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Community Wireless Networks

Resource Management Issues

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"The best way to predict the future is to invent it."
- Alan Kay

Municipal Wireless Networks: Motivations[1]

Public safety and city services

Economic development/job creation

Digital divide/universal access

Enhance tourism and visitor experience

Education

Wireless access to all citizens can be seen as comparable to other communal basic services

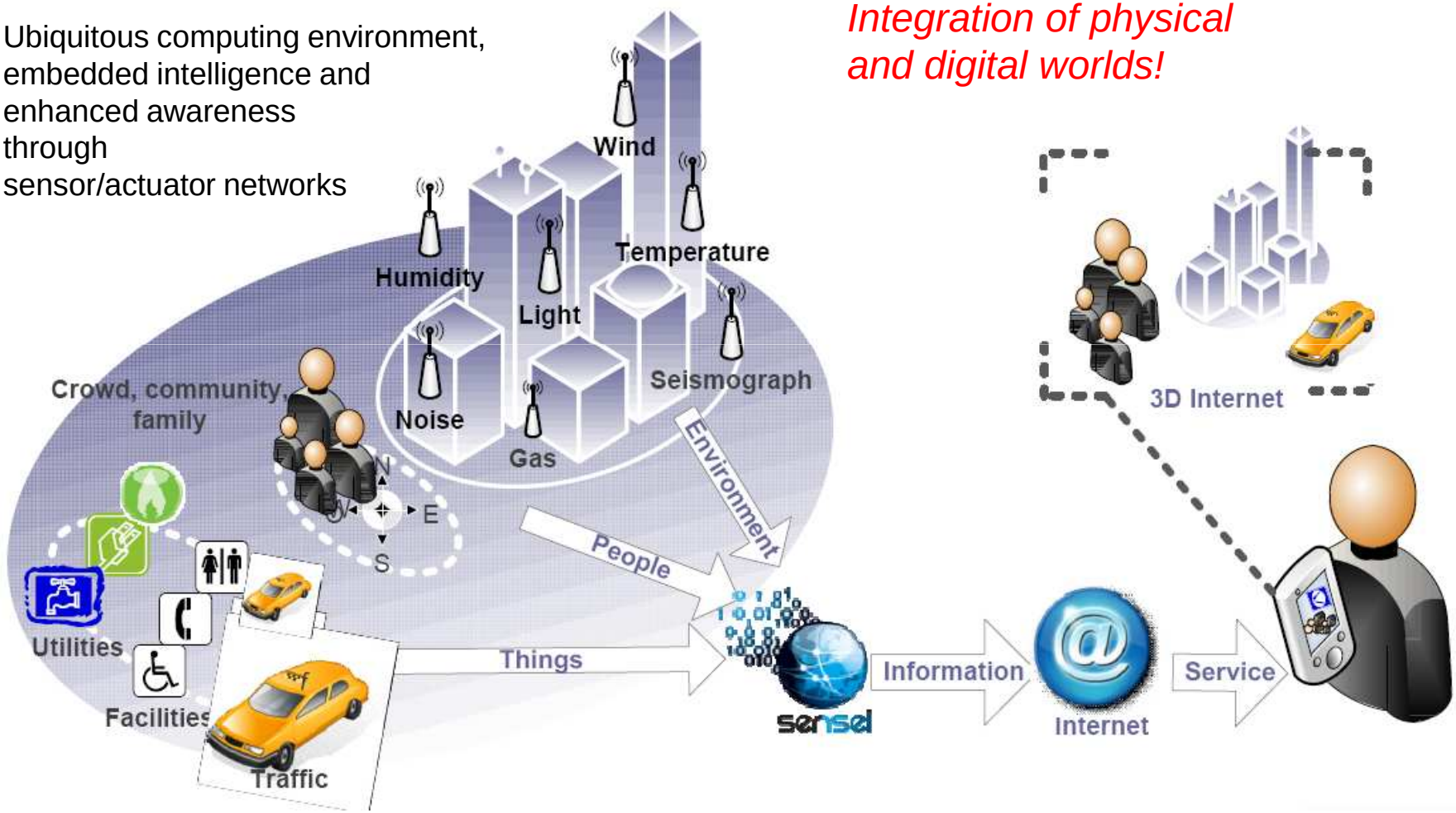
-> Smart Cities

[1] Alvarez and Rodrigues, 2008

Smart City – SENSEI FP7 project

Ubiquitous computing environment, embedded intelligence and enhanced awareness through sensor/actuator networks

Integration of physical and digital worlds!



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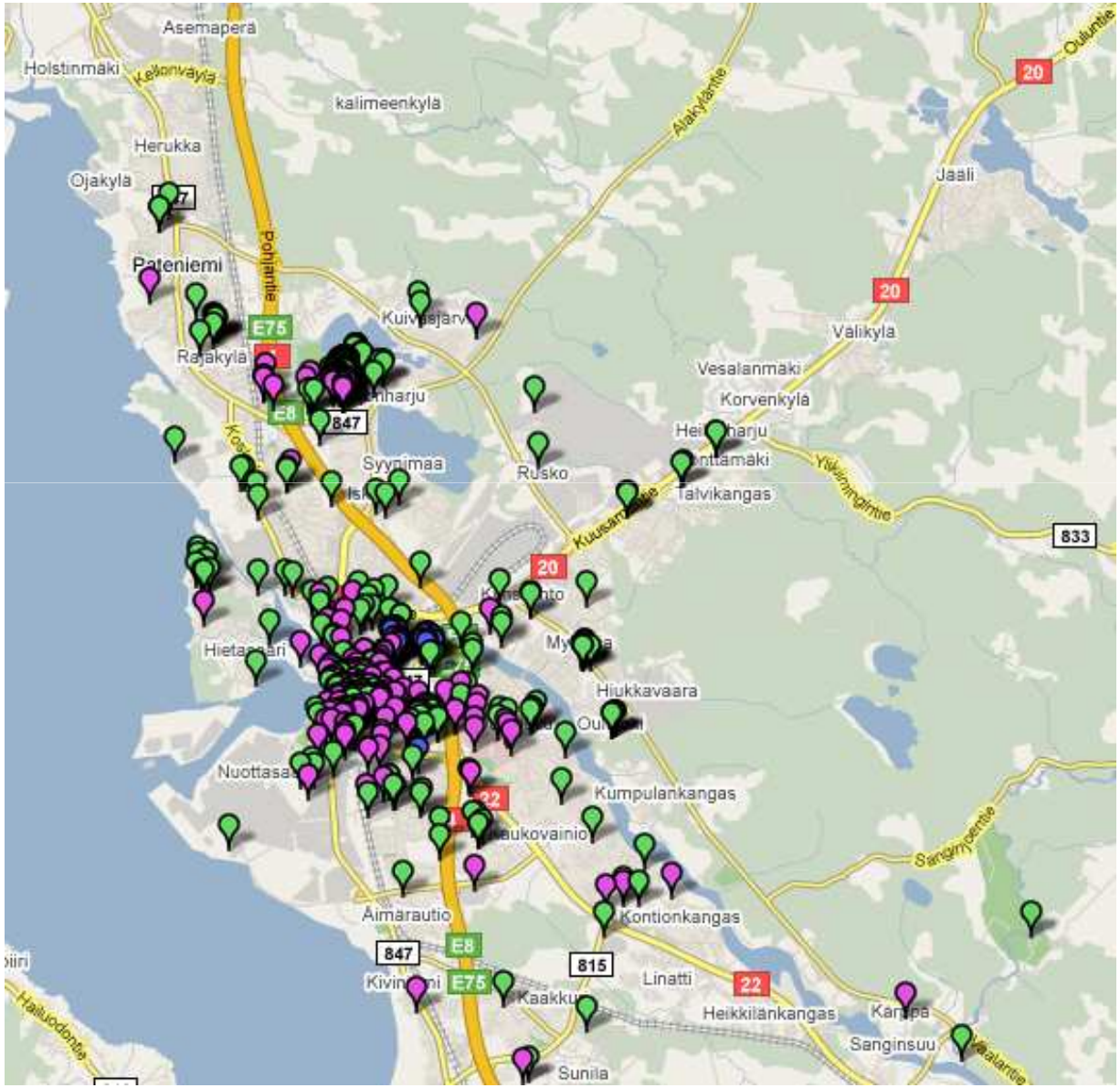

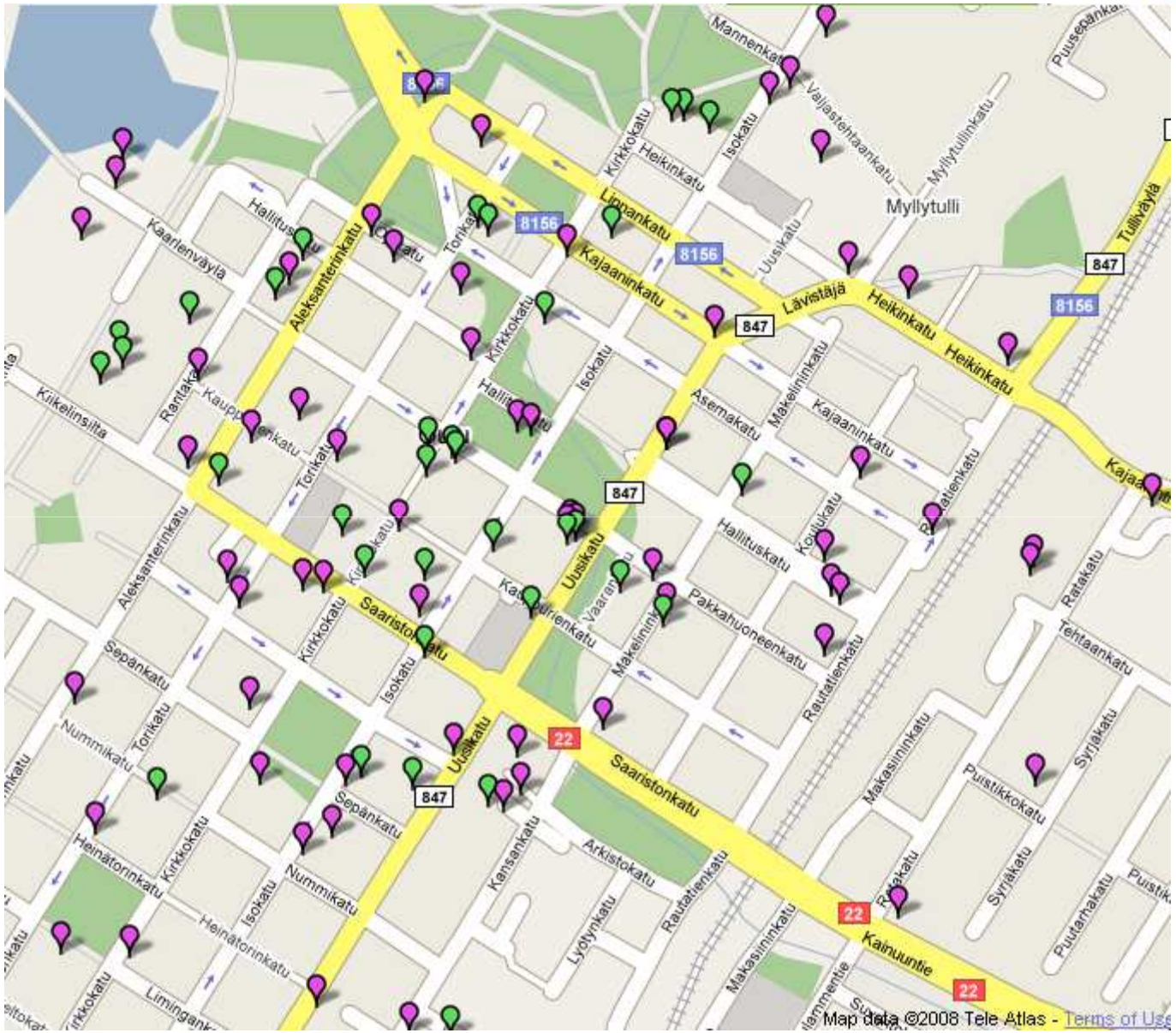
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Community/Municipal wireless

Coverage of community networks can be further enhanced by Private hotspots and Wireless Community Networks

- Maintained by individuals willing to share their fixed highspeed connection
- Alternative network topologies arise: ”neighborhood mesh”

ANYONE can put up an open WLAN network!

There is no guarantee that networks are always set up and maintained correctly!

Mechanisms for autonomous network managent are needed

Cognitive Radio Networks!

Future radio system design should allow:

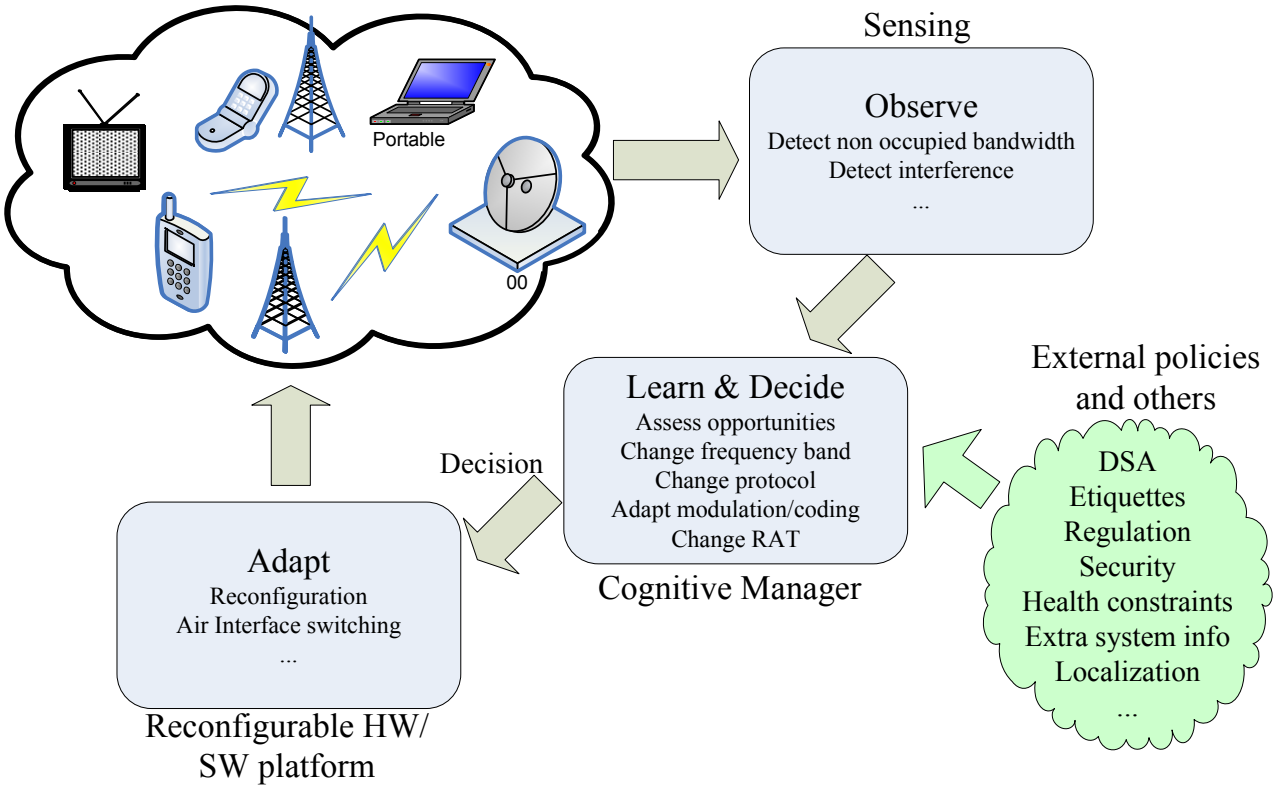
- optimal utilization of multiple wireless interfaces
- large variations in system requirements and network topologies
- evolutionary/adaptive waveform/L1 development
- any kind of system optimization based on its surroundings, radio propagation, interference levels, traffic,...
- and most importantly autonomous network management because
  ->users are stupid, networks must be intelligent

Could CWNs be seen as playgrounds for cognitive networking?

Cognitive Radio

A definition

One could define cognitive radio as an environment aware, self reasoning and learning capable radio that can change any of its parameters or protocols based on interaction with the environment in which it operates.



Software defined radio

The radio equipment

- A multiband radio capable to support different phy solutions.

Cognitive radios

Typically lower layers

- physical layer and signal processing issues such as spectrum sensing.
- Some MAC control issues are addressed, but research on resource allocation is not well covered.

Cognitive radio networks

Intelligent management of networks

- RRM and distributed network control are the key issues.

Ambient networks

(Typically higher layers

- With emphasis on upper layer issues, ambient network (AN) research addresses seamless interoperation of heterogeneous networks.

Autonomic communications

Self-configuring networks

- AC initiative addresses the problem of self-configuring radio research management and MAC.
- Can be conceived as cognitive networks.

Dynamic spectrum access

Frequency sharing view

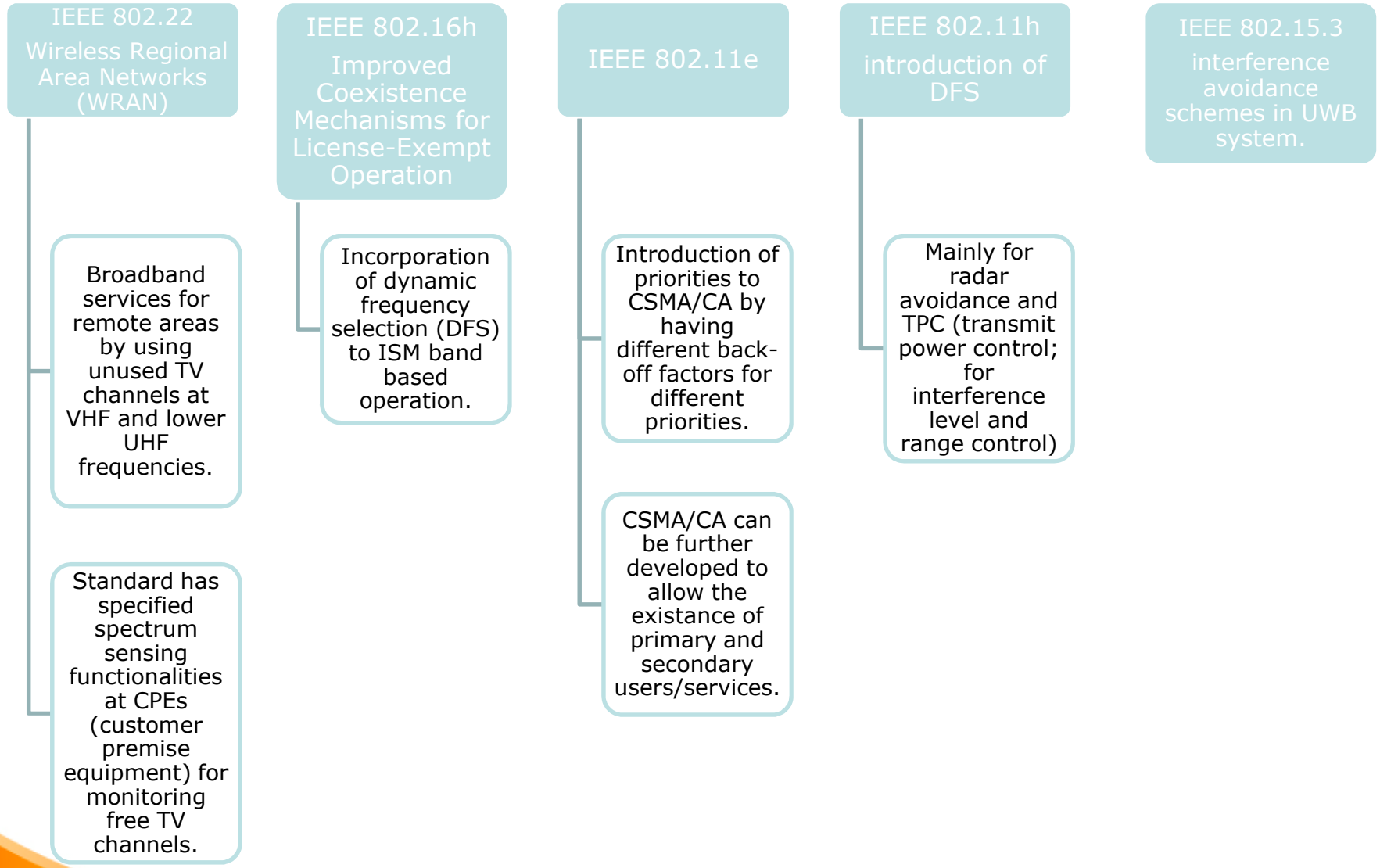
- Try to encompass different approaches to spectrum reform.

Different camps aiming at similar goals!

Scalability issues for future flexible networks

Scalability in **range**:	• Unless heavy centralised information is quaranteed, only local mesh-type solutions are viable; • Is CRN only a local solution?
Scalability in **frequency spectrum**:	• Besides current frequency regulation, RF implementation is a strict limiting factor; • Are antennas spoiling the party?
Scalability in **number of users**:	• As the number of users increases, spectrum usage databases and amount of control increases; • What is the limit for number of networks, nodes and users?
Scalability in **cost**:	• CRs would impose new TRX functionalities such as real-time spectrum scanning; • Could this be managed in cheap terminals?

Some examples of applying DSA or CRs



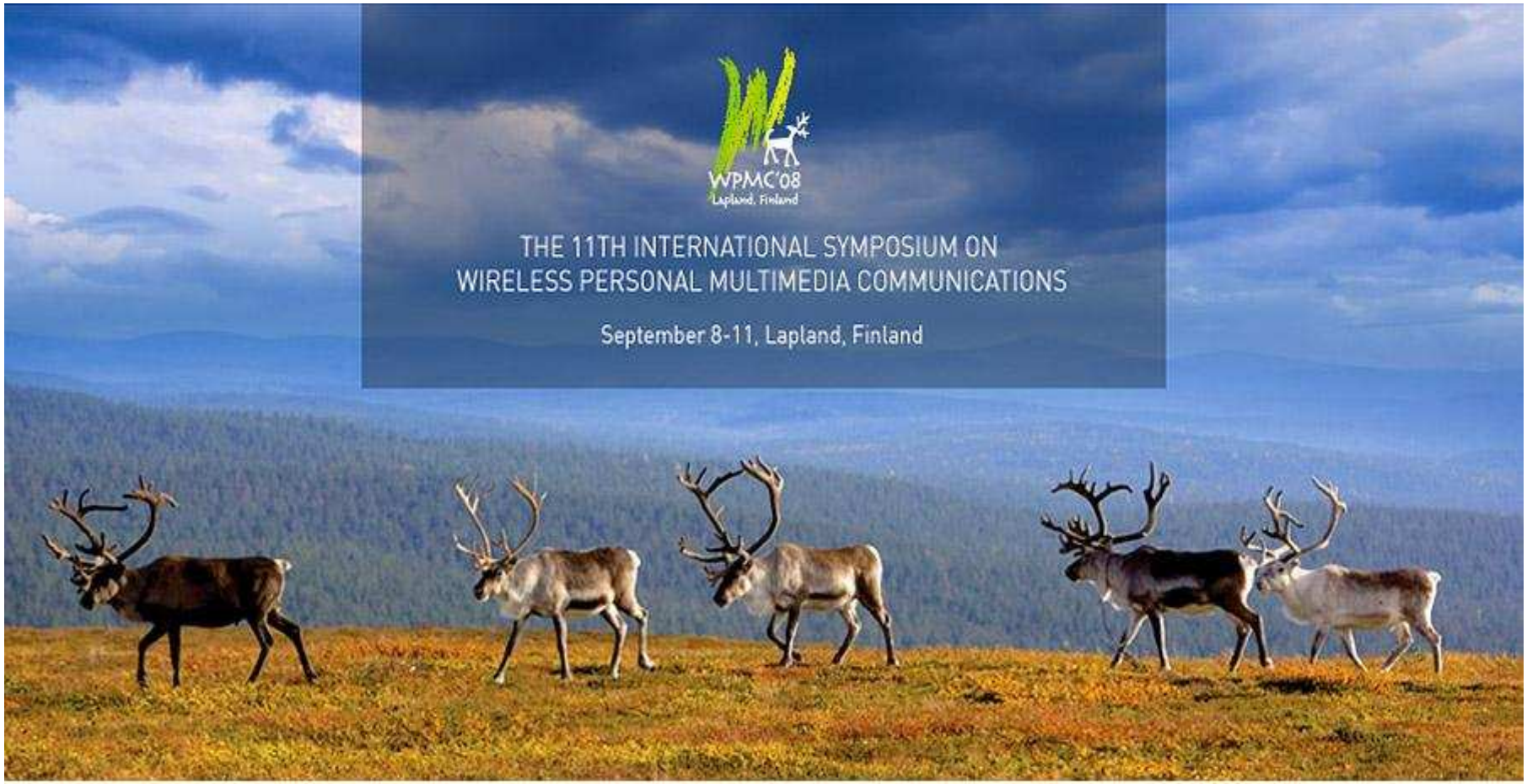
Other interesting developments

More flexibilities in network topologies	•Ad-hoc (802.15, 802.16) •Mesh (802.11s, 802.15.5) •Mobile multihop relays (802.16j)
More and more information will be collected to data bases	•Network management (802.11v, 802.16f, 802.16g) •Radio resource management (802.11k) •Mobility management (802.16i)
Physical layer adaptation based on radio channel behaviour	•MIMO mode selection (diversity, beamforming, spatial multiplexing) •OFDMA user scheduling •Adaptive modulation and coding
Many of these will be deployed in 3G-LTE	•IMT-A/LTE-A dynamic spectrum use is a key element

What else should be done

- Speed up de-regulation so that spectrum sharing amongst some widespread technologies would become possible.
- Allow local mesh-type solutions with lot of independence in network set-up and yet to guarantee connection to ”legacy systems”.
- Augment existing network infrastructures in such a way that all necessary information on spectrum opportunities, available RANs, local channel & traffic behaviour, etc. could be collected and shared efficiently.
- Dramatically improve existing RRM functionalities by deploying CR type approaches.
- Allow MAC adaptation based on interference, channel characteristics, transmission needs & priorities etc.


Thank you!



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