

Kommunikációs Hálózatok 2

Tárgyak Internete IoT: D2D, M2M

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BME TMIT

2017. április 25.

Kedd 12:15 - 14:00

IB.028



IoT: Internet of Things (Tárgyak Internete)

- ❑ <https://www.ericsson.com/research-blog/5g/iot-networking/>
- ❑ <https://www.ericsson.com/research-blog/lte/iot-positioning-lte-standardization/>
- ❑ <https://www.ericsson.com/research-blog/internet-of-things/cellular-iot-alphabet-soup/>
NAGYON JÓ!
- ❑ <https://www.ericsson.com/research-blog/internet-of-things/4g-iot/>
- ❑ <https://www.ericsson.com/research-blog/lte/narrowband-iot-standardization-soon-finalized/>
- ❑ <https://www.ericsson.com/publications/white-papers/iot-security-protecting-the-networked-society>
- ❑ <https://www.ericsson.com/publications/white-papers/cellular-networks-for-massive-iot--enabling-low-power-wide-area-applications>
- ❑ <https://www.ericsson.com/publications/white-papers/machine-to-machine--exploring-potential-operator-roles>
- ❑ https://en.wikipedia.org/wiki/Internet_of_things
- ❑ https://en.wikipedia.org/wiki/NarrowBand_IOT NAGYON JÓ

NEM KELL VIZSGÁRA!!!

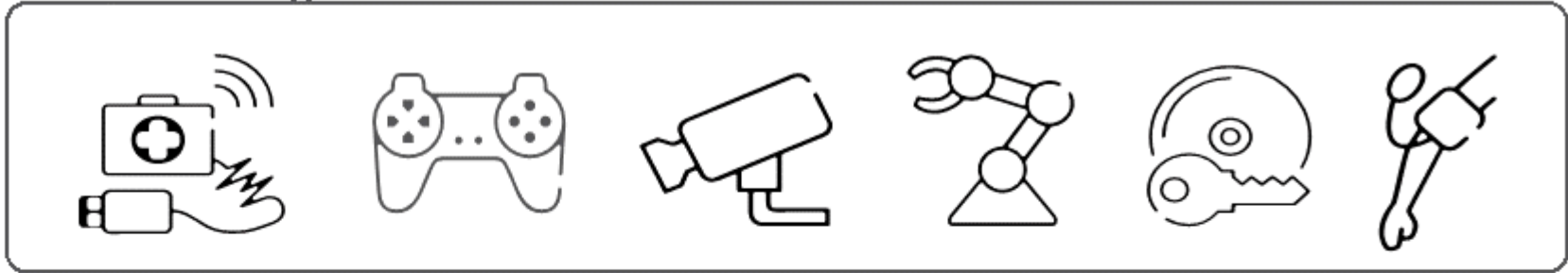
IoT: Mi is az?

- ❑ IoT is "the infrastructure of the information society."
- ❑ Okos város (okos iroda, okos otthon, automatizálás)
- ❑ Okos mezőgazdaság
- ❑ Okos közlekedés és szállítmányozás
- ❑ Okos energetikai rendszer, energiamenedzsment
- ❑ Okos egészségügy
- ❑ Gyártás (Ipar 4.0)
- ❑ Környezet figyelés
- ❑ Infrastruktúra menedzselés

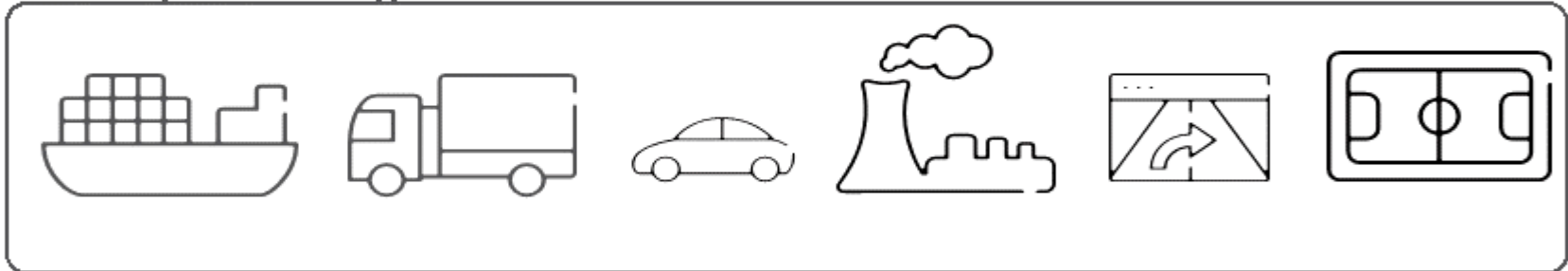
IoT: Mi is az?

- 2021-re 15 000 000 000 eszköz lesz „behálózva”
<https://www.ericsson.com/research-blog/5g/iot-networking/>

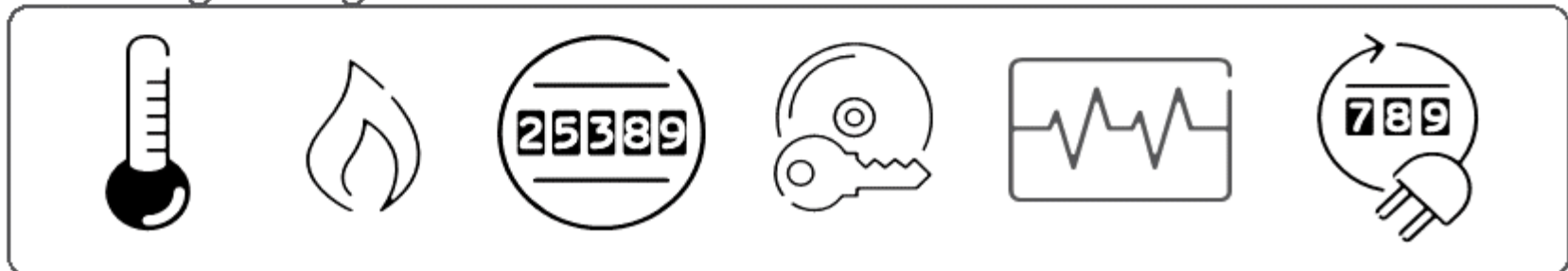
Smart “things”



Transport “things”



Sensing “things”



IoT Funciók

- Azonosítás
- Pozicionálás (beltérben is)
- „Massive” és „Critical”

- Mérünk
- Összegyűjtjük
- Szűrjük, rendszerezünk
- Elemezzük
- Döntünk
- Visszacsatoljuk / szabályozzuk / irányítjuk

IoT kommunikációs hálózatok I

Short-range wireless

- ❑ [Bluetooth low energy](#) (BLE) – Specification providing a low power variant to classic [Bluetooth](#) with a comparable communication range.
- ❑ [Light-Fidelity](#) (Li-Fi) – Wireless communication technology similar to the Wi-Fi standard, but using [visible light communication](#) for increased bandwidth.
- ❑ [Near-field communication](#) (NFC) – Communication protocols enabling two electronic devices to communicate within a 4 cm range.
- ❑ [QR codes](#) and [barcodes](#) – Machine-readable optical tags that store information about the item to which they are attached.
- ❑ [Radio-frequency identification](#) (RFID) – Technology using electromagnetic fields to read data stored in tags embedded in other items.
- ❑ [Thread](#) – Network protocol based on the [IEEE 802.15.4](#) standard, similar to ZigBee, providing [IPv6](#) addressing.
- ❑ [Transport Layer Security](#) (network protocol)|[TLS](#) – Network security protocol.
- ❑ [Wi-Fi](#) – Widely used technology for [local area networking](#) based on the [IEEE 802.11](#) standard, where devices may communicate through a shared access point.
- ❑ [Wi-Fi Direct](#) – Variant of the Wi-Fi standard for peer-to-peer communication, eliminating the need for an access point.
- ❑ [Z-Wave](#) – Communication protocol providing short-range, low-latency data transfer at rates and power consumption lower than Wi-Fi. Used primarily for home automation.
- ❑ [ZigBee](#) – Communication protocols for [personal area networking](#) based on the IEEE 802.15.4 standard, providing low power consumption, low data rate, low cost, and high throughput

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IoT kommunikációs hálózatok II

Medium-range wireless

- [HaLow](#) – Variant of the Wi-Fi standard providing extended range for low-power communication at a lower data rate.
- [LTE-Advanced](#) – High-speed communication specification for mobile networks. Provides enhancements to the [LTE](#) standard with extended coverage, higher throughput, and lower latency.

Long-range wireless

- [Low-power wide-area networking \(LPWAN\)](#) – Wireless networks designed to allow long-range communication at a low data rate, reducing power and cost for transmission.
- [Very small aperture terminal \(VSAT\)](#) – [Satellite](#) communication technology using small [dish antennas](#) for [narrowband](#) and [broadband](#) data.

Wired

- [Ethernet](#) – General purpose networking standard using [twisted pair](#) and [fiber optic](#) links in conjunction with [hubs](#) or [switches](#).
- [Multimedia over Coax Alliance \(MoCA\)](#) – Specification enabling whole-home distribution of high definition video and content over existing [coaxial cabling](#).
- [Power-line communication \(PLC\)](#) – Communication technology using electrical wiring to carry power and data. Specifications such as [HomePlug](#) utilize PLC for networking IoT devices.

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Csak a Short/Medium/Long Range wireless és wired rendszerezésről kell tudni...

IoT kommunikációs hálózatok III


Low-Power Wide-Area Network (LPWAN)


LPWAN jellemzői és a 3 telt nyíllal jelölt technika kell, a többi NEM KELL VIZSGÁRA!!!

- + Wireless network (nem kell fizikailag „bekötni”)
- + Long range (akár 140 km-ig is sikerült !!!)
- + Low power (5-10 évig működik egy elemen !!!)
- - Low data rate (1-100 kb/s nagyságrend, napi néhány csomag...)

 LoRa, proprietary, [CSS](#) modulation technology used for LPWAN patented by [Semtech](#) by LoRa Alliance used by LoRaWAN, Haystack Technologies, and Symphony Link.^[3] On 16 June 2015 version 1.0 of the LoRaWAN specification was released.^[4]

- [Haystack](#), a DASH7 Mode 2 development framework for low power wireless networks by Haystack Technologies.^[9]

 LTE Advanced for Machine Type Communications ([LTE-MTC](#)), an evolution of [LTE](#) communications for connected things by [3GPP](#).^[10]

 [NarrowBand IoT](#), (NB-IOT), standardization effort by [3GPP](#) for a LPWAN used in cellular networks,^[11] that evolved from Huawei's NB-CIoT effort.^[12]

- [NB-Fi](#) Protocol, from [WAVIoT](#).^{[13][14]}
- NWave, proprietary technology that also forms the basis of the Weightless protocols^{[15][16]}
- [RPMA](#), [Random Phase Multiple Access](#), technology from [Ingenu](#),^[17] formerly known as [On-Ramp Wireless](#).

 [Sigfox](#), UNB-based technology and French company.

- UNB, [Ultra Narrow Band](#), modulation technology used for LPWAN by various companies including [Telensa](#),^[18] NWave,^[19] Weightless-N^[20] and [Sigfox](#).^[21]
- [Weightless](#), a set of communication standards from the Weightless SIG.

Cellular IoT – Cellás IoT: 1.

- Mobil szolgáltatók kedvence
 - Gombnyomásra SW upgrade
 - Nincs még végberendezés (2017 augusztusra ígérik)
 - MTC (LTE-MTC), Cat-0, Cat-1, LTE-M, NB-IoT, EC-GSM...
- DL/UL sebességek viszonya (kisebb/nagyobb kell), számértékek és a többi jellemző a táblázatból NEM KELL VIZSGÁRA!!!*

	LTE Rel-8 Cat-1	LTE Rel-12 Cat-0	LTE Rel-13 Cat-M1	NB-IoT Rel-13
DL peak rate	10 Mbps	1 Mbps	1 Mbps	~0.2 Mbps
UL peak rate	5 Mbps	1 Mbps	1 Mbps	~0.2 Mbps
Duplex mode	Full	Half or full	Half or full	Half
UE bandwidth	20 MHz	20 MHz	1.4 MHz	0.18 MHz
Maximum transmit power	23 dBm	23 dBm	20 or 23 dBm	23 dBm
Relative modem complexity	100%	50%	20-25%	10%
Note: peak data rates refer to full duplex operation for Cat-0 and Cat-M1				

Cellular IoT – Cellás IoT 2. (folyt.)

- **MTC** – Machine-Type Communication
 - Machine-to-Machine (**M2M**)
 - Device-to-Device (D2D)
- **Cat-1** – Category 1, LTE Rel.8
 - 3G-nél rosszabb, majdnem kihalt
 - De IoT-re nem rossz, és már élő szabvány!!!
- **Cat-0** – Category 0, Rel. 12
 - Olcsó modem, IoT-re kiélezve
- **Cat-M1** – Category M1 (Category M), Rel. 13
 - M, mint Machine
 - Még kisebb fogyasztás
 - Kisebb sávszélesség
 - Nagyobb hatótáv: 15dB

Cellular IoT – Cellás IoT 3. (folyt.)

□ **LTE-M** (LTE MTC)

- Power Saving Mode (PSM) (10 évig egy elmen)
- extended DRX cycles (eDRX) hosszabb alvó állapot

□ **NB-IoT** (NarrowBand IoT)

- 180 kHz sávban 200 kbit/s (fel is, le is, fél-duplex)
- „inband”: az LTE resource block-okat és alvívőket használja
- < 5 USD modem költség a cél (de még messze van...)

□ **EC-GSM-IoT** (EC-EGPRS)

- Extended Coverage GSM for IoT
- Sima GSM felett megvalósítható
- 20 dB teljesítmény – nagyobb táv

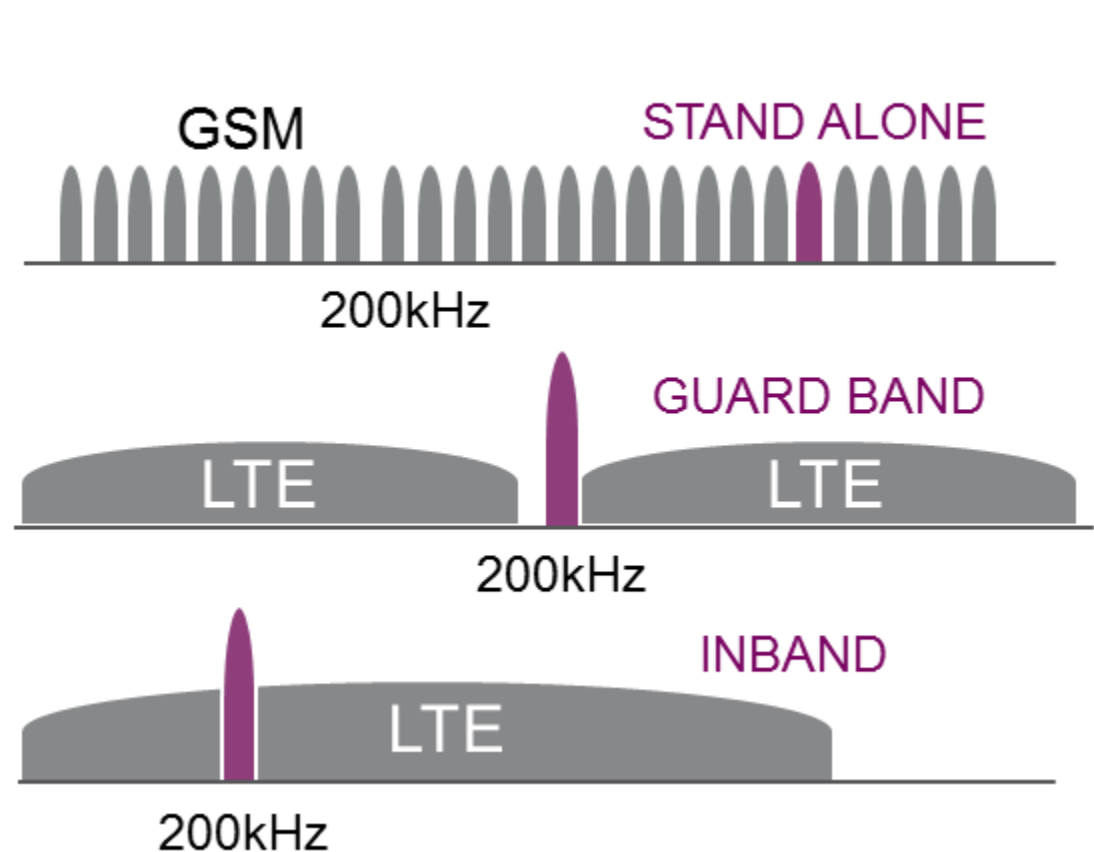


NB-IoT helye a frekvenciasávban

- Az NB-IoT sávok (lila) és a GSM és LTE sávok (szürke)
- LTE sávban NB-IoT jelszintje nagyobb!

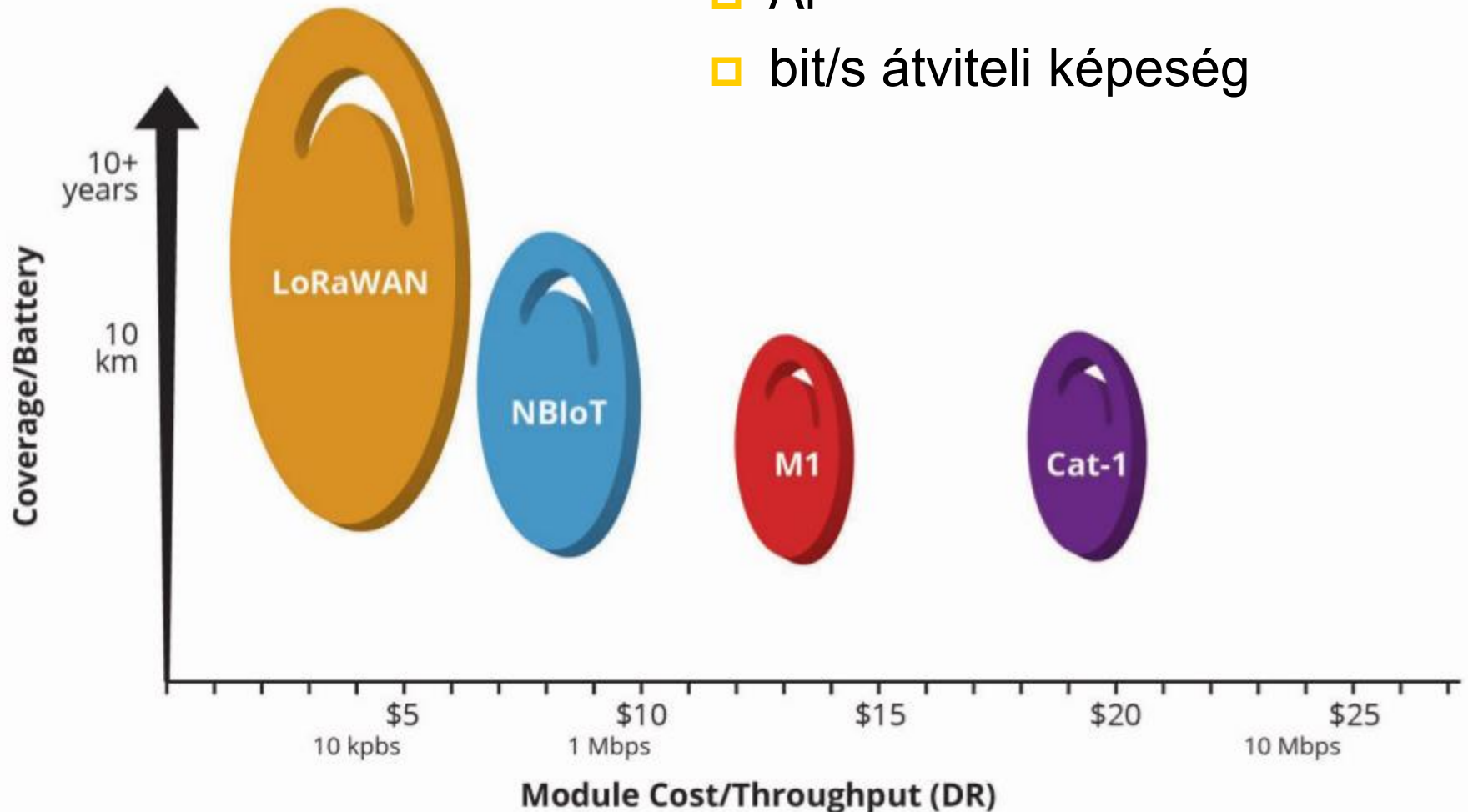


NB-IoT



LoRa, LoRaWAN és Semtech

- SigFox – zárt
- LoRaWAN – nyitott(abb)
- Hatótáv
- Fogyasztás
- Ár
- bit/s átviteli képesség



Architektúrák

- Csillag
- Csillagok csillaga
- cellás?

- Capillary Gateway (kapilláris átjáró)
 - BLE, Wi-Fi, stb. át gyűjt a modul vagy a GW
 - küld tovább felfelé