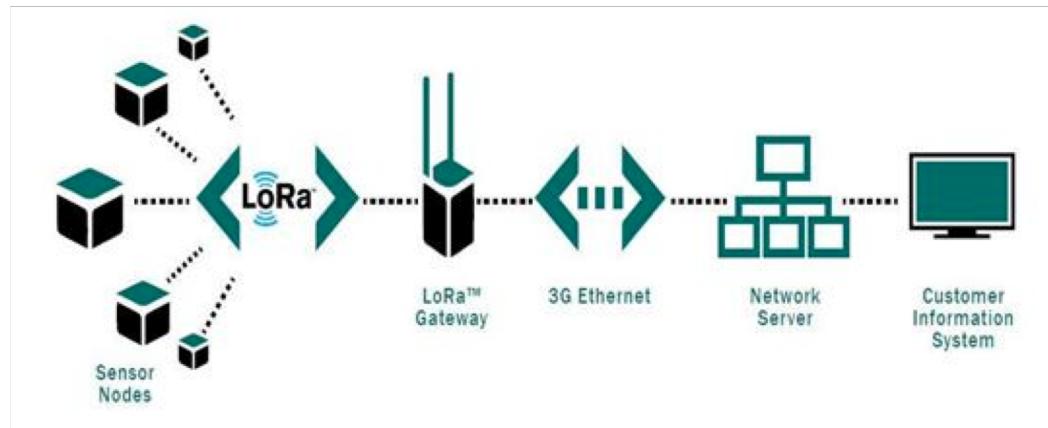
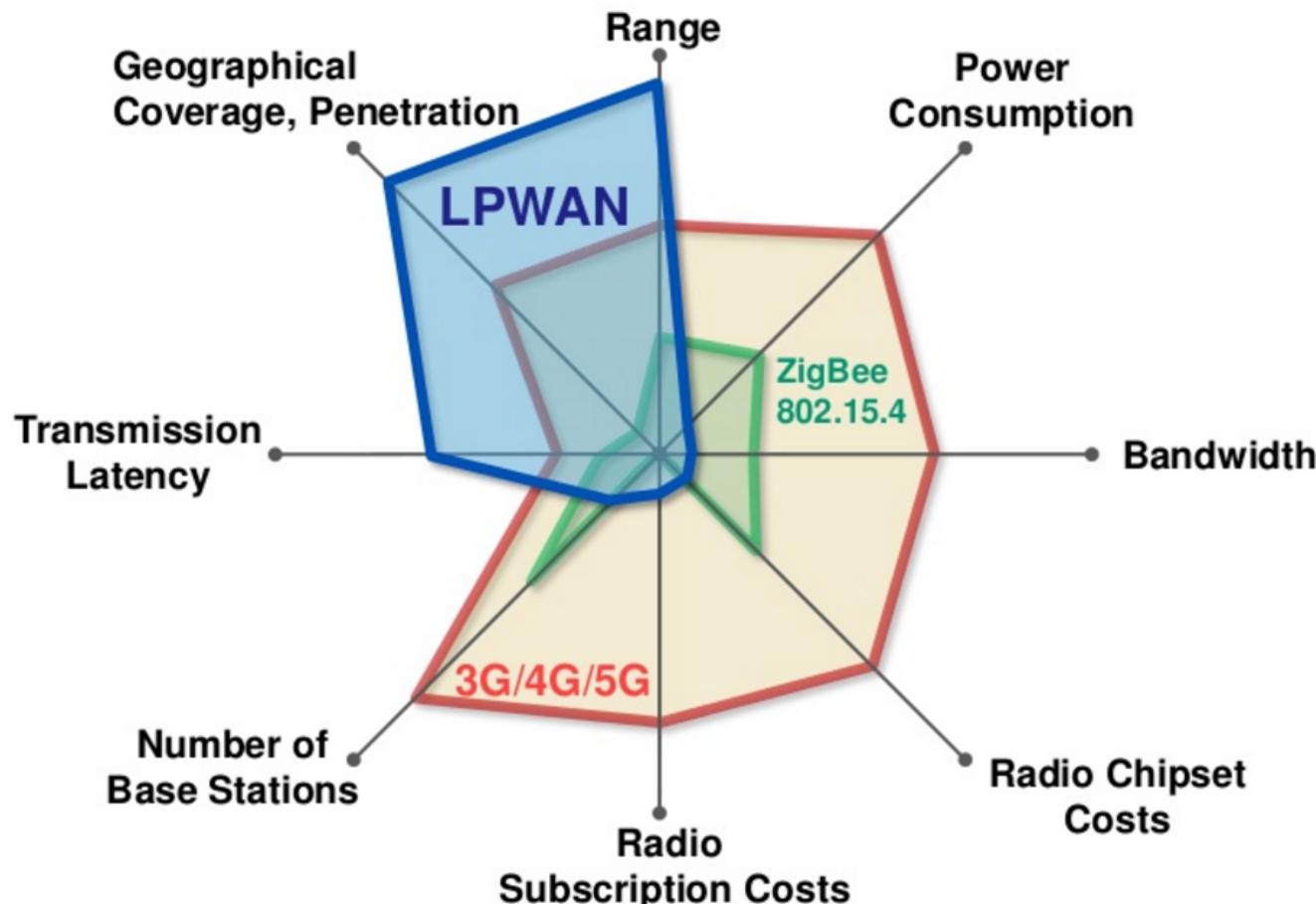


LoRaWAN basics

✓ <https://lora-alliance.org/>



Technologies comparison



SOURCE: PETER R. EGLI, 2015, <http://www.slideshare.net/PeterREgli/lpwan>



Overview of LPWAN technologies

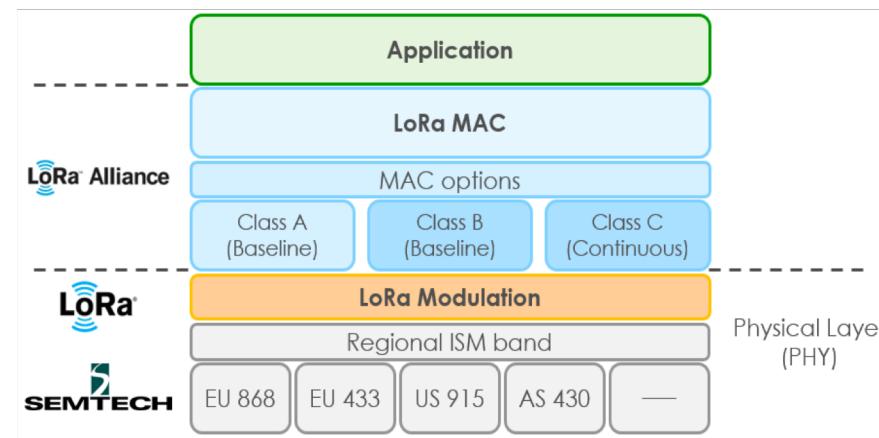
	Sigfox	LoRaWAN	NB-IoT
Modulation	BPSK	CSS	QPSK
Frequency	Unlicensed ISM bands (868 MHz in Europe, 915 MHz in North America, and 433 MHz in Asia)	Unlicensed ISM bands (868 MHz in Europe, 915 MHz in North America, and 433 MHz in Asia)	Licensed LTE frequency bands
Bandwidth	100 Hz	250 kHz and 125 kHz	200 kHz
Maximum data rate	100 bps	50 kbps	200 kbps
Bidirectional	Limited / Half-duplex	Yes / Half-duplex	Yes / Half-duplex
Maximum messages/day	140 (UL), 4 (DL)	Unlimited	Unlimited
Maximum payload length	12 bytes (UL), 8 bytes (DL)	243 bytes	1600 bytes
Range	10 km (urban), 40 km (rural)	5 km (urban), 20 km (rural)	1 km (urban), 10 km (rural)
Interference immunity	Very high	Very high	Low
Authentication & encryption	Not supported	Yes (AES 128b)	Yes (LTE encryption)
Adaptive data rate	No	Yes	No
Handover	End-devices do not join a single base station	End-devices do not join a single base station	End-devices join a single base station
Localization	Yes (RSSI)	Yes (TDOA)	No (under specification)
Allow private network	No	Yes	No
Standardization	Sigfox company is collaborating with ETSI on the standardization of Sigfox-based network	LoRa-Alliance	3GPP

<https://doi.org/10.1016/j.icte.2017.12.005>



LoRa & LPWAN: Sub-gigahertz wireless

- LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things in a regional, national or global network
 - Developed by Semtech Corporation (<http://www.semtech.com/>)
- LoRaWAN™ defines the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link.



- The LoRa® Alliance is an open, non-profit association of members (<http://lora-alliance.org/>) whose mission is to standardize Low Power Wide Area Networks
 - <http://lora-alliance.org/What-Is-LoRa/Technology>
- Specification Updates:
 - LoraWAN TM 1.0.0 -> 1.0.1 -> 1.0.2 -> 1.1
- Specification is free to download now
 - <https://lora-alliance.org/lorawan-for-developers>



	Europe	North America	China	Korea	Japan	India
Frequency band	867-869MHz	902-928MHz	470-510MHz	920-925MHz	920-925MHz	865-867MHz
Channels	10	64 + 8 +8				

Spreading factor (at 125 kHz)	Bitrate	Range (indicative value, depending on propagation conditions)	Time on Air (ms) For 10 Bytes app payload
SF7	5470 bps	2 km	56 ms
SF8	3125 bps	4 km	100 ms
SF9	1760 bps	6 km	200 ms
SF10	980 bps	8 km	370 ms
SF11	440 bps	11 km	740 ms
SF12	290 bps	14 km	1400 ms
(with coding rate 4/5 ; bandwidth 125Khz ; Packet Error Rate (PER): 1%)			



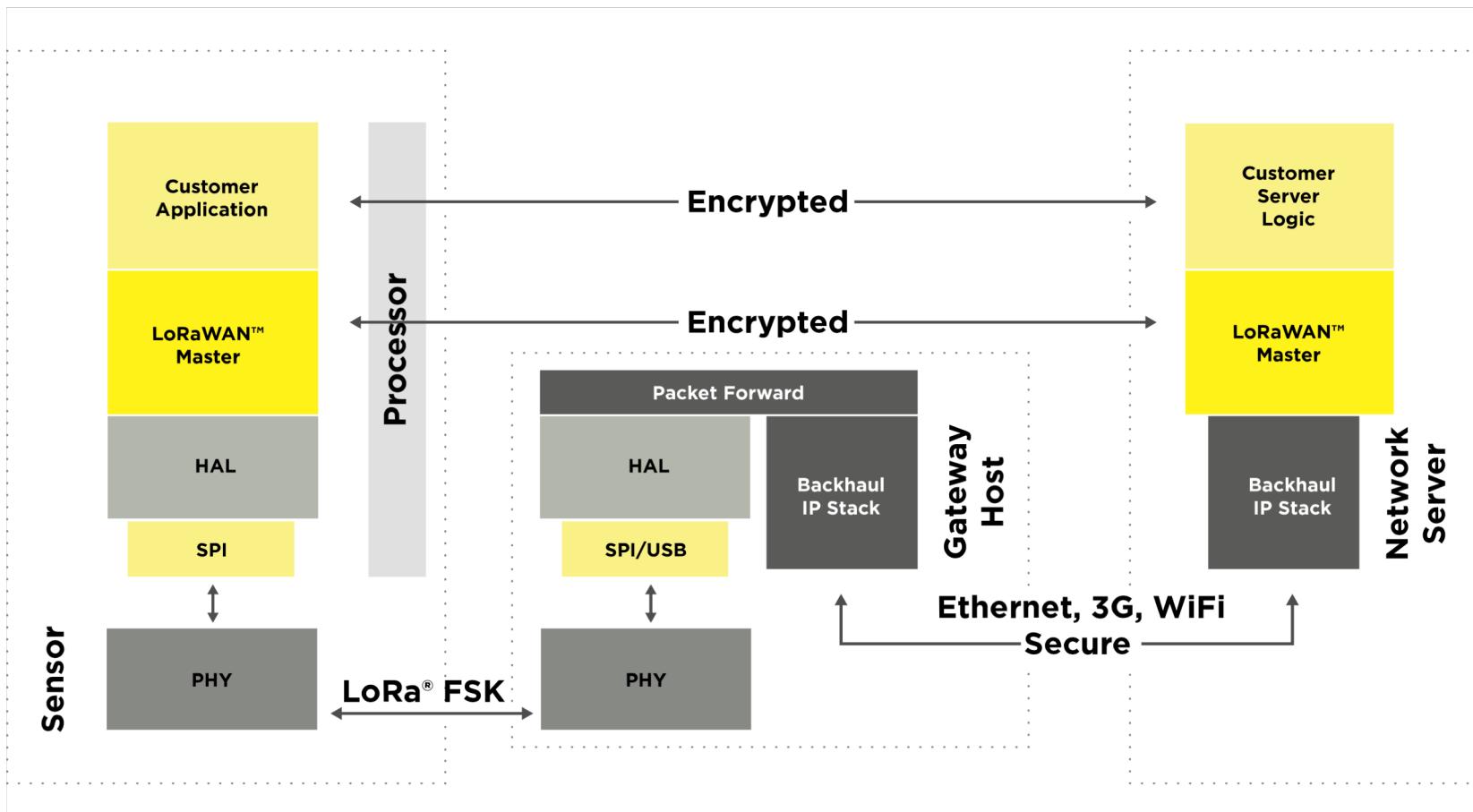
- The **duty cycle of radio devices is often regulated by government.**
- In Europe, duty cycles are regulated by section 7.2.3 of the ETSI EN300.220 standard.
- This standard defines the following sub-bands and their duty cycles:
 - g (863.0 – 868.0 MHz): 1%
 - g₁ (868.0 – 868.6 MHz): 1%
 - g₂ (868.7 – 869.2 MHz): 0.1%
 - g₃ (869.4 – 869.65 MHz): 10%
 - g₄ (869.7 – 870.0 MHz): 1%
- Additionally, the **LoRaWAN specification dictates duty cycles for the join frequencies**, the frequencies devices of all LoRaWAN-compliant networks use for over-the-air activations (OTAA) of devices. In most regions this duty cycle is set to 1%.
- Finally, on “community network” like TTN there typically is a **Fair Access Policy** that limits the uplink airtime to 30 seconds per day (24 hours) per node and the downlink messages to 10 messages per day (24 hours) per node.

Duty Cycle indicates the fraction of time a resource is busy.

When a single device transmits on a channel for 2 time units every 10 time units, this device has a duty cycle of 20%.



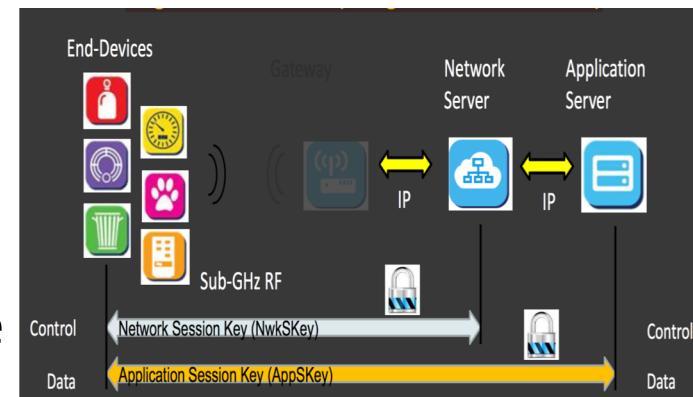
LoRaWAN data flow



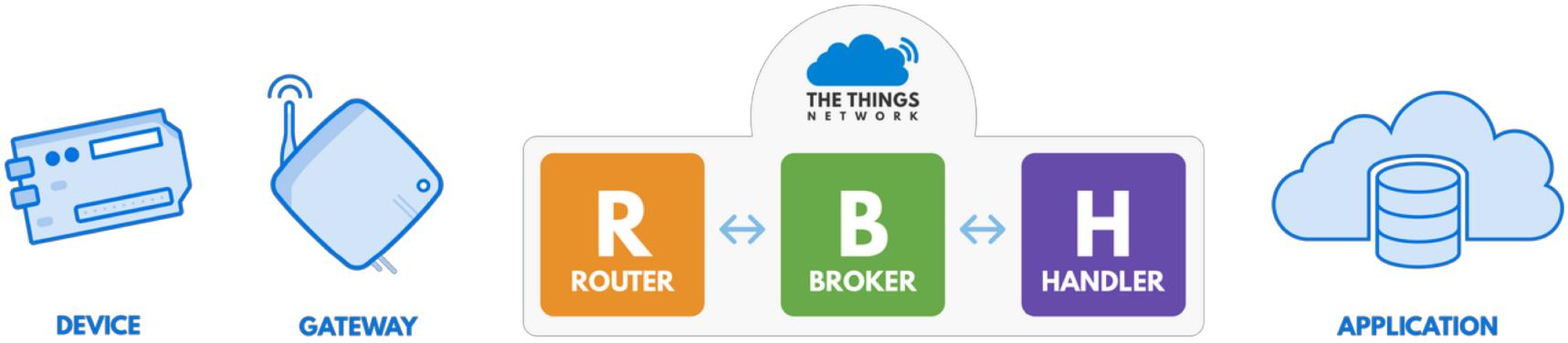
HAL: Hardware Abstraction Layer



- Before an end-device can communicate on the LoRaWAN network, it must be activated
- The following information is required:
 - Device Address (DevAddr)
 - Network Session Key (NwkSKey)
 - Application Session Key (AppSKey)
- To exchange this information, two activation methods are available:
 - Over-the-Air Activation (**OTAA**)
 - Based on Globally Unique Identifier
 - Over the air message handshaking
 - Activation By Personalization (**ABP**)
 - Shared keys stored at production time
 - Locked to a specific network



The Things Network (TTN)



The Things Network (TTN)

About 5000 gateways active worldwide



