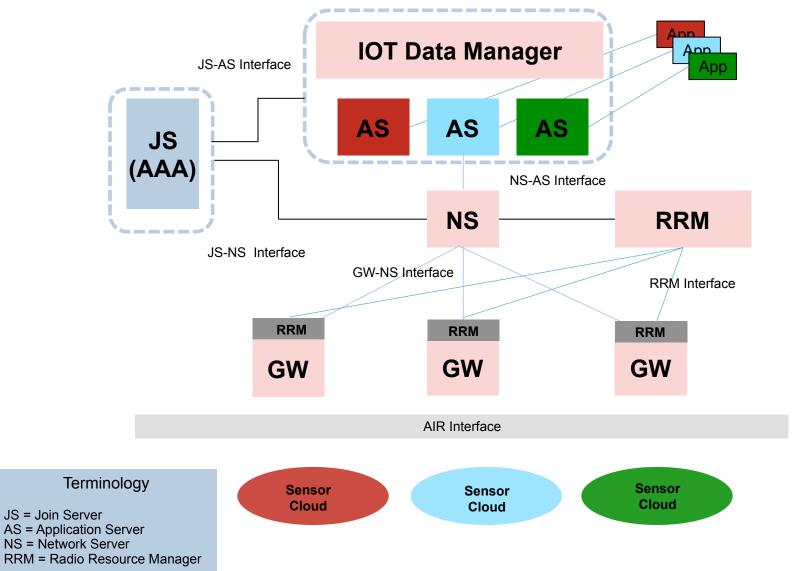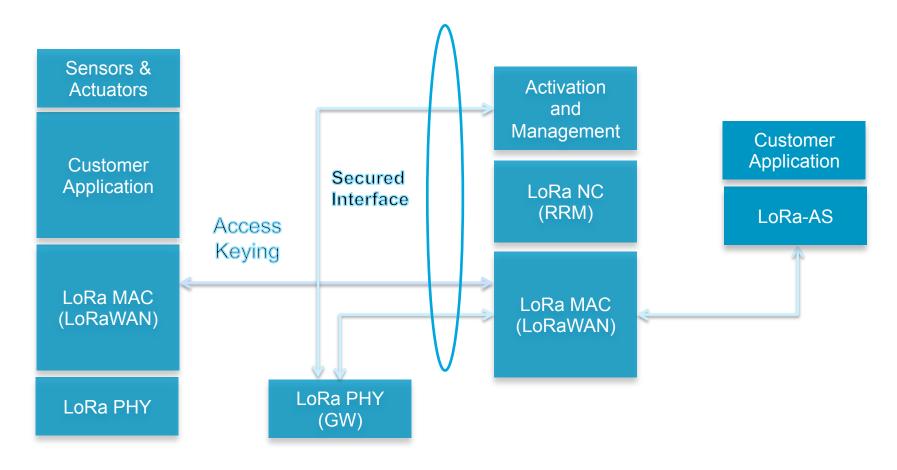# Protocol Interfaces for LPWAN: Discussion

- Sri Gundavelli (sgundave@cisco.com)

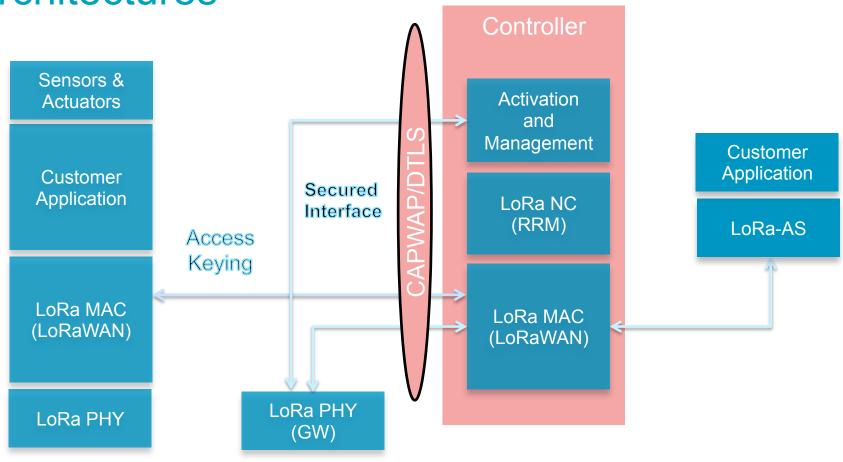# LPWAN Functional Architecture

JS-AS Interface

IOT Data Manager

App
App
App

JS
(AAA)

AS   AS   AS

NS-AS Interface

NS   RRM

JS-NS Interface

GW-NS Interface

RRM Interface

RRM   RRM   RRM

GW   GW   GW

AIR Interface

Terminology

JS = Join Server
AS = Application Server
NS = Network Server
RRM = Radio Resource Manager

Sensor Cloud

Sensor Cloud

Sensor Cloud

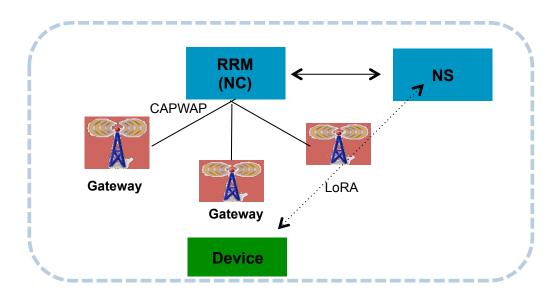# Comparison of LoRaWAN and 802.11 Access Architectures

Comparison of LoRaWAN and 802.11 Access Architectures

Radio Resource Management

- The RRM server (NC) can provision the radio parameters on the gateway.

  - *The interface between NS and NC will allow exchange of radio parameters. The RRM can control the device radio parameters via NS over LoRA.*

  - *The interface between NC and the gateway will be based on CAPWAP. This interface can be used for radio provisioning, diagnostics, monitoring and audit. List of parameters that can pushed per device. Drate, Channel Mask, Redundancy, Tx {pwer. Drate Tx Power, Max Duty Cycle, Offset time between receive windows, Margin ..etc*

LPWAN - Radio Resource Management

- The following are the key radio and service related aspects that will be managed on the gateway using CAPWAP protocol.

Category	Description
Radio Configuration	Radio configuration settings on the LoRA Gateway
Per-Channel Statistics	Channel specific performance characteristics
Gateway Configuration	Configuration of the protocol handlers and packet forwarder functions.
Device Bindings	Details related to every single device that has currently some session state on the NS and on the Gateway.
Device Statistics & Counters	General statistics and counters related to sensor attachments, failures, protocol and security violations

Radio Configuration

Object	Description
Country Setting Mode	Operating mode/region
Number of Channels configured	Number of Channels enabled on the Lora Gateway
Guard Band	Guard-band between channels; Default 150Mhz between channels
Spreading Factor	Spreading factor used in each supported channel; SF6 – SF12
Power Transmission	Downlink Power Transmission towards Lora end device; dBm or mW
ISM Band	Supported ISM Bands; Enum; 169MHz, 434MHz, 470MHz, 868MHz, 915MHz
Channel Table {Central Frequency, Bandwidth, Spreading Factor}	List of channels with channel specific details
Antenna Type/Height/ Gain	Type of antenna improvement of Rx and Diversity; Height; Gain

Per-Channel Statistics

Object	Description
Noise	Noise levels in the channel;
Duty Cycle	Duty Cycle of the LoRA gateway per Sub-band
Packet Error Rate	Receiver sensitivity per channel
CRC Error Rate	Percentage of packets received with CRC errors per-channel
CRC Error Packet Forwarded Count	Number of packets with CRC errors forwarded to Network Server
CRC No-Error Packet Forwarded Count	Number of packets with no-CRC errors forwarded to the network server
Tx Packet Rate	Percentage of total transmitted packets towards network server over each channel

LoRA Packet Forwarded Configuration

Object	Description
CRC Packet Handling	Behavior of the gateway w.r.t handling CEC error packets
Packet Scheduling Behavior	If the gateway should forward packets based on the NS scheduled times, or it should ensure the DL slots match the device negotiated slot
Device Black List Table	List of devices not authorized to use this gateway
Device White List Table	List of devices allowed to use this gateway
NS based on Application Type	List of application types with the corresponding Network Server address

Per-Device Bindings

Object	Description
Protocol Version	LoRa Protocol version that the device supports
Sensor Identifier	DevEUID / DevId
RSSI	Received Signal Strength Indication
SNR	SNR ratio on the received LoRA fram
CRC Coding Rate	CRC error coding to perform forward error detection and correction
Data Rate	Bit-rate of the received LoRA frame
Packet Error Rate	Gateway receiver sensitivity
CRC Error Rate	Percentage of total received packets with CRC errors
Number of packets with CRC errors forwarded to the NS	Number of packets with CRC errors that are forwarded to the NS
Number of packets with CRC errors forwarded to the NS	Number of packets with non CRC errors that are forwarded to the NS
Retransmitted Packet Count	Total number of re-transmits based on FrameCounter

Per-sensor Bindings

Object	Description
Tx Packet Rate	percentage of total transmitted packets towards NS received over each uplink channel for each end device
Packets with incorrect MIC	Total number of packets failing MIC
Packets with repeated DeviceNonce	Number of Join requests with re-used DevNonce
RX1 Delay	the delay between uplink and first down slot(RX2_DELAY must be RX1_DELAY + 1s)
Channel list	List of channel frequencies end device is using
Duty Cycle	limitation of the maximum aggregated transmit duty cycle of an end-device
Rx1 data rate offset	Rx1 data rate offset from Tx data rate.
Rx2 data rate	RX2 Data Rate
RX2 Channel	
Battery Level	Battery level obtained using DevStatusReq
Fcnt UP / FCNT DN	Frame Counters UP and DOWN / Difference

Device Statistics & Counters

Object	Description
Total Unique Devices Seen	Total unique device count
List of Devices with protocol violations	Table of device entries that are non-conforming to the LoRA protocols