# The 4th Industrial Revolution
## and the Future of Linguistics

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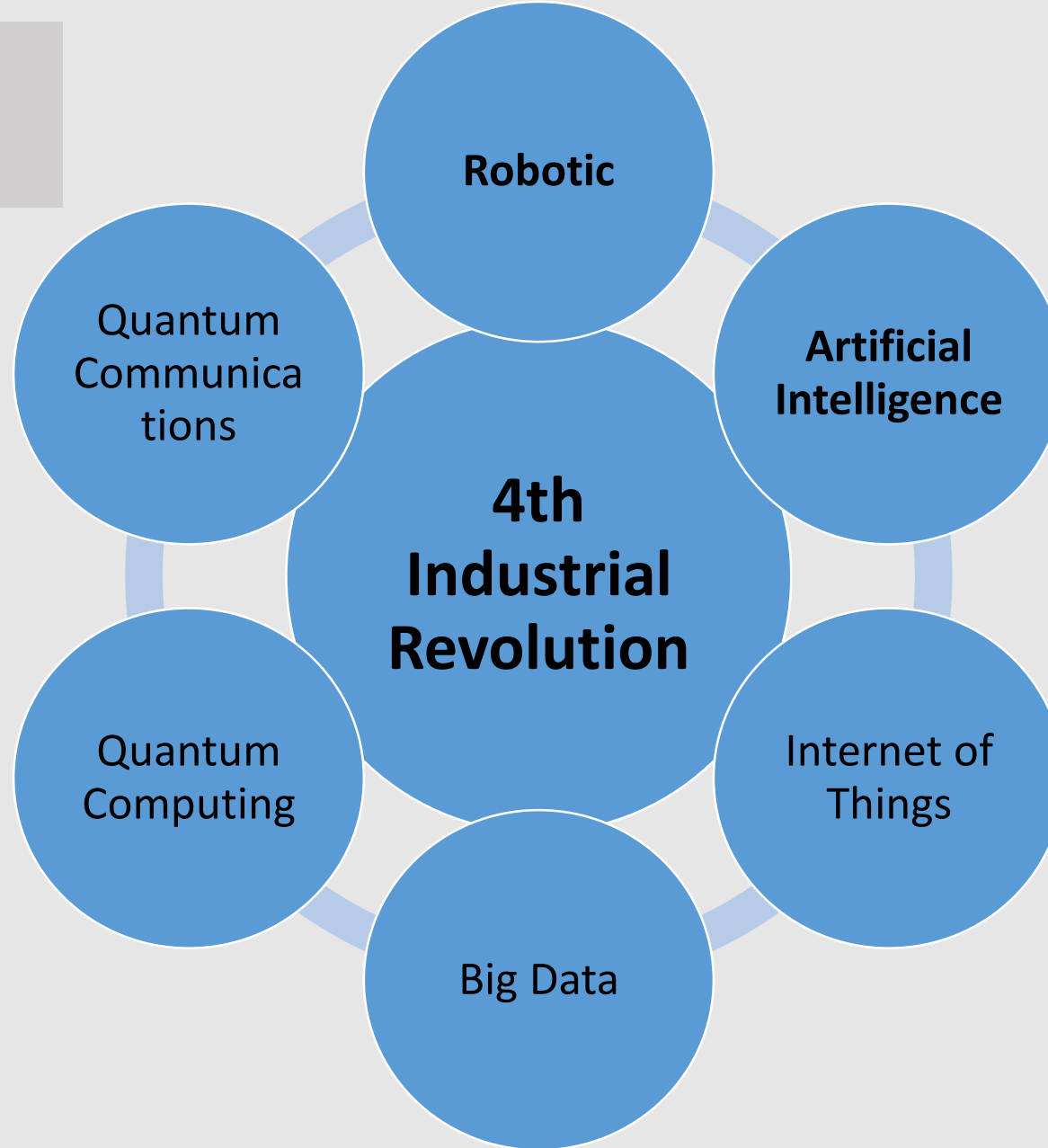
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# Introduction – The 4th Industrial Revolution

- **5G Cellular Communications (2020)**
  - Relates to **Internet of Things** and will support **hiperconnectivity**, generating data **20 times faster** (20 Gb/s) than with 4G, and with a lattency 10 times lower. Will support **point-to-point communications (IoT)**, instead of only through a Base Station.

- **Big Data**
  - Consists of **massive quantity of data**, structured or non-structured, that requires **processing with Artificial Intelligence** to generate **Knowledge**.

- **Robotic and Artificial Intelligence**
  - A Robot is used to accomplish a certain task, but requires intelligence → **4th Industrial Revolution**
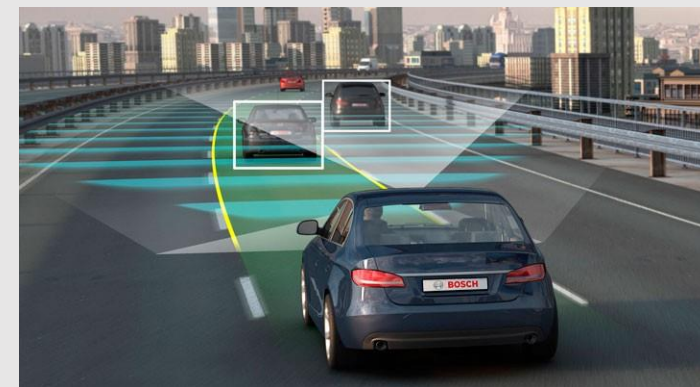
- Quantum Computing & Communications
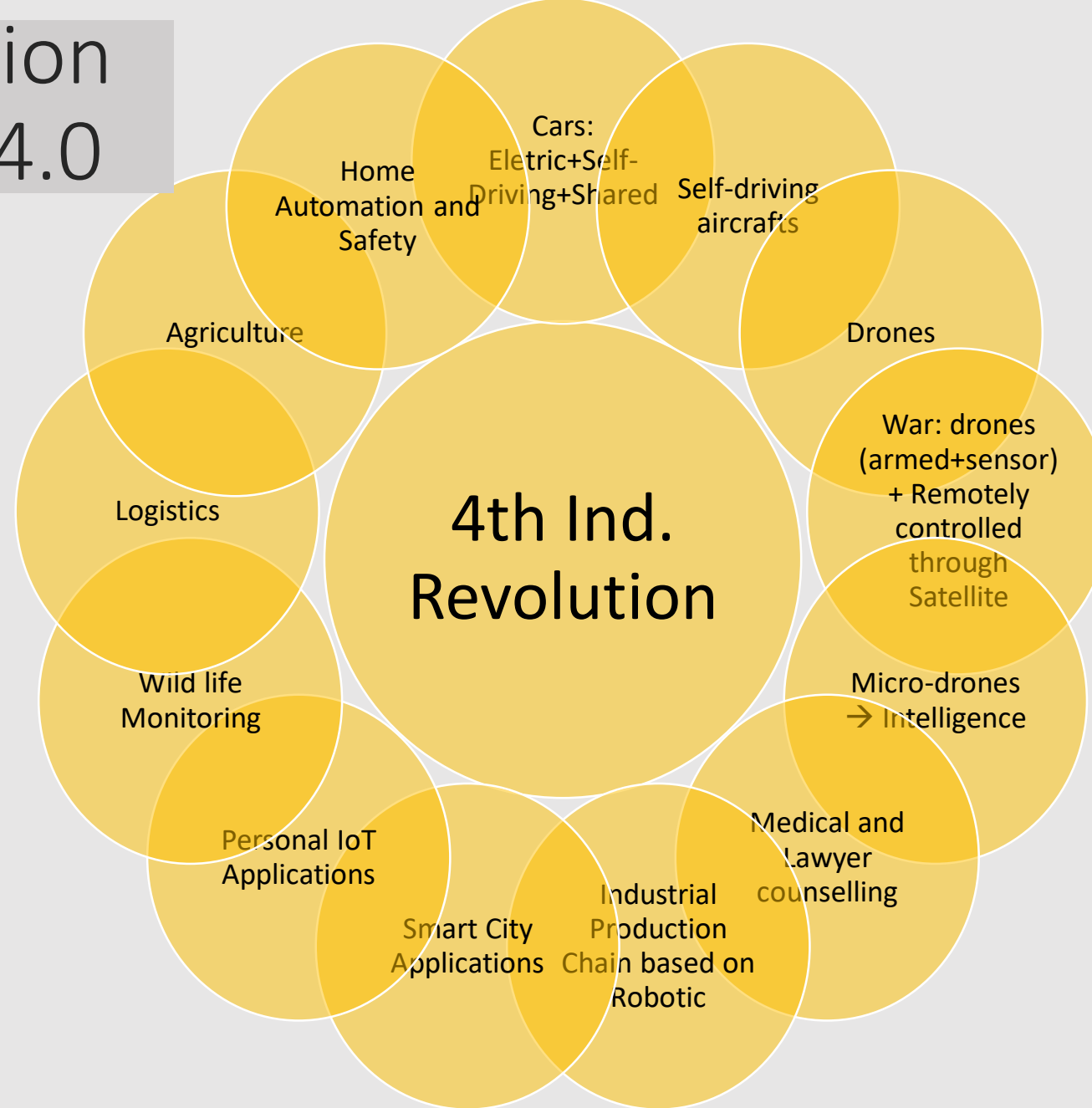  - <u>Moore's Law</u> **is not being followed**: The speed of **microprocessors duplicates every 2 years.**

  - <u>Gilder's Law</u> **is not being followed**: "the total bandwidth of communication systems triples every twelve months".

  - <u>**Quantum Computing & Communications**</u> relates with the principles of Quantum Mechanics:
    - "Entaiglement"
    - Quantum Duality
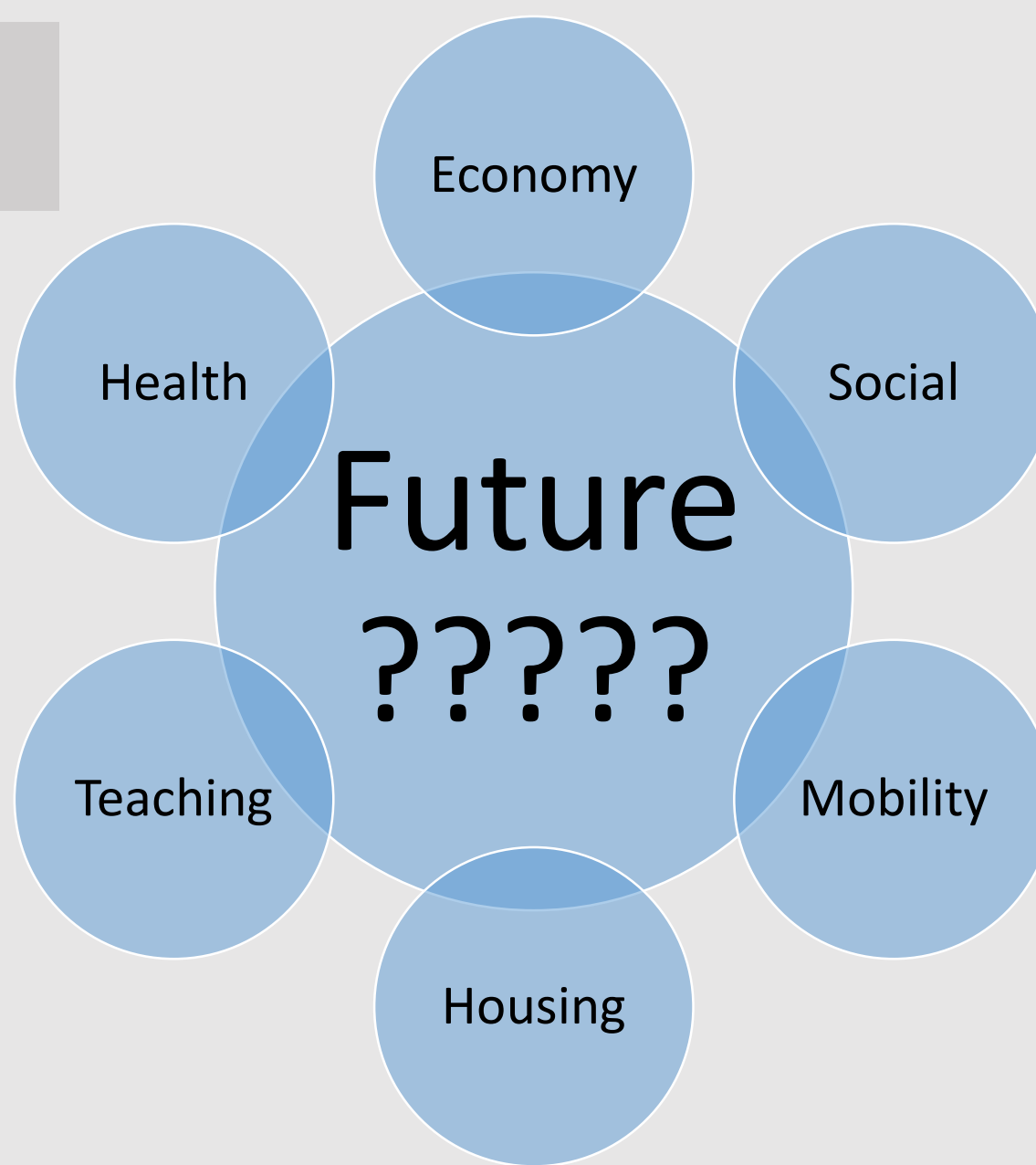
Economy

Health

Social

Future ?????

Teaching

Mobility

Housing

**The shape of the Robot is not an issue.**
**The future of Robot comprises a shape adapted to its functionality.**
**Ex: Self-Driving Car.**

## 4th Ind. Revolution

- Cars: Eletric+Self-Driving+Shared
- Self-driving aircrafts
- Home Automation and Safety
- Agriculture
- Drones
- War: drones (armed+sensor) + Remotely controlled through Satellite
- Logistics
- Micro-drones → Intelligence
- Medical and lawyer counselling
- Wild life Monitoring
- Personal IoT Applications
- Smart City Applications
- Industrial Production Chain based on Robotic

# Introduction – The 4th Industrial Revolution

- Self-Driving Cars
  - **In the Future (15 years) Mobility will be with cars: 1) Electric; 2) Self-Driving; 3) Shared.**
- Self-driving Aircrafts
- Medical and Lawyer counselling
- Cirurgies with Robots
- Functional Drones and War
  - War with Drones, armed and with sensors, controlled through satellite, remotely operated from other parts of the globe
  - Micro-drones → Intelligence
- Industrial Production Chain based on Robotic
- Automatic Translation
- Facial Reconnaissance
- Intelligent Houses (including vacuum machines, etc.)
- Personalized marketing in the Internet
- **The shape of the Robot is not an issue. The future of Robot comprises a shape adapted to its functionality. Ex: Self-Driving Car.**

# Aplicações da Robótica / Inteligência Artificial

- # Implicações Sociais:
  - Existem receios de que a 4ª Revolução Industrial traga Desemprego
  - Semelhante antecipação ocorreu com as anteriores Revoluções Industriais, nomeadamente com a 3ª (Revolução da Informação -> Tecnologias de Informação e Comunicação)
  - Na realidade, parece-me que os receios que se anteveem funcionarão para aqueles que não se preparam para o "novo paradigma", i.e., **desaparecerão alguns empregos e aparecerão outros**.
  - Implicará que estejamos **atentos** e nos **adaptemos**. Para aqueles que não se adaptam à nova realidade, existirão **consequências laborais, e sociais**.
  - Mas BIG BROTHER (hoje já somos controlados com telemóveis, cartões de crédito, passes sociais, via verde, **Google**, Facebook, Instagram, iPhone, etc.): câmaras espalhadas pelo território, com reconhecimento facial, podem saber tudo sobre nós (com histórico), mas também localizar criminosos em poucos minutos. Cidade Chinesa já oferece sistema de recompensa por pontos, pela cidadania, que é monitorizada e avaliada pelas câmaras associadas a IA → eficiência vs liberdade / proteção dos dados pessoais

- # Implicações Económicas:
  - Existirão ganhos de eficiência para as pessoas e organizações (como empresas), tal como com as anteriores Revoluções Industriais (razão para a sua implementação). No entanto, tal como na área social, implica uma readaptação ao novo Paradigma. A forma concreta de posicionamento da organização face à 4ª Revolução Industrial depende do tipo de empresa…..

- # Implicações Jurídicas:
  - A lei vai atrás da tecnologia, com algum atraso e com muitas lacunas.
  - E a IA substituirá o aconselhamento jurídico.

**5G systems (2020) are aimed to achieve [as compared to 4G]:**

- Higher throughputs (1-20 Gbps)
- Lower Latency (0,5-1 ms)
- Higher Capacity
- Better Spectral Efficiency

**3GPP Release 15 (from ETSI):**

- Covers: 1-Radio Access Network; 2-Services and Systems Aspects; 3-Core Network and Terminals
- ITU-T is expected to standardize 3GPP Release 15 (5G) as IMT-2020
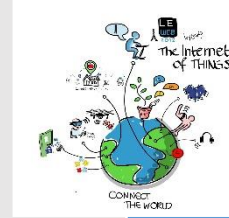
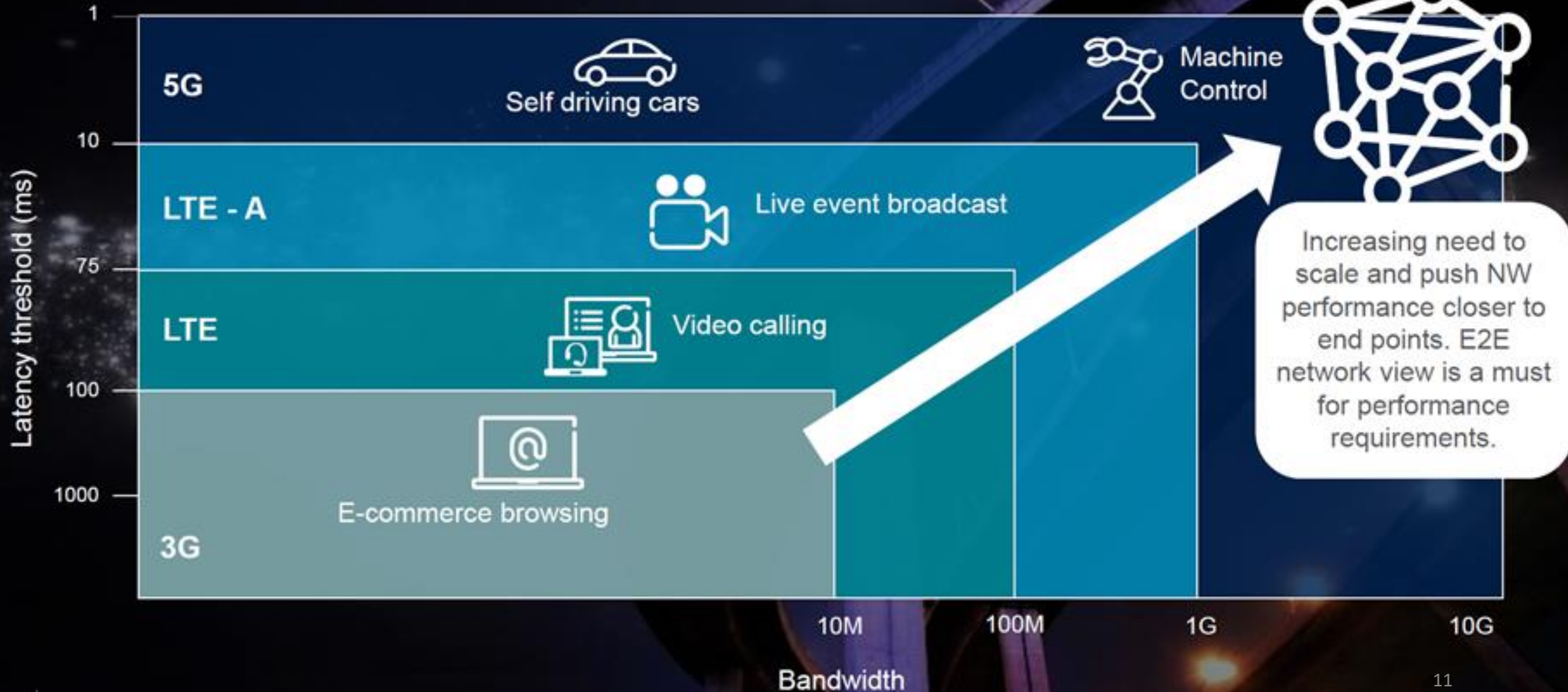**Support of new and Emergent Services:**

- VTC on the Move
- Real-Time Communications
- Augmented Reality
- Support of Self-Driving Cars
- Machine-to-machine communications (IoT and Security Apps) – in addition to infrastructure centralized architecture

**Massive MIMO schemes involving several hundreds or even thousands of antenna elements are expected to be central technologies for 5G systems**

# New Paradigm of 5G

- Support of new and emerging services

- Increase of data rates (20 Gb/s) and lower delays

- Increase of offer tends to originate an increase of demand => new services will come

# LATENCY & BANDWIDTH

Latency threshold (ms) vs Bandwidth

- 5G — Self driving cars, Machine Control
- LTE - A — Live event broadcast
- LTE — Video calling
- 3G — E-commerce browsing

Increasing need to scale and push NW performance closer to end points. E2E network view is a must for performance requirements.

HOW TO ACHIEVE 5G?

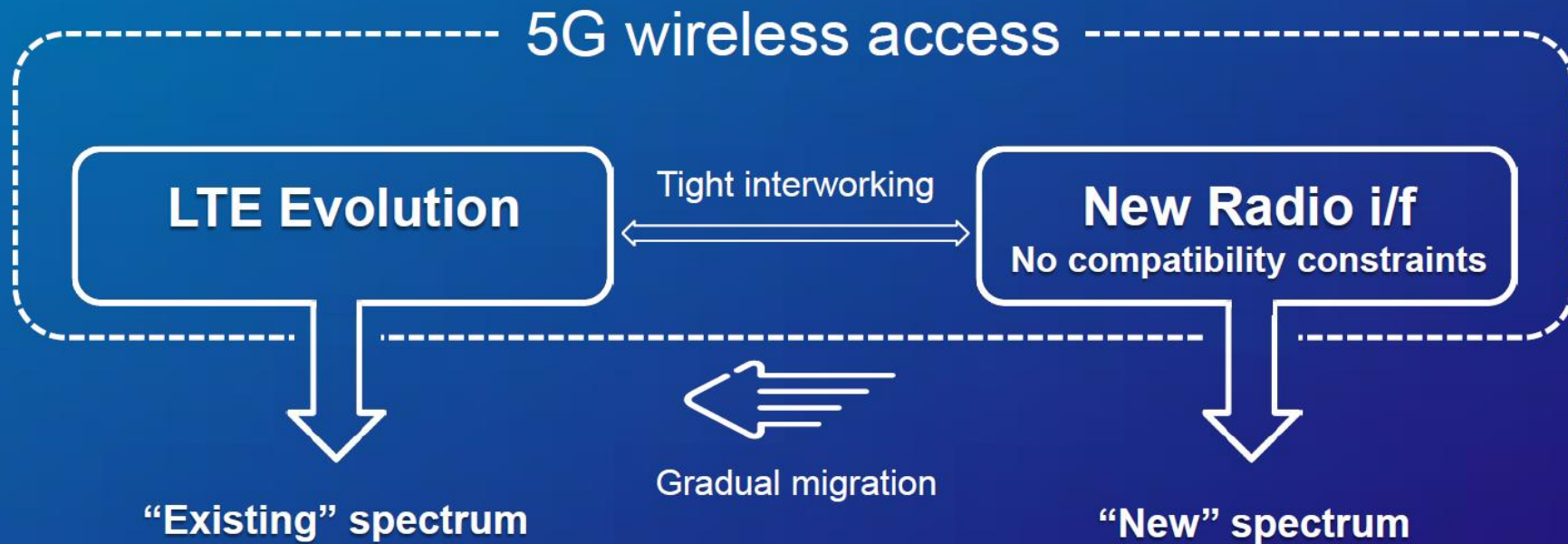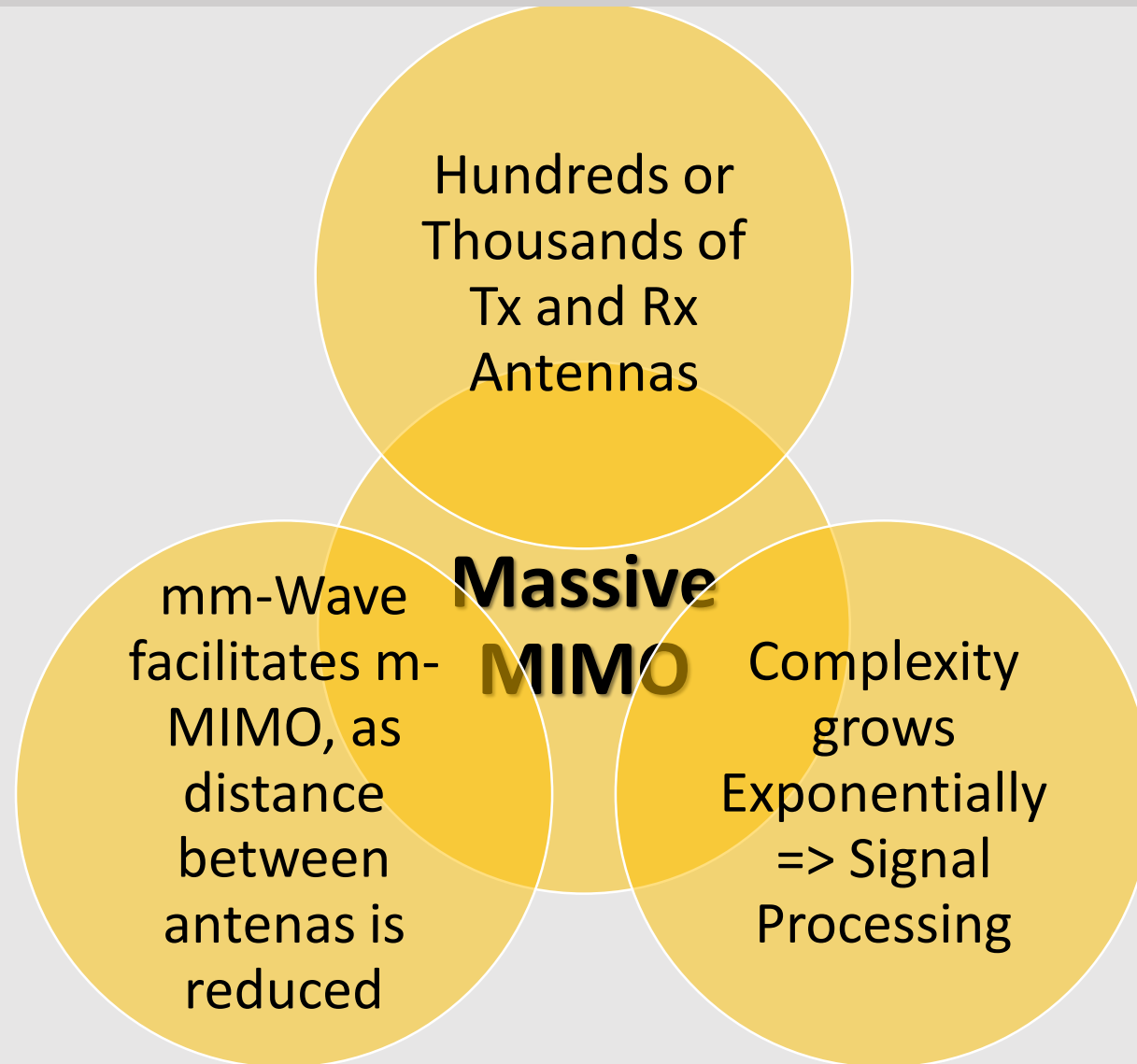| **Massive MIMO** | **Millimeter Waves** | Base Station Coperation | Multi-hop Relay | All-over IP | OFDM & Other Block Transmission Techniques | Adaptive Modulation & Coding | Multi-Resolution Techniques | Carrier Aggregation |

# 5G RADIO ACCESS ~2020

5G wireless access

**LTE Evolution** ←→ Tight interworking ←→ **New Radio i/f** No compatibility constraints

Gradual migration

"Existing" spectrum

"New" spectrum

1 GHz  3 GHz  10 GHz  30 GHz  100 GHz

1 GHz  3 GHz  10 GHz  30 GHz  100 GHz

**Below 6 GHz**

**Above 6 GHz**
**New spectrum below 6 GHz**

Hundreds or Thousands of Tx and Rx Antennas

**Massive MIMO**

mm-Wave facilitates m-MIMO, as distance between antenas is reduced

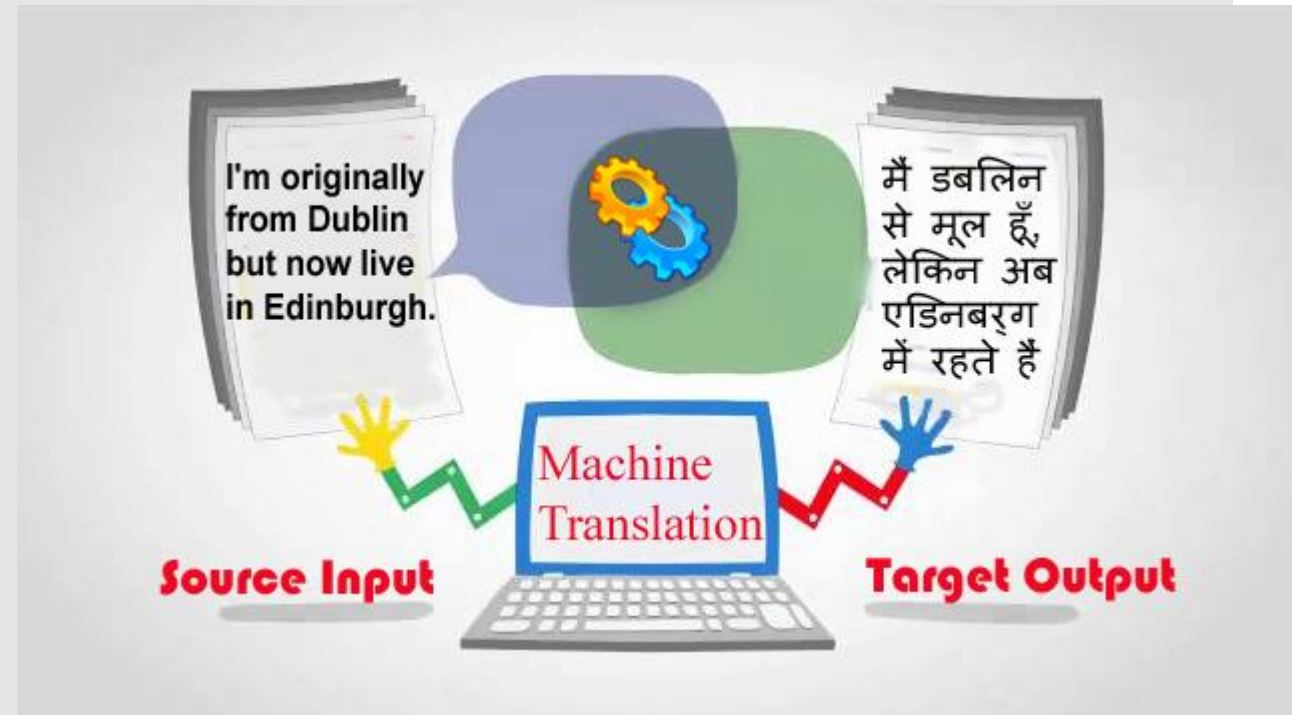Complexity grows Exponentially => Signal Processing

## mm-Wave and Massive MIMO

**mm-Wave communications** (30-300GHz - EHF) are expected to be a crucial part of 5G systems due to their **increased channel coherence bandwidth**, as compared to centimeter Wave. These systems use carrier frequencies of 30 - 70 GHz, where we have large unoccupied bandwidth. – E.g.: IEEE802.11ad uses 2.16 GHz of BW in **60 GHz band** (ISM band), supporting up to 7 Gbps.

The **distance between antennas is reduced**, facilitating a higher number of antenna elements (Massive MIMO)

However, mm-Wave suffers from high path loss and rain and oxygen absorption.

THANK YOU