BEŽIČNE MREŽE - BEMR

Univerzitet u Beogradu
SAOBRAĆAJNI FAKULTET

Bežične mreže

- Nastavnici:
  - Prof. dr Goran Marković, redovni profesor, g.markovic@sf.bg.ac.rs
  - Prof. dr Marija Malnar, vanredni profesor, m.malnar@sf.bg.ac.rs
- Šifra predmeta: BEMR
- Broj ESPB bodova: 6
- Način polaganja:
  - Aktivnost u toku nastave 10 poena,
  - Seminarski rad 50 poena,
  - Usmeni ispit 40 poena.
- Cilj predmeta je da studente upozna sa osnovnim principima planiranja i fukncionalnim karakteristikama savremenih bežičnih mreža.
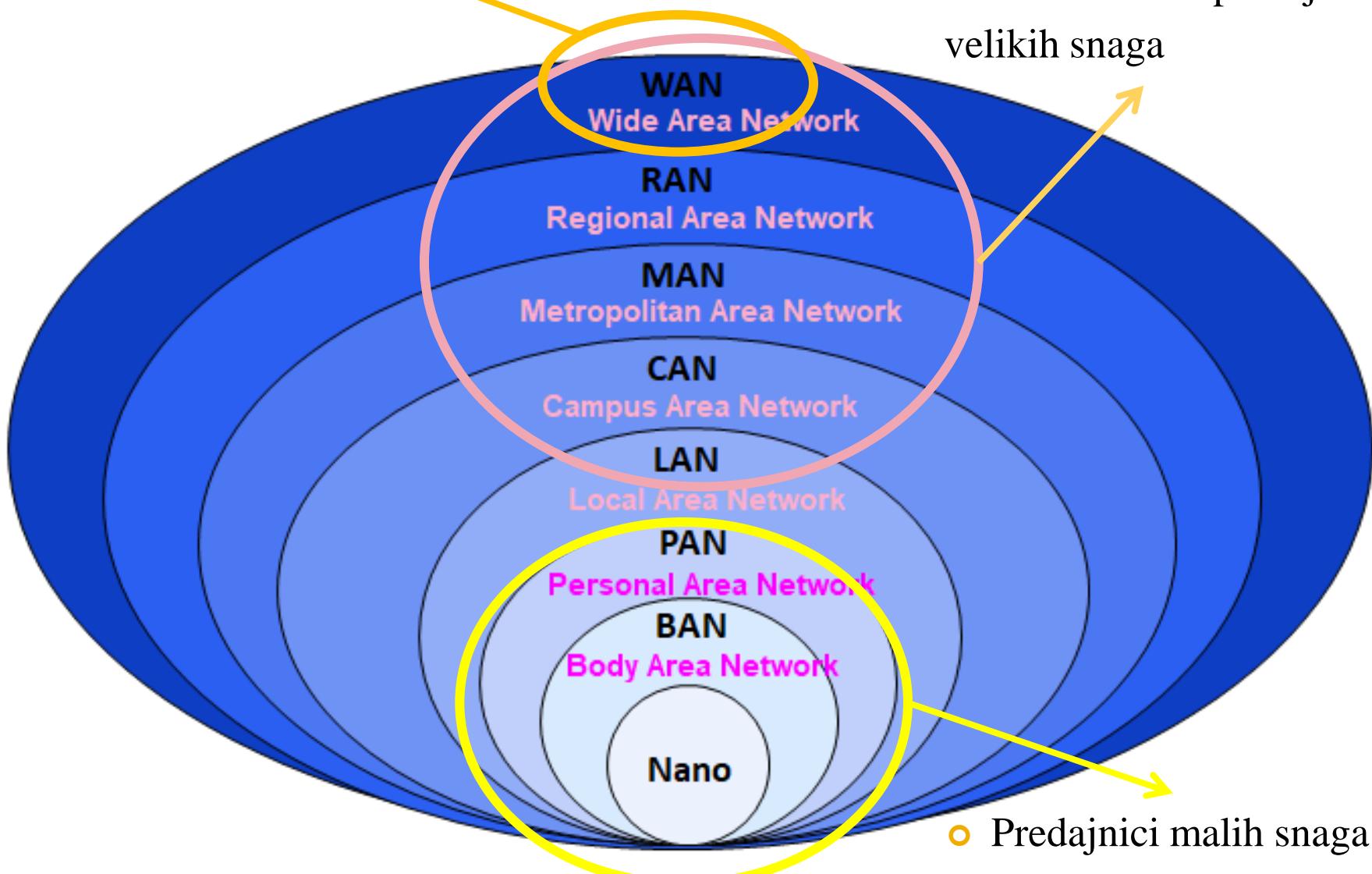
SADRŽAJ PREDMETA (1)

- Aktuelni trendovi u oblasti bežičnih komunikacija.
- Ključne tehnologije za realizaciju bežičnih mreža.
- Principi planiranja i realizacije bežičnih mreža.
- Bežično umrežavanje, core (jezgro) mreže.
- Širokopojasni bežični pristup (BWA).
- Bežične lokalne računarske mreže (WLAN – HIPERLAN, WiFi).
- Bežične personalne mreže (WPAN – Bluetooth, Ultra Wideband, ZigBee).
- Bežične mreže male snage i velikog dometa (LPWAN - Low Power Wide Area Networks): LoRa, SigFox, NB-IoT...
- Mobilne celularne mreže za širokopojasni pristup (LTE/WiMax).
- Mobilne mesh mreže.
- Satelitske mreže.
- Stratosferske platforme za bežično umrežavanje.
- Zemaljske radiodifuzne mreže.

SADRŽAJ PREDMETA (2)

- Taktičke komunikacije.
- Bežične senzorske mreže.
- Bežične ad hoc mreže: MANET, VANET, FANET, WMN.
- Integrisane ad hoc mreže.
- Korporativne mreže.
- Kampus bežične mreže.
- Softverski definisani radio (SDR).
- Kognitivni radio.
- Inteligentni antenski sistemi.
- MIMO antenske tehnike.
- Sigurnost i kvalitet servisa u bežičnim mrežama.
- Upravljanje mobilnošću u savremenim bežičnim mrežama.
- Internet stvari – IoT.
- Budućnost bežičnih komunikacija.

- LPWAN (*Low Power* WAN) čiji predajnici su malih snaga

- Mreže koje su u svojoj osnovi imale predajnike velikih snaga

WAN
Wide Area Network

RAN
Regional Area Network

MAN
Metropolitan Area Network

CAN
Campus Area Network

LAN
Local Area Network

PAN
Personal Area Network

BAN
Body Area Network

Nano

- Predajnici malih snaga

Odnos popularnih bežičnih tehnologija

- Po dva resursa se mogu uskladiti.

- LAN mreže imaju imaju dobar protok tj. propusni opseg, ali nisu velikog dometa i dosta su veliki potrošači energije (baterija je problem!). Postoje standardi koji o tome vode računa – BLE, ZigBee, ...

- Mobilna telefonija imaja dobro pokrivanje tj. veliku distancu i veliki protok, ali i veliku potrošnju.

- LPWAN ima malu potrošnju i vrlo veliki domet, ali veoma mali protok.

LAN
Short Range
Communicating Devices

ZigBee3.0 | WiFi
4.0 Bluetooth

Well established standards
Good for:
• Mobile
• In-home
• Short range
Not good for:
• Battery life
• Long range

Cellular
Long Range w/ Power
Traditional M2M

GSM 3G+/H+ lte Advanced Pro
lte Cat-M1/NB1

Well established standards
Good for:
• Long range
• High data-rate
• Coverage
Not good for:
• Battery life

Low Power WAN
Long Range w/ Battery
Internet of Objects

SIGFOX LoRa
WEIGHTLESS inGENU

Emerging PHY standards
Good for:
• Long range
• Long battery
• Low cost
Not good for:
• High data-rate
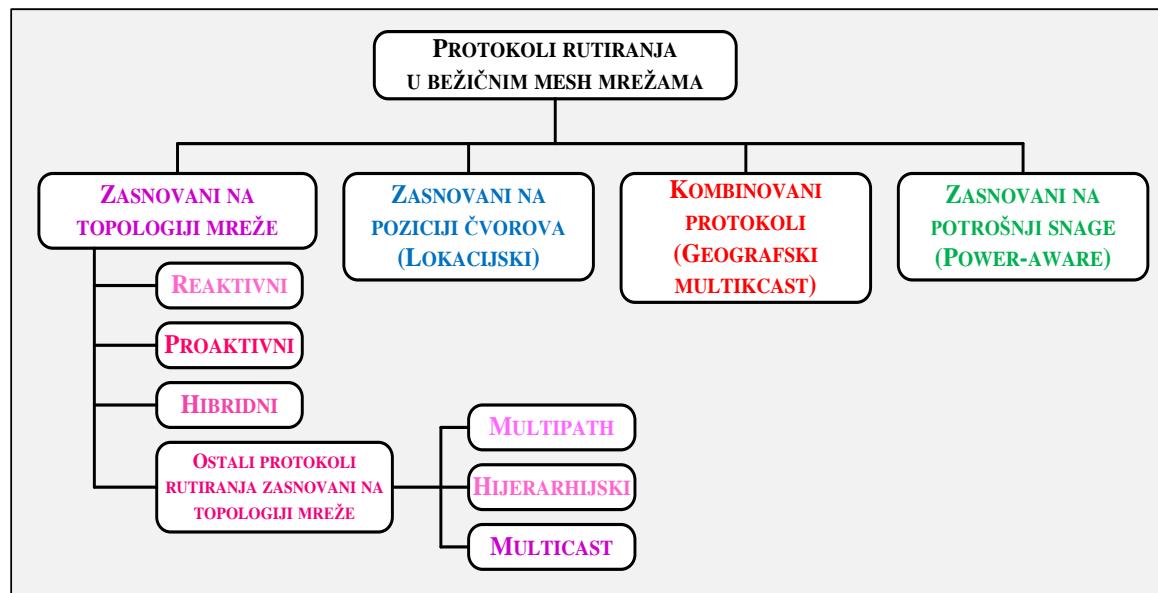
BEŽIČNE MREŽE – CELULARNI SISTEMI
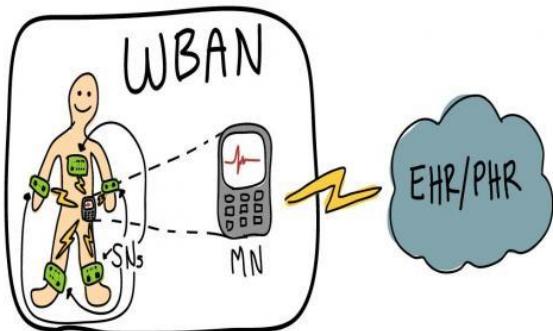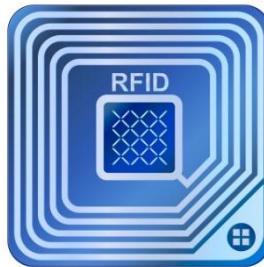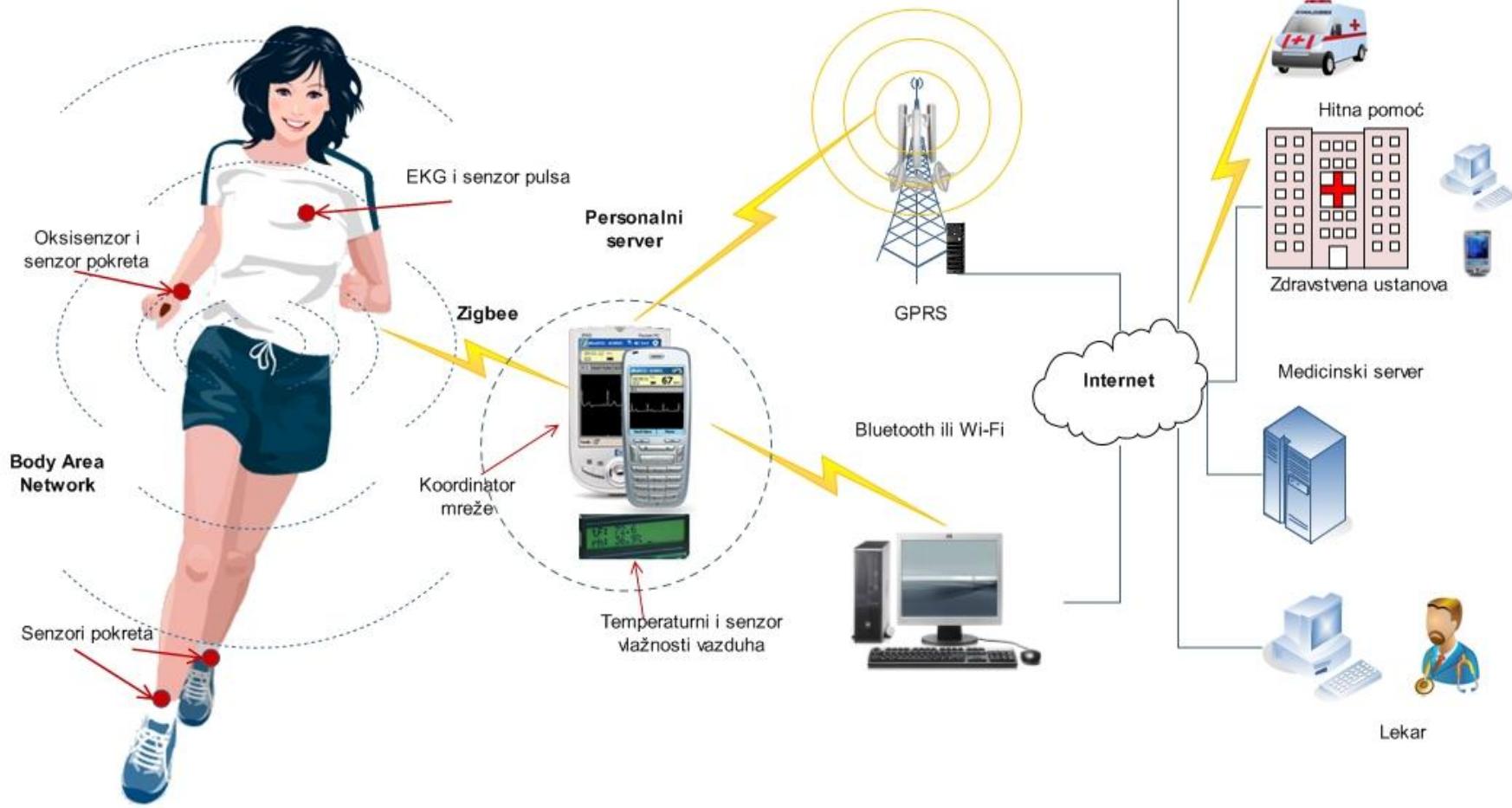
BEŽIČNE LOKALNE MREŽE - WLAN


```
                    PROTOKOLI RUTIRANJA
                  U BEŽIČNIM MESH MREŽAMA
                            │
        ┌─────────────┬─────────────┬─────────────┐
        │             │             │             │
  ZASNOVANI NA   ZASNOVANI NA  KOMBINOVANI   ZASNOVANI NA
  TOPOLOGIJI     POZICIJI      PROTOKOLI     POTROŠNJI SNAGE
  MREŽE          ČVOROVA       (GEOGRAFSKI   (POWER-AWARE)
                 (LOKACIJSKI)  MULTIKCAST)
    │
    ├── REAKTIVNI
    │
    ├── PROAKTIVNI
    │
    ├── HIBRIDNI
    │
    └── OSTALI PROTOKOLI ─── MULTIPATH
        RUTIRANJA ZASNOVANI
        NA TOPOLOGIJI MREŽE ─ HIJERARHIJSKI
                            │
                            └ MULTICAST
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BEŽIČNE PERSONALNE MREŽE - WPAN
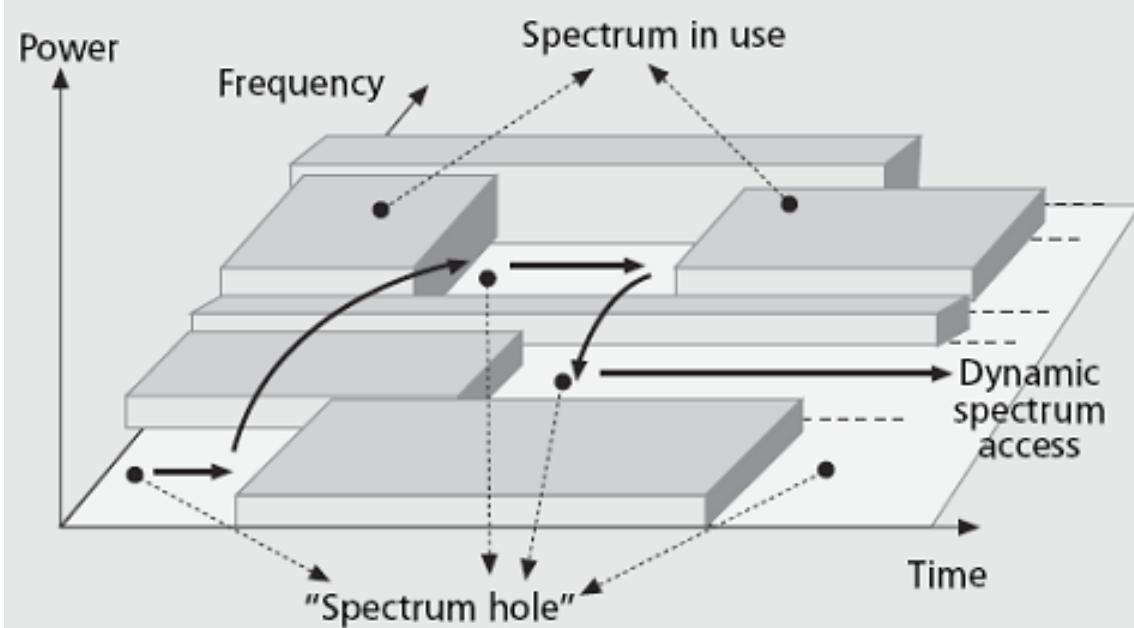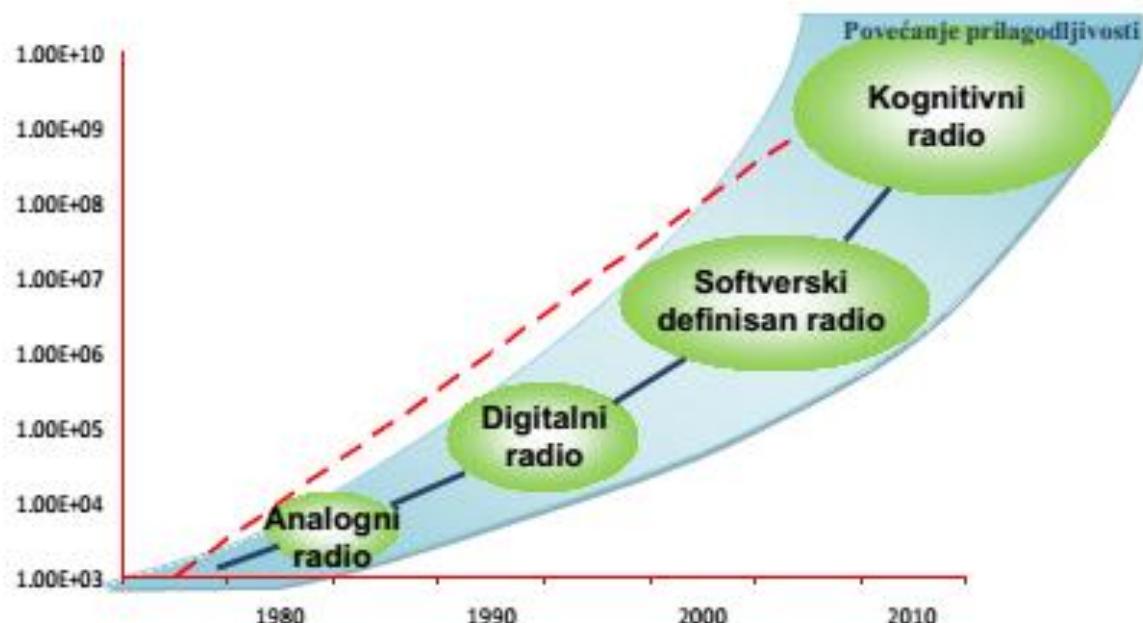
LPWAN
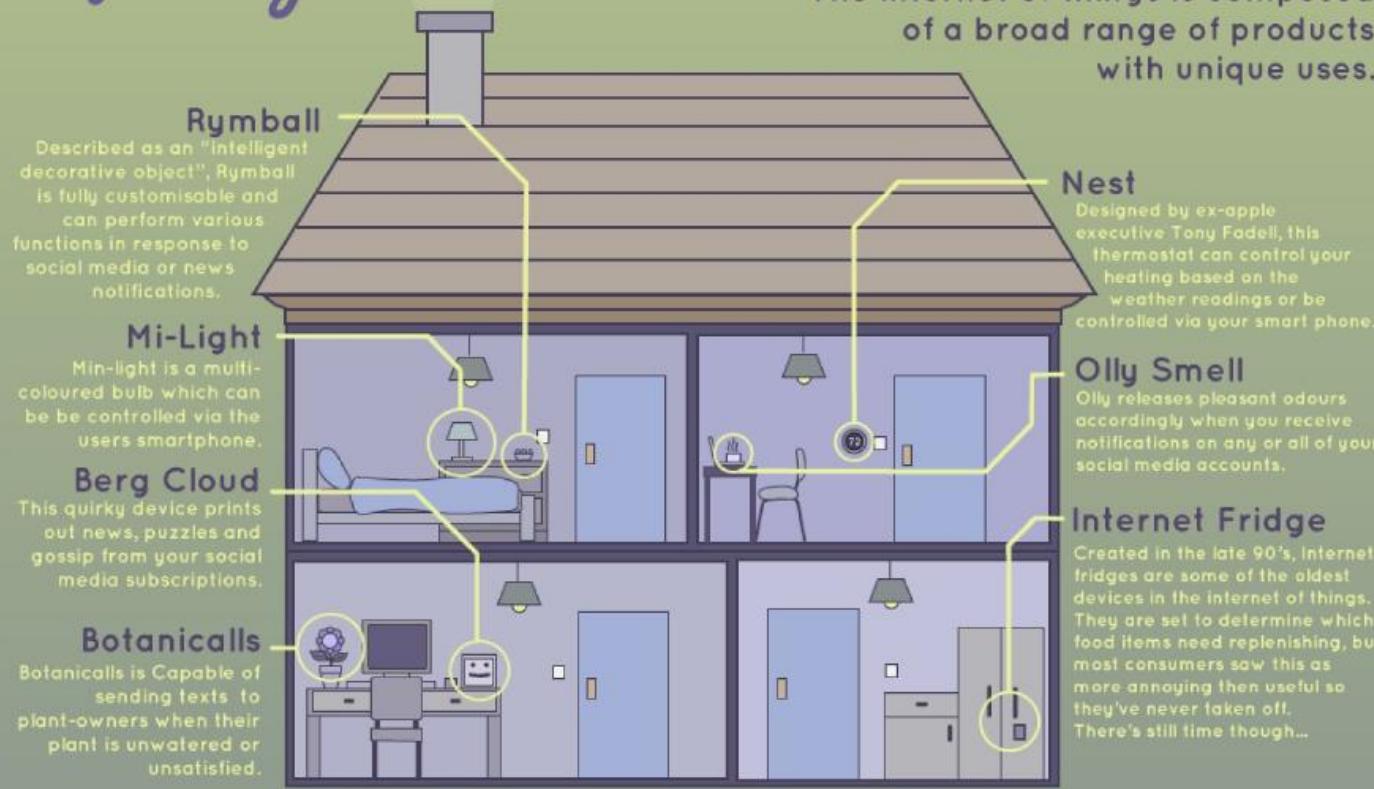
KOGNITIVNI RADIO – CR

INTERNET
Of things

The internet is no longer predominantly accessed by PC's. More and more non-PC internet connected devices are being created, and their not just smartphones and tablets. The internet of things is composed of a broad range of products with unique uses.

Rymball
Described as an "intelligent decorative object", Rymball is fully customisable and can perform various functions in response to social media or news notifications.

Nest
Designed by ex-apple executive Tony Fadell, this thermostat can control your heating based on the weather readings or be controlled via your smart phone.

Mi-Light
Min-light is a multi-coloured bulb which can be be controlled via the users smartphone.

Olly Smell
Olly releases pleasant odours accordingly when you receive notifications on any or all of your social media accounts.

Berg Cloud
This quirky device prints out news, puzzles and gossip from your social media subscriptions.

Internet Fridge
Created in the late 90's, Internet fridges are some of the oldest devices in the internet of things. They are set to determine which food items need replenishing, but most consumers saw this as more annoying then useful so they've never taken off. There's still time though...

Botanicalls
Botanicalls is Capable of sending texts to plant-owners when their plant is unwatered or unsatisfied.

Population of things

Over the past decade, the amount of things connected to the internet has exceeded the amount of people living on earth.

2003 **2010** **2015** **2020**

It is estimated that by 2020, the internet of things will be populated by over 50 billion internet devices. Approximately seven for everyone on the planet.

Libelium Smart World

Air Pollution
Control of CO$_2$ emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Wine Quality Enhancing
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Sportsmen Care
Vital signs monitoring in high performance centers and fields.

Structural Health
Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Smartphones Detection
Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Electromagnetic Levels
Measurement of the energy radiated by cell stations and and WiFi routers.

Traffic Congestion
Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.

Smart Roads
Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

Intelligent Shopping
Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Noise Urban Maps
Sound monitoring in bar areas and centric zones in real time.

Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis
Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Item Location
Search of individual items in big surfaces like warehouses or harbours.

Quality of Shipment Conditions
Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Golf Courses
Selective irrigation in dry zones to reduce the water resources required in the green.

Waste Management
Detection of rubbish levels in containers to optimize the trash collection routes.

Smart Parking
Monitoring of parking spaces availability in the city.

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