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# Cost Analysis: LoRaWAN vs. Mesh Network (ZAR)

## 1. Introduction

### LoRaWAN (Standard)

LoRaWAN requires a star-topology where all sensors speak directly to a Gateway. This usually requires expensive, high-performance gateways but allows for cheap, standardized sensor modules.

- **CAPEX**: High (Gateways) / Low (Nodes)
- **OPEX**: Moderate (Recurring Network Server fees)

### Mesh Network (Proprietary/Dual-Band)

Mesh allows cheap, standardized nodes to relay data to each other, forming a dynamic network that funnels to a simple, low-cost gateway.

- **CAPEX**: Low (Gateways) / High (Nodes)
- **OPEX**: Low (Self-managed, no external LNS fees assumed)

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## 2. Assumptions & Scope

**Currency Exchange**: $1 = R16.16 | €1 = R19.16

### Exclusions

- Backhaul Connectivity (SIM/Ethernet cost).
- Sensor Manufacturing Base Cost (Housing/Battery/PCB).

### Inclusions

- **Hardware**: Radio Modules & Gateways.
- **Software**: LoRaWAN Network Server (LNS) is included as a **monthly recurring cost**.

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## 3. Cost Parameters

| Component | Standard LoRaWAN | Mesh | Notes |
|---|---|---|---|
| Radio Module (CAPEX) | R120.00 | R422.00 (€22) | Mesh module is ~R300 more expensive per unit. |
| Gateway (CAPEX) | R2,297.00 | R950.00 | LoRaWAN Gateway is ~R1,350 more expensive. |
| LNS Fee (OPEX) | | R0.00 | Based on R 3716,80 ($230)/1000<br><br>devices/month. Mesh is zero-rated for local routing. |

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## 4. Total Cost of Ownership (TCO) & Projections

Since LoRaWAN has an ongoing cost, we must compare Total Cost over time (M months).

### Formula

LoRaWAN

Cost CAPEX = (Gateway Cost * Gateway Quantity) + (Radio Module Cost * Radio Module) +

Cost OPEX = LNS/1000* Node Quantity

Mesh

Cost CAPEX = (Gateway Cost * Gateway Quantity) + (Radio Module Cost * Radio Module)

### Scenario A: Large Scale (1000 Sensors, 5 Gateways)

*Context: A large commercial deployment.*

- **LoRaWAN CAPEX**: (R2,297.00 * 5) + (R120.00 * 1000) = R11485.00 + R120,00.00 = R 131,485.00
- **Mesh CAPEX**: (R950.00 * 5) + (R422.00 * 1000) = R4,750.00+R422,00.00 = R 426,750.00
- **Initial Diff**: LoRaWAN is **R295,265 cheaper** upfront.
- **LoRaWAN OPEX**: 1000 * R3.76188 = R3716,80
- **Break Even Time**: R295,265.00 / R3716.80 ~ 79 months

**Result**: LoRaWAN is cheaper for the first **6.6 Years**. After 6.7 years, the cumulative monthly fees exceed the one-time savings on modules.

### Scenario B: Medium Scale (100 Sensors, 2 Gateway)

*Context: A typical smart-farm.*

- **LoRaWAN CAPEX**: (R2,297.00 * 2) + (100 * R120.00) = R4,594.00 + R12,000.00 = R16,594.00
- **Mesh CAPEX:** (R950.00 *2) + ( R422*100 )= R1,900.00 + R 42,200.00 = R 44,100.00
- **Initial Diff:** LoRaWAN is R27,506.00 cheaper.
- **LoRaWAN OPEX**: R3.7168 *100 = R 371.68
- **Break Even Time**: R25,606.00 / R 3771.68 ~ 74 months

**Result**: Consistent with the large sale; LoRaWAN wins for any project shorter than ~6.16 years.

### Scenario C: Small & Complex (10 Sensors, 5 Gateways)

*Context: A confusing layout (tunnels/basements/ hills) requiring many gateways for few devices.*

- **LoRaWAN CAPEX**: (R2,276.00 * 5) + (R 120.00 *10) = R 11,380.00 + R 1,00.00 = R 12,580
- **Mesh CAPEX**: ( R 950.00 * 5 ) + ( R 422.00 * 10) = R 4,750.00 + R 4,220.00 = R 8,970.00
- **Initial Diff**: **Mesh is R3,610.00 cheaper** upfront.
- **LoRaWAN OPEX**: R45.30 / month.
- **Result**: Mesh starts cheaper and **stays cheaper forever**. LoRaWAN never catches up because it has higher CAPEX *and* higher OPEX in this scenario.

### Exact Break-Even Point (5 Gateways, 60 Months)

- To find the exact number of nodes N where LoRaWAN and Mesh costs are equal over a 5-year (60 month) period with 5 Gateways:

**The Variables**

- **Gateway Cost Diff:** 5 *(R2,297 - R950) = R6,735 (Infrastructure debt of LoRaWAN)
- **Module Cost Diff:** R422 - R120 = R302 (Upfront unit saving of LoRaWAN)
- **Operational Cost (60 mo):** R3.7167 * 60 = R223.00 (Recurring cost per LoRaWAN node)
- **Net Unit Saving (60 mo):** R302 - R223.00 = R79.00

**The Calculation:**

- N = R6,735/R79.00 = 85.25

- **Conclusion:** For 5 gateways over 5 years, the break-even point is exactly 85 sensors.
- **Below 85 sensors:** Mesh is cheaper due to avoiding R6,735 in gateway costs.
- **Above 85 sensors:** LoRaWAN is cheaper as the R302 unit saving eventually offsets the infrastructure and LNS costs.

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## 5. Conclusion

The updated LNS fee of **R3.7167 per device/month** further solidifies LoRaWAN's position as the most cost-effective solution for scaled deployments.

1. **For Standard Deployments (>50 sensors)**: **LoRaWAN is the winner.**

* The significant CAPEX savings on radio modules (**R120 vs R422**) create a massive financial cushion.

* LoRaWAN remains cheaper for a minimum of **6 to 6.6 years** (74-79 months) depending on scale. This duration likely exceeds the operational battery life of the sensors themselves.

* *Recommendation*: For any commercial or agricultural project where sensor volume is the primary driver, LoRaWAN offers the lowest Total Cost of Ownership (TCO) over the device lifecycle.

2. **For Complex/Niche Deployments (<20 sensors)**: **Mesh is the winner.**

* In environments requiring many gateways for few devices (e.g., mine shafts, extremely hilly terrain), Mesh's lower gateway cost (**R950 vs R2297**) and zero monthly fees make it the superior choice.

* Mesh starts cheaper and stays cheaper because the infrastructure savings are never eroded by recurring fees.

### Final Recommendation

**Standardize on LoRaWAN** for general-purpose IoT sensor networks. The "break-even" point has moved out to over 6 years, making the initial investment in higher-cost gateways more than justified by the long-term module savings. Use Mesh only as a tactical solution for extreme coverage gaps that cannot be economically reached via LoRaWAN.