

27/11/2018



NB-IoT™

WIRELESS PROTOCOLS FOR CONNECTED OBJECTS

Jonathan Malique
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SUMMARY

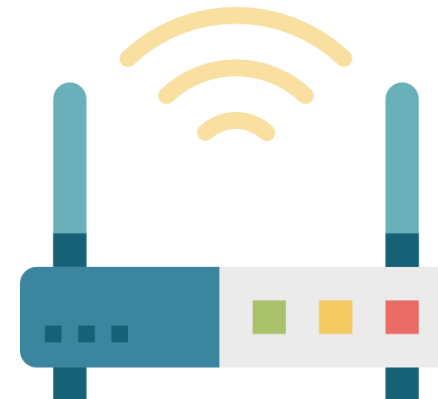
INTRODUCTION

I. PHYSICAL LAYER

II. POWER CONSUMPTION

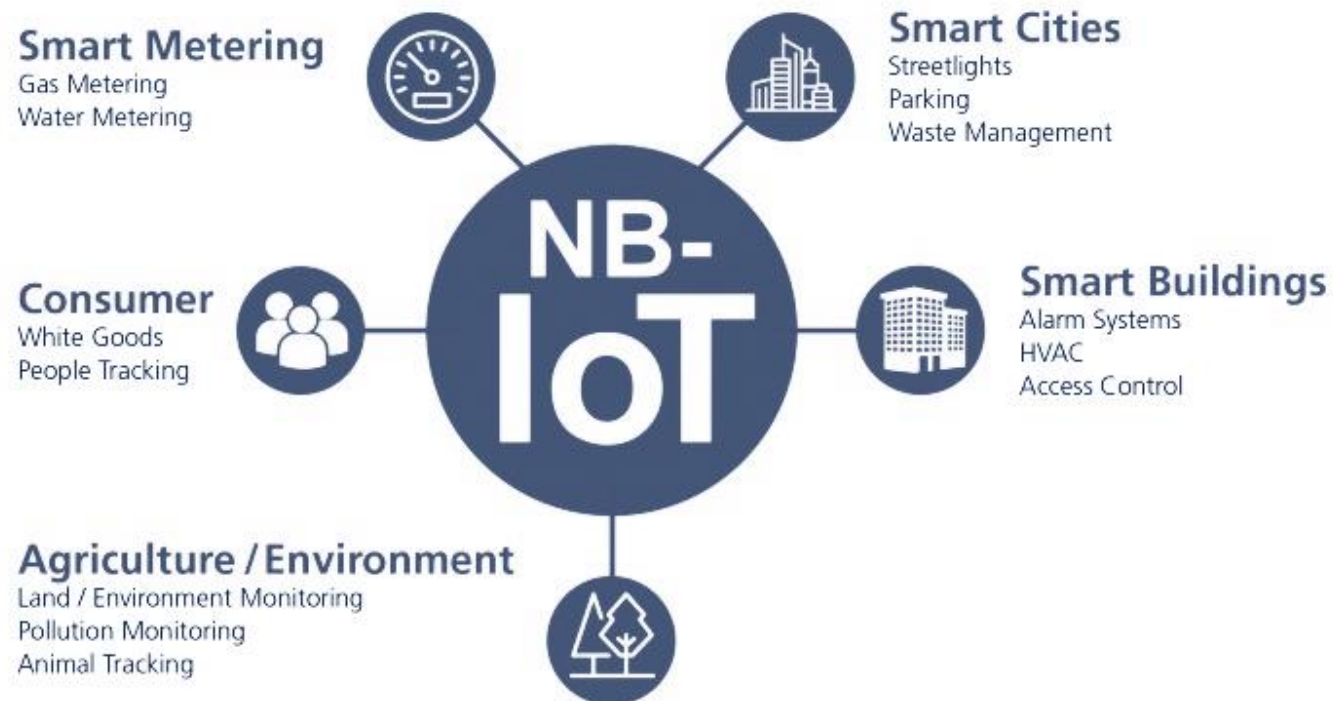
III. MAC LAYER

IV. SECURITY

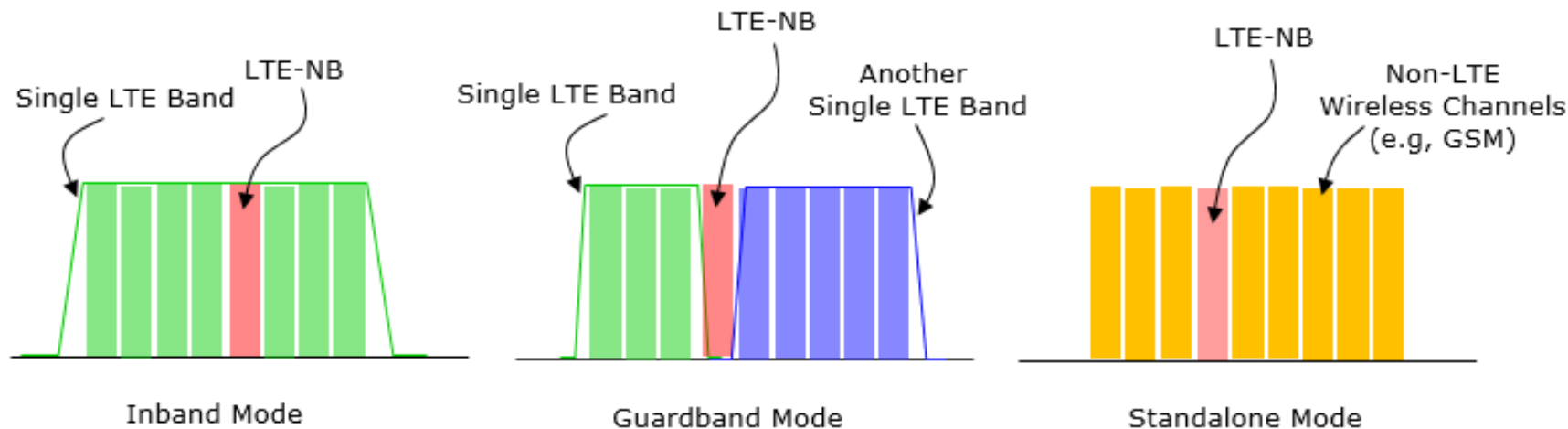


INTRO – I. PHYSICAL LAYER – II. POWER CONSUMPTION – III. MAC LAYER – IV. SECURITY

NB-IoT: Low Power Wide Area Network (LPWAN) developed by 3GPP, in the release 13 (2016)



Operation modes & frequencies



BW
180 kHz

Some restrictions:

In-band operation: 1.4MHz not supported

Guard band operation: synchronization for f bands totally in the guard band

Coverage & Modulation

3 Coverage Enhancement (CE)

- 0 to 2, being the worst
- Duplex-mode (*FDD Half Duplex type B*) → UL & DL not at the same time



- **Downlink:** QPSK
- **Uplink:** Single Tone* π /QPSK, π /BPSK / Multi Tone** QPSK

- **DSS:** Direct-sequence Spread Spectrum modulation → reduce interference

Physical Channels & Signals

- For **Downlink**, 3 physical channels...
 - **NPBCH**, narrowband physical broadcast channel
 - **NPDCCH**, the narrowband physical downlink control channel
 - **NPDSCH**, the narrowband physical downlink shared channel
- ...and 2 physical signals:
 - **NRS**, Narrowband Reference Signal
 - **NPSS** and **NSSS**, Primary and Secondary Synchronization Signals



Physical Channels & Signals

- For **Uplink**, 2 physical channels...
 - **NPUSCH**, the narrowband physical uplink shared channel
 - **NPRACH**, the narrowband physical random-access channel

and the...

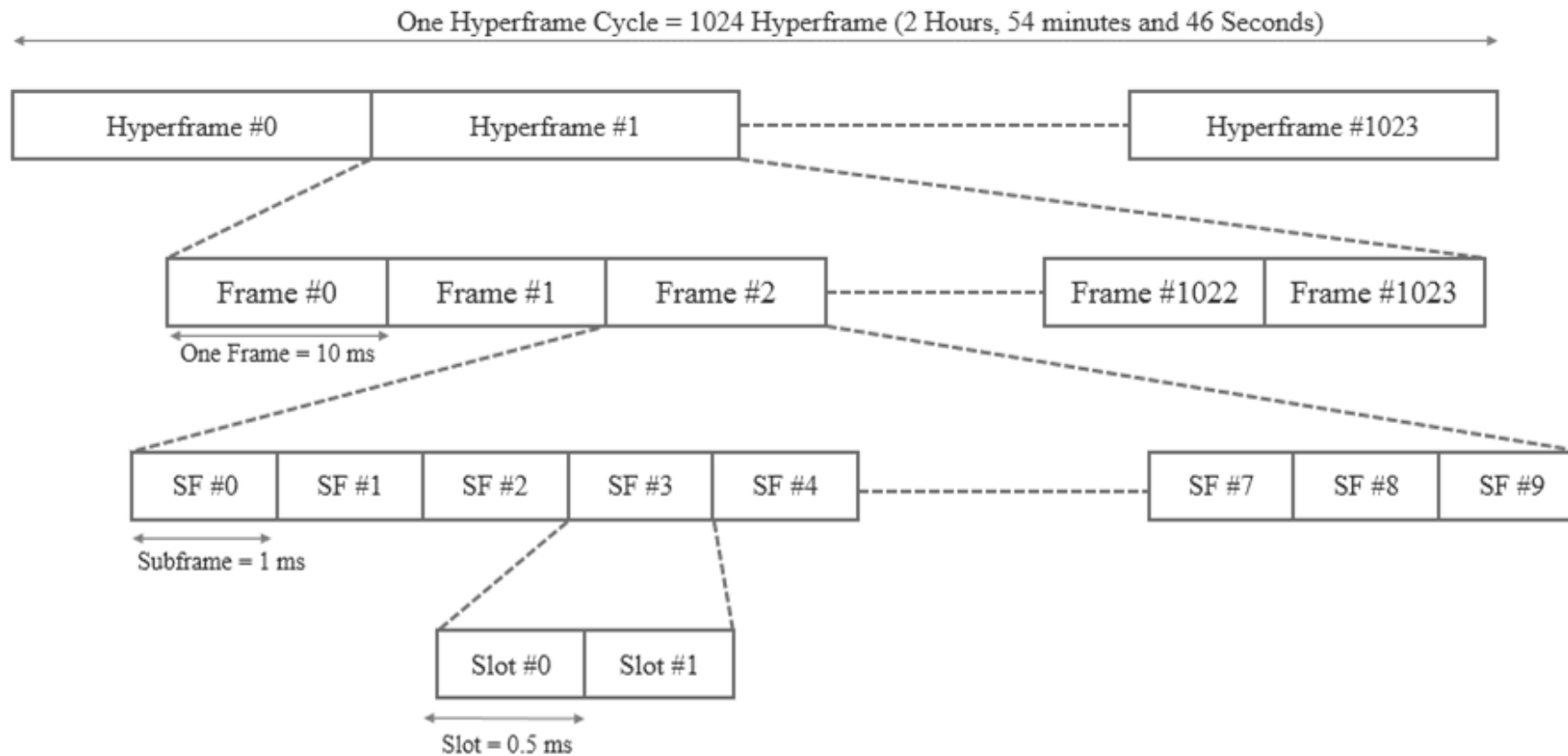
- **DMRS**, Demodulation Reference Signal



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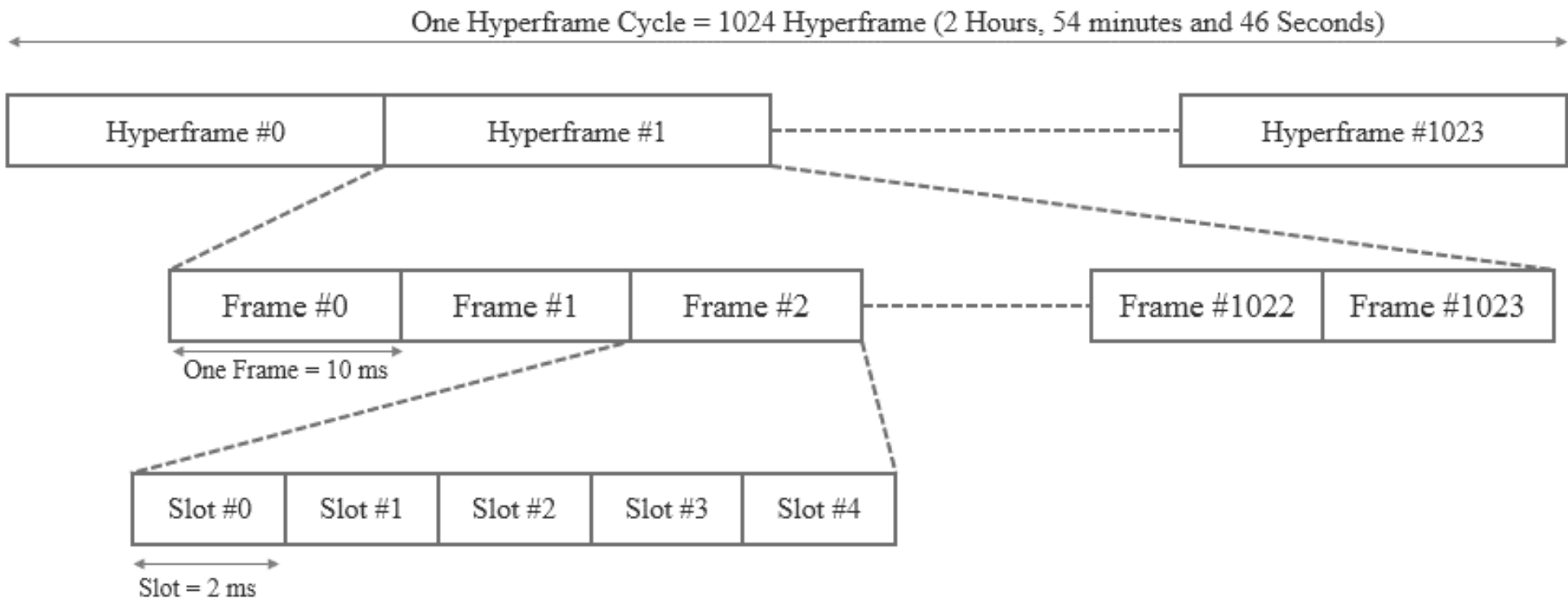
Data frame: Downlink and Uplink Subcarrier Spacing **15kHz**



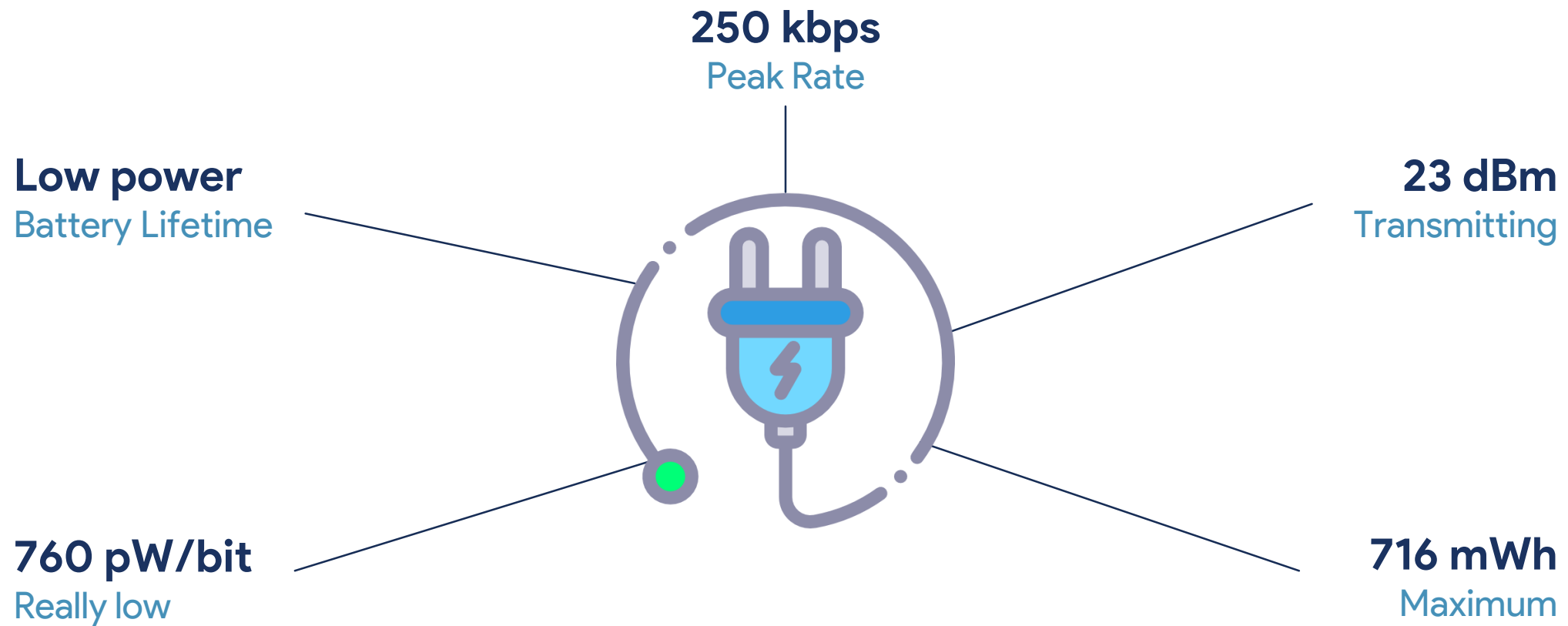
INTRO - I. PHYSICAL LAYER - II. POWER CONSUMPTION - III. MAC LAYER - IV. SECURITY



Data frame: Uplink Subcarrier Spacing **3.75kHz**

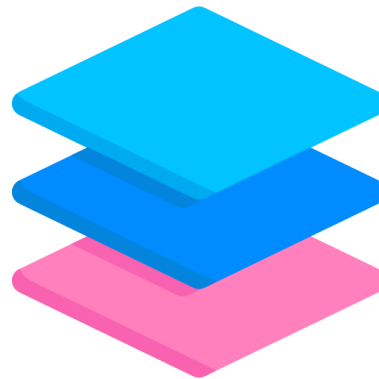


INTRO – I. PHYSICAL LAYER – **II. POWER CONSUMPTION** – III. MAC LAYER – IV. SECURITY



INTRO - I. PHYSICAL LAYER - II. POWER CONSUMPTION - **III. MAC LAYER** - IV. SECURITY

Media Access Channel



Transport Blocks
Multiplexing PDU

Error Correction
HARQ Retransmission
S&W protocol

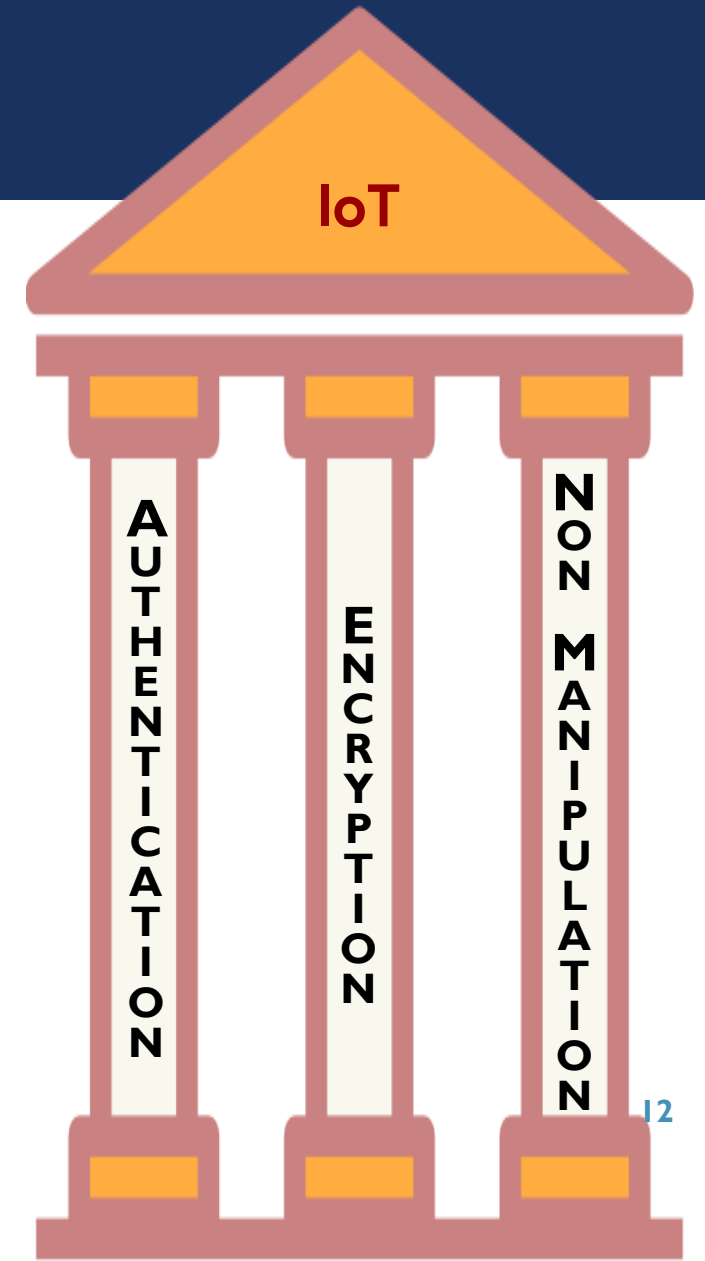
Dynamic Scheduling
Priority Handling
Transmission Time Interval

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UDP: Ideal (low consumption), but all data is visible through the Internet



- **Mobile network security**
- **3GPP Security Protocols**
- **Operator platform**
Intermediate server, secure VPN
- **UDP protocol securing**
Data encrypted (end-to-end)



SUM-UP WITH COMPARISON TABLE


	 Sigfox	 LoRa	 NB-IoT
Coverage	160dB	157dB	164dB
Technology	Proprietary	Proprietary	Open LTE
Spectrum	Unlicensed	Unlicensed	Licensed (LTE/any)
Duty Cycle restrictions	Yes	Yes	No
Output power restrictions	Yes (14dBm = 25mW)	Yes (14dBm = 25mW)	No (23dBm = 200mW)
Downlink data rate	0.1kbps	0.3 – 50kbps	0.5 – 200kbps
Uplink data rate	0.1kbps	0.3 – 50kbps	0.3 – 180kbps
Battery life (200b/day)	10+ years	10+ years	15+ years
Module cost	<\$10 (2016)	<\$10 (2016)	\$7 (2017) to <\$2 (2020)
Security	Low	Low	Very high

Fig 1. Key technical specifications for NB-IoT (from R1-157741, Summary of NB-IoT evaluations results, 3GPP RAN1#83, Nov 2015), Sigfox, and LoRa (from LoRaWAN: a technical overview of LoRa and LoRaWAN, LoRa Alliance, Nov 2015).

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THANK YOU FOR YOUR ATTENTION !

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