



Empowering Waste Sorting Robotics with 6G

A Case Study of TeknTrash's Alpha Robot

Al Costa · CEO, TeknTrash Robotics · alcosta@tekntrash.com

The Problem with Traditional Humanoid Robots

Onboard Sensing & Compute Don't Scale

Identifying dirty, crushed, or deformed waste demands heavy hardware — with real costs



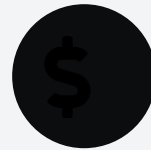
High Power Consumption

Continuous sensing & processing drains batteries fast, forcing frequent recharge or heavy packs that hinder mobility.



Computational Constraints

Edge devices are limited by size and thermal ceilings — too weak for deep learning-based waste ID.



Cost & Scalability

High-performance onboard hardware raises per-robot cost, making fleet deployment economically hard.



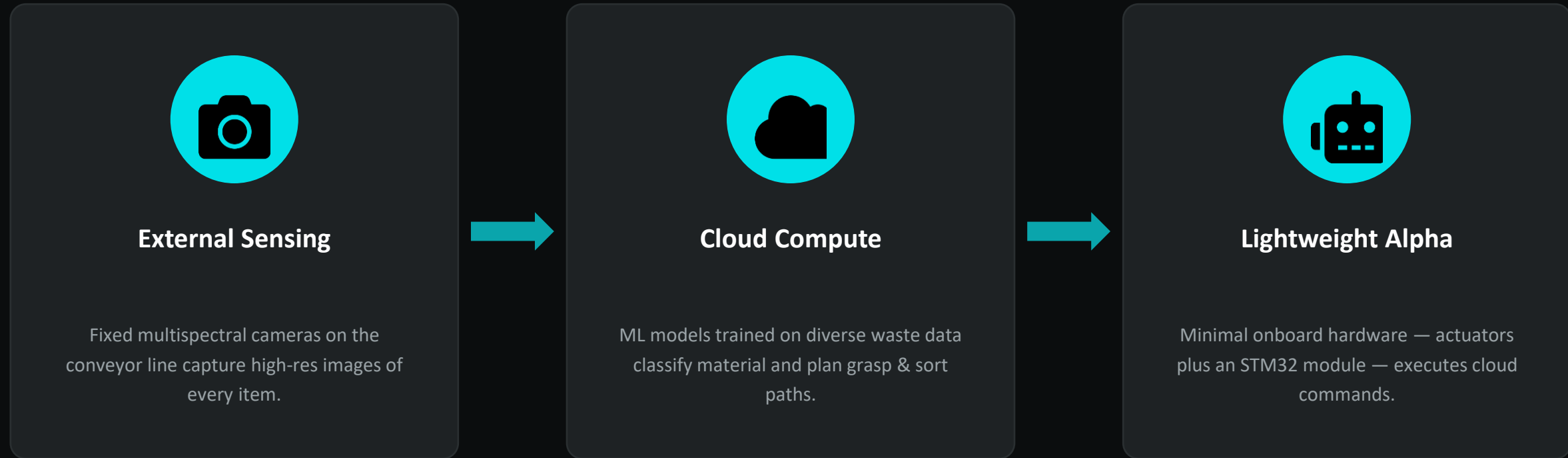
Maintenance Overhead

Harsh recycling-plant conditions wear onboard systems down, driving frequent downtime.

TeknTrash's Alpha: A Cloud-Centric Approach

How Alpha Works

Sensing and compute move off the robot and into the plant + the cloud



Why Cloud-Centric Wins



Energy Efficiency

Less onboard processing extends operational time and shrinks battery size.



Scalability

One cloud backend supports fleets of Alpha units across a large plant.



Flexibility

ML models improve centrally — no hardware changes needed on the robot.



Cost Reduction

Shared infrastructure lowers per-robot cost, easing wider adoption.

03

SECTION

The Connectivity Gap in Recycling Plants

What Alpha Needs vs. What's Available

REQUIREMENTS

Bandwidth

Tens of Mbps per camera for real-time HD video feeds

Latency

Sub-10ms round-trip for precise sorting control

Reliability

Minimal packet loss to avoid operational interruptions

Coverage

Consistent signal across large plants with machinery obstructions

WHY CURRENT NETWORKS FALL SHORT



Wired

Reliable but impractical to run across large, dynamic plant floors.



Wi-Fi

Limited range, highly susceptible to machinery interference.



5G

5-20ms latency & poor indoor penetration through metal structures.

The 6G Solution

Five 6G Capabilities That Unlock Alpha



Ultra-High Bandwidth

Peak rates up to 1 Tbps via terahertz frequencies enable seamless multi-camera feeds.



Ultra-Low Latency

0.1-1ms latency via ISAC and edge-cloud integration for real-time sorting control.



High Reliability

Massive MIMO & network slicing deliver packet error rates below 10^{-6} .



Ubiquitous Coverage

Non-terrestrial networks and reconfigurable surfaces reach remote, indoor zones.



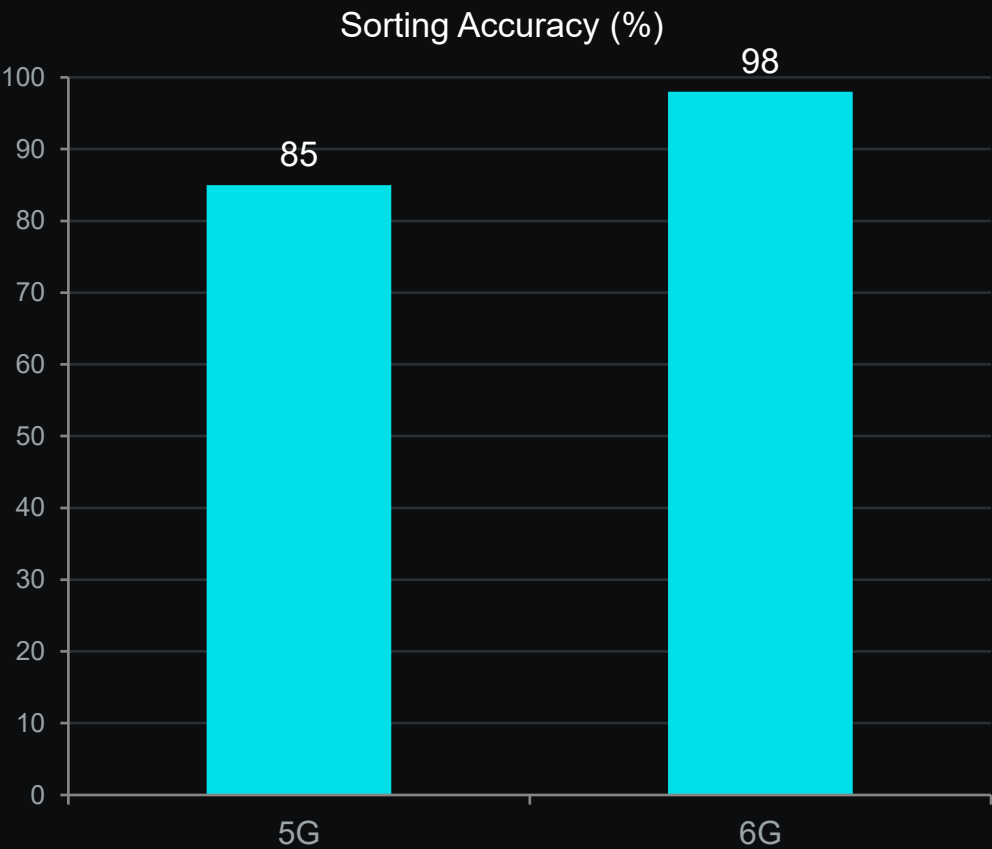
AI-Native Networking

Predictive resource allocation and interference mitigation, built in.

Case Study: Alpha at Scale

5G vs. 6G in a 10,000 m² Recycling Plant

20 cameras · 1,000 tons/day processed · 100 sorting actions/minute



1 ms

6G control latency vs. 5-20ms on 5G

2 Gbps

Uplink capacity, double 5G's 1 Gbps

+20%

Throughput increase over 5G deployment

99.999%

Network reliability under 6G slicing

Challenges on the Road to 6G

1

Infrastructure Deployment

Base stations, satellites & RIS require investment — public-private partnerships can accelerate rollout.

2

Energy Efficiency

THz frequencies and dense networks raise power draw; green protocols and energy harvesting help offset it.

3

Security

Cloud-linked robots are exposed to interception and control-signal attacks; quantum comms & AI-driven defenses mitigate risk.

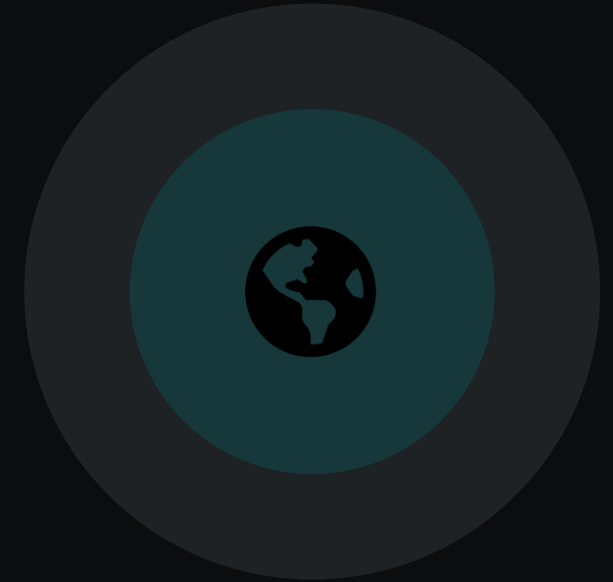
4

Standardization

Interoperable 6G standards, driven by bodies like the one6G Association, ensure cross-vendor compatibility.

The Bottom Line

Alpha proves that offloading sensing and compute to the cloud can make humanoid waste-sorting robots lighter, cheaper, and easier to scale. The missing piece is connectivity — and 6G's bandwidth, latency, reliability, and coverage are what will finally let cloud-centric robots run at full capacity in the field.



- ✓ Cloud-centric design cuts onboard cost, weight & power
- ✓ 5G falls short on latency, reliability & indoor coverage
- ✓ 6G closes the gap: sub-ms latency, 1 Tbps peak, 99.999% reliability
- ✓ Solving deployment, energy & security unlocks recycling at scale



Thank You

Questions & discussion

Al Costa · CEO, TeknTrash Robotics · alcosta@tekntrash.com · tekntrash.com/alpha.php