FACTORS THAT INFLUENCE THE DISTRIBUTION OF WIRELESS NODES IN URBAN ENVIRONMENT

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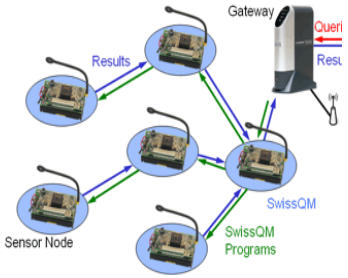
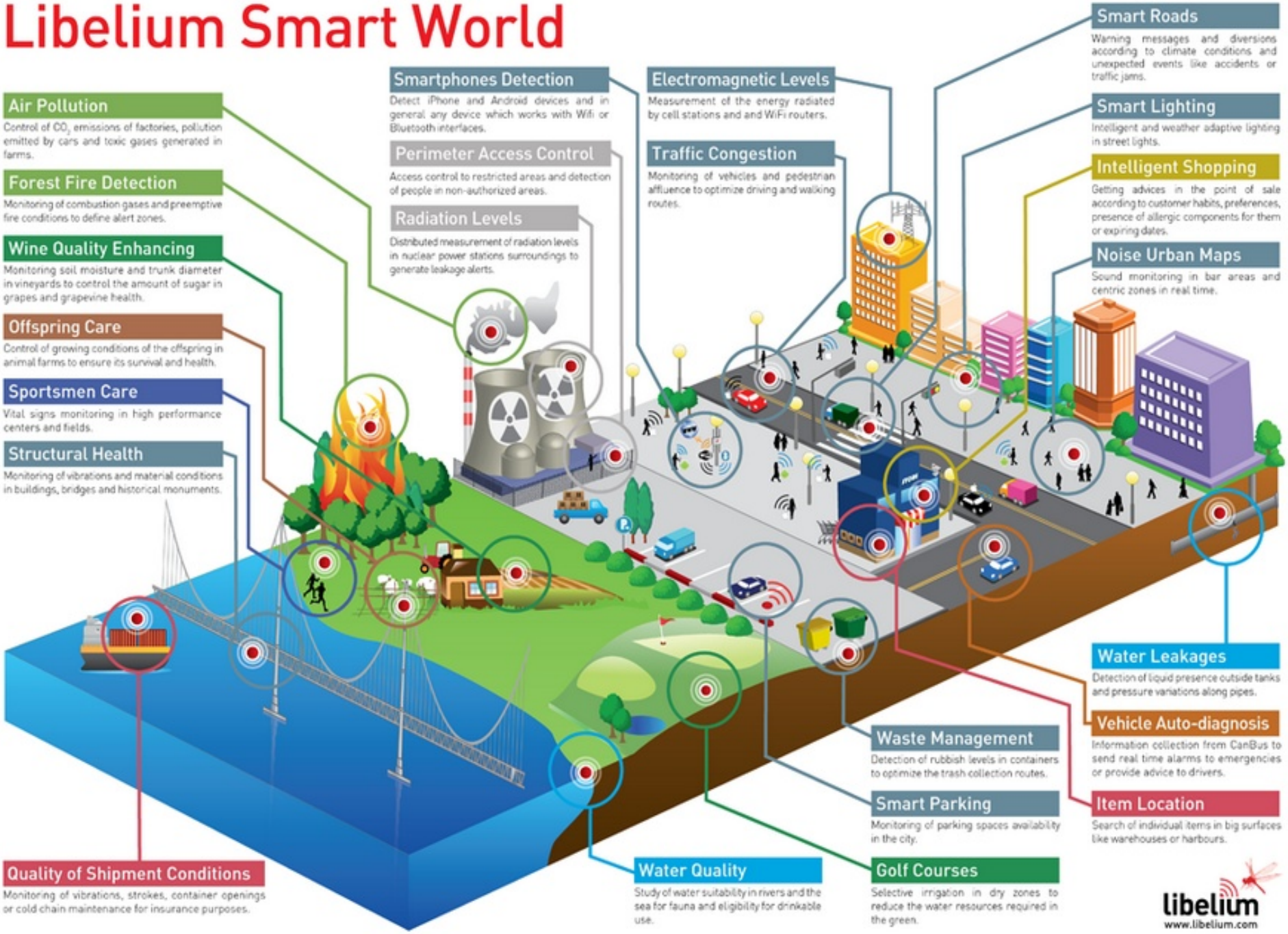
WIRELESS SENSOR NETWORK (WSN)

- new fast evolving technology that can be used in environmental and socioeconomic domain
- every wireless sensor network consists of:
  - nodes equipped with sensors
  - gateway (gathering point)
  - server (long time storage, visualization)



- every node communicates with the defined node(s) to direct the measured values to a gateway (depends on the used topology)
- electromagnetic waves are used for communication

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.

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

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.

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

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.

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

Smart Parking
Monitoring of parking spaces availability in the city.

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

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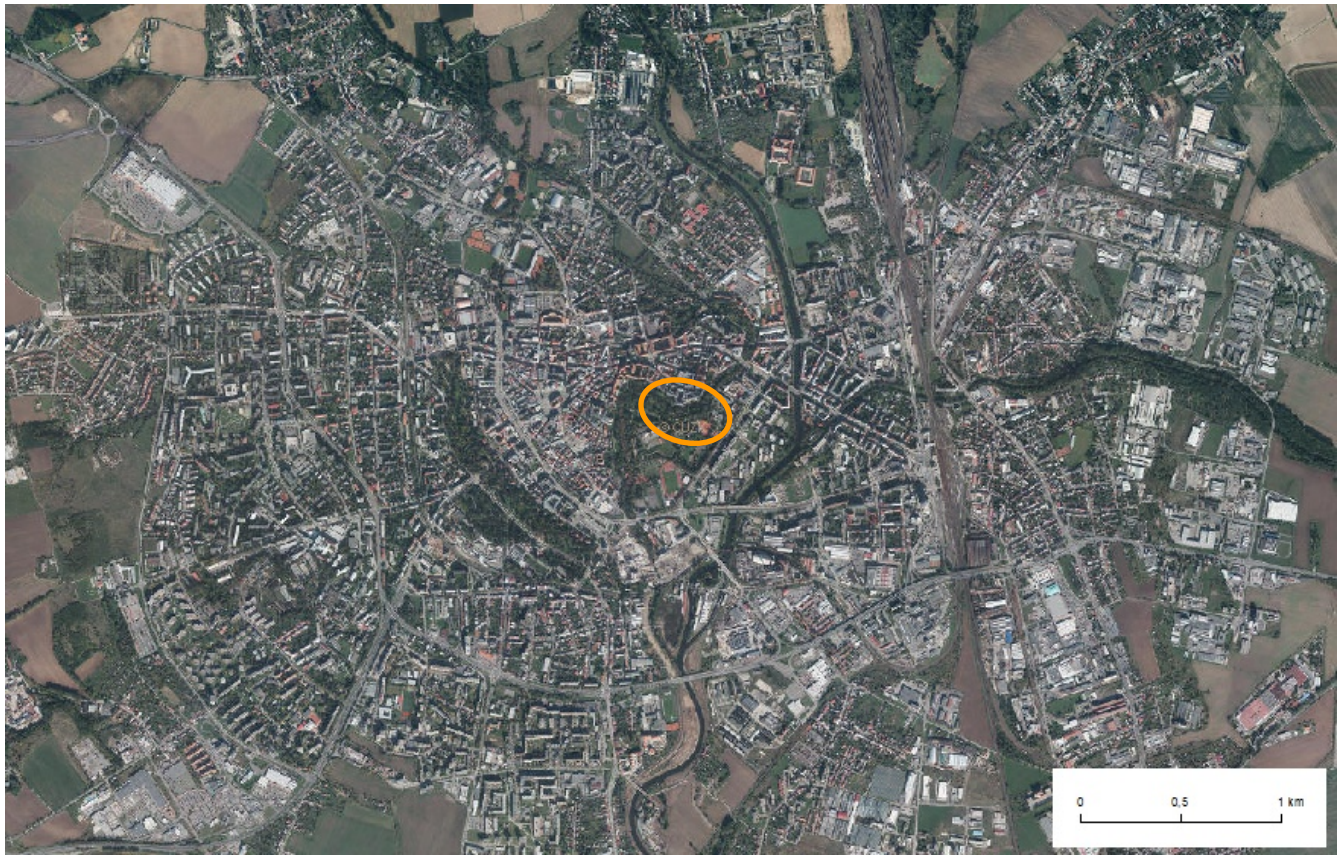
THE RESEARCH AREA



FACTORS THAT INFLUENCE THE DISTRIBUTION OF SENSOR NODES

Factors that influence the distribution of wireless nodes in urban environment can be divided into 3 groups:

- pre – distribution steps,
- technical,
- terrain.

PRE – DISTRIBUTION STEPS

Pre - distribution steps involve determination of:

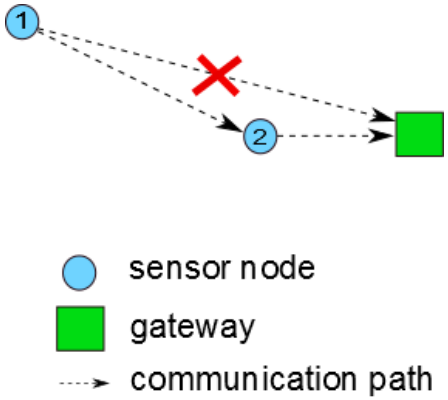
- region of interest (where, size),
- number of sensor nodes in the region of interest,
- height of sensor nodes above ground.

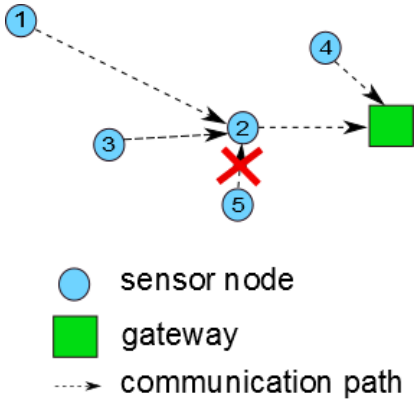
TECHNICAL FACTORS

Technical factors influencing spatial distribution of wireless nodes in the region of interest are:

- battery life,
- communication distance,
- balanced number of neighbours,
- back – up communication paths.

TECHNICAL FACTORS





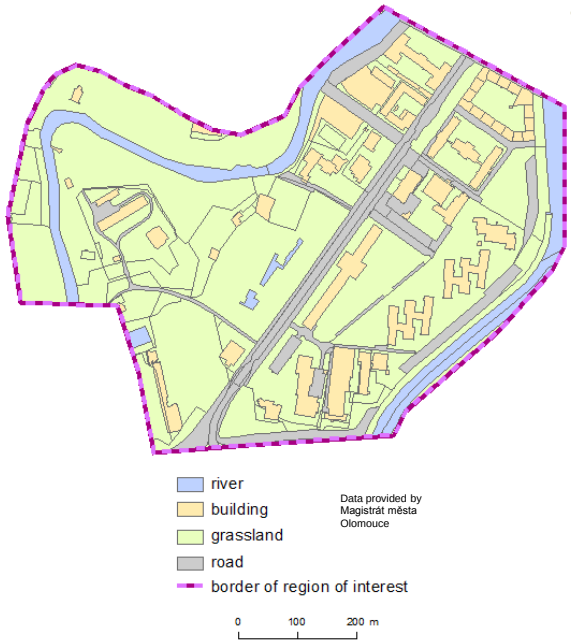
- *battery* consumption in all nodes should be as equal as possible
- battery is discharged with the second power of *communication distance*
- battery is depleted faster when the sensor node has more *neighbours*
- *back up communication paths* represent alternative communication paths (necessary because the short cuts can appear)

TERRAIN FACTORS

Terrain factors including the demands on measured elements are:

- landcover (type),
- obstacles (visibility, quality of signal),
- characteristics of measured elements,
- security,
- property conditions.

TERRAIN FACTORS



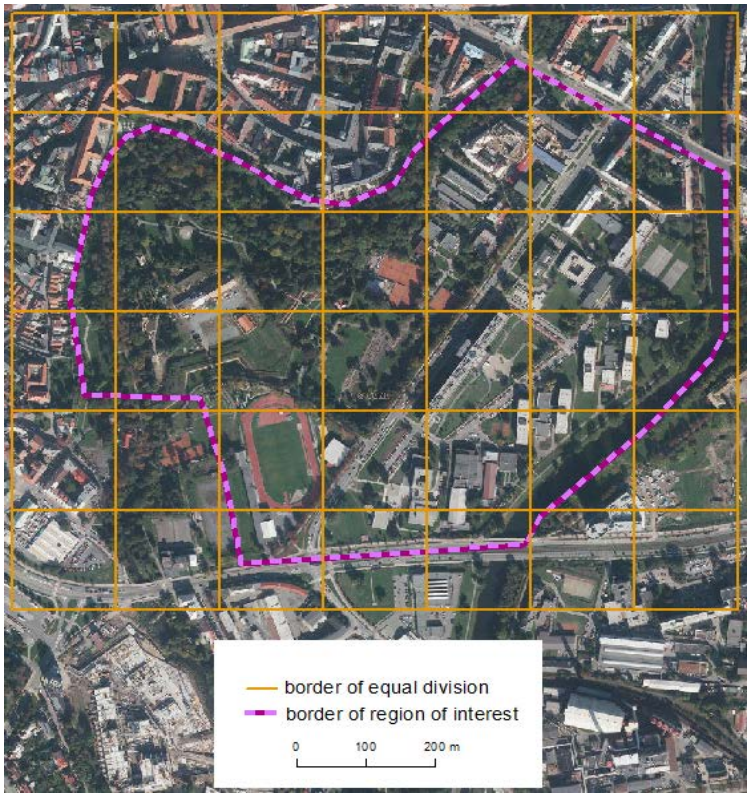
WHAT HAS TO BE KNOWN AT THE BEGINNING OF DISTRIBUTION PROCESS?

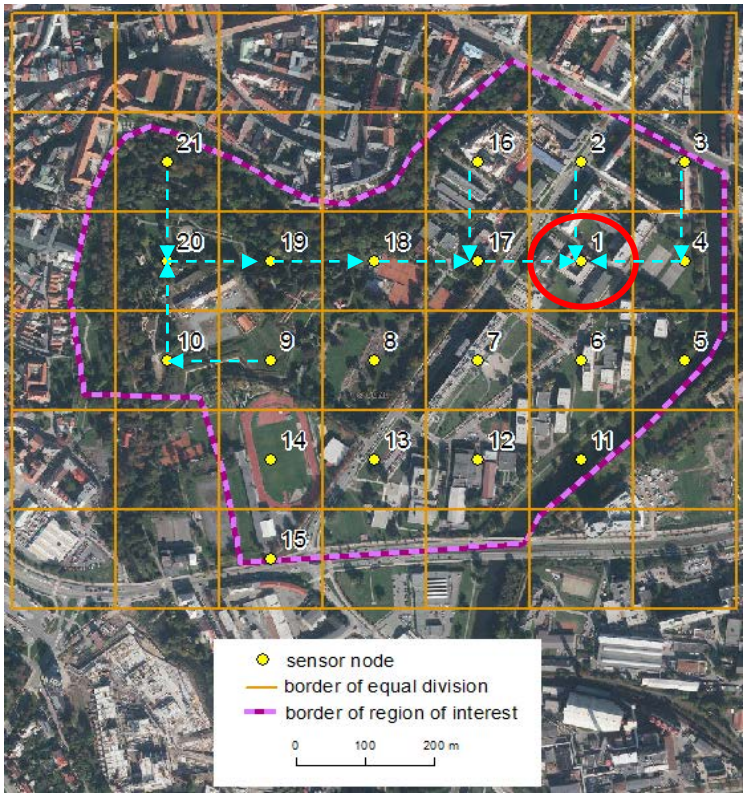
What has to be known?	Suggested values
Size of the region of interest	0.5 km^2
Number of nodes in the region of interest	15
Height of nodes above the ground	2 meters
Position of starting point	KGI
Maximal communication distance	150 meters

ELEMENTARY DISTRIBUTION OF WIRELESS NODES IN THE AREA OF INTEREST

- grid pattern of distribution of wireless nodes
- square edge is as long as the maximal defined communication distance of one node (150 m)
- nodes are situated in the centre of every square
- nodes communicate through the nearest edges so that the communication distance is exactly the same as the maximal defined one
- optimal number of nodes situated in the region of interest is defined on the basis of this division

ELEMENTARY DISTRIBUTION OF WIRELESS NODES IN AREA OF INTEREST

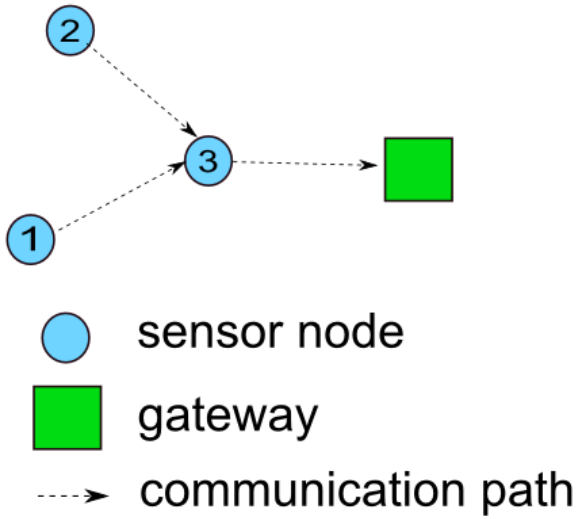




21 nodes, one obtaining data at the same position as gateway

GRAPH THEORY

- communication among wireless nodes can be easily described by a graph



CONCLUSION

- a lot of factors influence distribution of wireless nodes in urban environment
  - Pre-distribution steps
  - Technical
  - Terrain
- factors that influence the distribution of wireless nodes in urban environment were suggested
- graph theory seems to be an appropriate methodology for solving the problem of distribution of wireless nodes in urban environment
- terrain factors can be included in the calculation as weights or are there any other possibilities?

THANK YOU FOR YOUR ATTENTION