
# 5G Technology Elements for Future Internet of Things

**Dr. Geng Wu**

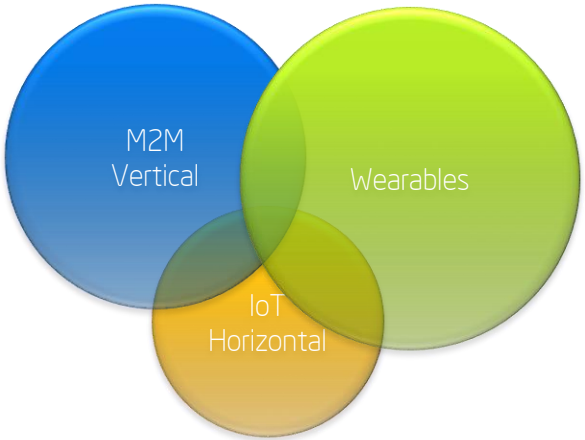
**Chief Scientist, Wireless Standards and Advanced Technologies**

geng.wu@intel.com

# The future of Internet of Things

## Applications

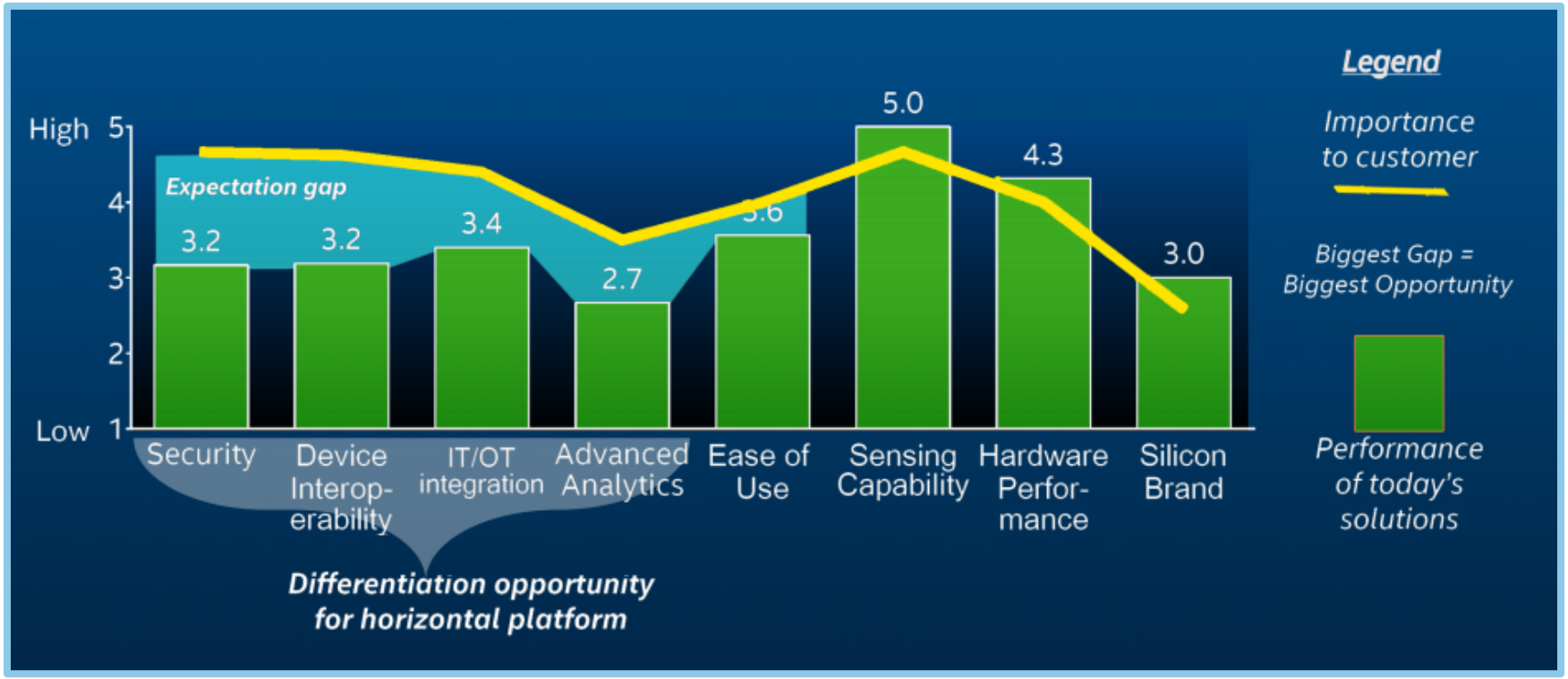

## Ecosystem




Future IOT requires new network capabilities to support massive number of devices, and efficient SW/HW platforms for both devices and networks

Future IOT requires close partnership among many industries and ecosystems to offer integrated compute and communication capabilities

# IOT expectation gaps




*Source Bain: Reflects n=37 interviews with tier 1 leaders in Smart Factory, Smart Building, Smart Fleet, Smart Grid Substation and Smart City Environmental Sensing domain*

# Enabling future IOT

## Technologies


*IDC
**IMC/EDC: The digital universe of opportunities

IOT requires end-to-end design considerations, from sensors to the cloud

## Standards and regulations

3GPP A GLOBAL INITIATIVE

one M2M

OPEN INTERCONNECT CONSORTIUM℠

ETSI World Class Standards

IEEE

Standards collaboration and regulatory compliance are essential

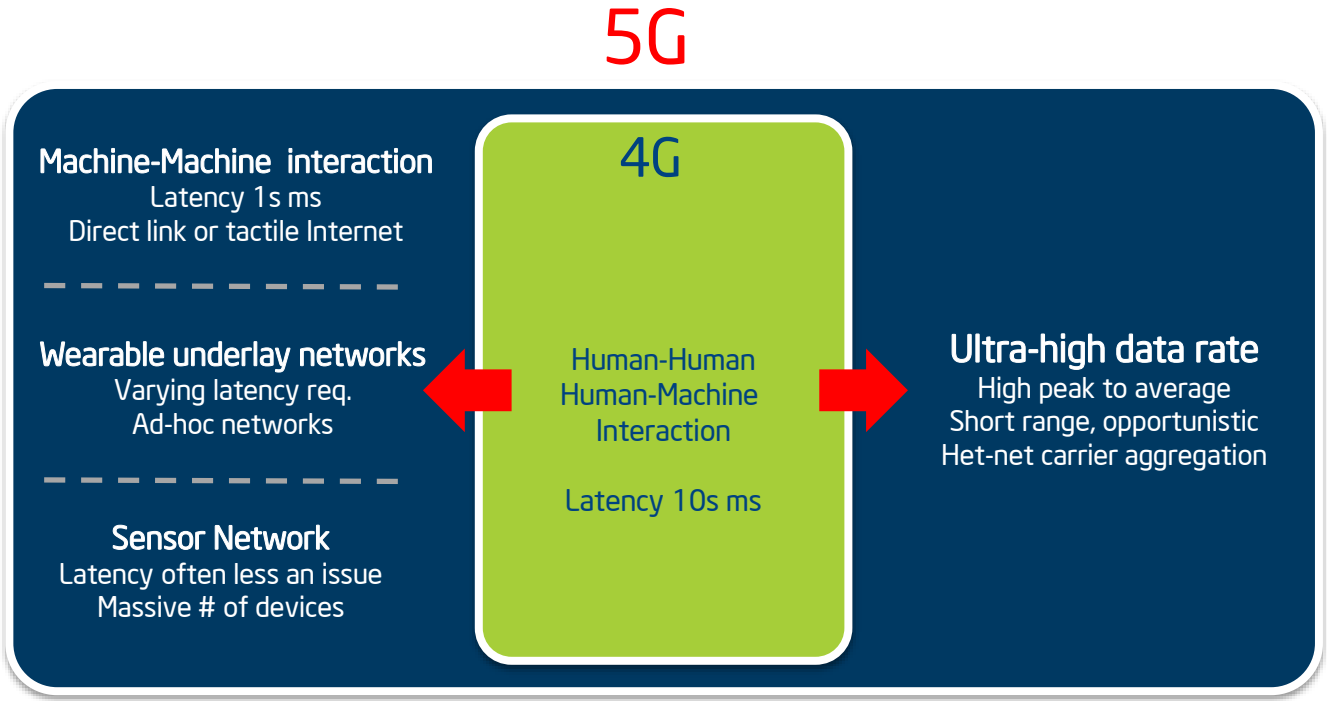
# 5G design goals

5G

| | IoT | 4G | mmWave |
|---|---|---|---|
| Data rate | Can be very low | 100s Mbps | 1-10 Gbps |
| Latency | From 2 ms to hours | Moderate | 2 ms |
| Battery life | Up to 10 years | Smart phone | Depends on app |
| Link budget | Penetration | Coverage | High data rate |
| Multiple access | Massive # of devices | Smart phones | Bursty/opportunistic |
| Network | Overlay | Hetnet | Hetnet/underlay |

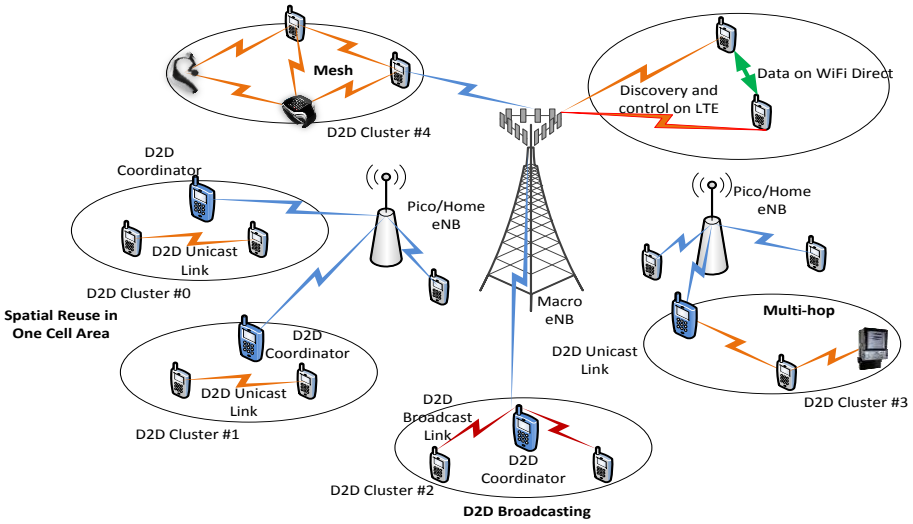
5G has to be designed as a system
Compute + communication becomes a necessity

# Air interface for IOT




Platform innovations enable applications/services innovations

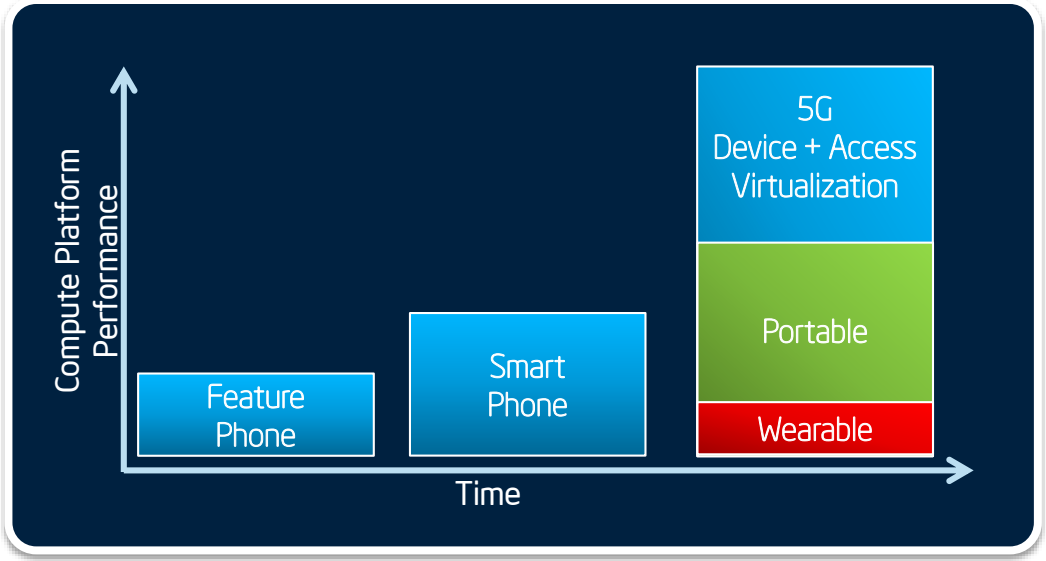
# Underlay networks for things and wearables

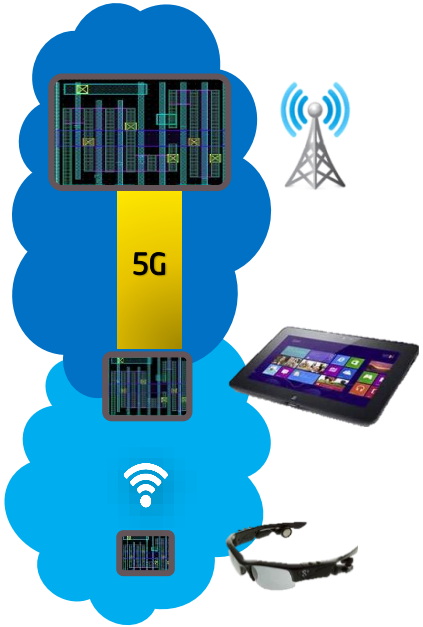



Many devices, types of devices, connections
Many moving underlay network clusters

One big intelligent and information network
Compute, storage, networking

# Virtualization of device and access

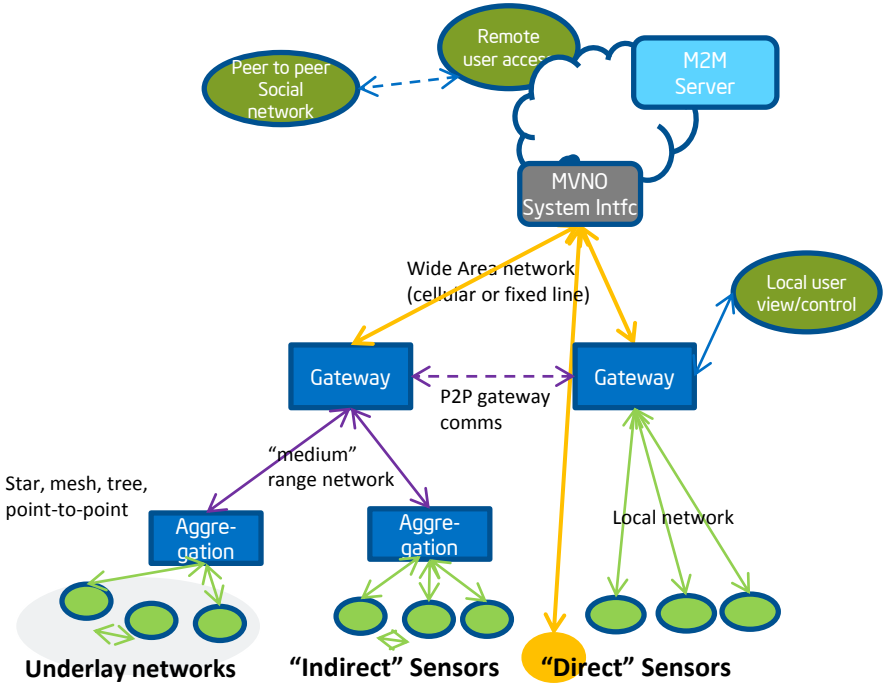



*5G device+access virtualization for scalability, versatility, energy efficiency*

- Future applications require intensified compute and communication but often smaller device form factor
- 5G high data rate + low latency radio links enable mobile device + access virtualization across the air interfaces
- 5G services are immersive. Sensing, intelligence and contents require edge cloud and device + access virtualization
- Breaking computing barrier through communication may transform consumers' relationship with network

# Future research areas



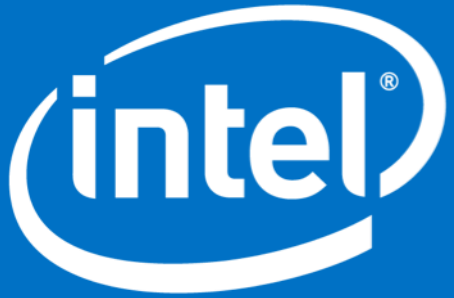

## System design

- Compute and communications tradeoffs
- Device and access network architecture tradeoffs
- Underlay networks and connectivity design tradeoffs

## User experience

- Privacy and security
- System manageability
- Subscriber ownership

# The evolution towards a world of IOT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