Enterprise Application of Autonomous UAVs: QoS & QoE from Modern Telecom Networks

ITU Workshop on Telecommunications Service Quality hosted by Turk Telekom in Istanbul

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Outline

About UAVs & UASs

Enterprise Application of Autonomous UAVs

Command & Control of Autonomous UAVs
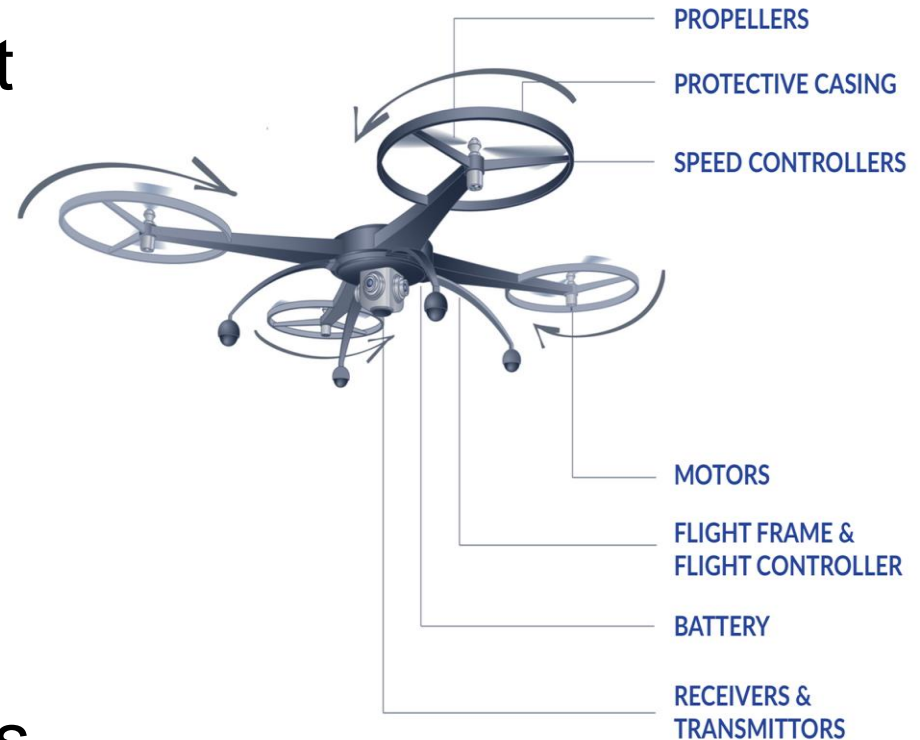
Criticality of QoS & QoE for UAV Control

Regulatory Considerations

Summary

Unmanned Aerial Vehicles (UAV)

- Remotely piloted aircraft or systems
- Also known as Unmanned Aerial System (UAS)
- FAA (Federal Aviation Authority) uses UAS
- Commonly referred to as drones

PROPELLERS
PROTECTIVE CASING
SPEED CONTROLLERS
MOTORS
FLIGHT FRAME & FLIGHT CONTROLLER
BATTERY
RECEIVERS & TRANSMITTORS

UAV Characteristics

- Aviation system
  - Multirotor, Fixed wing, Hybrid, Flapped-wing
- Level of autonomy
  - Human-operated, Human-supervised, Fully-autonomous
- Size and weight classes
- Energy source
  - Battery, Fuel-cell, Solar

Enterprise UAVs: A Snapshot

| UAVs Today	UAVs Tomorrow
• Operated manually • Visual Line of Sight (VLOS) • Not scalable • Human labor-intensive • Human error-prone • Lack of consistency	• Autonomous • Beyond VLOS • Massive scalability & consistency • Enterprise: Artificial Intelligence & Machine Learning

Manually Controlled Drones – Small Scale

Only works with given controller
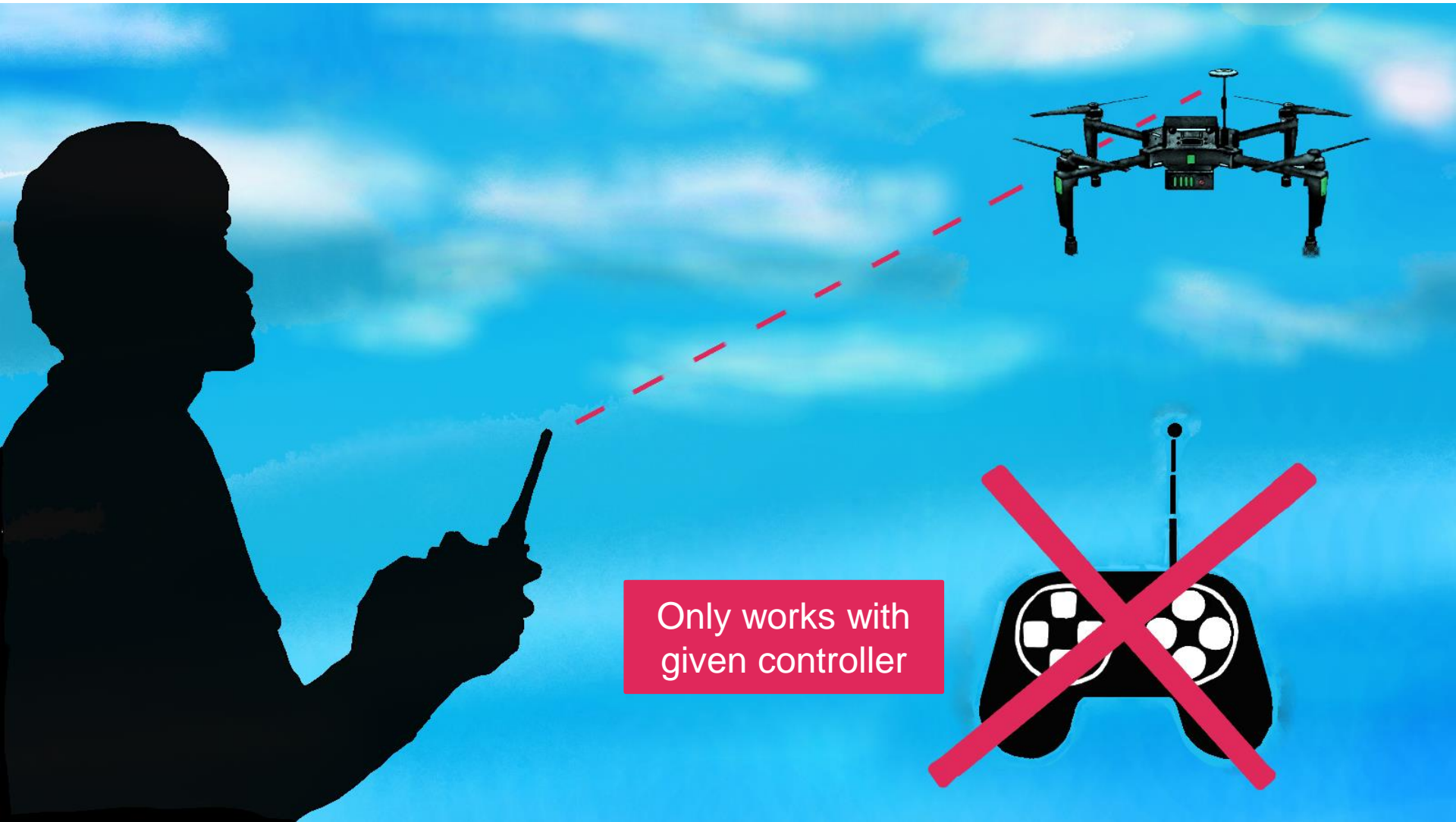
Autonomous: Beyond Visual Line of Sight (BVLOS) – Enterprise Applications
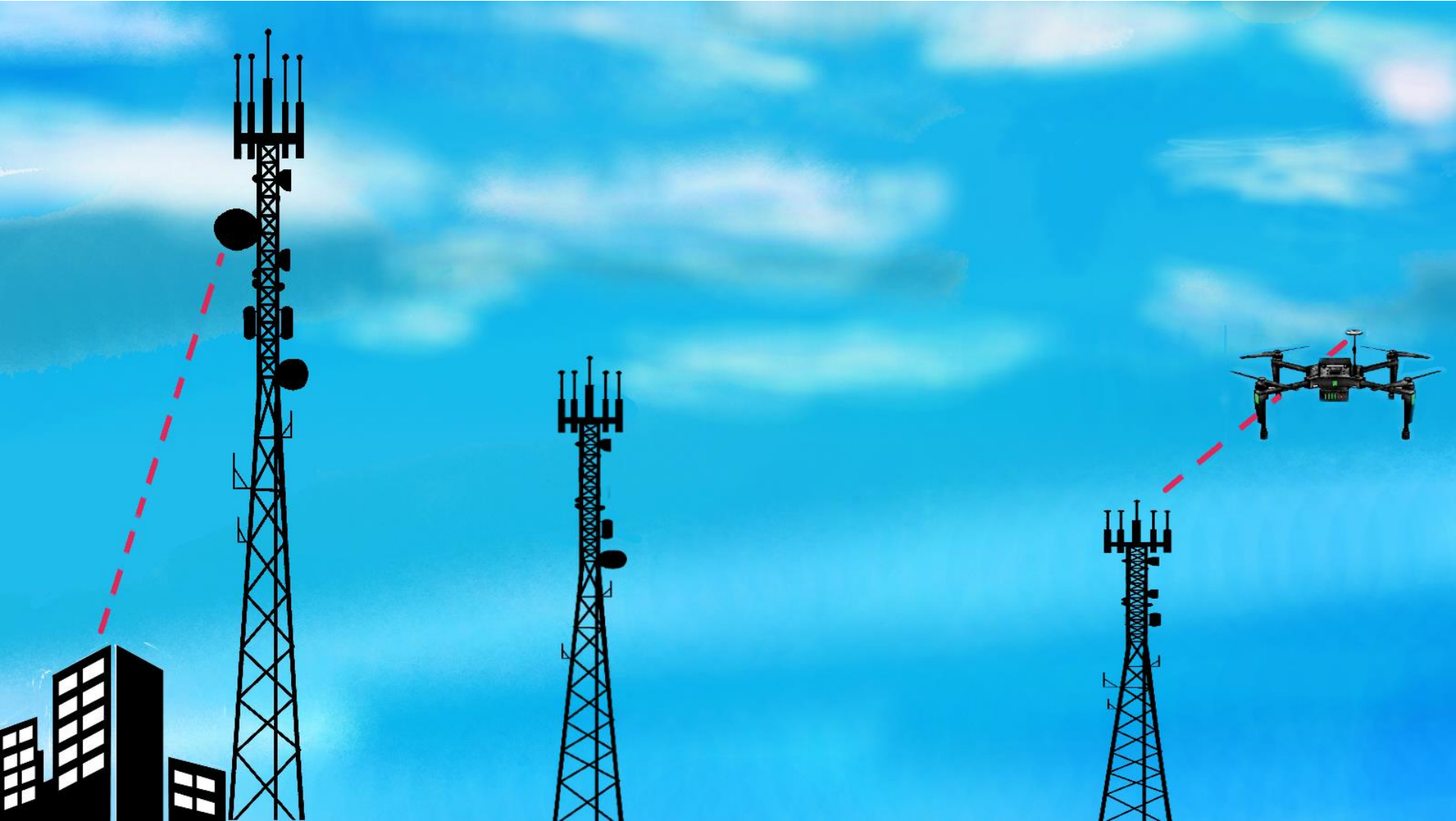
Platform-based Drone-enabled Applications

Data Input

Map	Wind
Terrain	Weather
Airspace	Availability
NOTAMs	Other UAVs
RF Signals	Lawful interception
Interference	Cost

Airborne UTM
Management Platform

Reg./Ident.	Mission	Planning
Operation	Analysis	Settings

- UAV handling/registration
- Mission creation
- Planning & Optimization
- Operation (#regulatory)
- Analytics

Web based | Cloud processing | Machine learning | Open interfaces

UAV Services

Delivery	First Aid
Tower inspect	Pipeline Inspect
Windmill Insp.	Public Safety
Cell on wing	Utilities
Agriculture	Insurance

Command & Control for Autonomous Drones

- Drones need uninterrupted wireless connectivity
- VLOS ensures manual operation
- How to maintain connection for BeVLOS?
- Most viable answer:
  - Cellular Connectivity
  - Strongly advocated by CTIA

MNOs & Autonomous UAVs

Autonomous UAVs need connectivity for monitoring, command & control

CTIA: Cellular connectivity – easiest & cheapest

Licensed, robust, secure & ubiquitous

With 5G, latency is <10ms

Regulatory-compliant latency

Enterprise UAVs will require nano/pico SIM

3D Air Space & 5G Radio Coverage Computation

Layers:
☑ Airspace
☐ Cell tower locations
☑ Mobile coverage
　☐ No service
　☑ Full service

Restricted no-fly zones

3D radio space
Signal, Interference, Latency
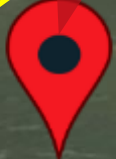
Optimized drone flight route

Need for RF coverage: Monitor, command & control

5G
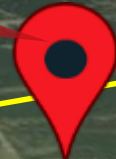
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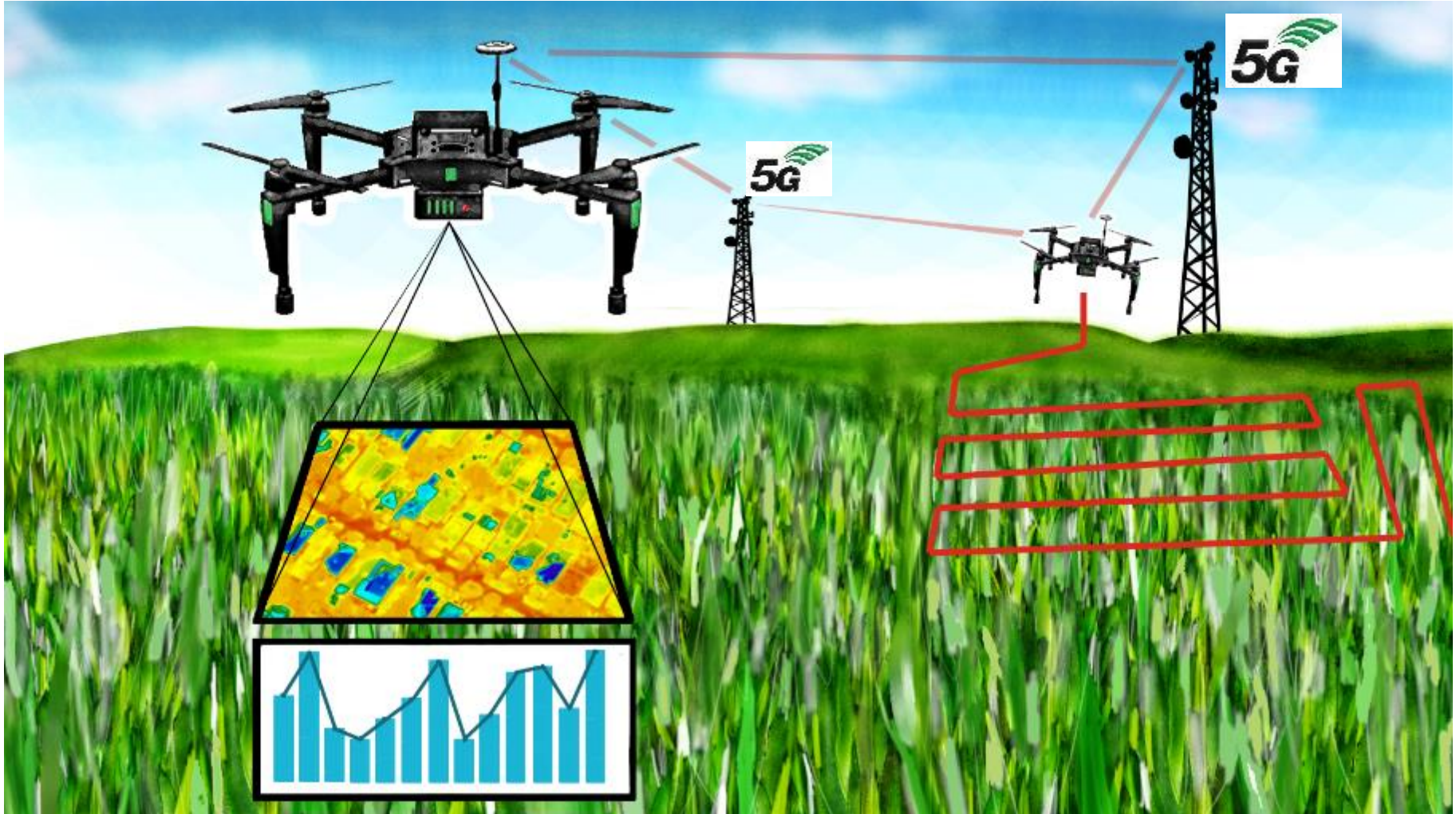# Use Case example: Inspection as a Service

Drone Hub

Target Area N

Target Area 1

Target Area 2

Enterprise deployment made feasible by 5G

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enhanced Precision Farming using 4G/5G

Outline

QoS & QoE Requirements for Drone-flying

- Regulatory bodies like FAA in the US have strict requirements
  - Constant connectivity
  - Redundancy in Critical Areas
  - Extremely low-latency between command & actuation
    - Consequences and liabilities of impact
    - Lost Connection between drone and cell
  - ETSI CoS (Class of Service) has to be 4: QoS guaranteed

Autonomous Drones: Latency is Critical

5G Latency is going to be ~10 mSec -> ~1 mSec

Source: Open Signal
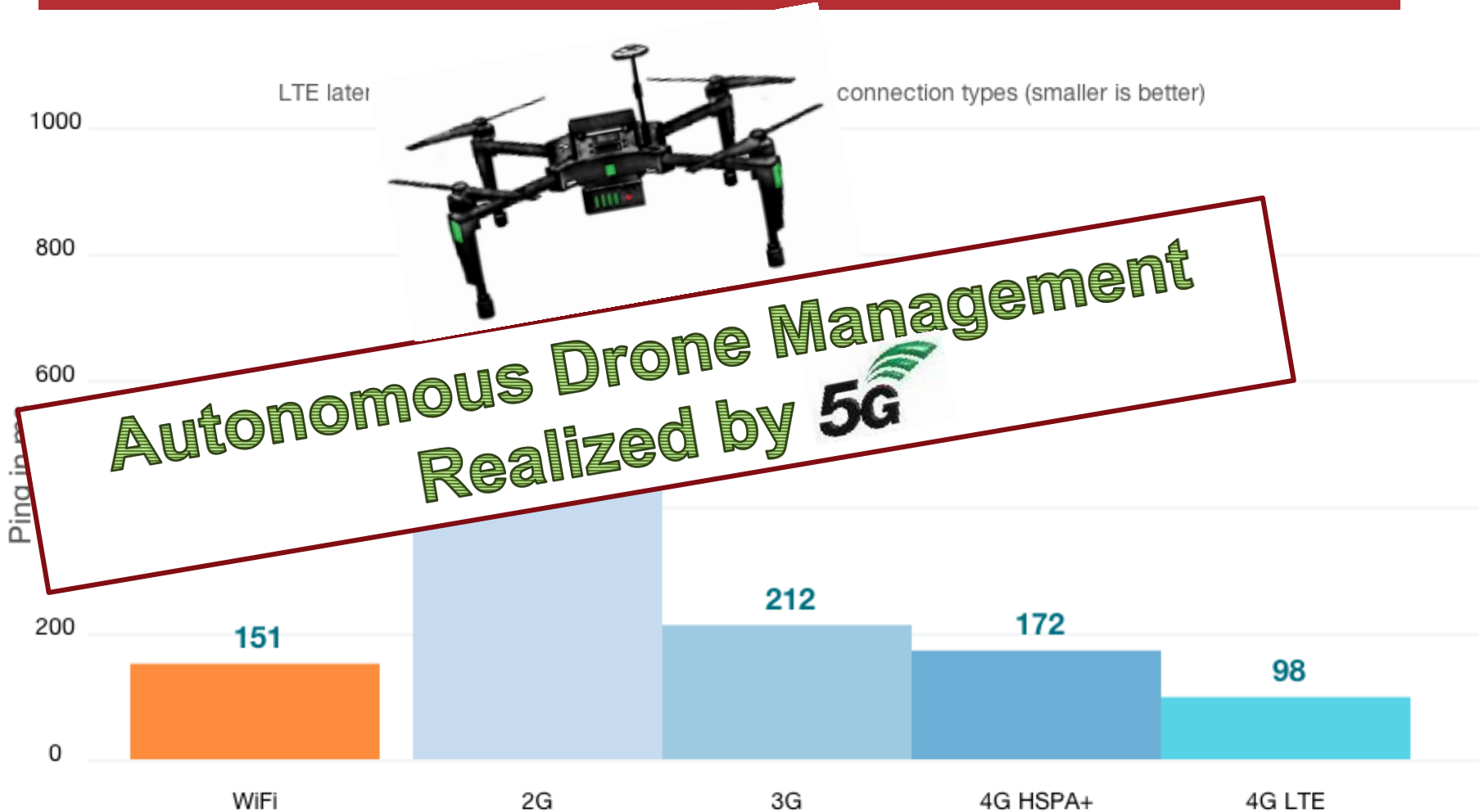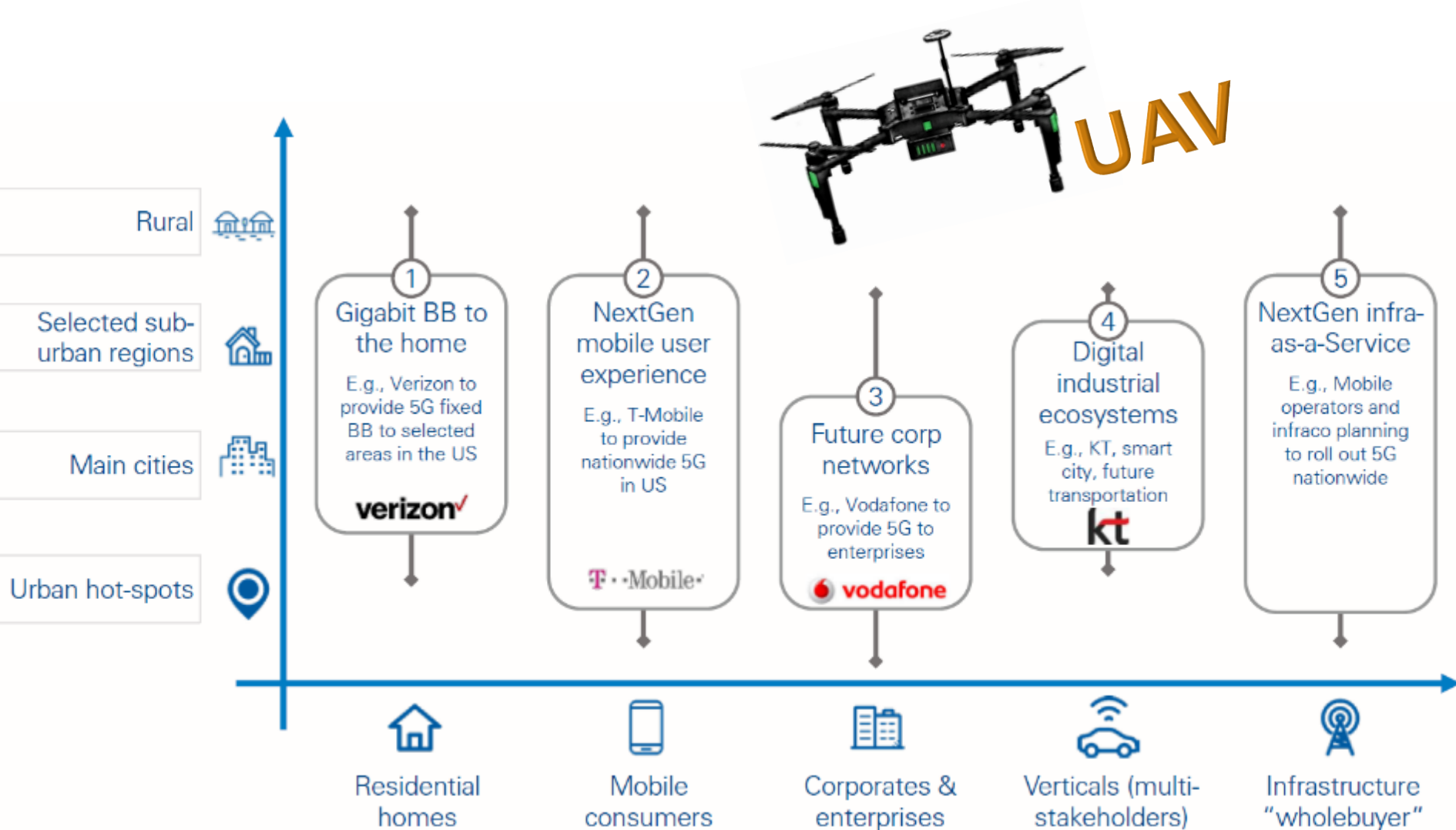
Cellular Network for Autonomous Drones

- Airspace Control Govt bodies, e.g. FAA LAANC (Low Altitude Authorization and Notification Capability) have non-violable QoS requirements
- Network design should ensure support of these
- Network Slicing ensures support of varying requirements

- One of the key growing areas for
  - Connectivity

Summary

- Commercial Autonomous Drones are going to be huge growth segment
- They require cellular connectivity to drones
- Very strong QoS requirements due to regulatory
- Network designers must use all available techniques to meet requirements

5G: Announced Business Cases

Source: ADL, Aug 2017