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System architecture and deployment to enable volume module sales for IOT

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Attributes of Existing Volume Modules

- **Deployed infrastructure**
  - Connect end-node to existing infrastructure

- **Well defined system and protocol**
  - Too many options keep cost high, volume low

- **Serve a variety of applications and services**
  - Industrial control
  - Building automation
  - Consumer
  - Asset tracking/localization

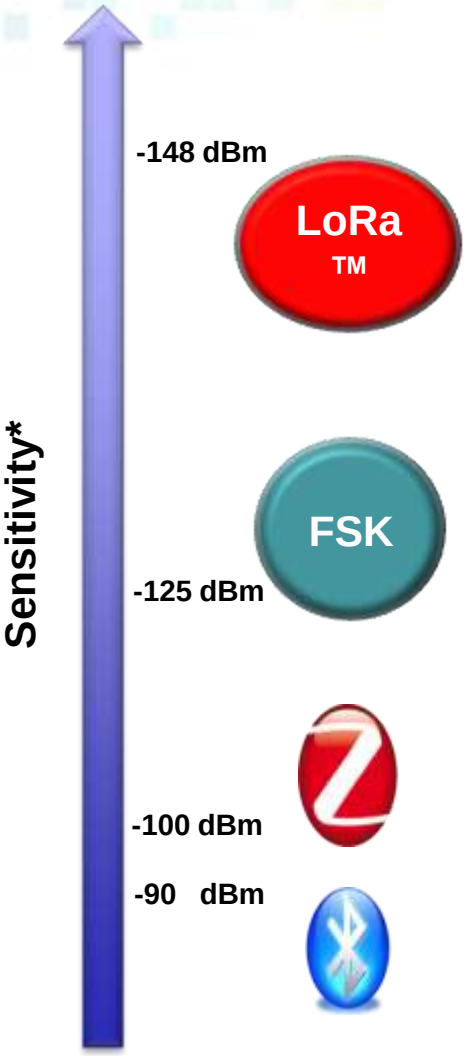
- **WiFi, Bluetooth, and GSM will not be choice for IOT**
  - Technologies not right for range, battery lifetime, and cost

Desired Attributes of an IOT Network

Key Features	Attribute/Benefit
150dB link budget	Long range 
10km range	
Minimal infrastructure	Ease of deployment 
Concentrator/gateway with capacity	
>10yrs battery lifetime	Long battery life 
RX < 10mA, sleep <500nA	
Unlicensed spectrum	Low cost 
Low infrastructure cost	
Low end-node cost	

- ❑ **Ideally same link budget as GSM**
  - Leverage existing elevated base station locations
- ❑ **Localization feature would drive new volume applications**

Semtech LoRa Technology



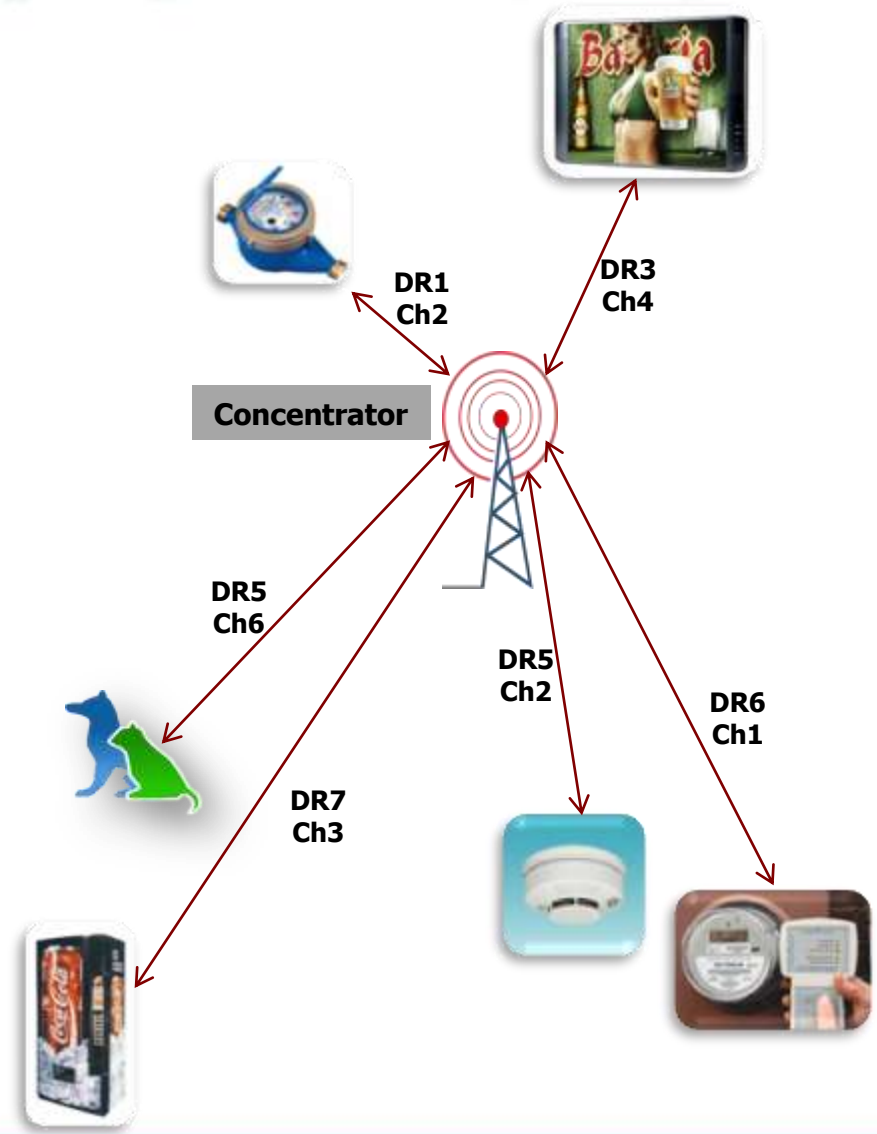
- **Long range and low power**
  At +14dbm output power:
  - In Sub-GHz: >10km range
  - 10mA RX current
- **Robust communication**
  - Not susceptible to interference from Wifi, Bluetooth, GSM, LTE, etc
- **High accuracy localization and ranging**
  - Modulation format permits high accuracy localization
  - Not RSSI based and accounts for multi-path and fading
  - Permits high value additional features
- **Improved network capacity**
  - Connect more nodes
  - Additional capacity for features

Application End-Node: SX127x Family

- Best in class RF with LoRa benefits
- All support 802.15.4g, WMBus & LoRa™

Key Features	Customer Benefit
>160dB link budget	**Longest range**
+20 dBm TX power	
Exceptional IIP3	**Robust links**
30dB more immunity to LTE than FSK	
Tolerant to in-channel burst interference	
Lowest RX current – 10 mA	**Extended battery li**
Low sleep current	
Ultrafast wake-up (sleep to RX/TX)	

Ideal Technology for M2M/IOT

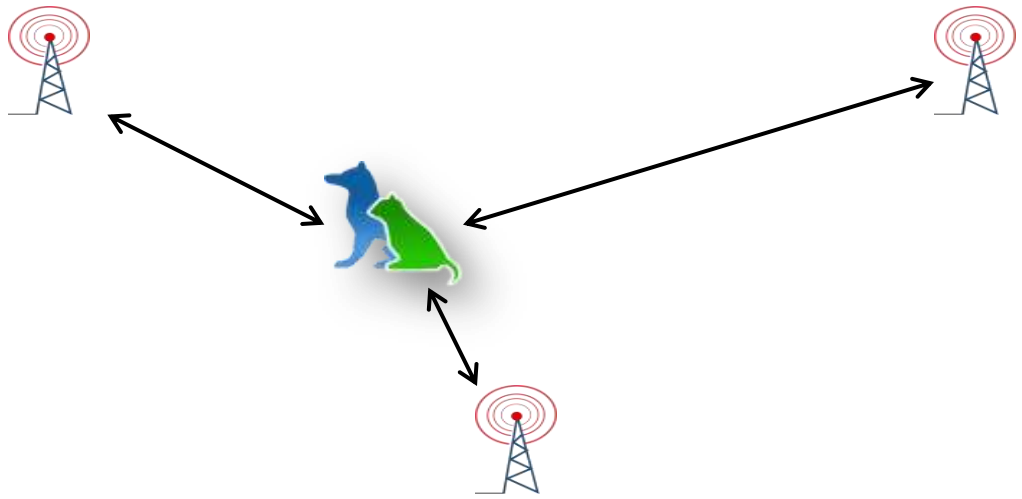


LoRa Concentrator

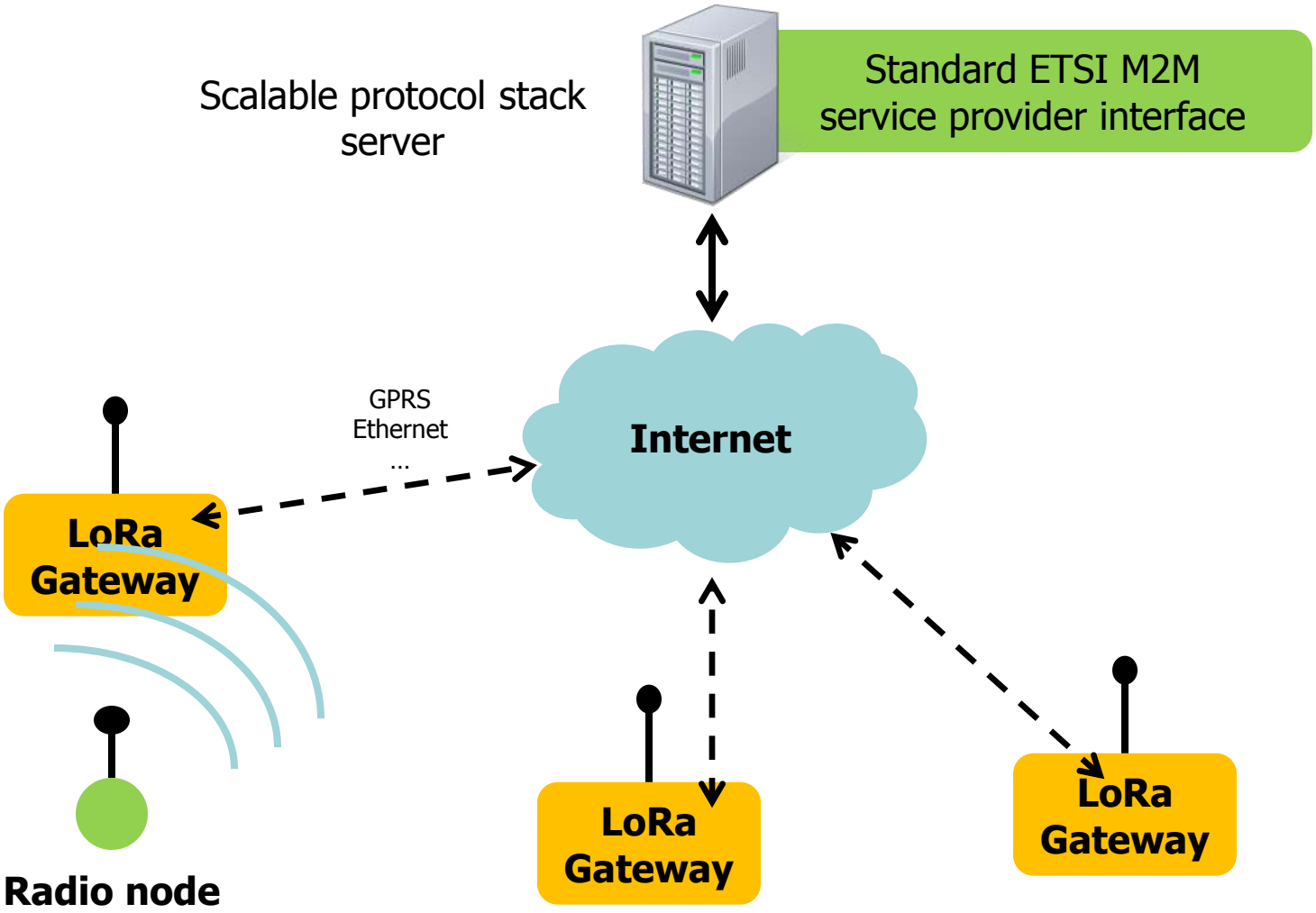
- **Multi-modem/channel concentrator**
  - Improved network capacity
    - Simultaneous reception on same channel
    - Easily scalable to add more capacity
  - Simple star network – no latency
  - Adaptive link rate
  - Connect 5-10 nodes per person
- **Localization**
  - The feature everyone wants
- **Solves all system desires**
  - Range, battery lifetime, capacity, cost
- **Better link budget than GSM**
  - Leverage existing base station locations
  - Optimal for fast deployment

LoRa Ranging & Localization

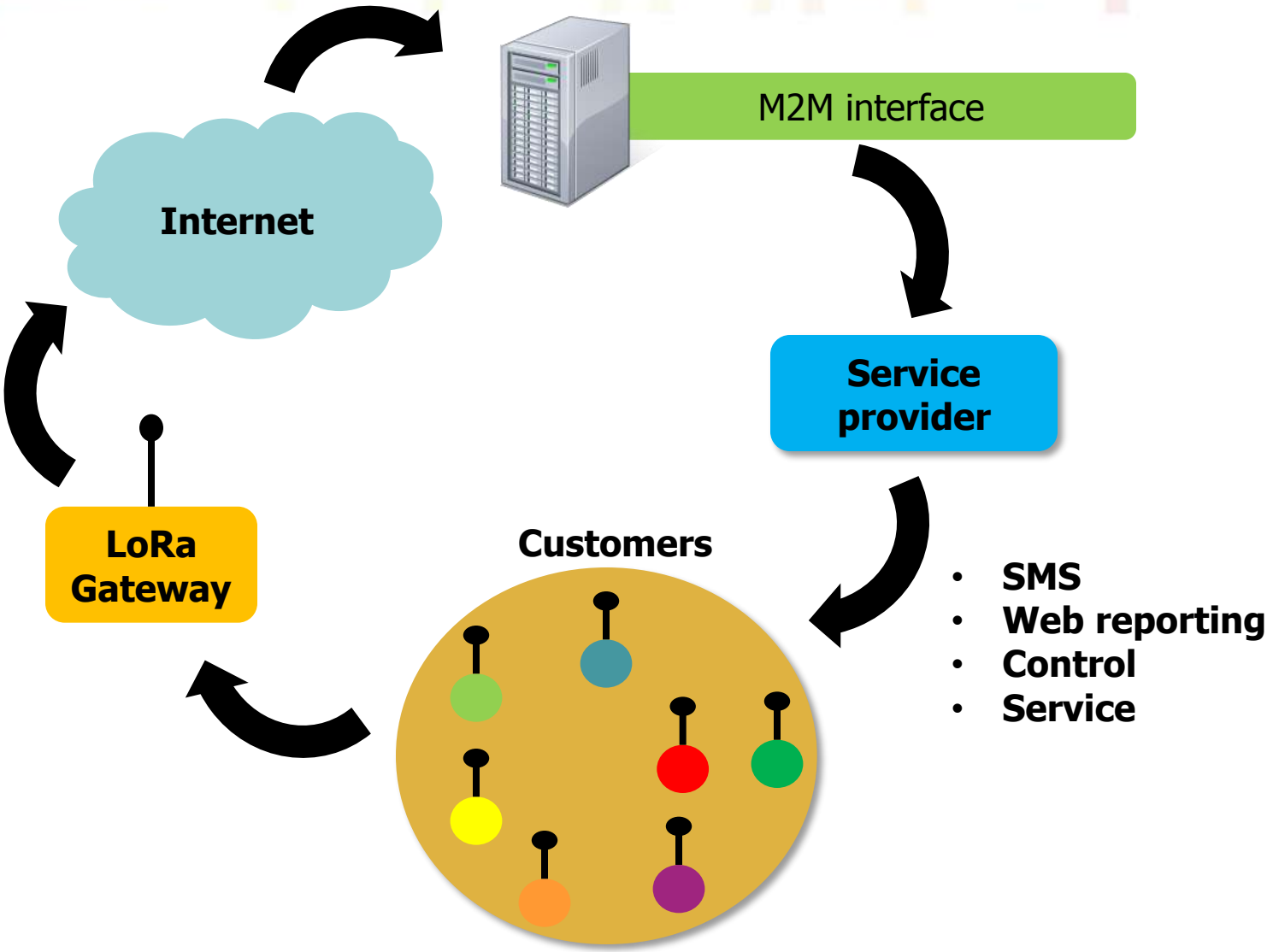
- Offers ability to locate long range sensors with extreme accuracy – within 7M up to 10kM



Network Architecture



Complete Ecosystem

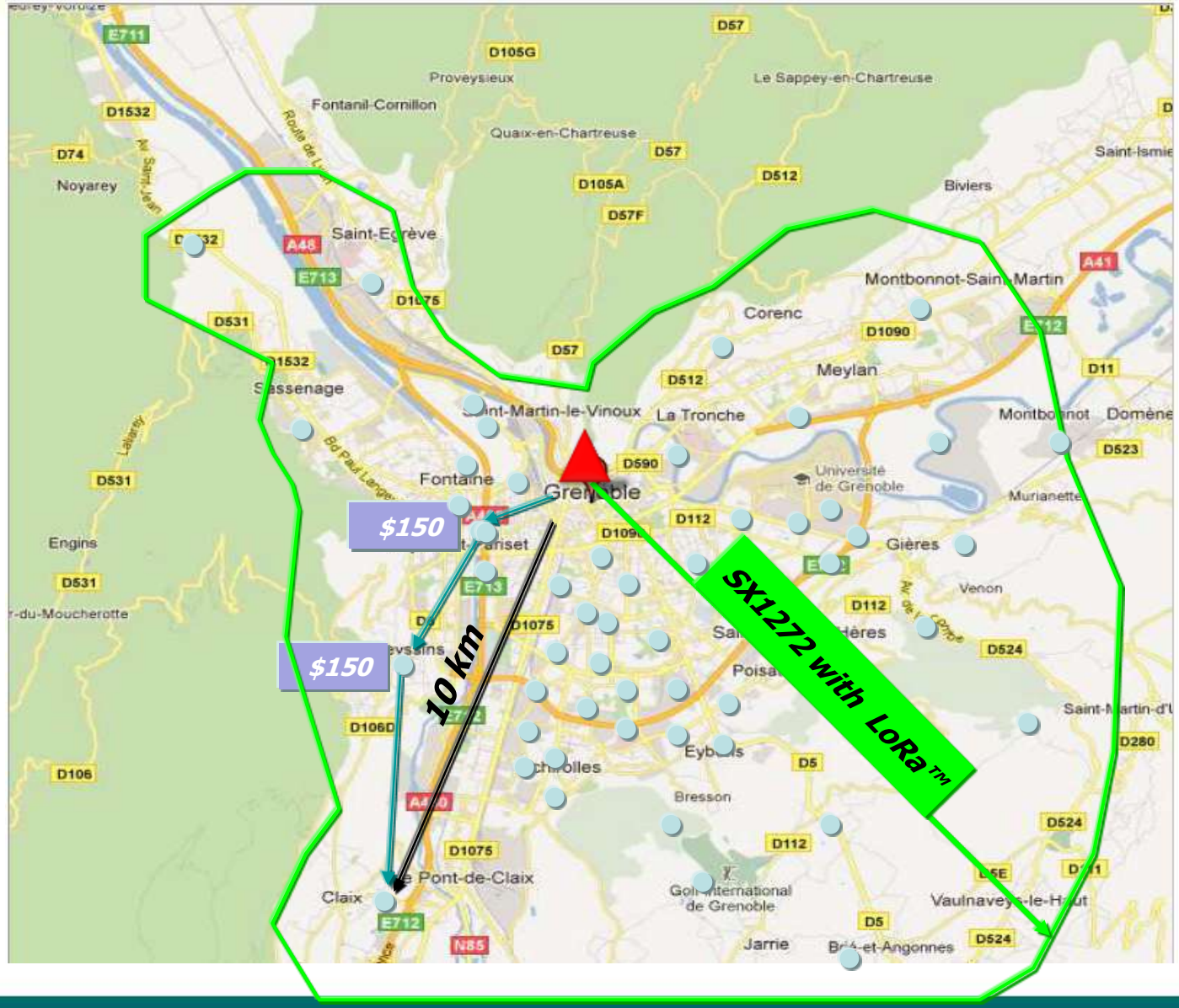


Initial Deployments

FSK Repeater

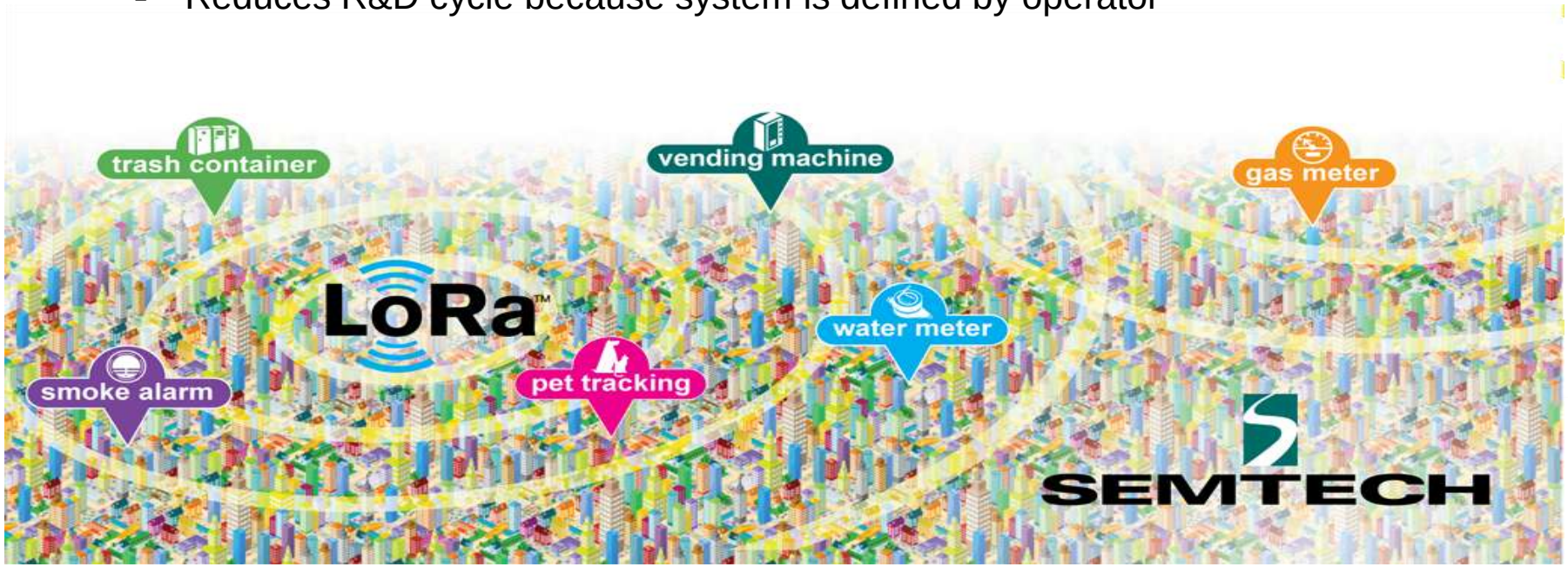
$150 per node

SX1272
10dB TX
(WITHOUT REPEATER)



Summary

- **LoRa + concentrator is the ideal technology to enable IOT**
  - Localization highly valued feature to sell more end nodes
  - Same link budget as GSM, speeds and eases deployment
  - Only solution two-way solution to provide range and network capacity
  - Low power to support battery operated end-points
- **Low cost infrastructure and end-nodes to drive volume**
- **Deployed network by Telecom fixes system/protocol**
  - Enables volume module opportunities
  - Reduces R&D cycle because system is defined by operator



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