

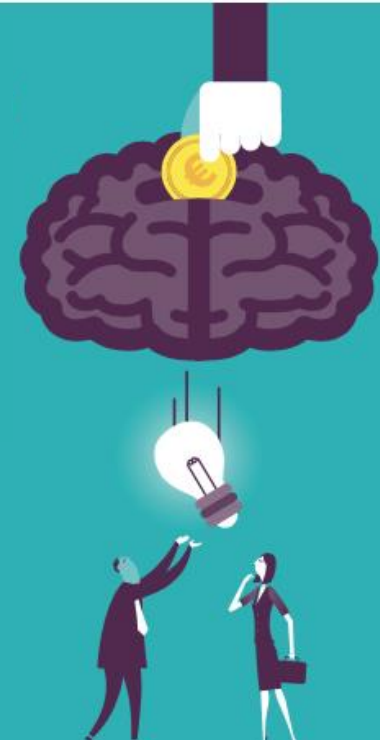


Rigorous empirical  
research on  
intellectual property

# The Internet of Things and 5G: An Overview

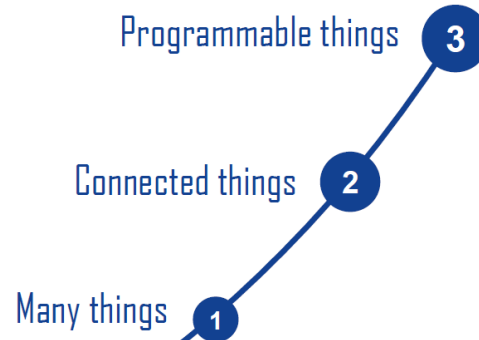
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*Member of 4ip Council*

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# The Past: Connecting People

## The Future: Connecting Things in a Programmable World



IoT is fundamentally a sensor, connectivity, and data analytics revolution

IoT is part of something bigger: The connected, programmable world

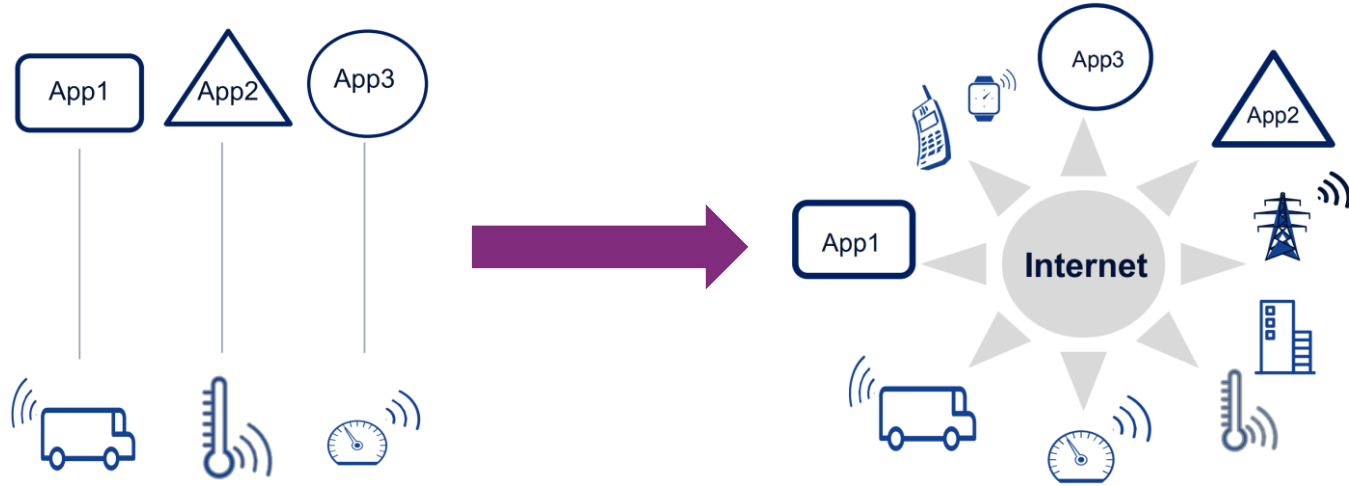
1bn fixed internet connections by 2005

Mobile internet with 5 bn people connected by 2020

Programmable World with 50 bn things connected by 2025

# Transformation from Point Solutions to IoT

## From the Intranet of Things to the Internet of Things



- < 5 Billion connected people
- Humans and ad-hoc M2M connections only source of data
- Data meaningful in context
- From product...

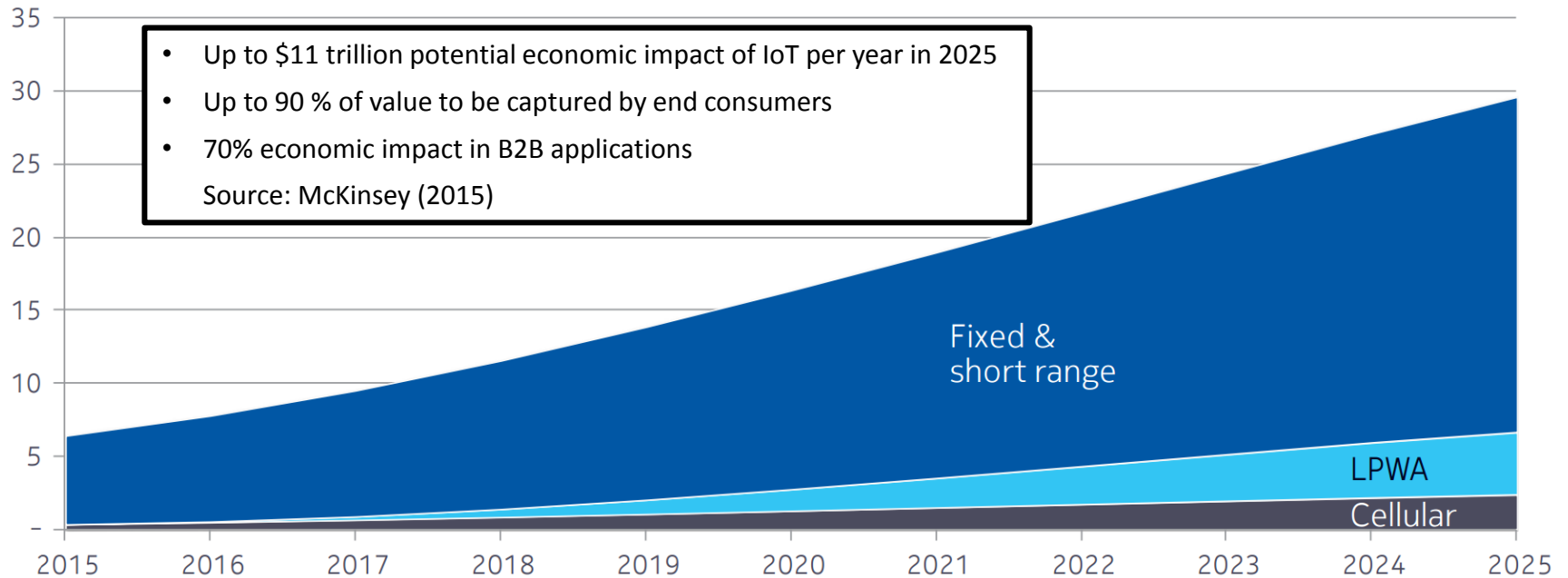
**Before**

- 50 Billion connected "things"
- Data disassociated from any source
- ...to almost everything delivered as a Service

**2025**

# Huge Economic Potential from Billions of IoT connections

## But Realization of this Potential is also Difficult and Uncertain



Graph: Machina Research (May 2015)

## Five Key Challenges for the Internet of Things

Robust connectivity:  
Latency, availability,  
coverage

1

Standardization:  
Standard connectivity  
for billions of things

2

Interoperability and  
open interfaces:  
Enabling platforms to  
talk with each other

3

Privacy and security:  
Prevent malware  
injection and data  
misuse

4

Domain knowledge:  
Deep, vertical-specific insights

5

# Wireless Connectivity for the Internet of Things

## 5G – The Next Generation Cellular Standard

- Open standard, operating on licensed radio spectrum
- In development, initial rollout later this year

“an open standard must be aimed at creating unrestricted competition between vendors and unrestricted choice for users” (Digital Standards Organization)

## Scarce Resource: Licensed Radio Spectrum

- Natural Oligopoly: licensed network operators
- Unlicensed-spectrum technologies for LPWAN create competitive pressure
- Market will grow tremendously

## Alternative Technologies for LPWAN

### LPWAN = low power, wide-area network

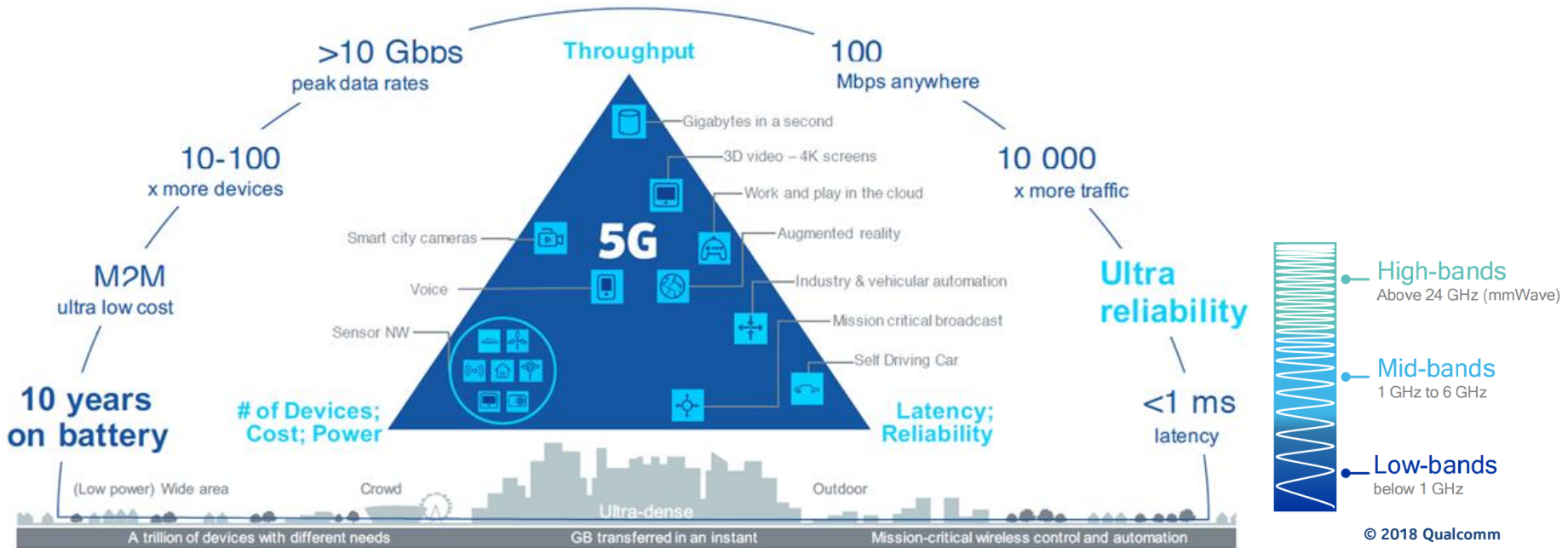
- Fixed, med-to-high density connections (smart cities / buildings)
- Long-life, battery-powered applications
- Operating on unlicensed spectrum
- Proprietary technologies already being rolled out

### Example: SigFox

- Inexpensive radios by multiple manufacturers
  - Software / network as a service - SigFox as network operator
- Can address only a subset of foreseen IoT use cases

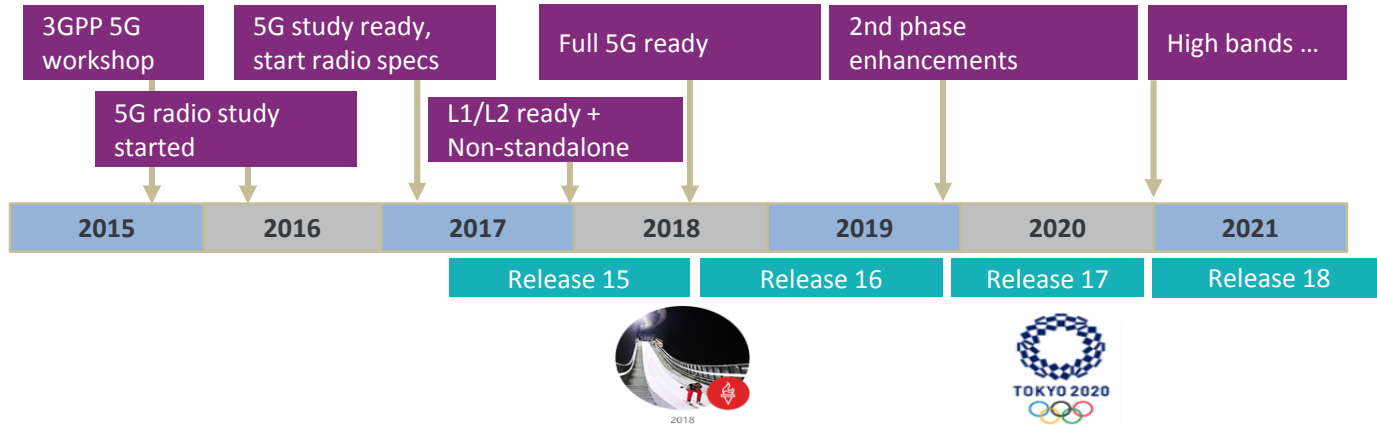
# 5G: The Next Cellular Generation

## Diverse Services, Diverse Spectrum, Diverse Deployments



# The Process towards 5G

## Building on Previous Standard Generations for Accelerated Roll-Out



- 3GPP Release 15 standard development prioritizes non-standalone NR (new radio) to accelerate 5G rollout
- Non-standalone NR specs frozen in March 2018, will utilize LTE network architecture for higher bandwidth
- 5G commercial rollout now scheduled to begin in late 2018
- Development of 5G will continue with Release 16 and beyond