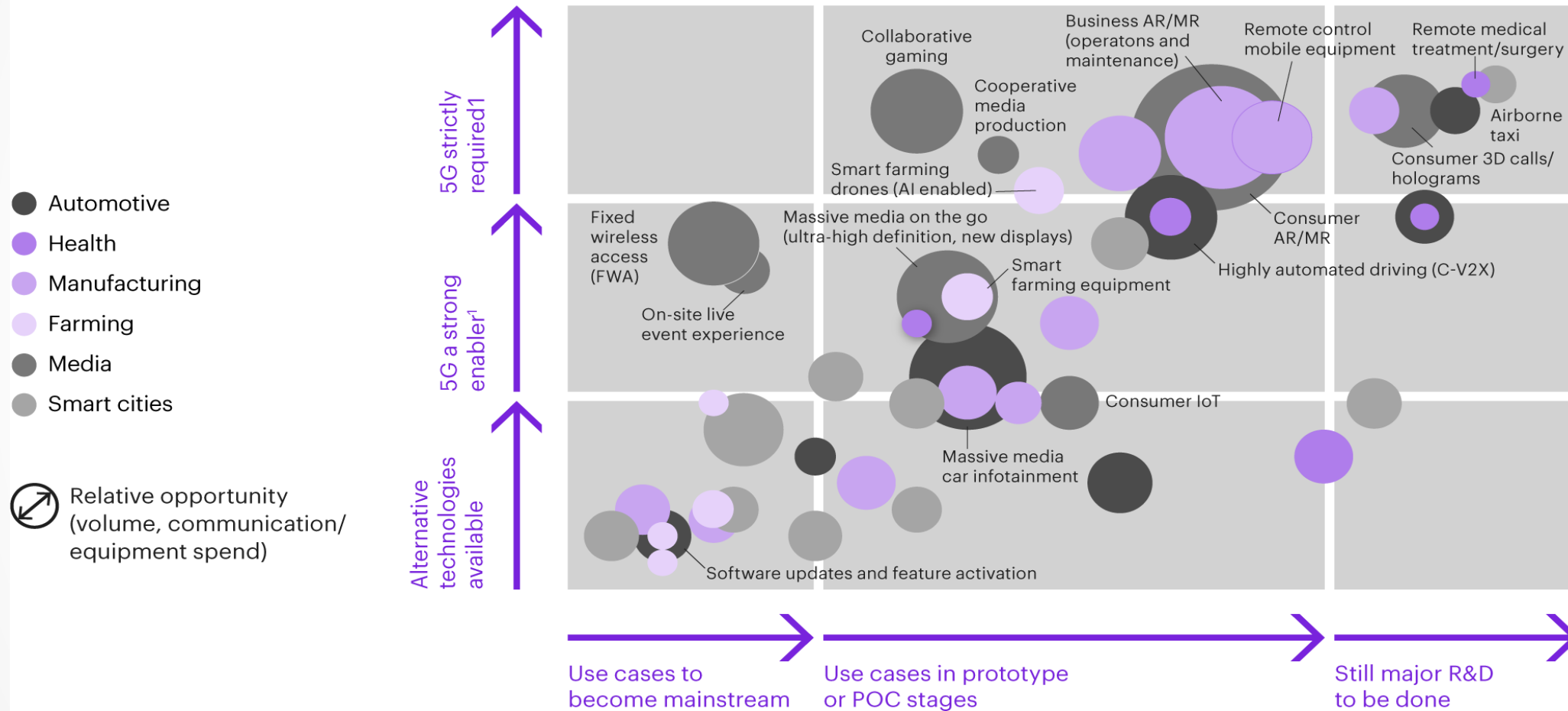


- Commercial priorities need to be decided in conjunction with clear understanding of **cost-to-serve**
- **Investments need to be timed** with commercial viability for the features they enable

- Rollout pace needs to strike balance between technical advantage vs. competition (front-heavy rollout) and benefitting from **cost erosion curve** (back-heavy rollout)

*Reference – Kearney Analysis*


# 5G Use Cases Progress

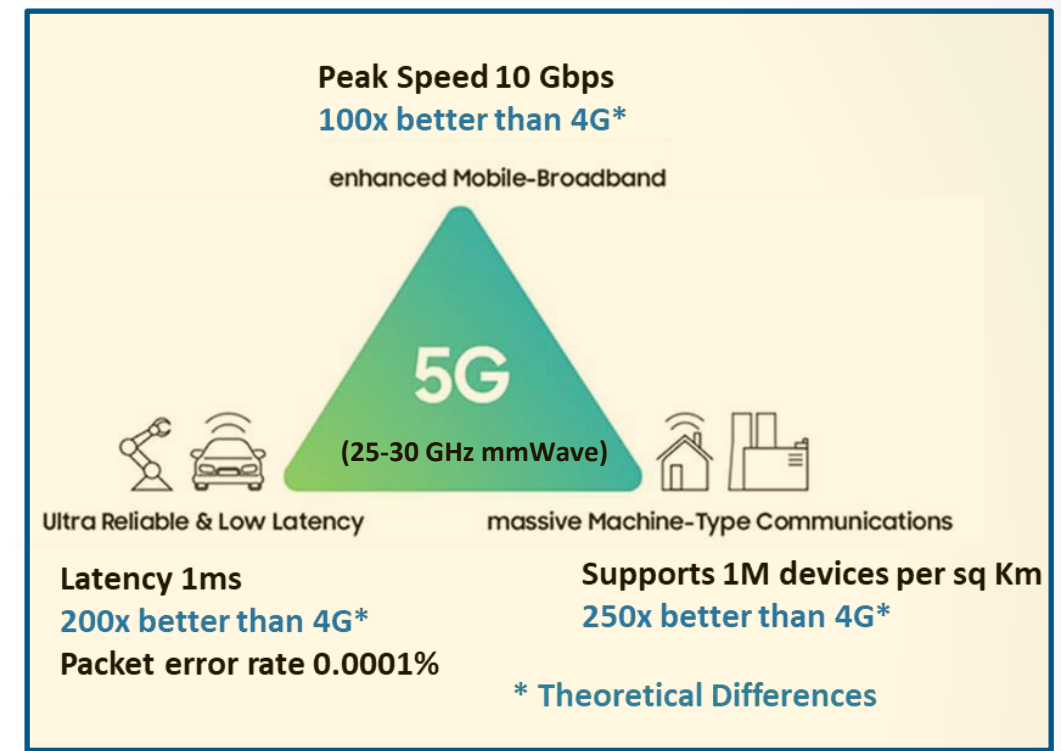
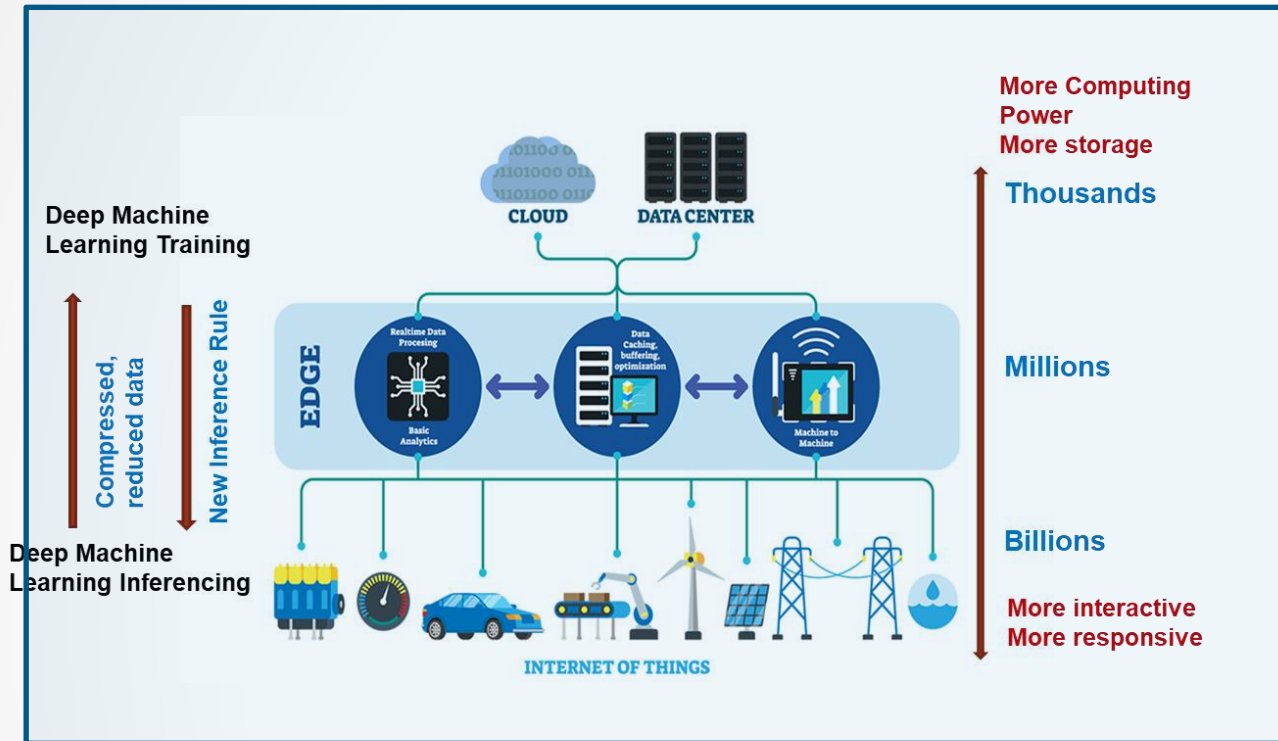


<sup>1</sup> 5G or alternative wireless technology with features similar to 5G

Source: Kearney analysis

			
<b>Dr Zhu Han</b> Speaker	<b>Dr Tilak Agerwala</b> Panelist	<b>Dr Darukhanavala</b> Panelist	<b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications

Section	Topic	Speaker/s
Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
 Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
Key Takeaways	Service Models for Industry 4.0	K.S. Rao



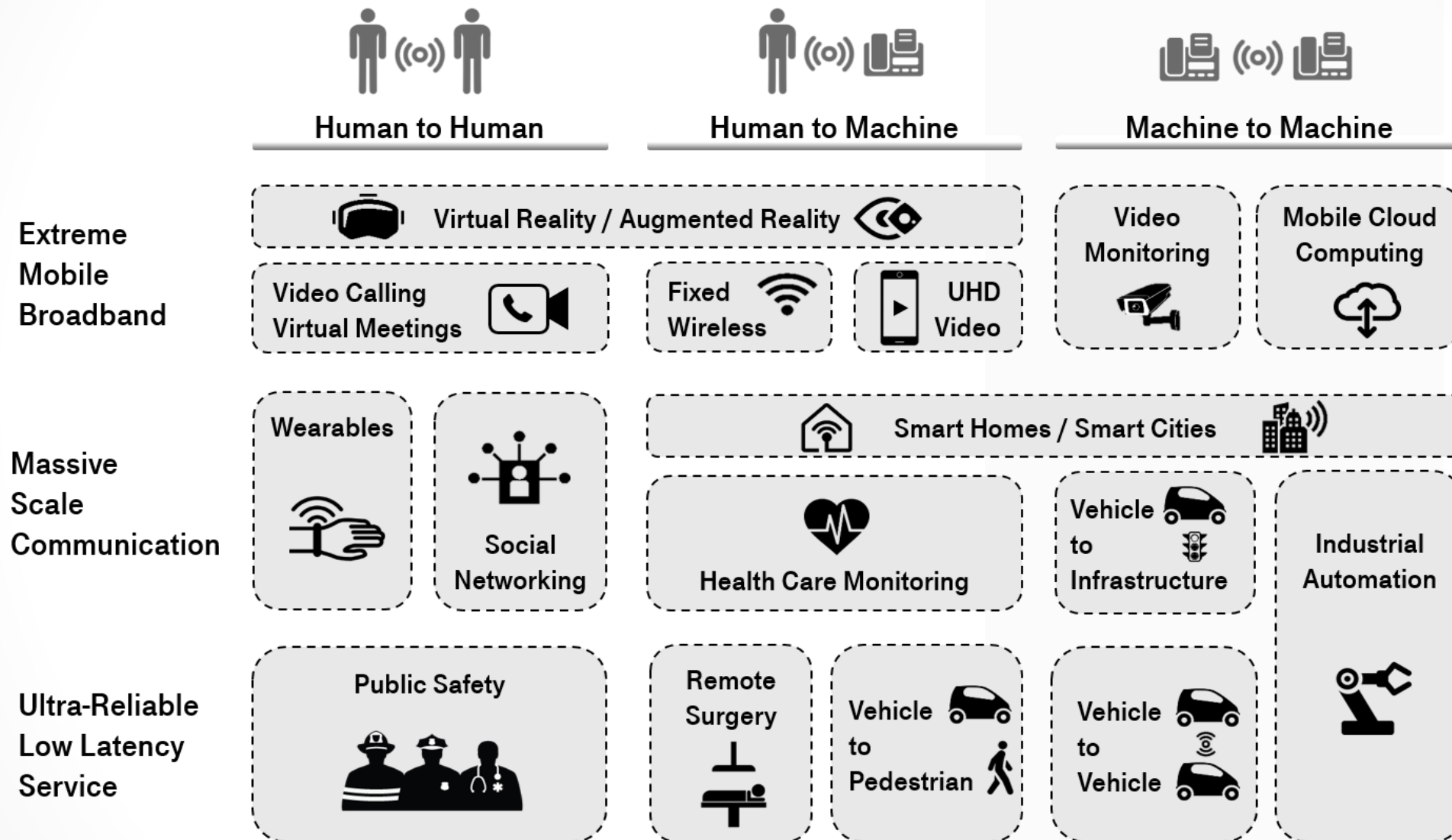
**IoT, AI, Cloud and Edge Computing,  
Smart Sensors**

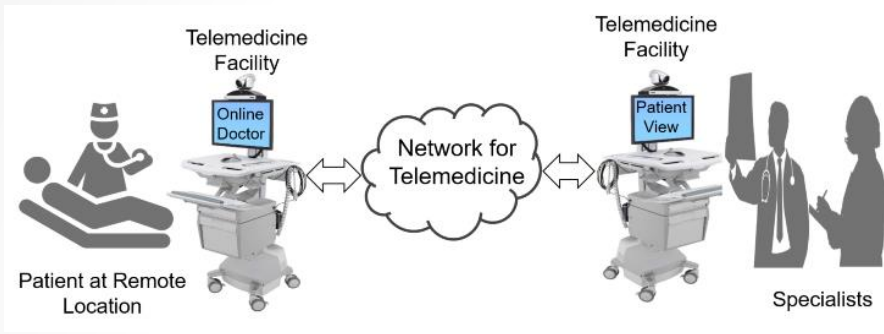


**The 5G Triangle**

**5G must be integrated with other technologies like AI, Edge Computing, Cloud Computing, geolocation sensors, remote monitors... to get the full benefit**

# Blending of 5G, Edge Computing & AI – Impact on Use Cases



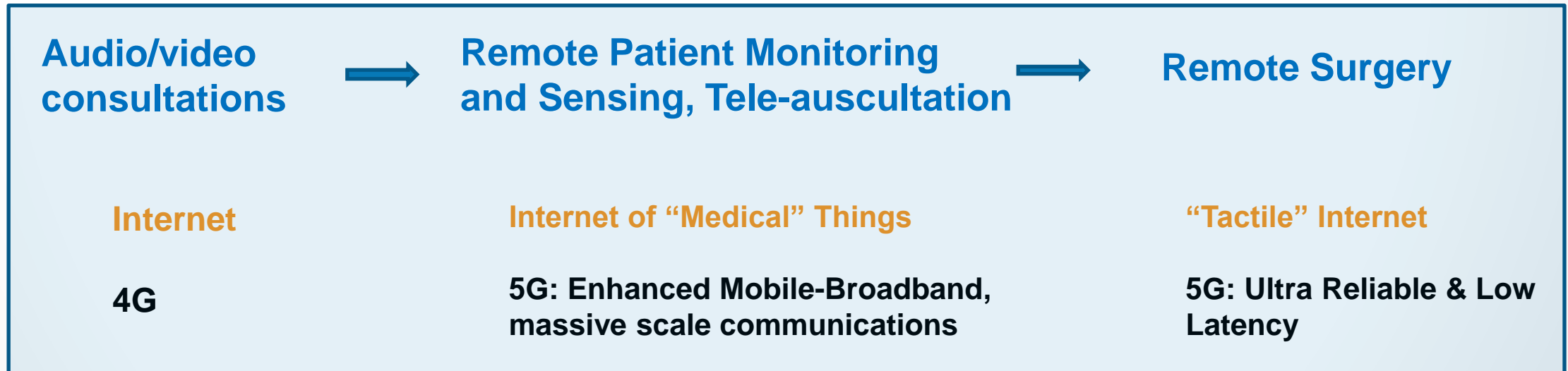


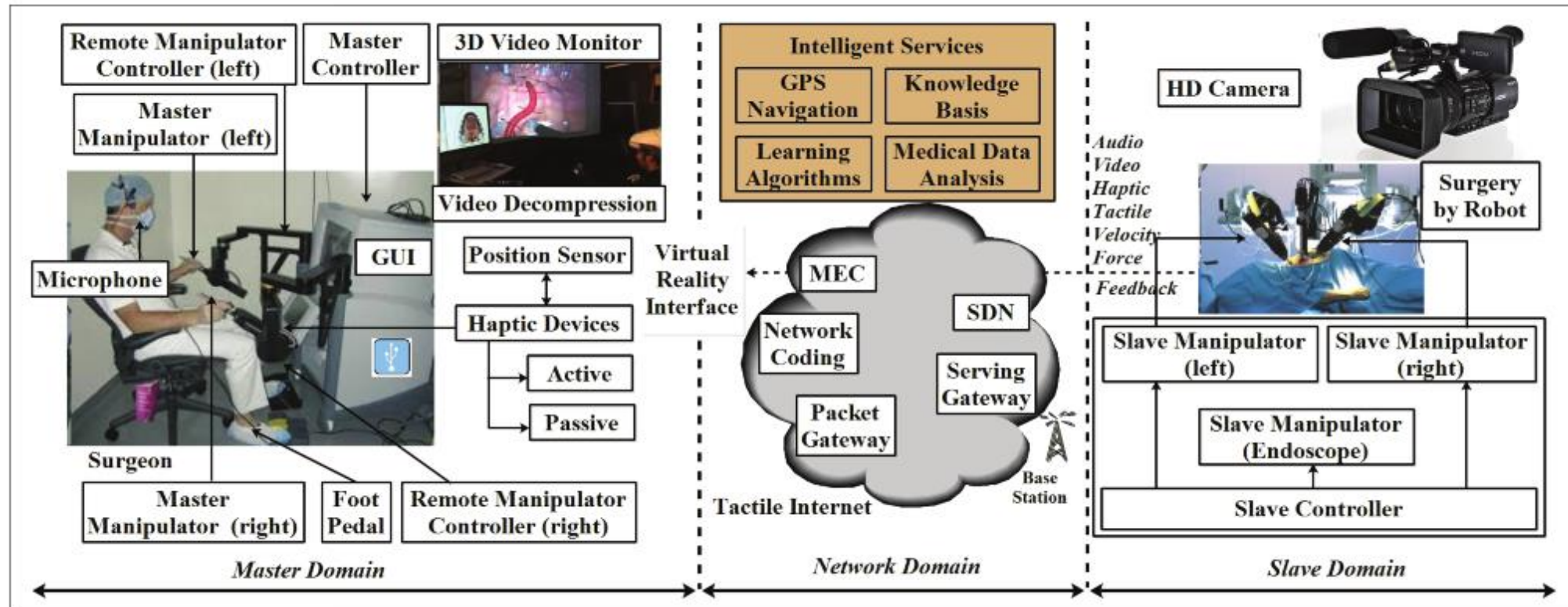
**Global Telemedicine Market \$430B, 25.9% CAGR**  
(Applied Market Research)

## Telemedicine Potential Benefits:

- **Scalable global healthcare solution (particularly for the developing world)**, chronic diseases management, independent care for elderly.
- **Increases access to care**, fewer and shorter hospital visits, **reduces healthcare costs**, enhances traditional face-to-face medicine, **improves patient engagement and satisfaction**

## 5G is an essential enabler

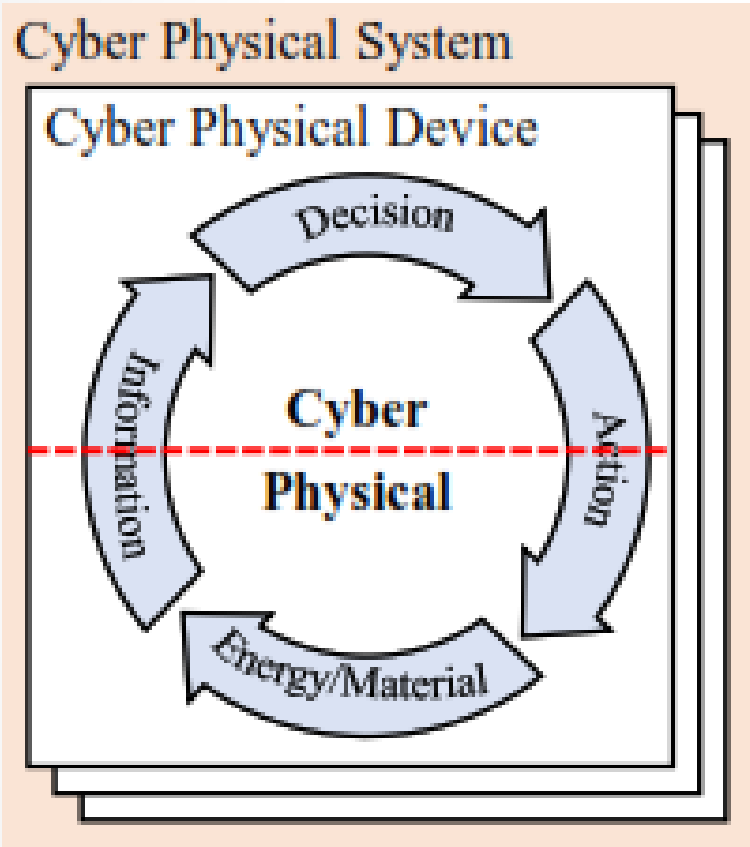




<https://ieeexplore.ieee.org/document/8933555>

Example: Telerobotic Spinal Surgery Based on 5G Network: The First 12 Cases, Neurospine 2020;17(1):114-120.

<https://doi.org/10.14245/ns.1938454.227>



**Cyber-Physical Security more complex than Cybersecurity**

- Prevent physical harm to people, destruction of property or environmental disasters.
- Traditional security measures are not sufficient - exponential growth in number cyber-physical devices

**Machine Learning introduces new security problems**

- Data can be “poisoned” during the training and inferencing stages

**CPS security incidents will rapidly increase in the coming years.**

(Gartner)

.

**Privacy is generally defined as freedom from unwanted knowledge, observation or company of others.**

**IoT Cyber-Physical environment far more complex and dynamic than Web environment**

Data/Related Processes	Web Environment	IoT Environment
<b>Data</b>	Digital, virtual environment	Cyber- <b>Physical</b> environment
<b>Data Entry</b>	Active, Consumer	Passive, Sensors
<b>Data Sharing</b>	With other service providers	Between machines
<b>Learning</b>	Actions in digital world	Actions in real world
<b>Decision Making</b>	Service providers, more static, less real-time	Machines, dynamic, real-time

### **Example:**

Simple Meter dataset → Extracts location and private user behavior patterns → Companies (Profit from personal data).


<https://ieeexplore.ieee.org/document/8416396>

Adapted from “Internet of Things: Convenience vs. privacy and secrecy, Bruce D. Weinberg et.al. Kelley School of Business, 2015

### **Who owns the data gathered by sensors?**

- GDPR: User own’s data and its use
- Companies must implement “Privacy by Design”

			
 <b>Dr Zhu Han</b> Speaker	<b>Dr Tilak Agerwala</b> Panelist	<b>Dr Darukhanavala</b> Panelist	<b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications



Section	Topic	Speaker/s
Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
 Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
Key Takeaways	Service Models for Industry 4.0	K.S. Rao


**Zhu Han,**

John and Rebecca Moores Professor, IEEE Fellow,  
AAAS Fellow


Department of Electrical and Computer Engineering  
University of Houston, TX, USA



			
 <b>Dr Zhu Han</b> Speaker	 <b>Dr Tilak Agerwala</b> Panelist	 <b>Dr Darukhanavala</b> Panelist	 <b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications

Section	Topic	Speaker/s
Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
 Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
Key Takeaways	Service Models for Industry 4.0	K.S. Rao

			
<b>Dr Zhu Han</b> Speaker	<b>Dr Tilak Agerwala</b> Panelist	<b>Dr Darukhanavala</b> Panelist	 <b>K.S. Rao</b> Moderator
Fellow IEEE, Fellow AAAS, John and Rebecca Moores Professor in University of Houston	IBM Vice President (Retired), Adjunct Associate Professor, Pace University-New York	Industry Advisor, Energy & Power, Technology Innovation, Ex-CTO, BP	Industry Leader, 5G/Telecom, Semi-Conductors, Industrial Applications

Section	Topic	Speaker/s
Topic Introduction	Introductions on 5G and Speakers	K.S. Rao
Speaker 1 Industry 4.0 Readiness and Challenges	5G, IoT & AI - Industry 4.0	Dr. Darukhanavala
Speaker 2 Impact & Applications in Select Industries		Dr. Tilak Agerwala
Speaker 3 5G, IoT & AI - Industry 4.0 (keynote)		Dr. Zhu Khan
Panel Discussion (Moderator)	Discussion and Q&As	Moderated by K.S. Rao
 Key Takeaways	Service Models for Industry 4.0	K.S. Rao

## Solution Areas

- **Network Design & Planning** - Business & Technical requirement Analysis, Capacity and Service planning, Architecture, Design (HLD, LLD), Strategy for migration
- **Core Engineering** – Installation and commissioning, VNF Onboarding, Configuration and Integration and Validation
- **VNF Testing & Certification** - Infrastructure testing, VNF Certification, Integration Testing, Performance Testing and Benchmarking, E2E Services Testing, Acceptance Testing
- **VNF Onboarding and Testing Automation** - VNF Onboarding Automation, Test Automation, Continuous Test Assurance, CICD Pipeline Development

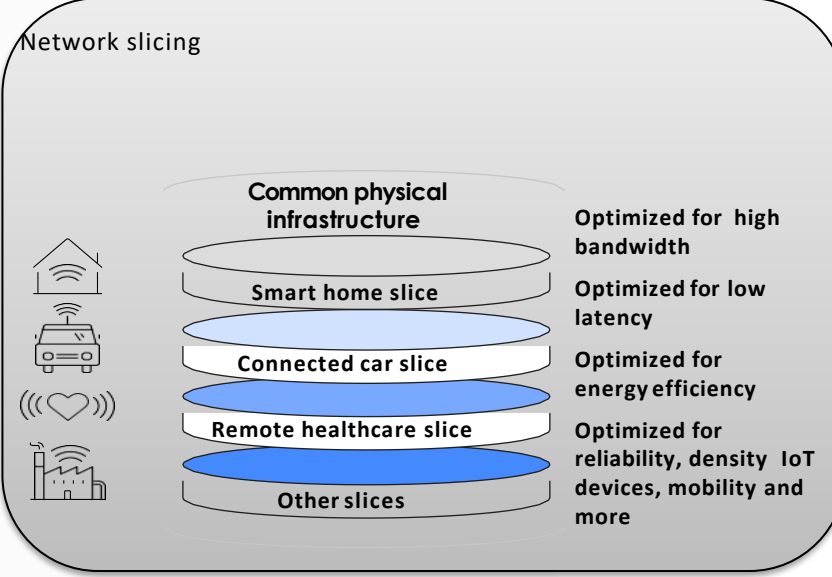
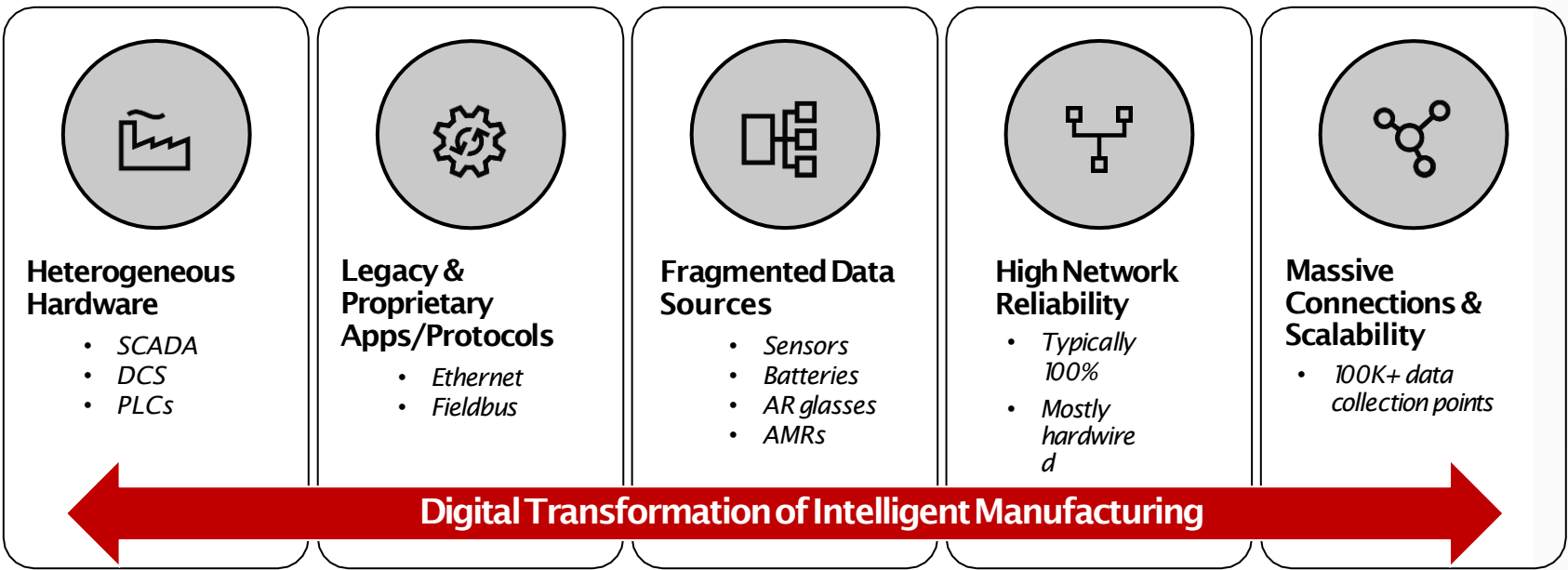
## Business Benefits

- Network Deployment acceleration
- Capital & Operational Expenditure optimization
- Enablement of new revenue streams with 5G introduction
- Improvement in service & technology agility with automation Establishment of a long-term architecture with multi-vendor platforms

## Ultimate Skills Required

- Experience in engagements with Tier 2 & Tier2 operators across the globe
- Availability of Highly skilled resources for delivery Ready to use test suites available for IMS, VOLTE, EPC
- Automated VNF onboarding
- Availability of a test Automation Framework
- Availability of a pool of customized open-source tools

# “5G-as-a-Service” for Industry 4.0



Autonomy	Connectivity	Devices, Endpoints & Management	Environment I Context	Data Capture & Processing
Pre-2011: Traditional Industry Automation of processes	Wired & Fiber	Robotics/PLCs/Etc.	Facility & Enterprise IT	Sensors & Metrology
2011-2027: Connected Industry Automation of insights	Wireless - 4G cellular & WiFi	Endpoint Management	Industrial IoT	API Gateways, Data Models, and Analytics
2027+: Orchestrated Industry Automation of operations	5G + MEC	Thin Client	Digital Twin / Simulation	Cloud & Edge AI

- Potential advantages of 5G-enabled technology include:
- Easily configurable, highly flexible, and modular production systems that operate on demand
  - Substantial increases in operations and resource efficiency
  - Just-in-time servicing of machines or replacement of machine parts
  - Zero-touch factory operations
  - More efficient warehousing and supply chains
  - The ability to use digital twins to gain insights into performance and potential problems.

## Energy

- Refinery Plant's Alerts & Events Forecasting
- Pipeline Leakage Analytics from IoT systems

## Manufacturing

- Real-time Machine Performance (MT Connect)
- Connected Factory Models with real-time operational KPIs

## Power Utilities

- Real-time Grid Anomalies Detection
- Real-time insights from MDM(Meter Data Management) systems

## Healthcare

- Real-time Tele-healthcare
- Embedding Predicted Models in the Digital X-Ray Machines

# Thank you



Performatica LLC  
[marketing@performatica.net](mailto:marketing@performatica.net)

<https://performatica.net/>