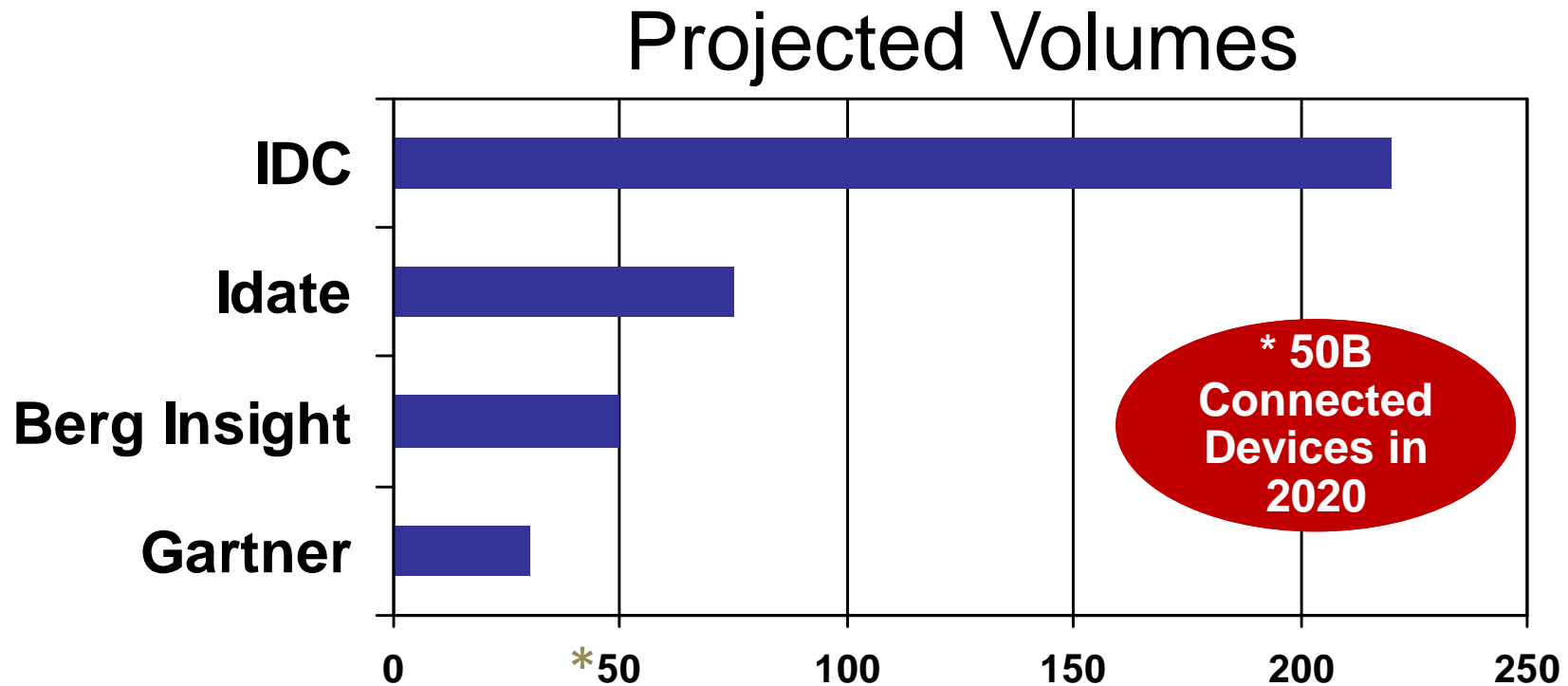




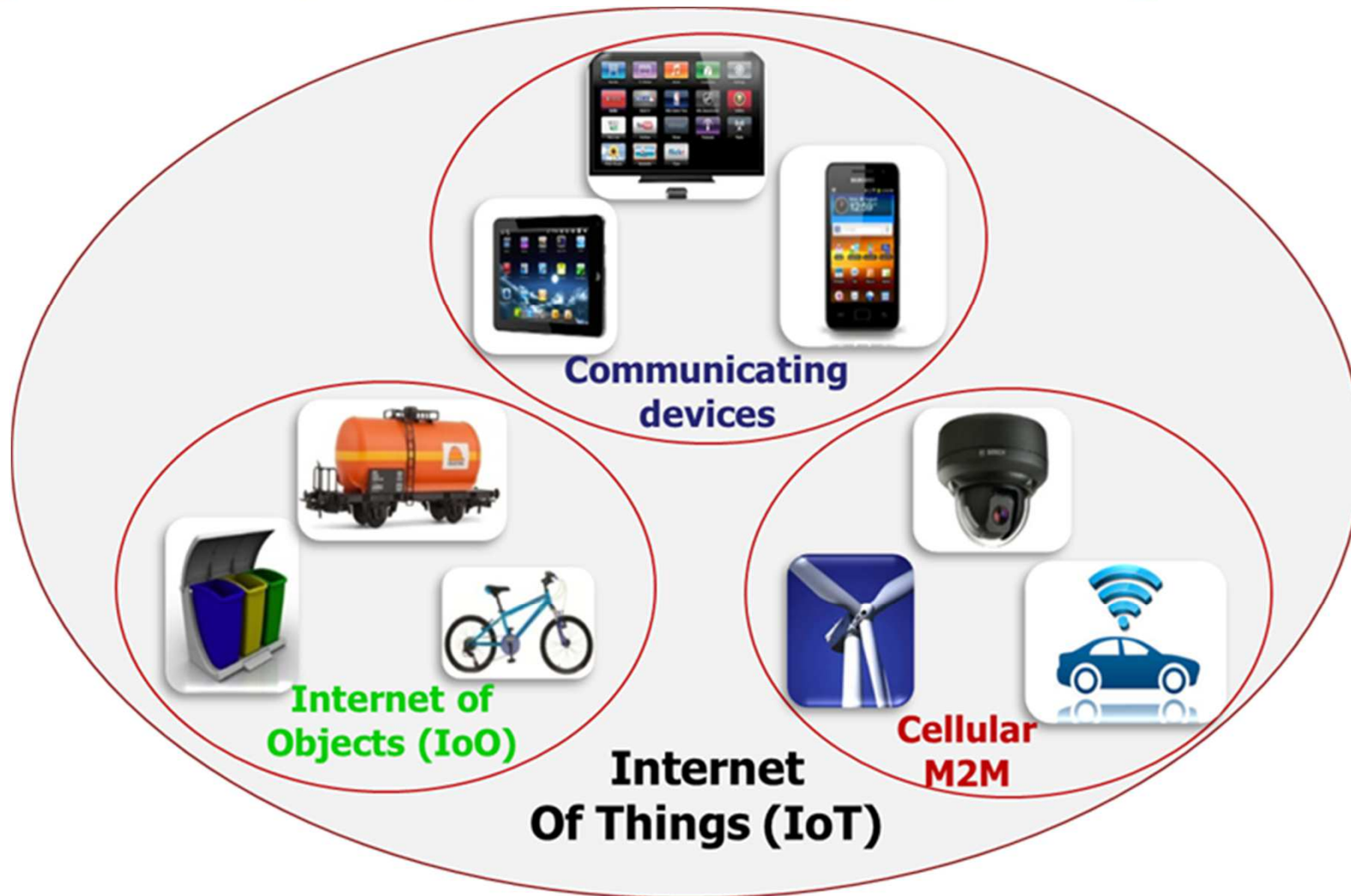
# Lora Network System Overview

# Connected Devices: Market



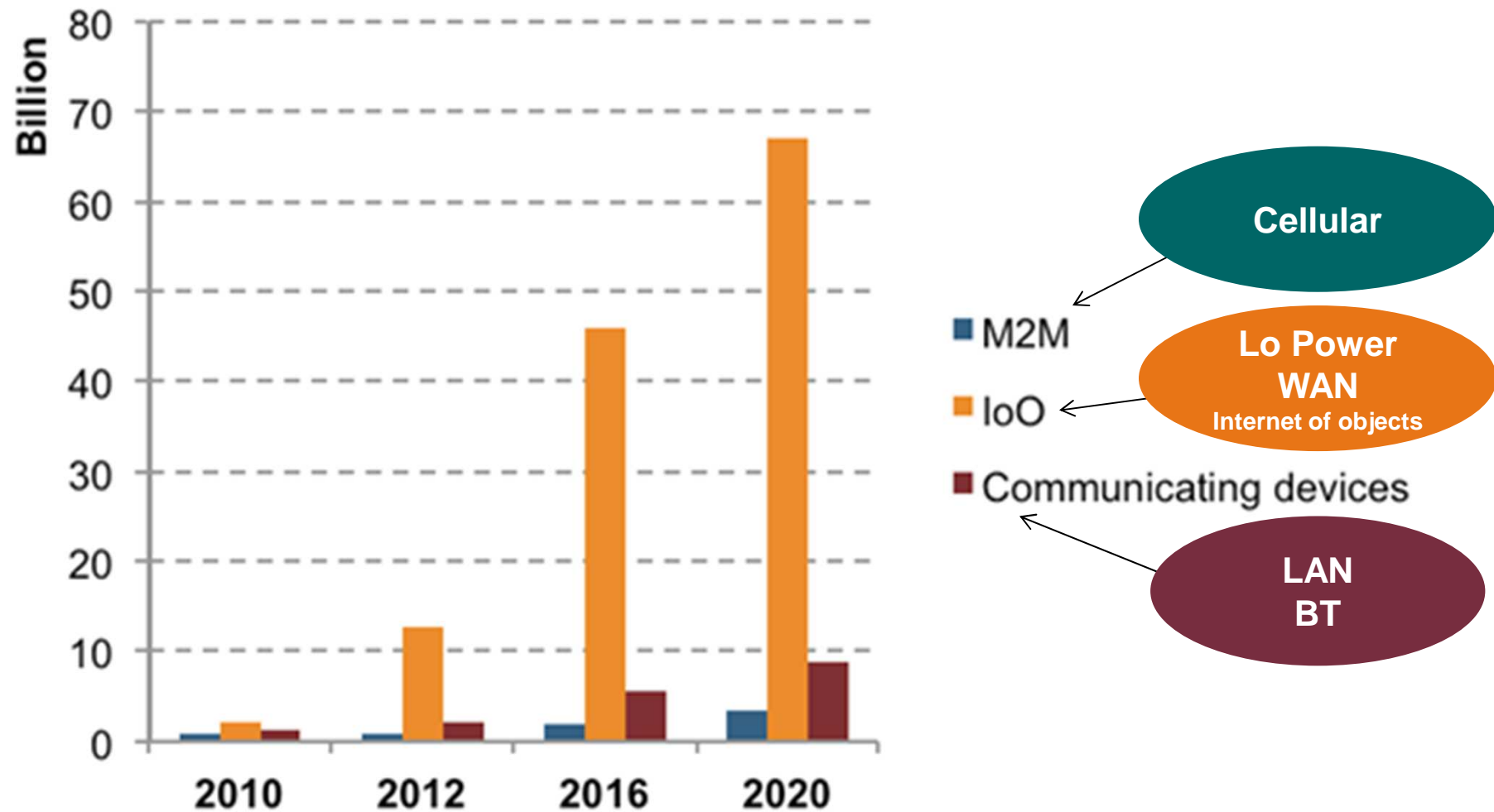
Connected Devices by 2020 (billions)

# IoT Segments



# Connected Devices: Market

## Projected by Type



# Connectivity is a Challenge

## Internet of Objects 80% of volume



## Requirements:

- How to connect battery operated low cost assets?
- Outdoor & harsh environments
- Low cost communication
- Low cost infrastructure
- Low power technology
- Robust communication
- Permits mobility
- Scalable system



# Connected Devices: Access

## LAN



Short Range  
Communicating Devices



35% SOM

- ✓ **Well established standards**
- ✓ **Good for:**
  - Mobile devices
  - In-home
  - Short range
- ❑ **Not good:**
  - Battery life
  - Long range

## Lo Power WAN



Long Range w/ Battery  
Internet of Objects



55% SOM

- ✓ **Emerging PHY solutions / Undecided**
- ✓ **Good for:**
  - Long range
  - Long battery
  - Low cost
- ❑ **Not good:**
  - High data-rate

## Cellular



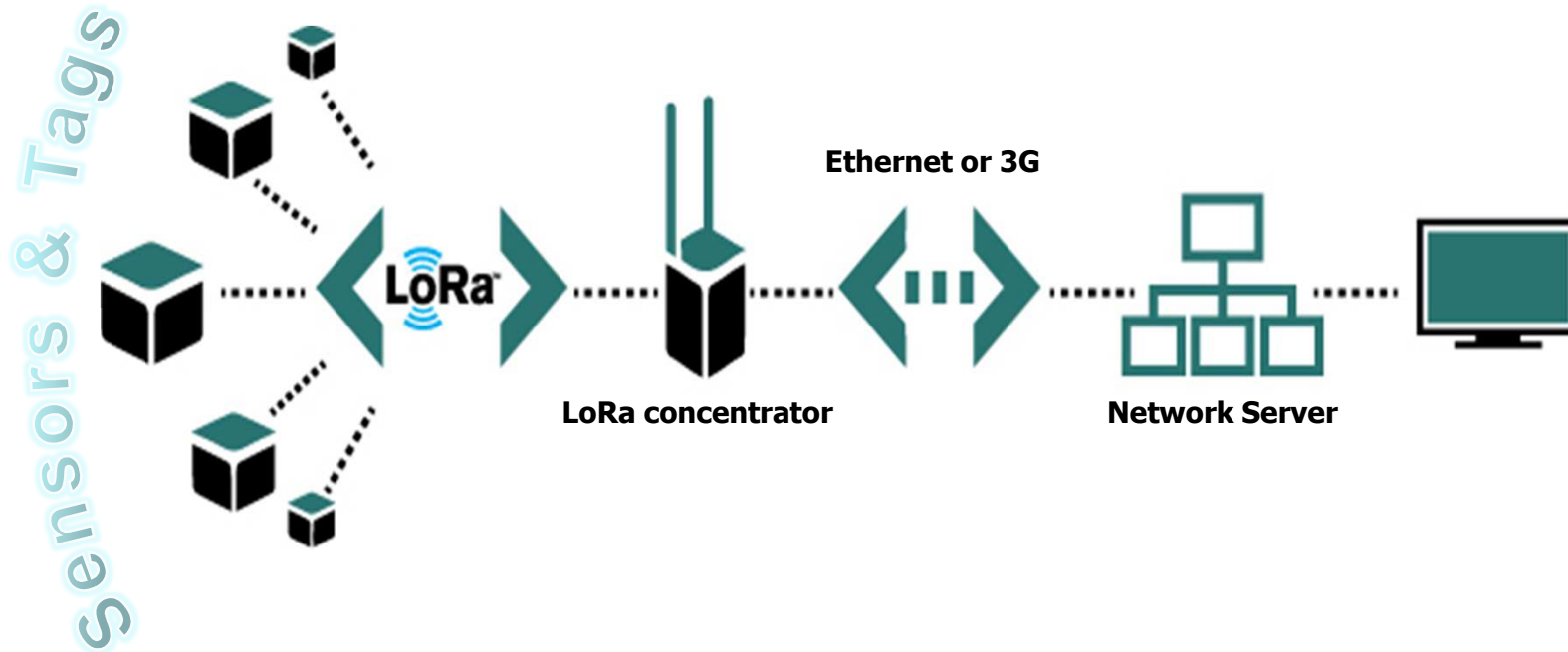
Long Range w/Power  
Traditional M2M



10% SOM

- ✓ **Well established standards**
- ✓ **Good for:**
  - Long range
  - High data-rate
  - Coverage
- ❑ **Not good:**
  - Battery life
  - Cost

# Network Architecture



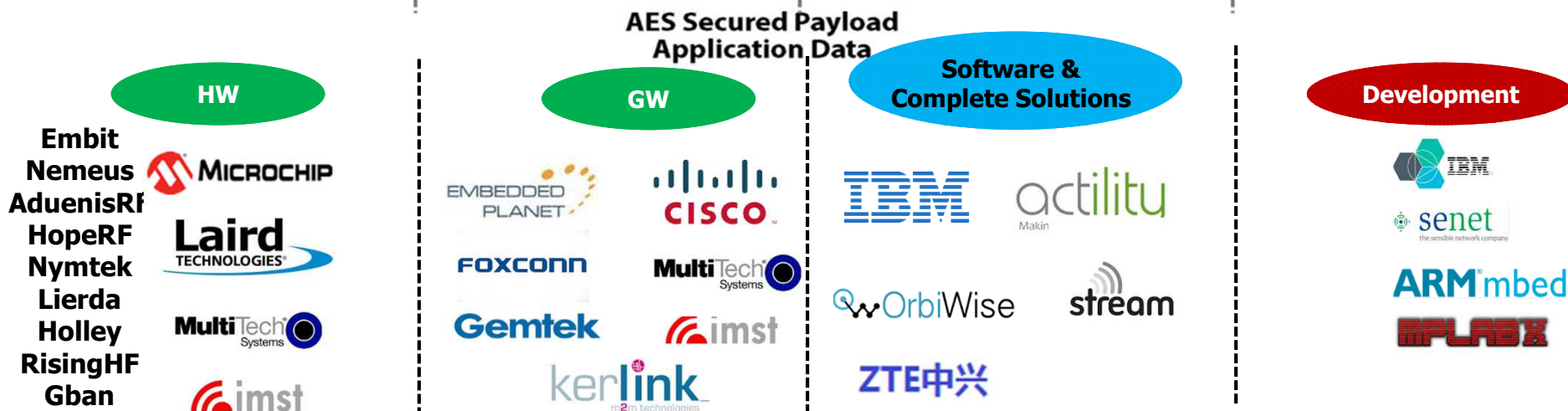
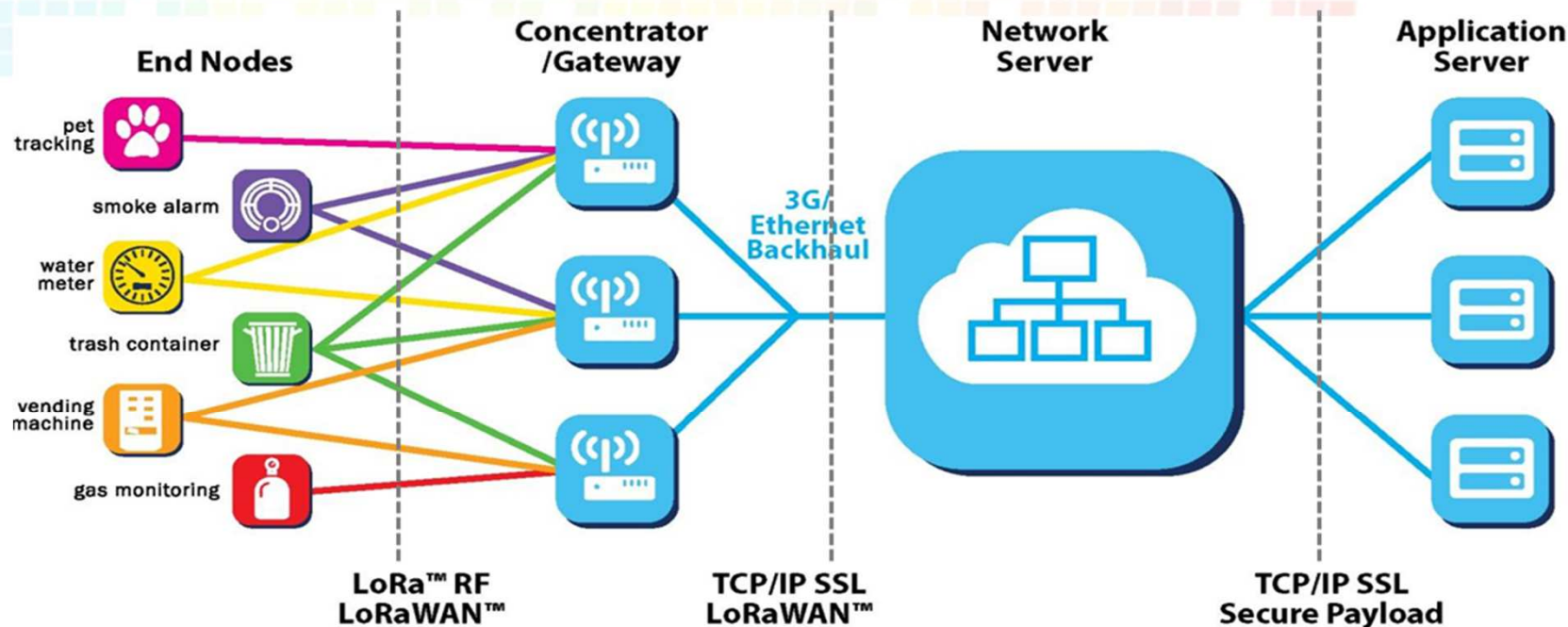
**Unique ID**  
**Encryption**  
**2 way**  
**Low Cost Low**  
**Power**

**Star network**  
**Packet Forwarder**  
**Full IPV6**  
**Low Filtering**

**Protocol**  
**Commissioning**  
**Provisioning**  
**Network Security**  
**Data Integrity**

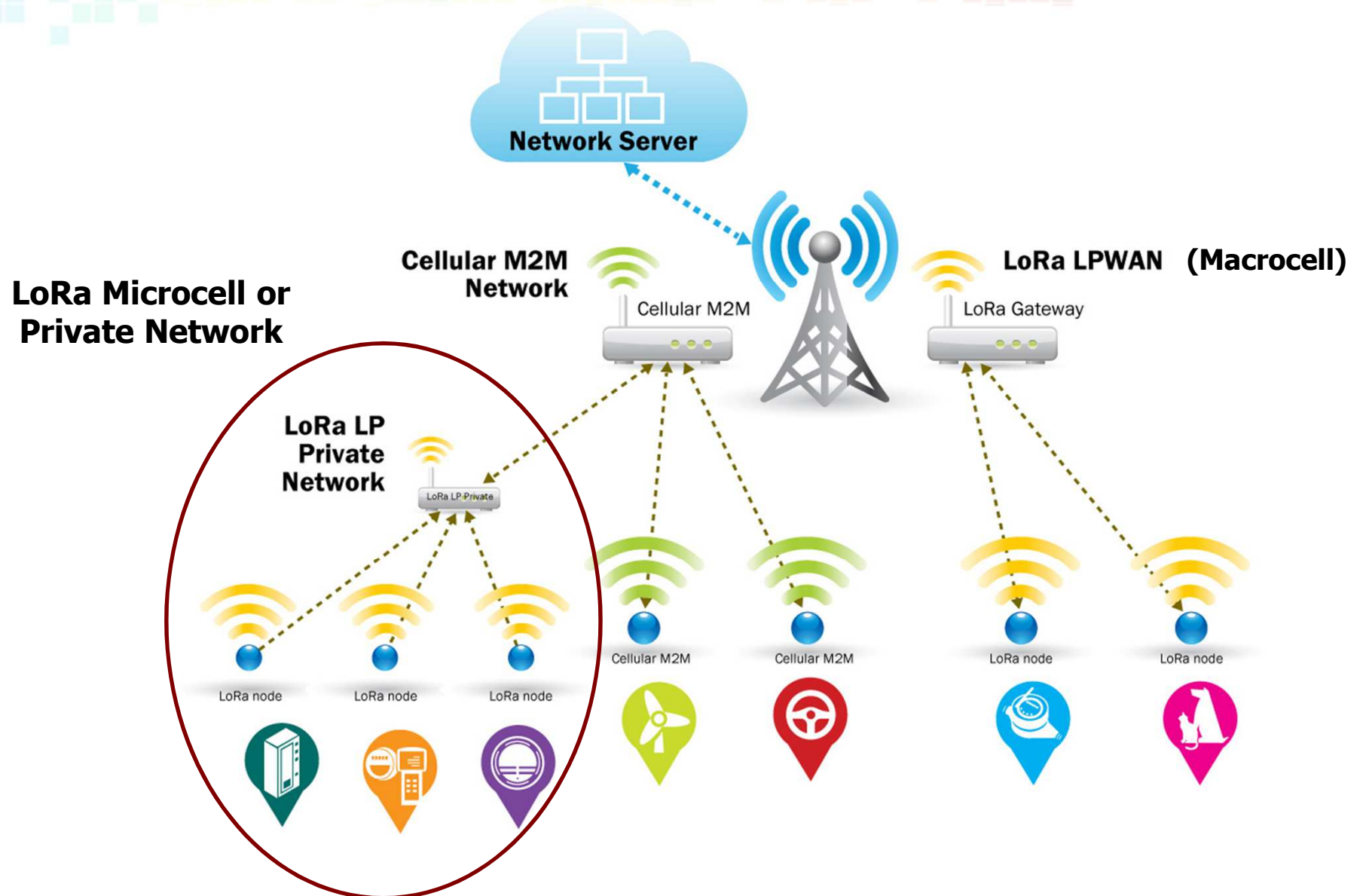
**Private Security**  
**Data Analytics**

# Strong Ecosystem Enables Customized Deployment





# Network Options



# AN OPERATED NATIONAL NETWORK TO COLLECT DATA FROM MILLIONS OF DEVICES



## Applications are many:

- Metering
- Tele- management
- Maintenance / Supervision
- Alerting
- Identification / géolocalisation
- Back up for GSM existing solutions

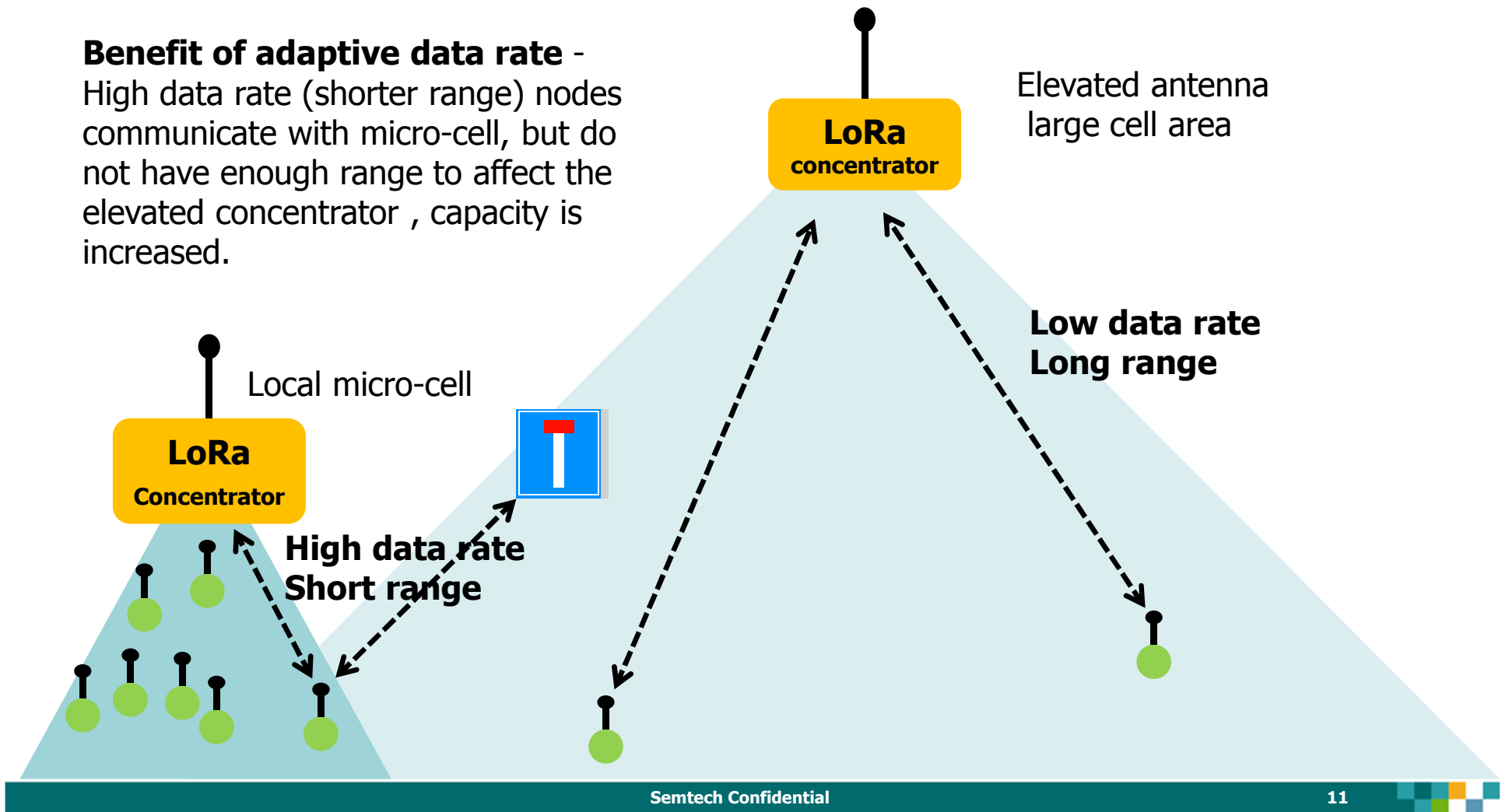
## Main asset of our solution:

**No Network Infrastructure to build  
or manage for the Customer**

# Network Capacity: Adaptive Data Rate

## Benefit of adaptive data rate -

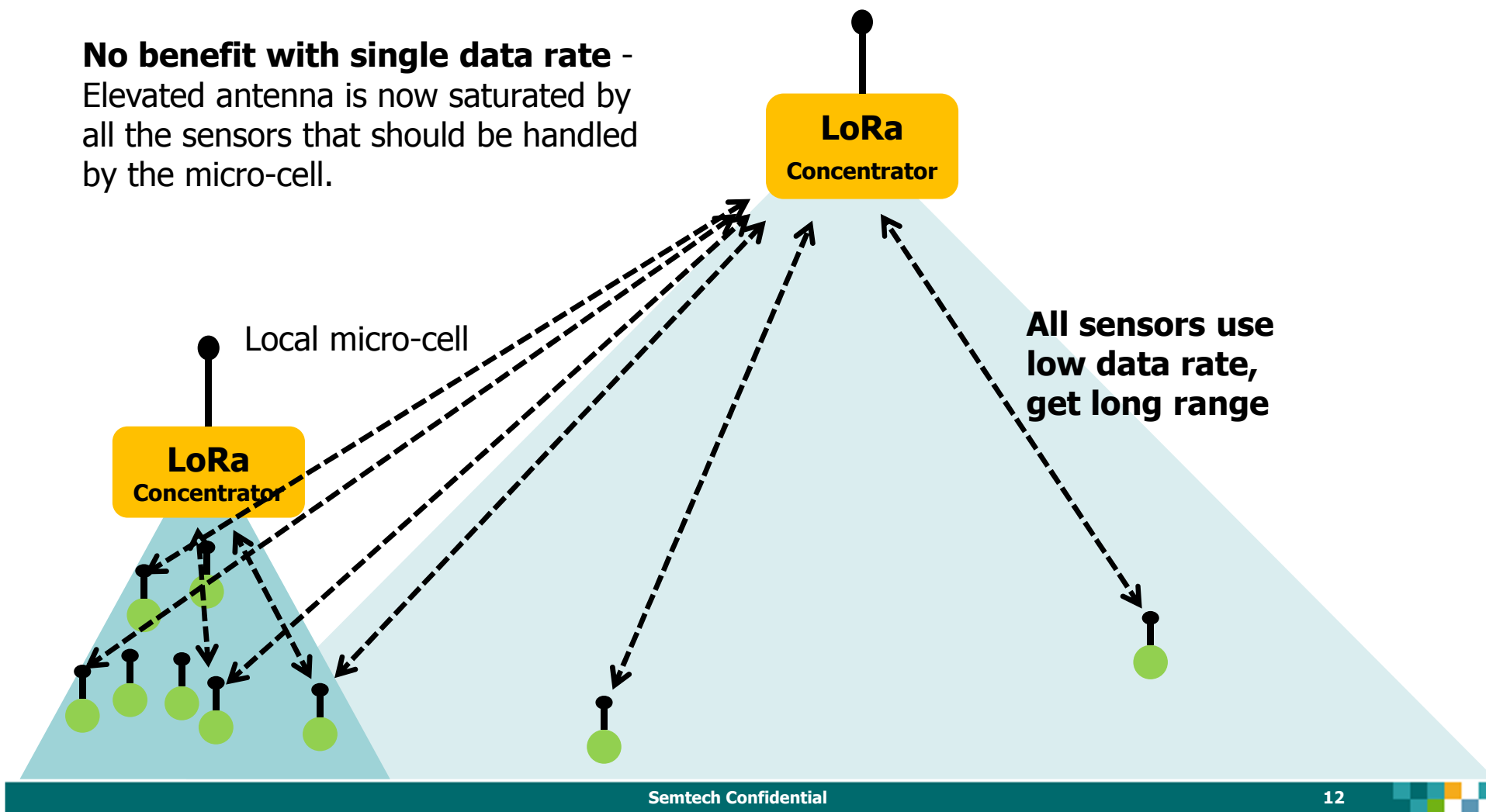
High data rate (shorter range) nodes communicate with micro-cell, but do not have enough range to affect the elevated concentrator, capacity is increased.



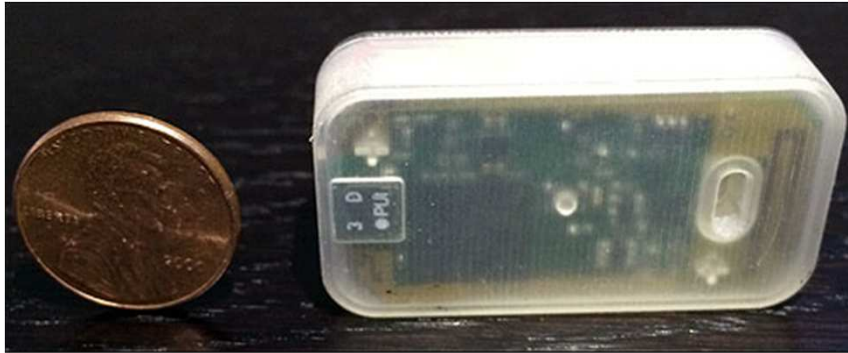
# Network Capacity: Single Data Rate

## No benefit with single data rate -

Elevated antenna is now saturated by all the sensors that should be handled by the micro-cell.



# LoRa End Node



- ❑ Partner module solution for NA
- ❑ TX = 1W, GPS+sensors, battery
- ❑ Fully Compliant with FCC



- ❑ Partner Module for EU
- ❑ ST Micro(STM32) + SX1272



**Abeeway – Asset tracking device**

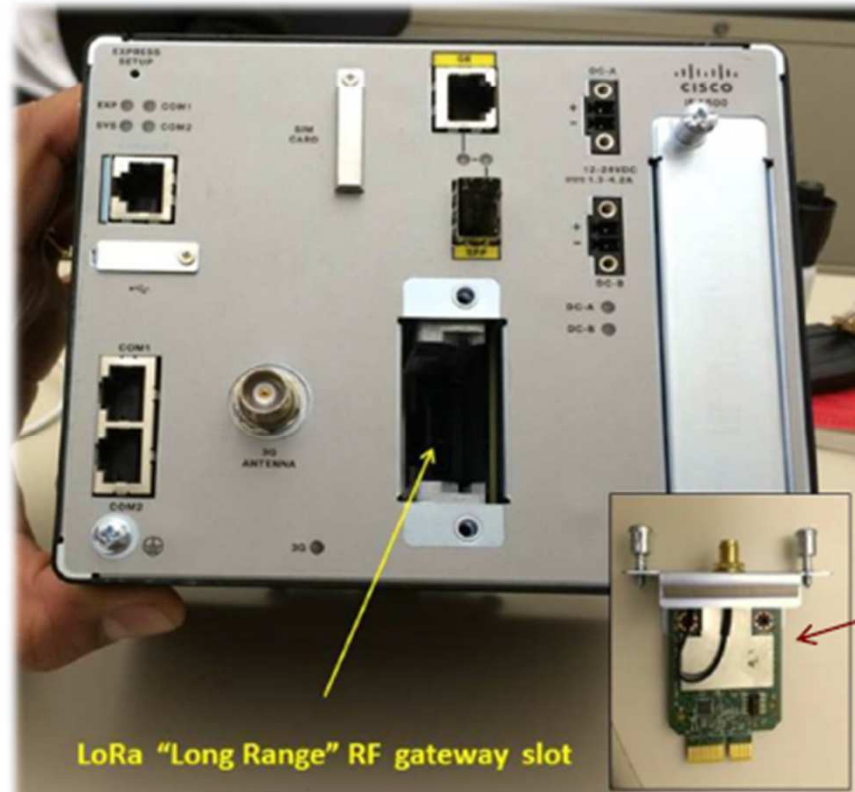


# RADIO ACCESS / Cisco Concentrator / Medium Capacity

Jun Wen  
Product Manager



Cisco IoT Systems Group  
Phone: +86-13910820902  
Mobile: 8610-85077084  
jwen2@cisco.com



LoRa Cards plug in for regions  
(EU/USA/China)

## IR 910

The Cisco 910 Industrial Router is a Cisco Internet of Things (IoT) gateway with a rugged design for Smart City applications - even those in harsh environments - using wireless sensor technology. With a modular slot design, it can adapt to a variety of wireless sensor technologies at regional RF bands and quickly go to market.

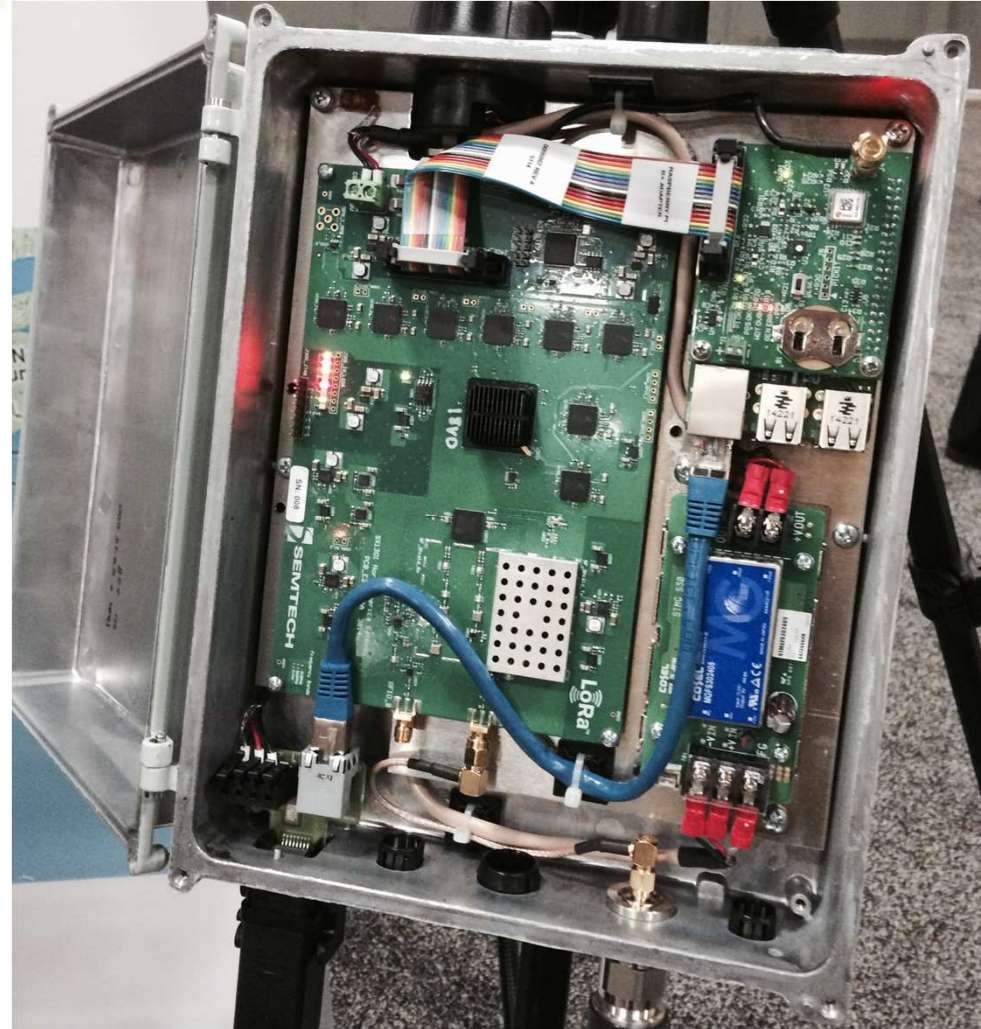
## Example Hardware



**Multitech – 8+1 channel concentrator**

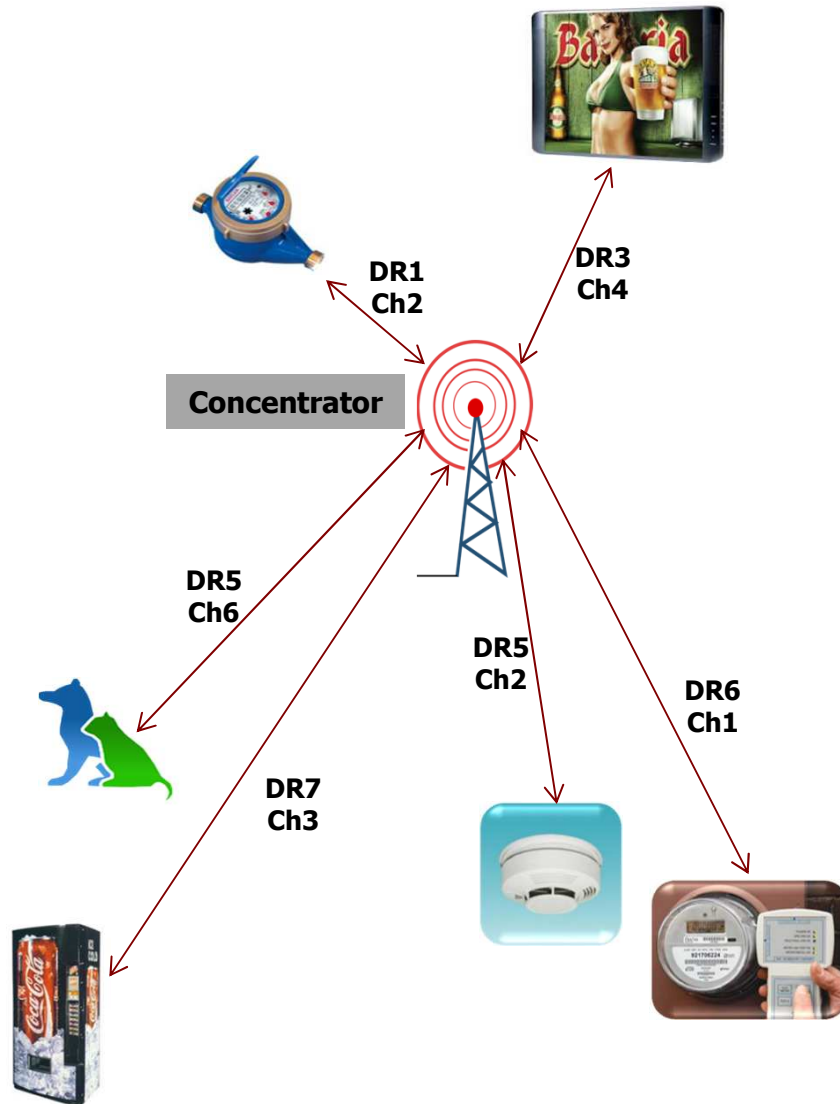


**Kerlink– 8+1channel concentrator**



**Senet - 64+8 channel tower top concentrator**

# LoRa Concentrator – SX1301



## Superior System

### ❑ Multi-modem/channel concentrator

- Improved network capacity
  - Simultaneous reception on same channel
  - Easily scalable to add more capacity
- Simultaneously demod - 2MHz spectrum
- Simple star network – no latency
- Adaptive link rate
- 5 million node transactions per SX1301
- Easily scalable for more capacity

### ❑ Localization

- The feature everyone wants

### ❑ Solves all system desires

- Range, battery lifetime, capacity, cost

### ❑ Reduces design cycle

- System HW and MAC provided



# SX1301 Overview

## ❑ Multi-Modem/Multi-channel

- 10 channels
- 9 LoRa modems
- 1 FSK modem

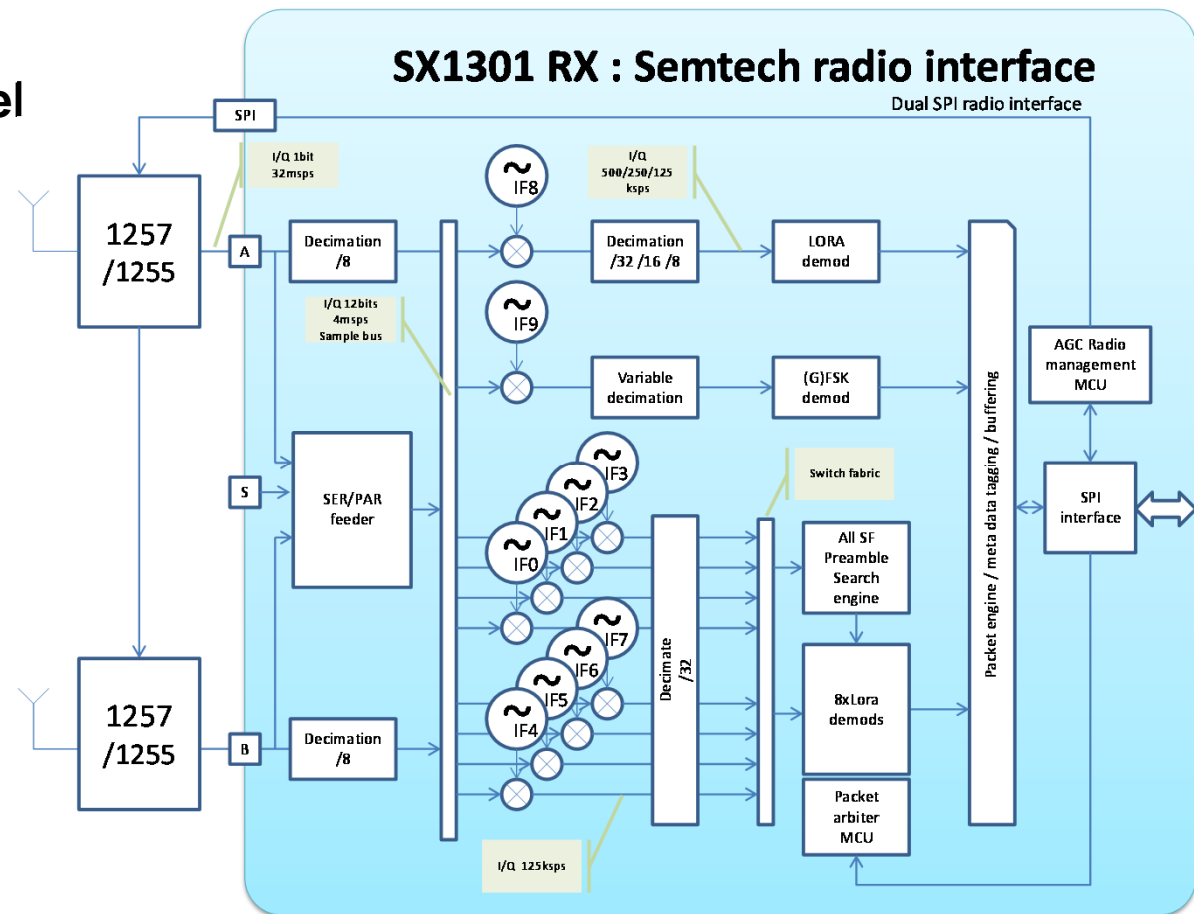
## ❑ Very high capacity

## ❑ Adaptive link rate

- Optimize capacity
- Scalable

## ❑ 2MHz of spectrum

- Wide FE can be used



# Semtech NA Concentrator



## ❑ FCC requirements

- Frequency hopping, 902-928MHz
- 400msec max channel dwell time
- 1W max output power

## ❑ Gateway

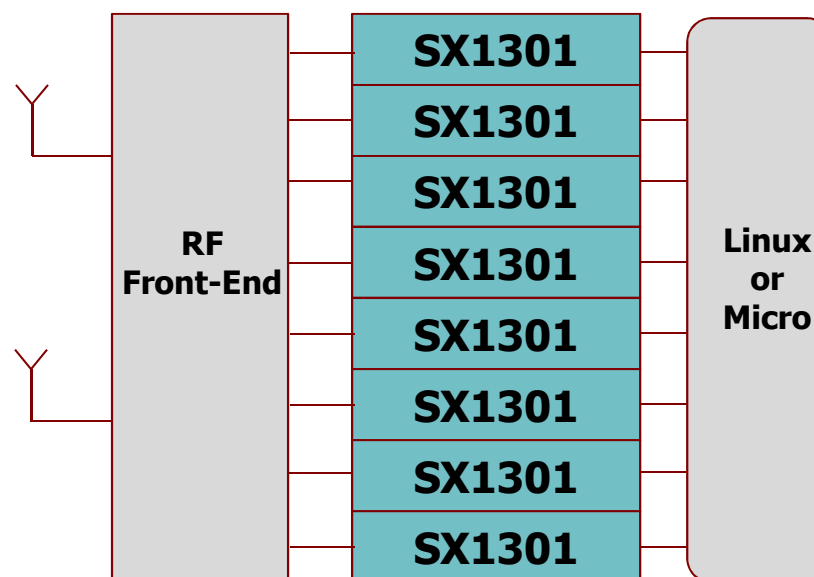
- Embedded Linux
- 8x SX1301

## ❑ PHY parameters

- Number of Channels: 64 Upstream, 2 down
- Number of Modems: 64 Rx Modems + 2 Tx
- Channel BW: 125 KHz Up and 500KHz Down
- RF Power: +20dBm up and +27dBm down (+36 with max antenna gain)
- Half Duplex (Possibility to split band and enable partial full duplex)
- Data rates up-link: 4 (SF7 – SF10)
- Data rates down-link: 4 Down (SF7 – SF10)

## ❑ Protocol parameters

- Asynchronous on all 64 channels



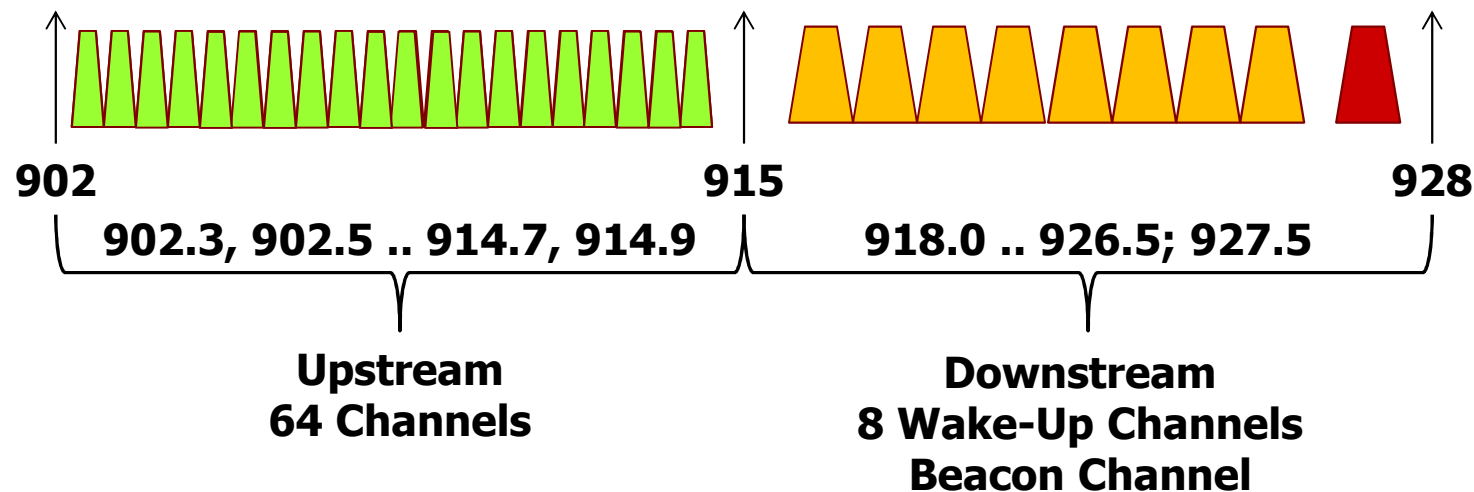


# LoRaMAC North America

□ Upstream – 64 parallel channels using 125 kHz BW, ADR

□ Downstream -

- Unicast on same channel as Upstream
- Beacon channel for network status and group ACK
- 8 Wake-Up channels using 500 kHz BW



# Concentrator Summary



	<b>EU</b>	<b>NA</b>	<b>China</b>
Number of SX1301	1	8	8
Channels Up	10	64	64
Channels Dn	1	2	2
RX modems	10	64	64
Channel BW Up	125kHz	125kHz	125kHz
Channel BW Dn	125kHz	500kHz	125kHz
TX Power Up	+14dBm	+20dBm(or +30)	+20dBm
TX Power Dn	+14dBm	+27dBm	+20dBm
SF Up	7-12	7-10	7-12
Link Budget Up	155dB	154dB	161dB
Link Budget Dn	155dB	157dB	161dB
Capacity	10-50K nodes	100-300K nodes	100-300K nodes

# LoRaWAN - Node



- ❑ **Light weight protocol for nodes and server**
- ❑ **Semtech provides an open source reference**
  - <https://github.com/Lora-net>
  - IBM provides a commercial implementation of the specification
- ❑ **Securely transfer data to the network**
  - Two layers of AES128 to provide secure network management and private data
- ❑ **Maximize battery life**
  - Simple Aloha style network
- ❑ **Provides for two basic classes**
  - Class A nodes are typically sensors.
    - Node Wakes up, sends data, sleeps for 1 second, and then wakes for any network traffic, goes back to sleep until next reporting cycle
  - Class C node
    - Node always in RX mode unless transmission
  - Class B nodes are typically actuators
    - Node wake up at scheduled times and the network uses this opportunity to initiate down stream traffic.
    - As a special case, some nodes may be listening at all times

# LoRaWAN – Server

## ❑ Provides a single network controller

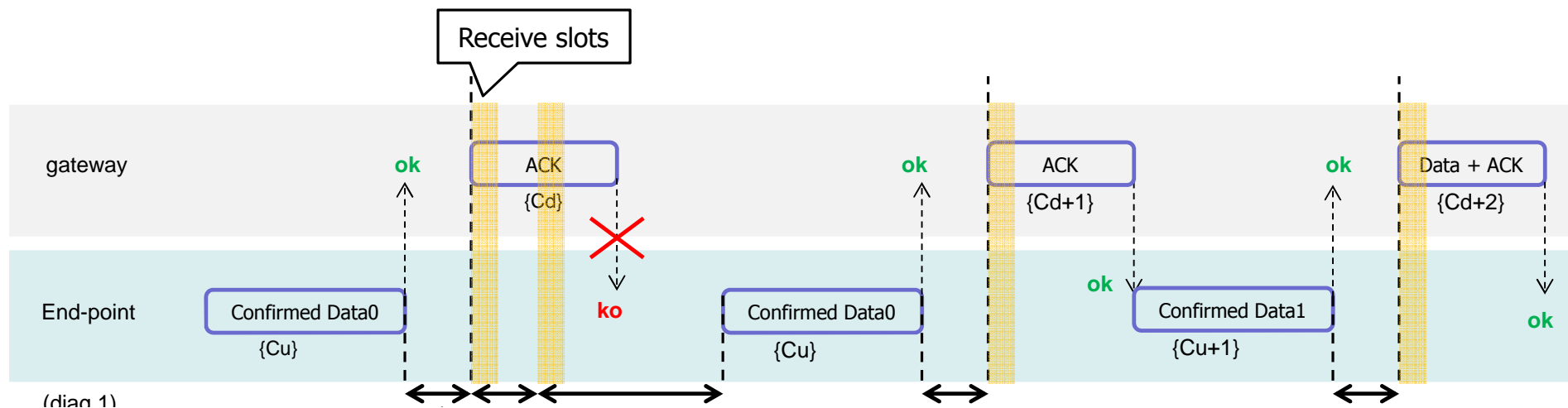
- Concentrators do not administer a subnet
- Concentrators forward packets to server after appending meta data.
- Server forwards data to other back-end servers and application servers

## ❑ Packets may be forwarded by several GW

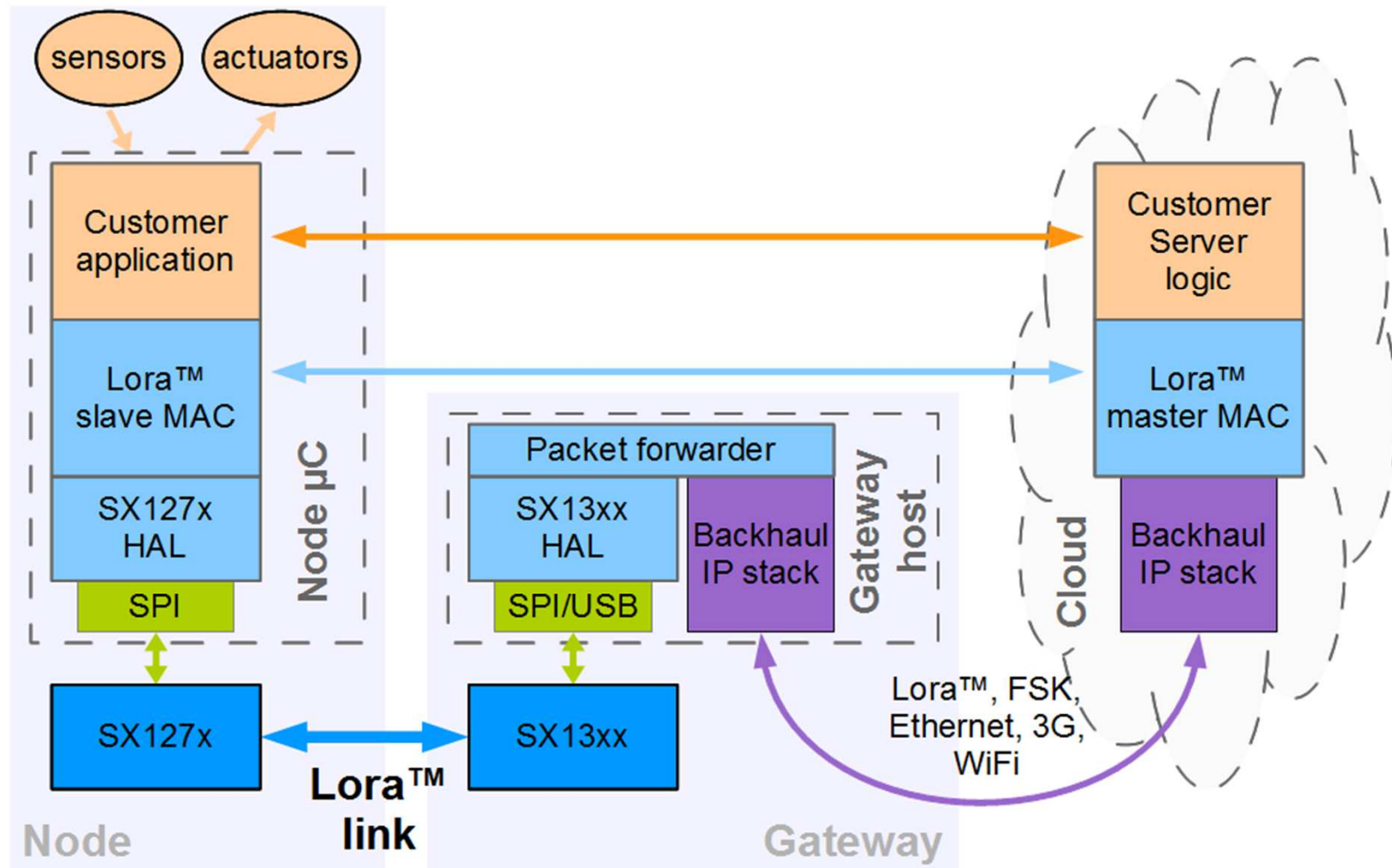
- Remove duplicates
- Select best down stream path based on meta data

## ❑ Schedule downstream traffic

- Concentrators have accurate timing in order to transmit messages when nodes are scheduled to be awake



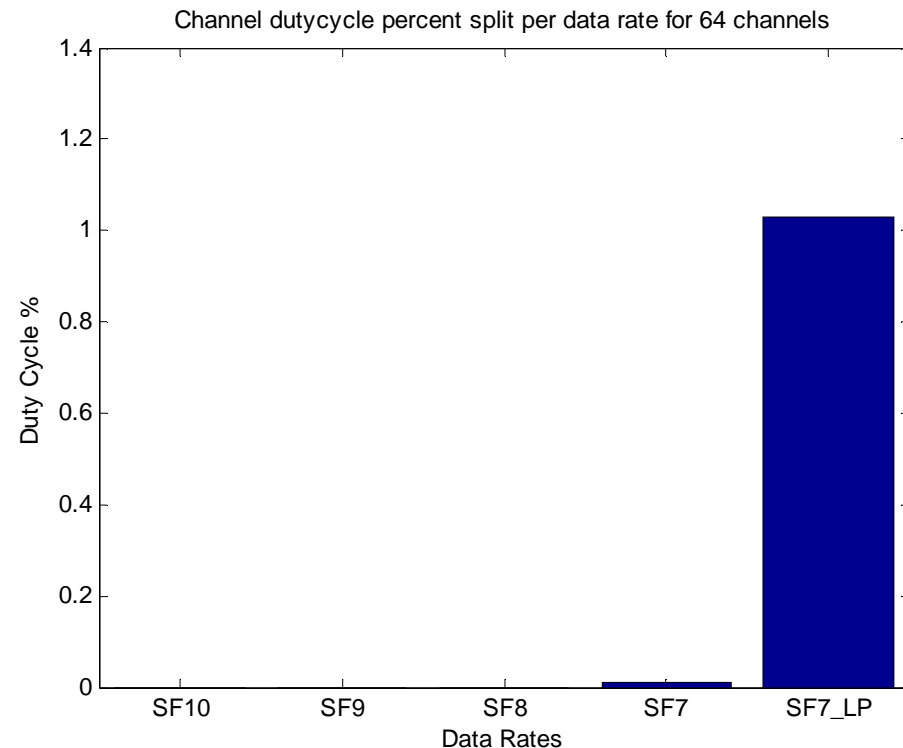
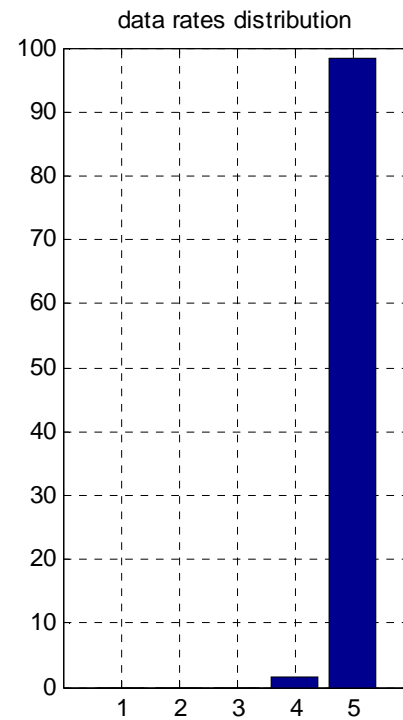
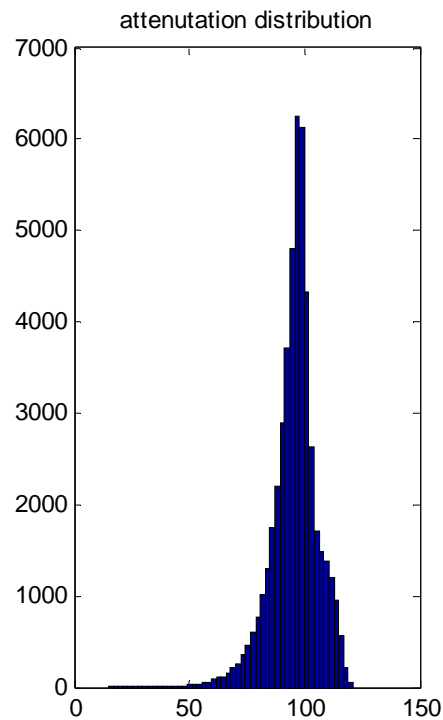
# Semtech Contribution





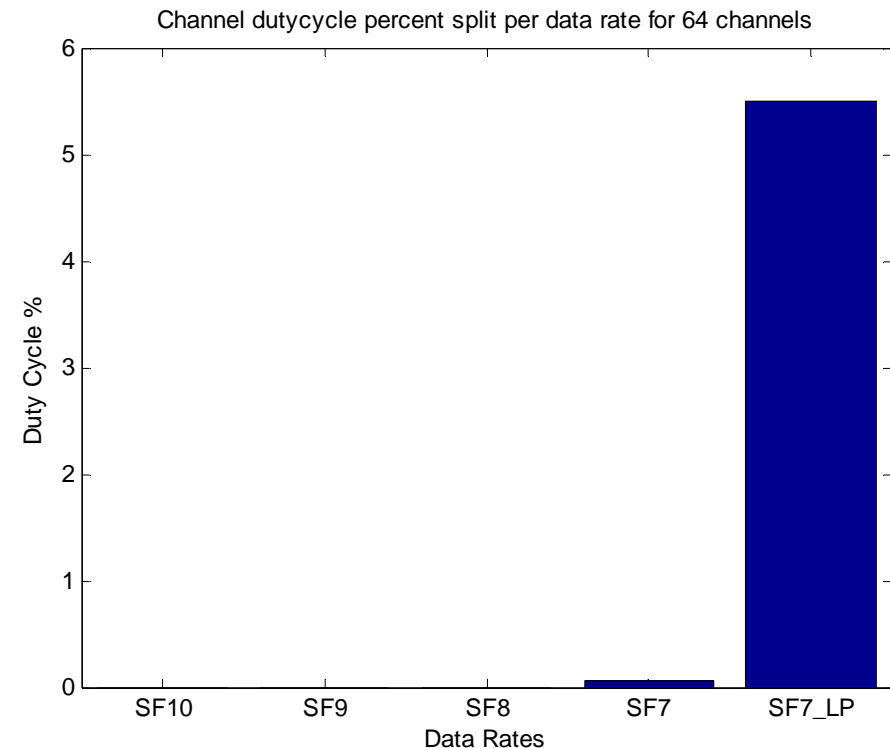
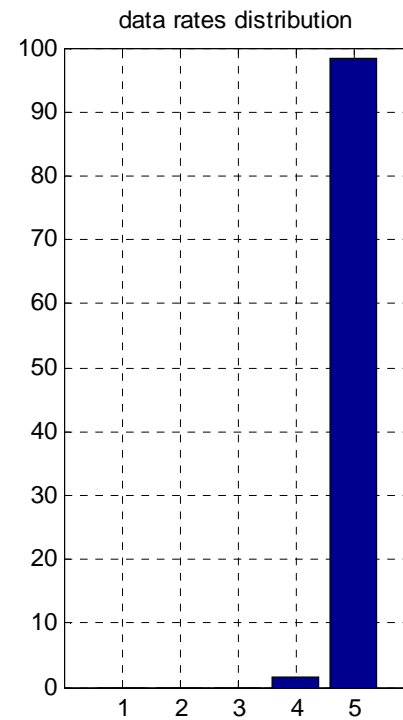
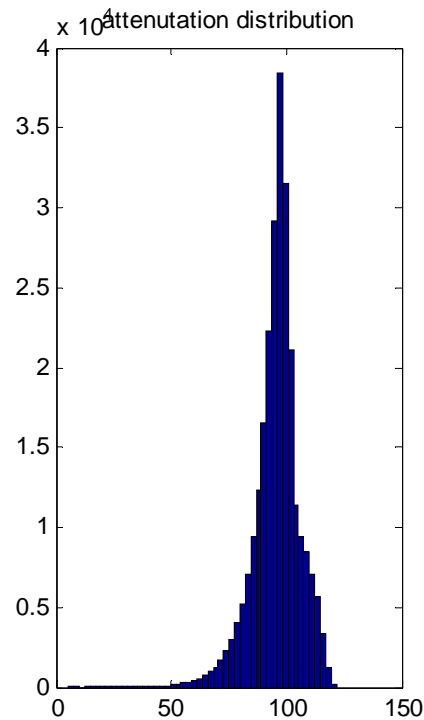
# MicroCell Model – Results 1

- ❑ 500m spacing, 3000 nodes, 32 byte payload, TX =10dBm
- ❑ Results : 64 channel network, TX once per hour
  - End nodes not connected (percent): 0.00
  - System Redundancy (# of nodes received vs planned) : 8.63
  - Duty cycle per RF Channel : (percent) 1.04



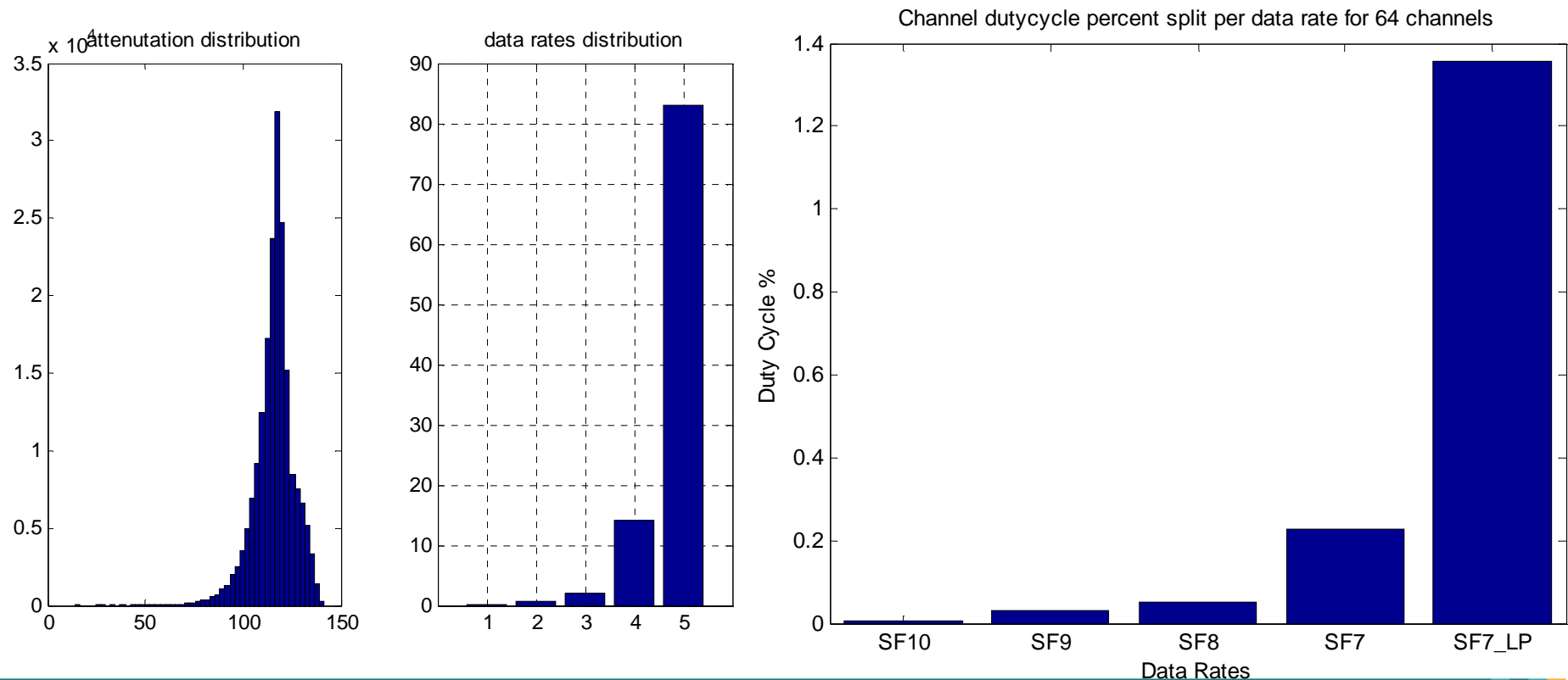
# MicroCell Model – Results 2

- ❑ 500m spacing, 16000 nodes, 32 byte payload, TX =10dBm
- ❑ Results : 64 channel network, TX once per hour
  - End nodes not connected (percent): 0.00
  - System Redundancy (# of nodes received vs planned) : 8.85
  - Duty cycle per RF Channel : (percent) 5.57



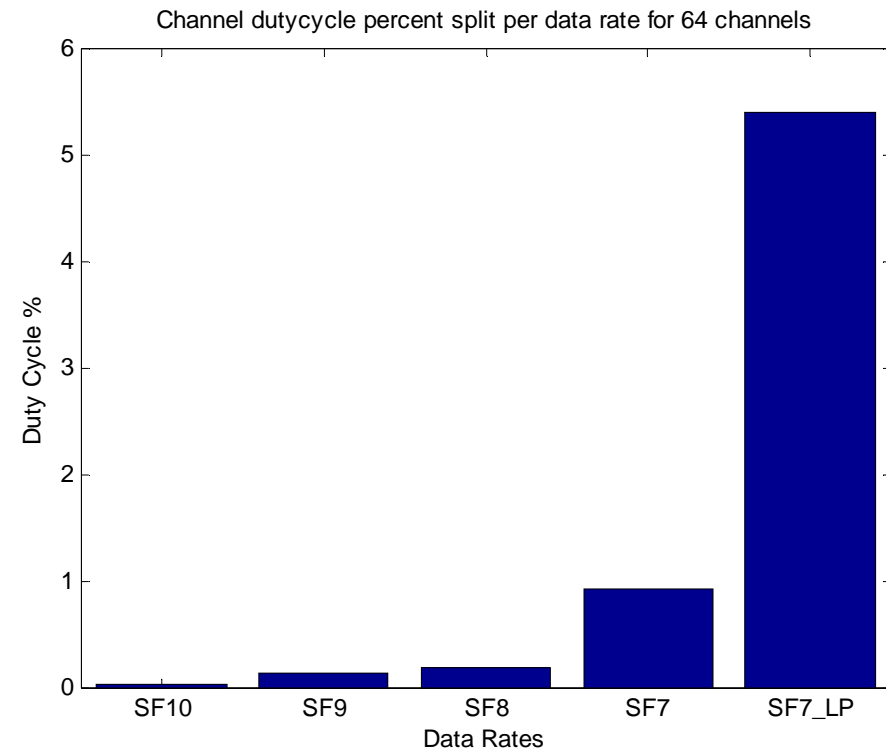
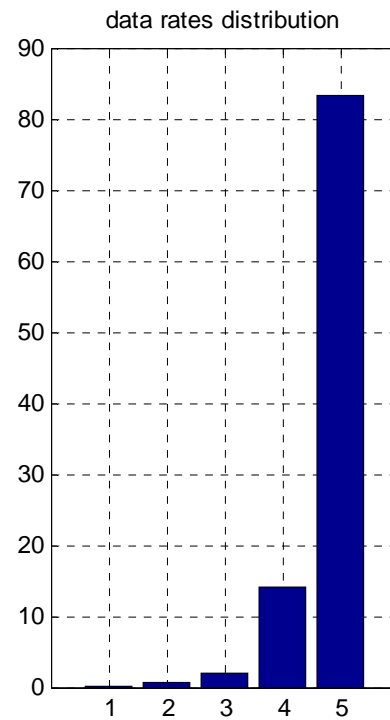
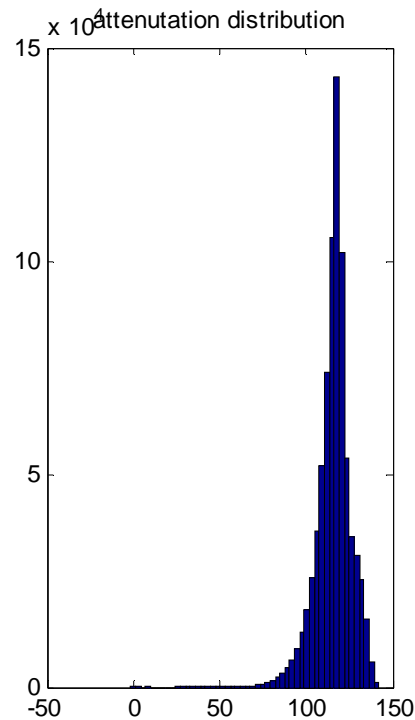
# MacroCell Model – Results 1

- ❑ 1732m spacing, 12000 nodes, 32 byte payload, TX =19dBm
- ❑ Results : 64 channel network. TX once per hour
  - End nodes not connected (percent): 0.00
  - System Redundancy (# of nodes received vs planned) : 3.43
  - Duty cycle per RF Channel : (percent) 1.67



# MacroCell Model – Results 2

- ❑ 1732m spacing, 48000 nodes, 32 byte payload, TX =19dBm
- ❑ Results : 64 channel network, TX once per hour
  - End nodes not connected (percent): 0.00
  - System Redundancy (# of nodes received vs planned) : 3.39
  - Duty cycle per RF Channel : (percent) 6.63





[www.semtech.com](http://www.semtech.com)

