WIRELESS WORLD RESEARCH FORUM®

WWRF - Research views on IMT Technology Evolution

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Outline

WIRELESS WORLD RESEARCH FORUM®

- About WWRF
- 3 technology trends
- System concept evolution
- Technology challenges, enablers and promising research directions

WWRF Role

WIRELESS WORLD RESEARCH FORUM®

- Develop future vision of the wireless world
- Inform and educate on trends and developments
- Bring a wide range of parties together to identify and overcome significant roadblocks to the vision
- Enable and facilitate the translation of the vision into reality

Principles of Operation

WIRELESS WORLD RESEARCH FORUM®

- Global
- Open to all
- NOT
  - A standard body
  - Research funding body
  - A typical research conference
- Based on membership
- All can attend meetings and make contributions

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Current Sponsor Members

Alcatel·Lucent

Nokia Siemens Networks

HUAWEI

NTT docomo

DOCOMO Euro-Labs

中国移动通信 CHINA MOBILE

NOKIA Connecting People

WWRF
Vision in a nutshell (1)

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7 trillion wireless devices
serving 7 billion people
by 2020

- All people will be served with wireless devices
- Affordable to purchase and operate
- Calm computing: technology invisible to users
- Machine to machine communications
  - Sensors and tags: e.g. intelligent transport, smart metering and e-health , to provide ambient intelligence and context sensitivity
- All devices are part of the (mobile) internet

WWRF Vision in a nutshell (2)

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- Wireless device(s) becomes our interface to the digital world
- An ambient life style where
  - … our mobile device becomes the key enabler to interact with smart environments and users
  - … our mobile guides and supports us against "digital threats"
- Has to be charged once a month only – green technology
- Untethered and connected user experience
- Ubiquitous service delivery with a consistent user experience

In Other Words:

Wireless – The Way to Future

Paradigm shifts….

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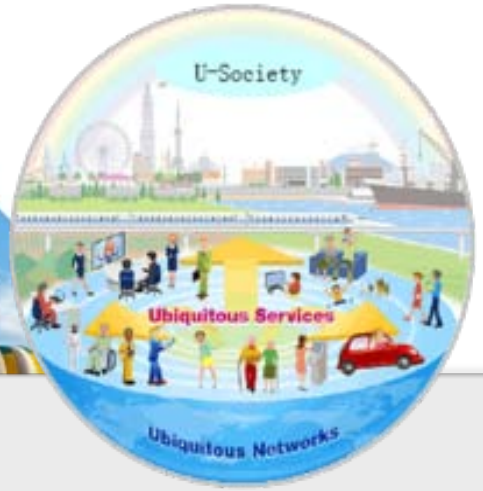
Digital Society



Connected | ICT Enabled | Digitalized

By 2020….

From voice to data

5.5 billion MBB users, 1.5 billion FBB users

From pipe to content

all media will be on-line , 750 million connected TV users

From people to machines

50 billion connections (the Internet of Things)

From CT to ICT

70% of companies (especially SMEs) will be using Cloud-based services

Communications become pervasive

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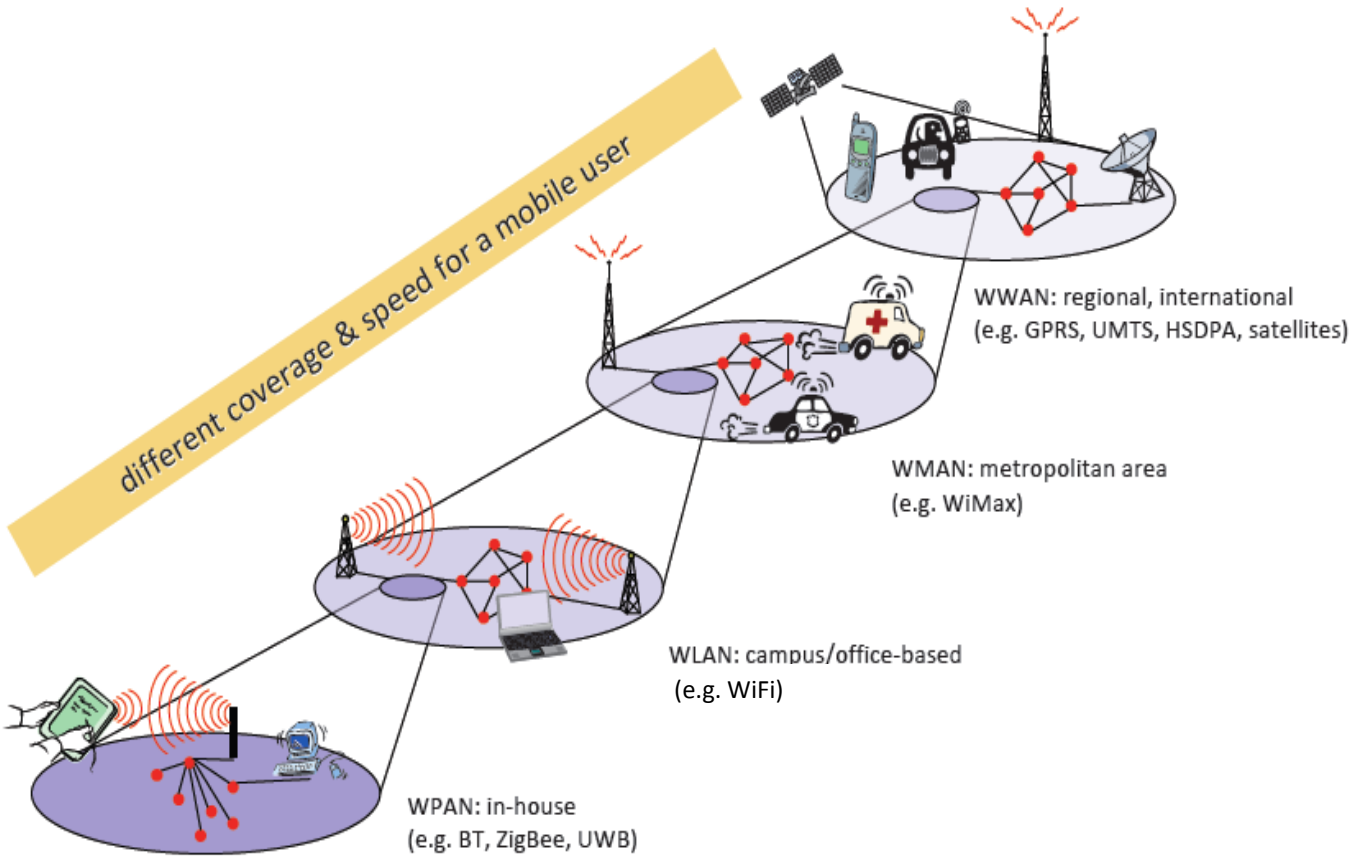
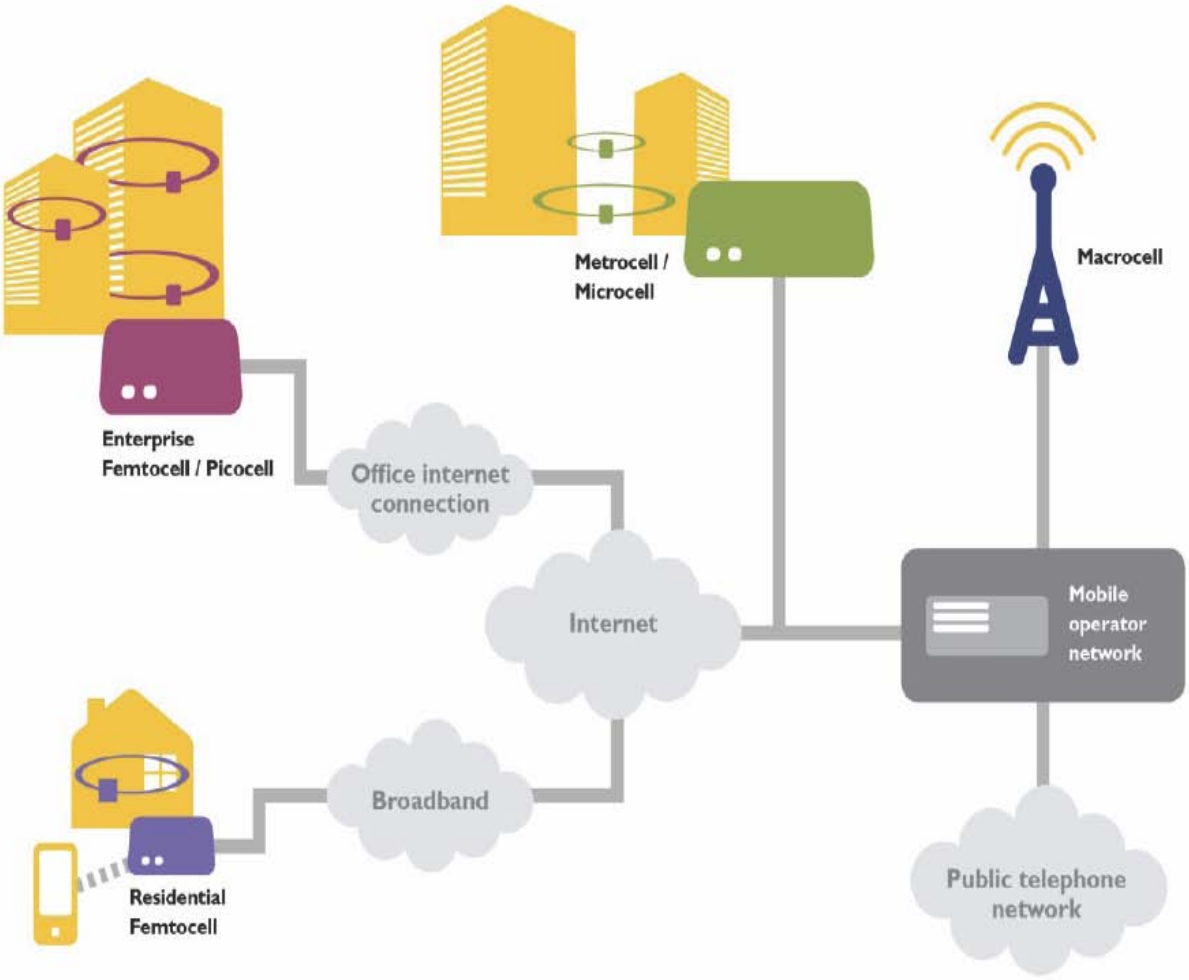
Pervasive Communication Systems consist of a very large number of ***computer-communication devices***, often of small size and/or embedded in the environment, which are able to interact with each other and with mobile users, ***dynamically form telecommunication networks*** and ***probe the environment*** in order to ***adapt and optimize,*** in a **context-aware** fashion, the networks performance and the user experience and QoS.

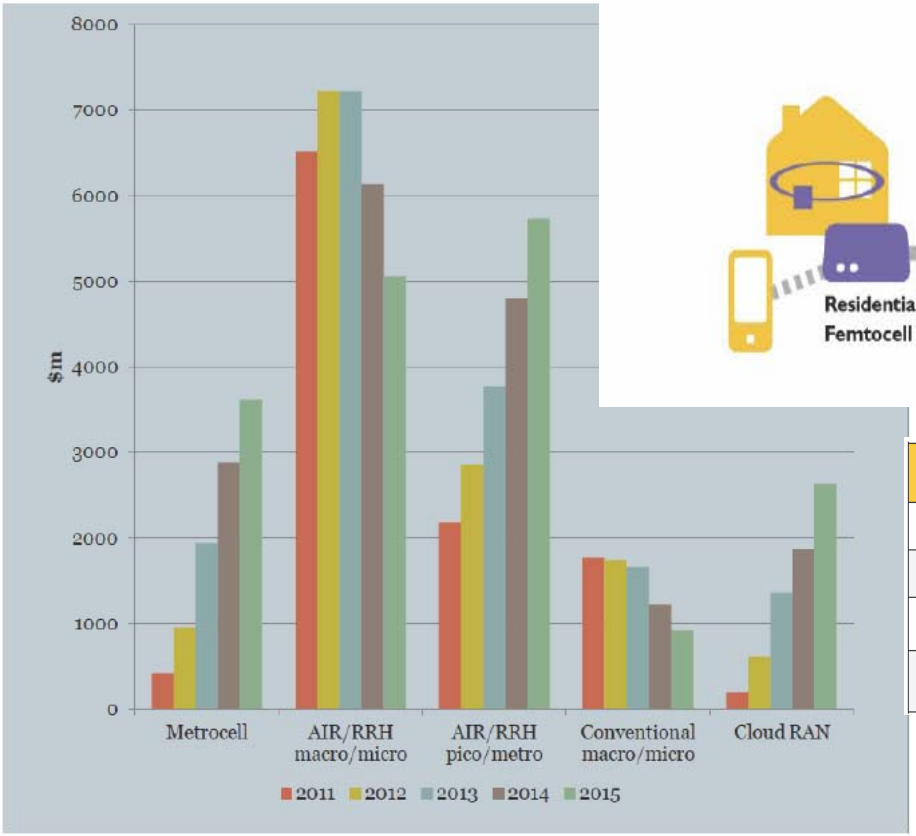
User mobility trends



Small(er) cells



Operator expenditure on small cell infrastructure (Source: Rethink Technology Research)



Technique	Capacity Gain
Frequency Division	5
Modulation techniques	5
Access to wider range of frequency spectrum	25
Frequency reuse through more cell sites	1600

[Source: Small Cell Forum]

Technology trend#1
Multiple Hierarchical Layers architecture or
the disappearing cell

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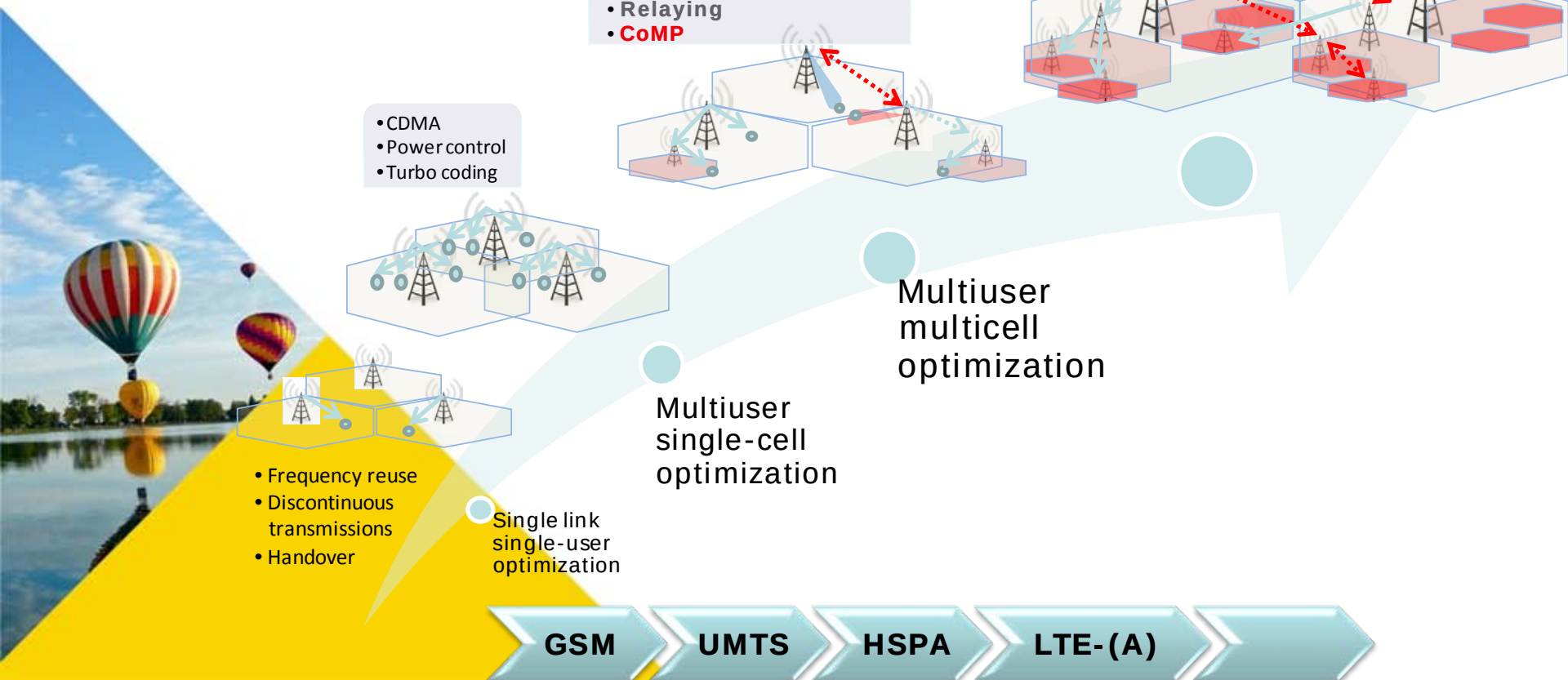

Yesterday's Computers Filled Rooms..

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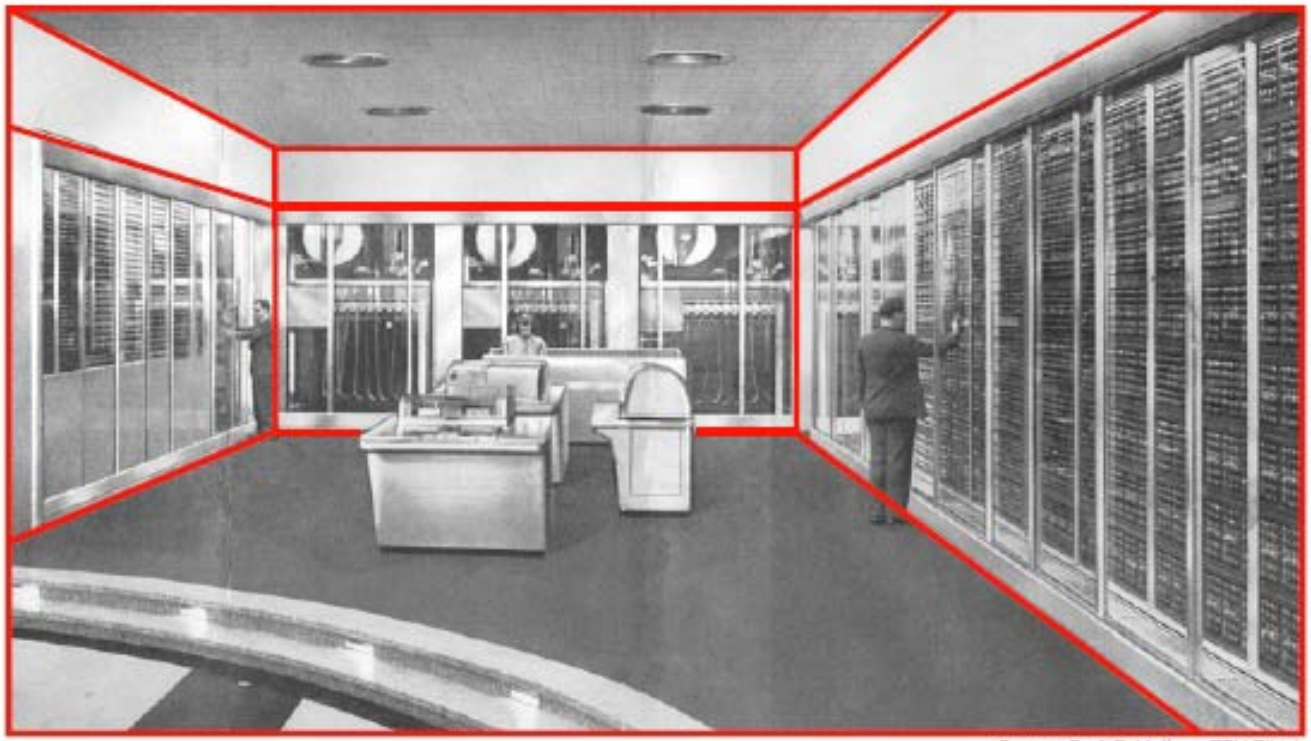

Source: Prof. F. Mattern, ETH Zürich

..So Will Tomorrow's

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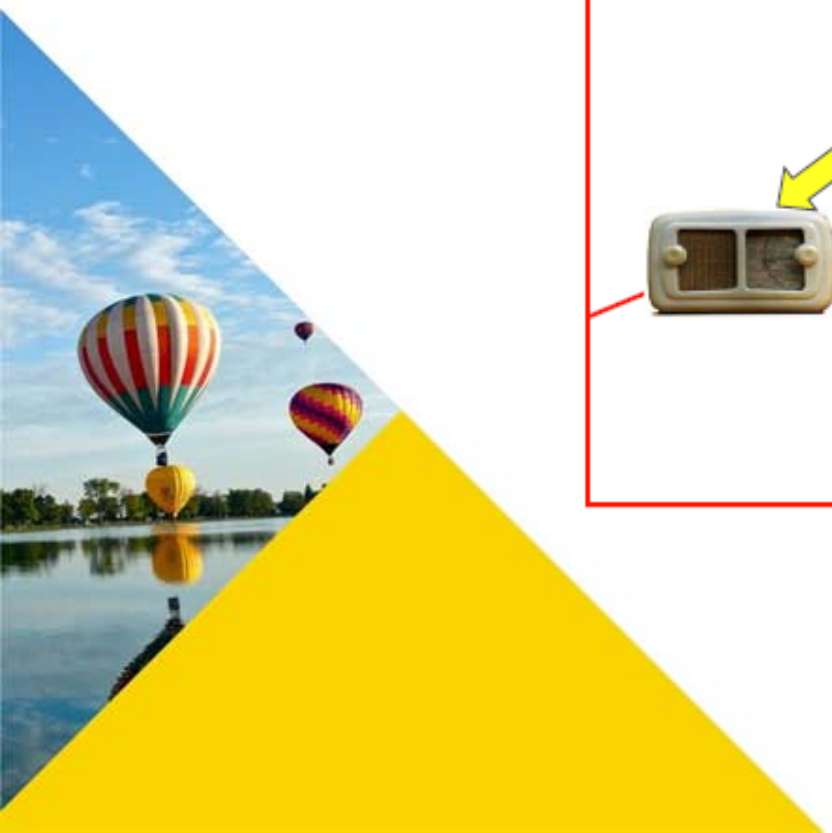

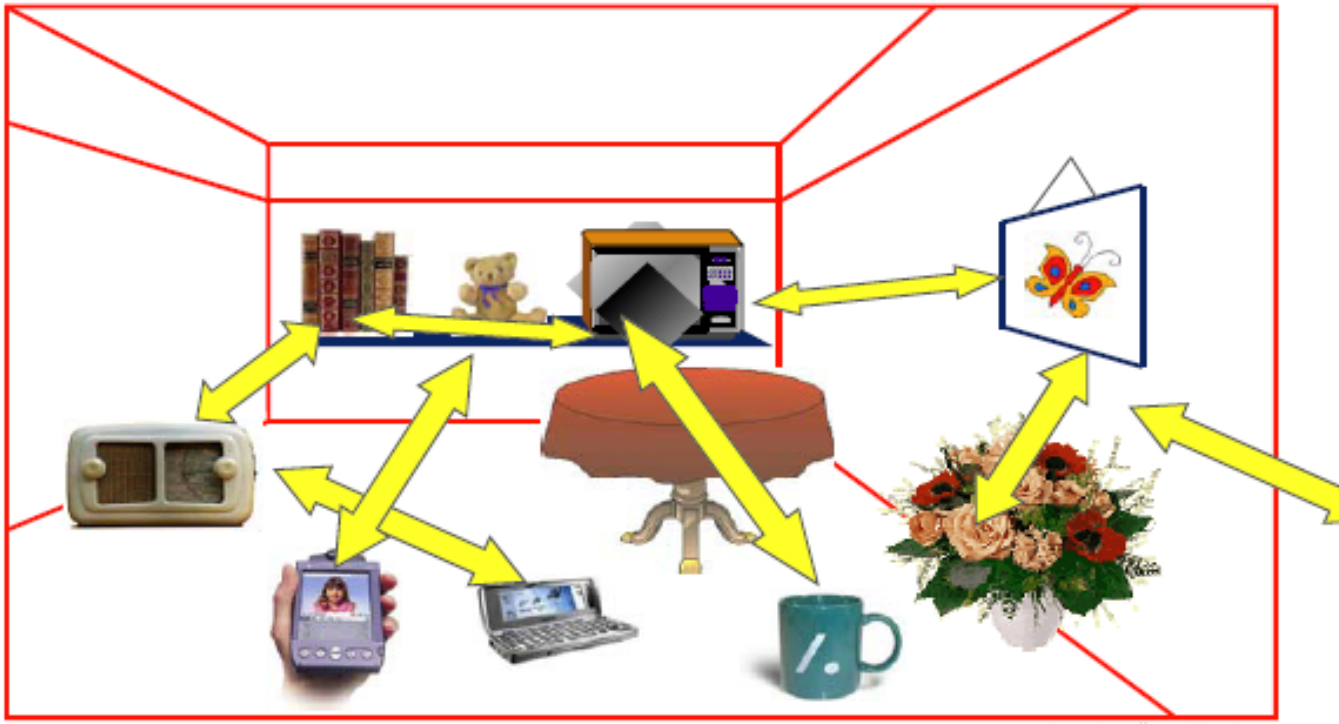

Source: Prof. F. Mattern, ETH Zürich

From Ubiquitous Computing and Pervasive Communications to the Internet of Things

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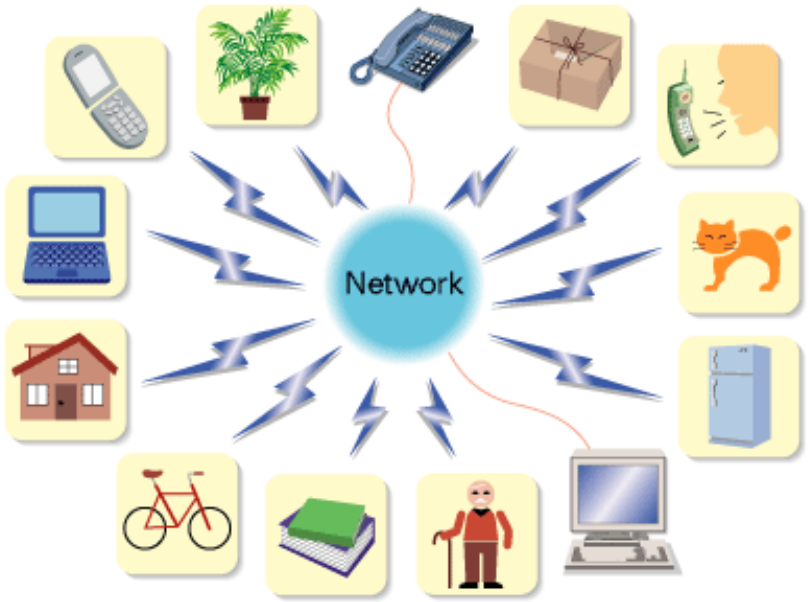
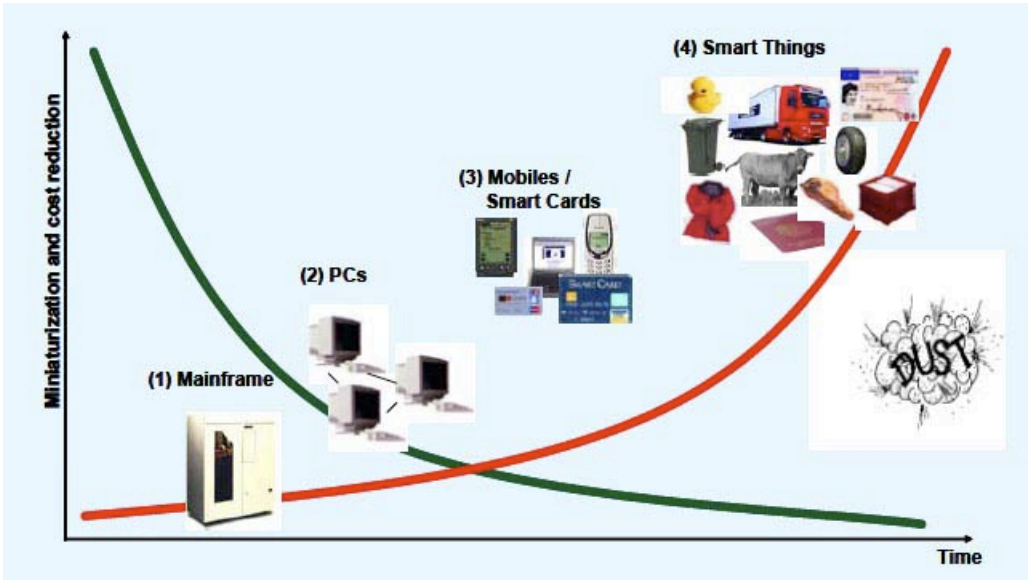


Ubiquitous computing will enable diverse wireless applications, including monitoring of pets and houseplants, operation of appliances, keeping track of books and bicycles, and much more.

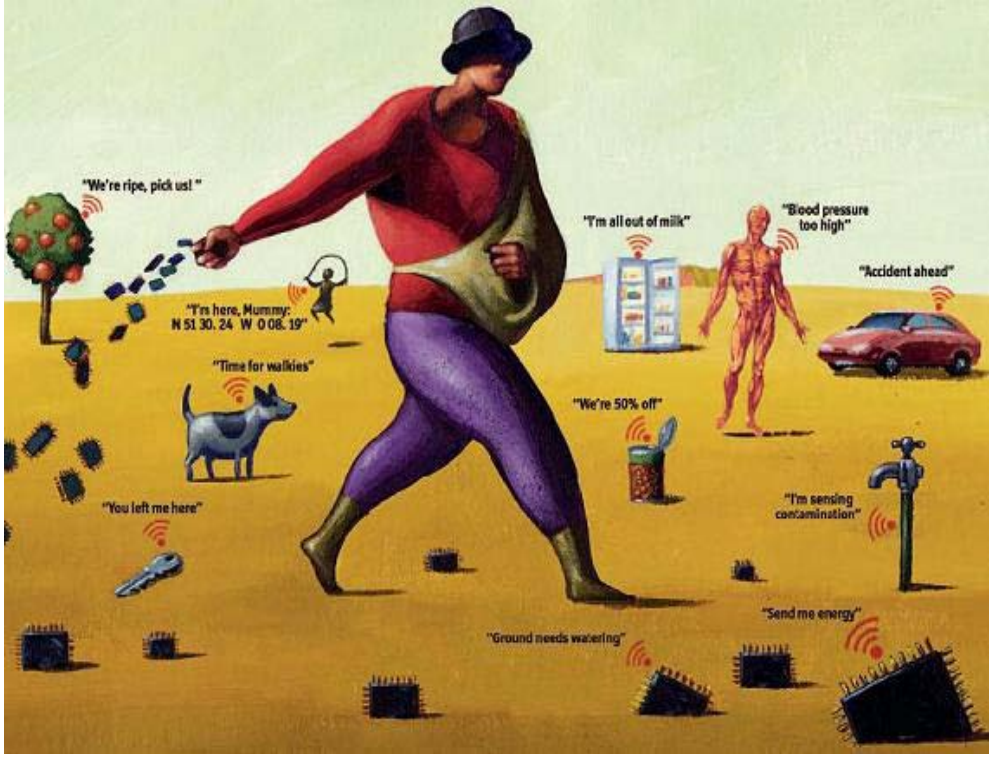


"The Internet of Things is a description of a not-too-distant future time, where everyday objects, rooms and machines have sensors and can "communicate" about themselves and with each other."
(Prof. Elgar Fleisch)

"Things that think want to link", Nicholas Negroponte(MIT)

Technology trend#2
Internet of Things or
the disappearing technology

Wireless Sensor Networks interact with the physical world in the IoT



Potential applications include:

- Industrial/building automation
- Smart office
- Smart home
- eHealth
- Environmental monitoring
- Retail and logistics
- Biometrics for security
- ...

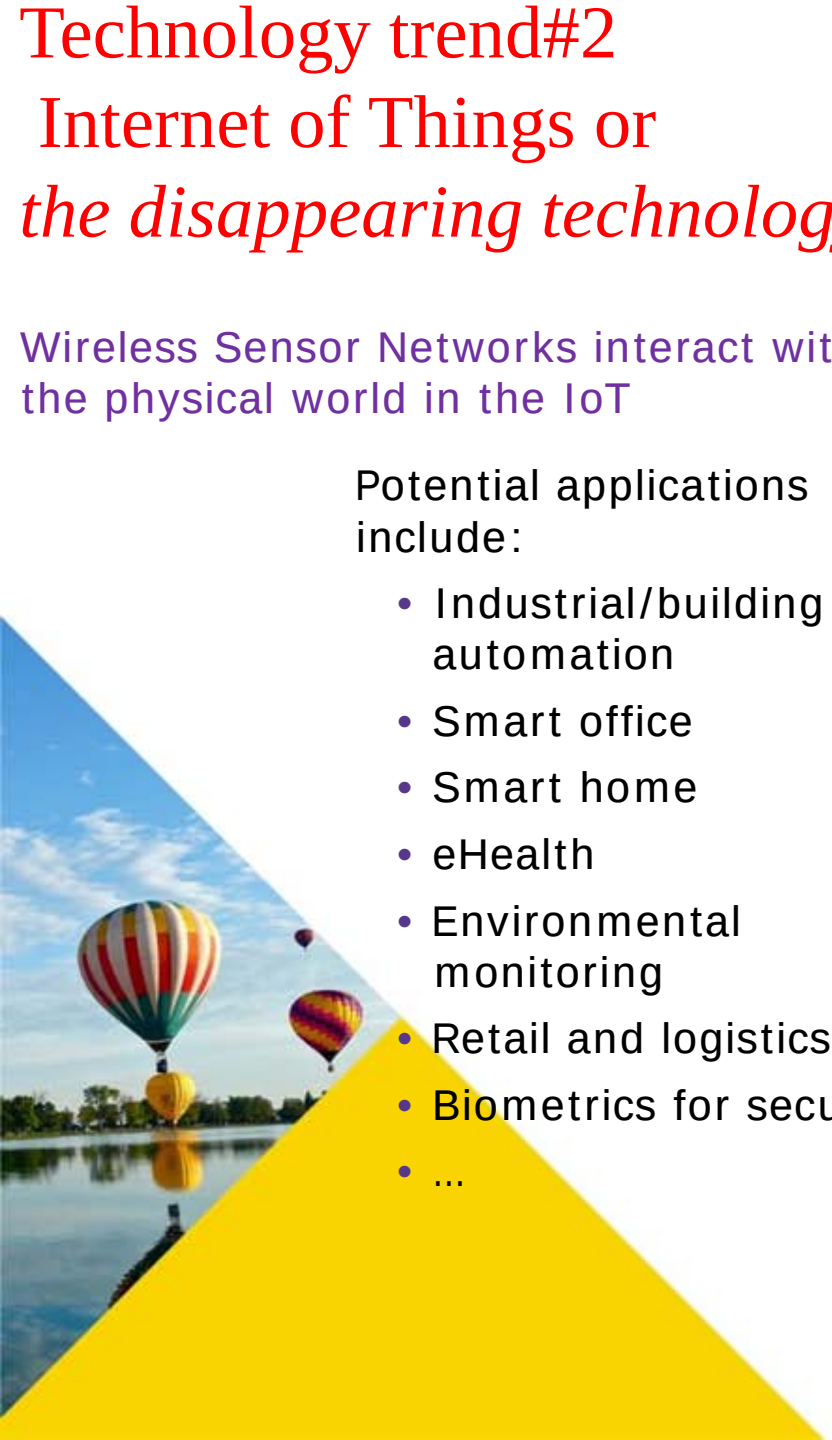
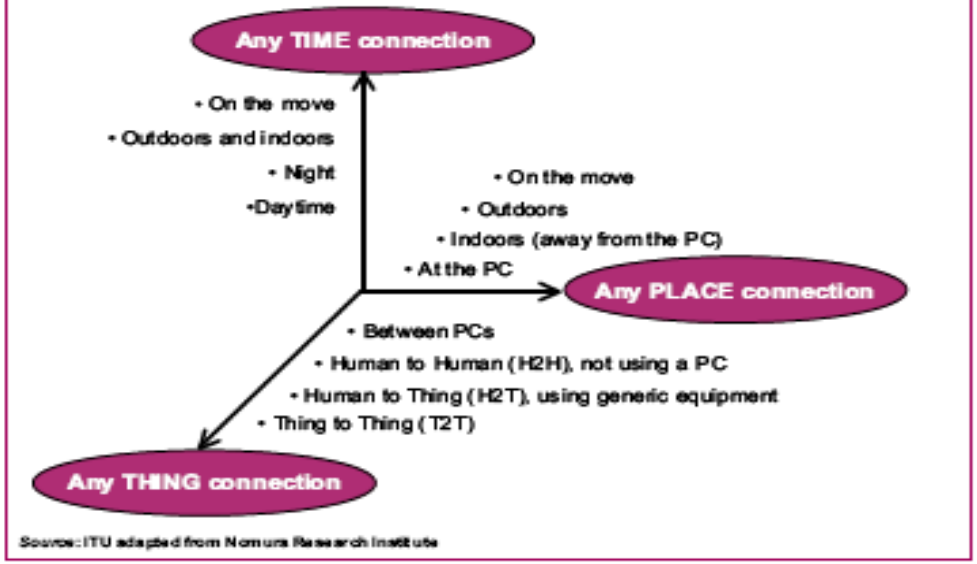


Figure 1 – A new dimension



Source: ITU adapted from Nomura Research Institute

Cloud Computing

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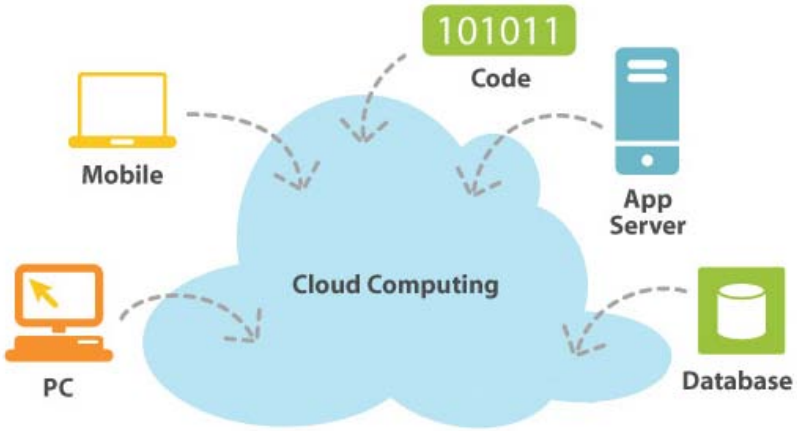
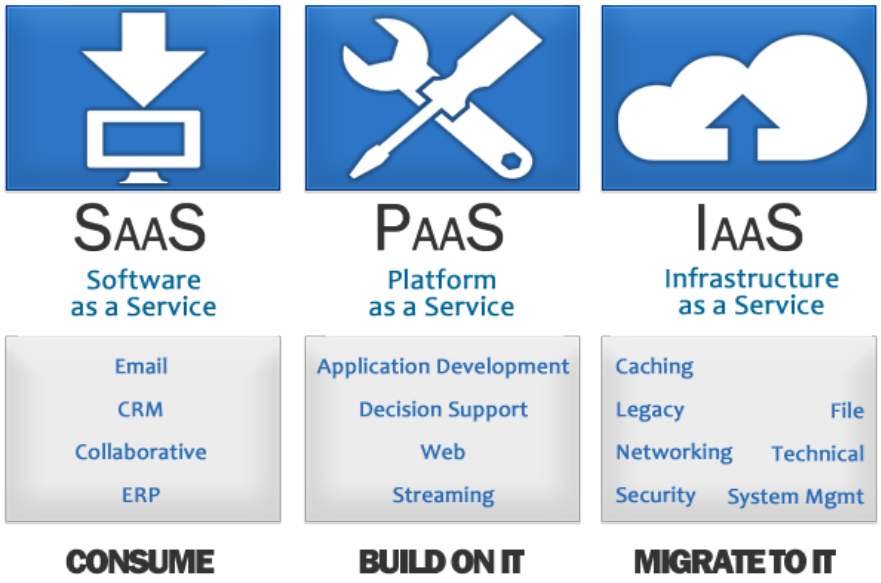
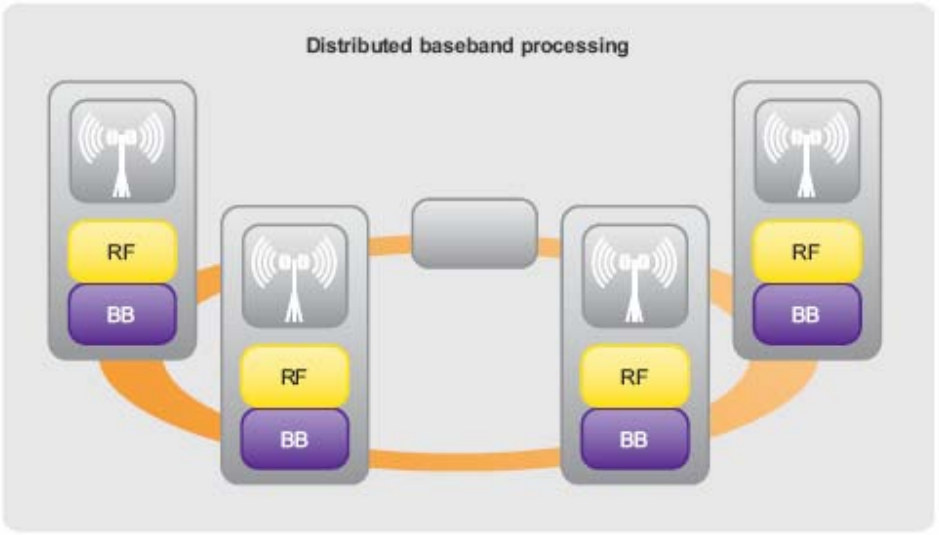
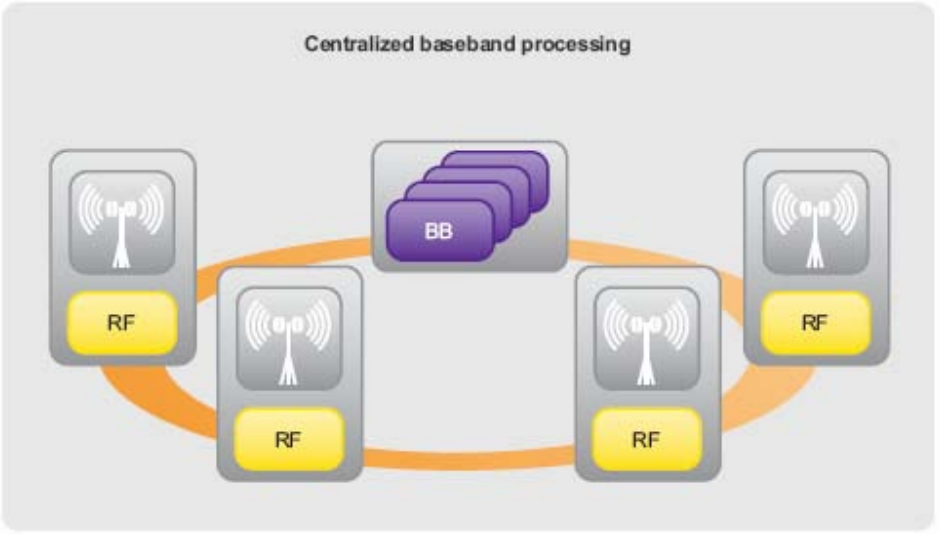


Cloud Computing is needed to address the dynamic, exponentially growing demands for real-time, reliable data processing in the Internet of Things



Distributed versus Centralized network architectures inspired by the Cloud





[Source: NSN "Liquid Radio" white paper]

Technology trend#3
Distributed versus centralized or *the rising Clouds*

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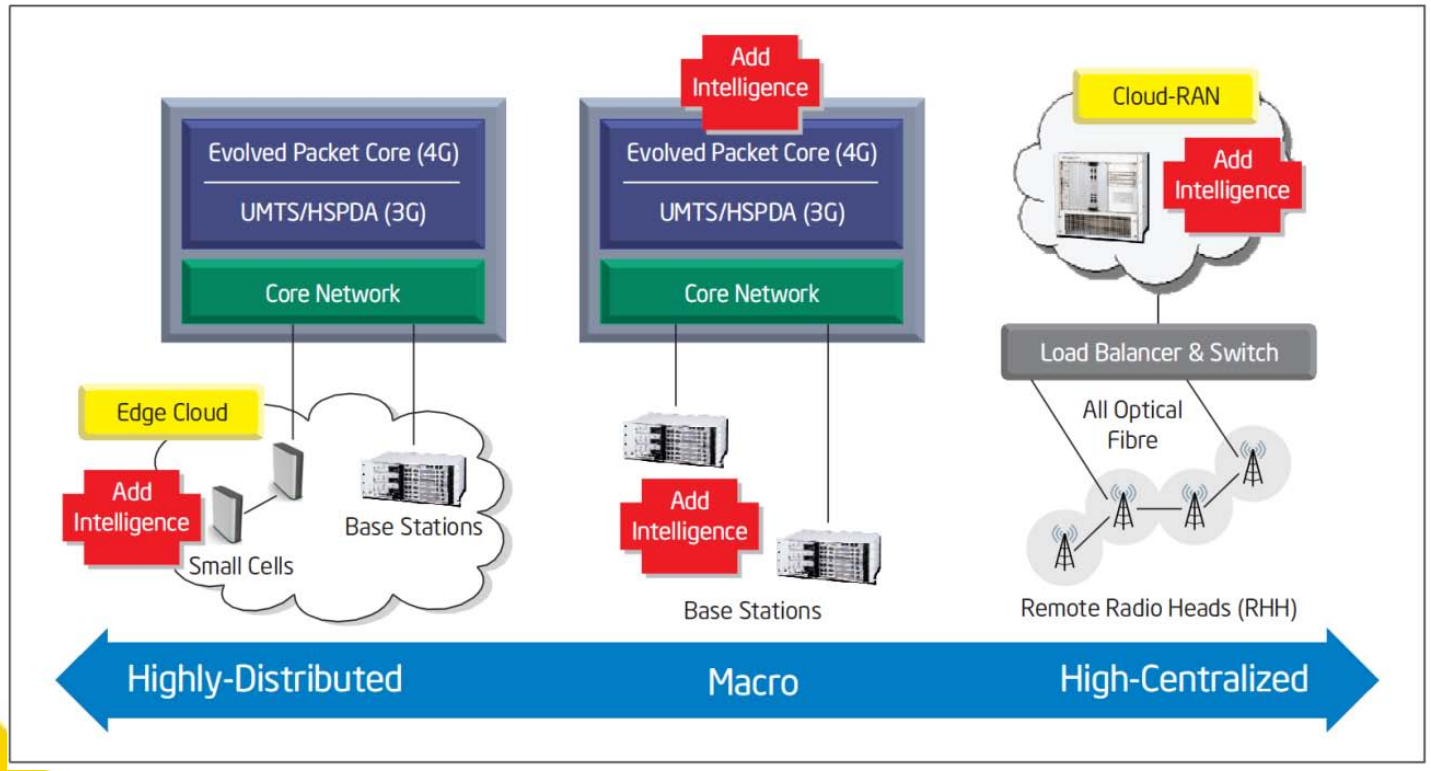

[Source: Intel Heterogeneous Network Solution Brief]

Prevailing business models?

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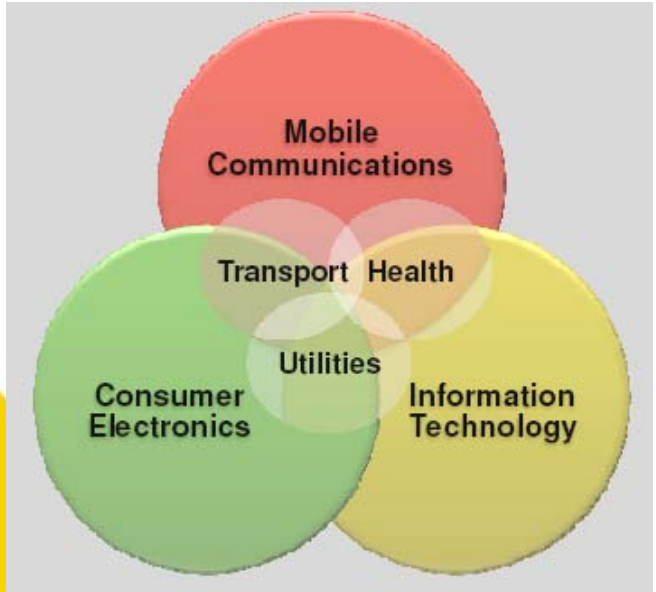
Killer apps

Download content by touching Service Tags!

Your phone is your credit/ debit/prepaid card!

Public Transport

Industry stakeholders



Wireless devices

System concept evolution

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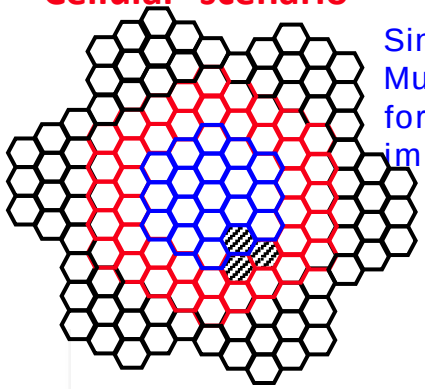
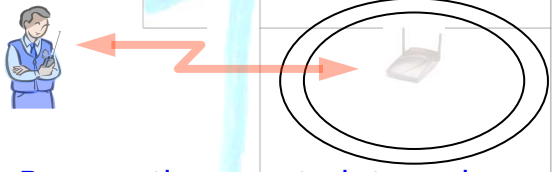
'Cellular' scenario

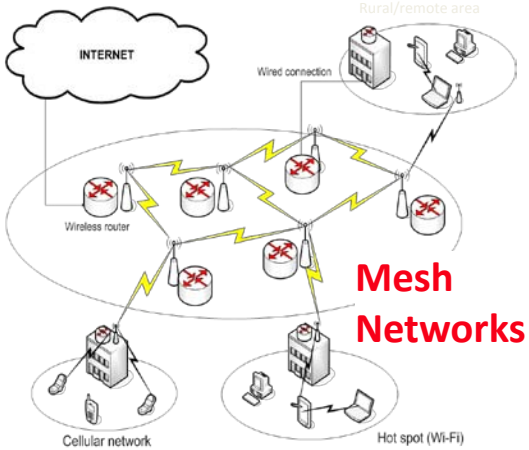


Single Link vs Single Cell vs Multicell optimization for peak / average / cell edge rate improvements

Open Access

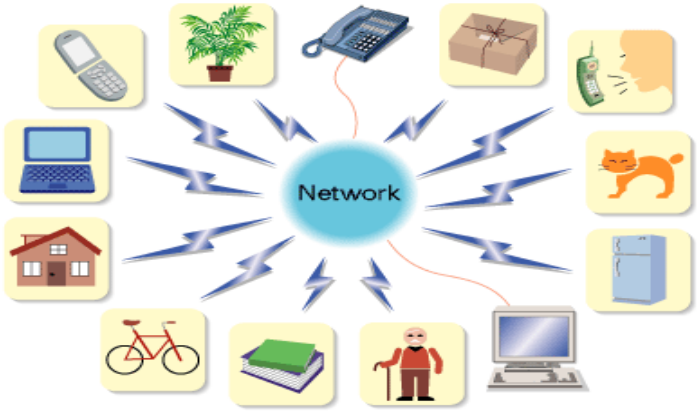


Propagation constraints and lack of coordination create challenging coverage and interference scenarios



Mesh Networks

Flexible deployment at the expense of coverage vs throughput vs delay tradeoff



Cellular extended for M2M

System concept..
..on the cloud

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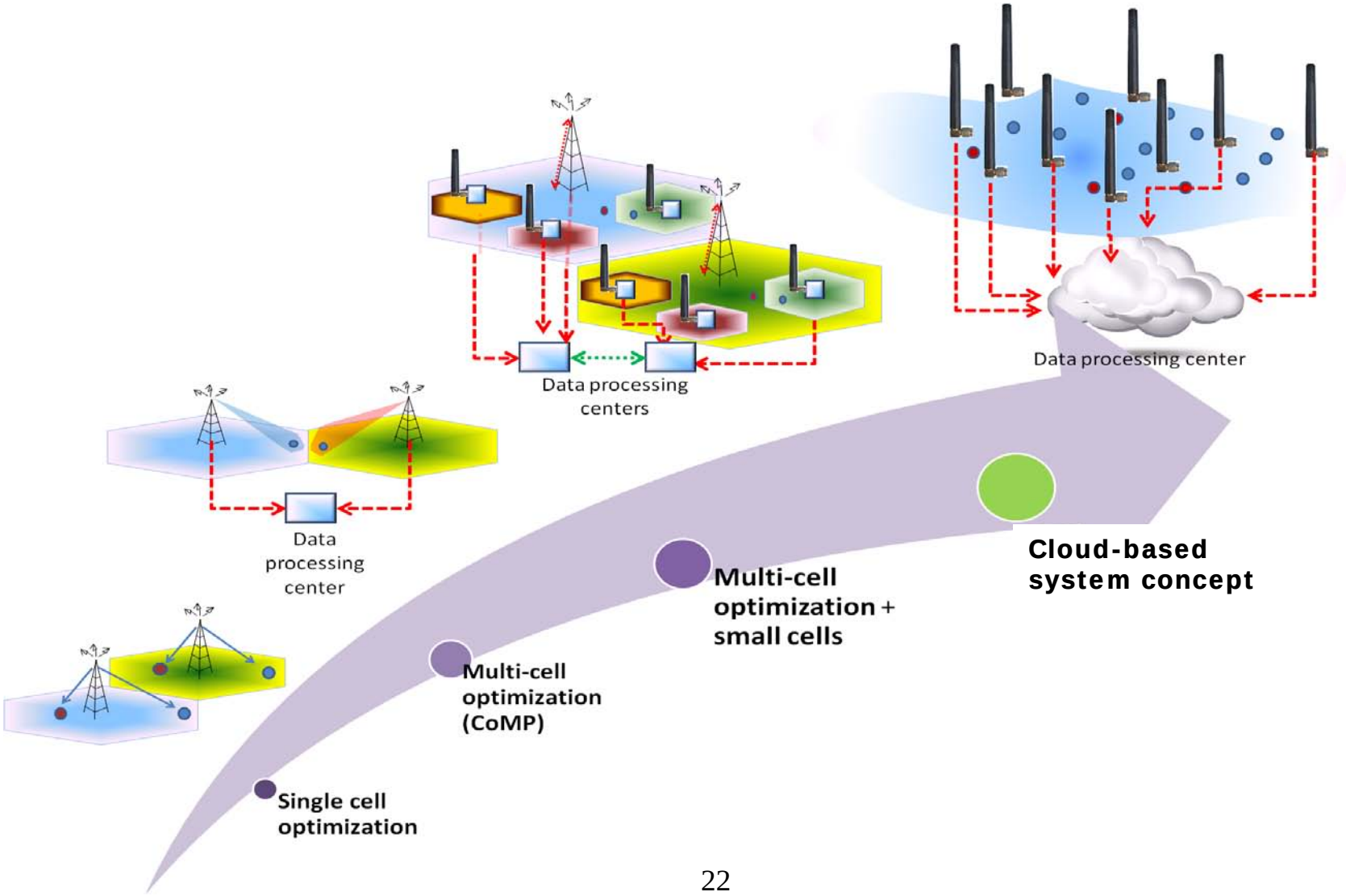

Technology challenges

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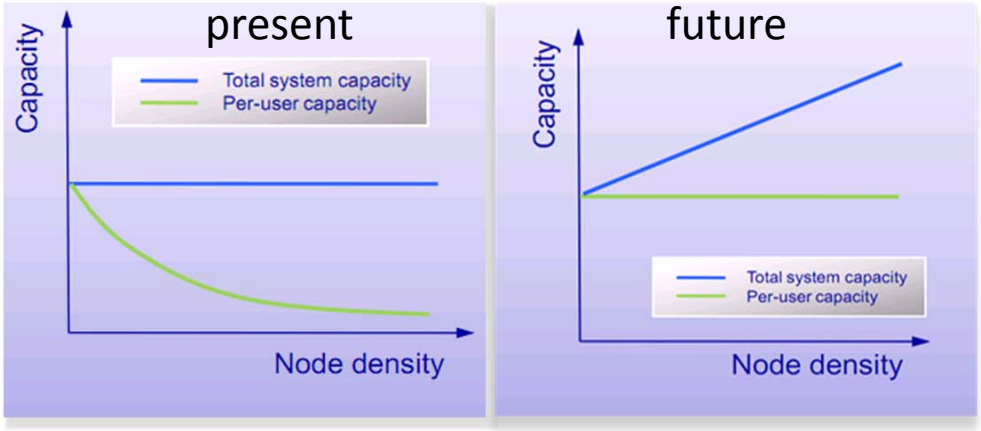

Cellular challenges:

- Multiple hierarchical layers and huge number of nodes: *interference management, resources allocation*
- Energy efficiency, often too stringent constraints
- Large dynamic range of throughput and delay constraints

M2M challenges:

- Data rates may be rather low but delay sensitivity may vary
- Security
- Lack of unified standardization approach

Enablers

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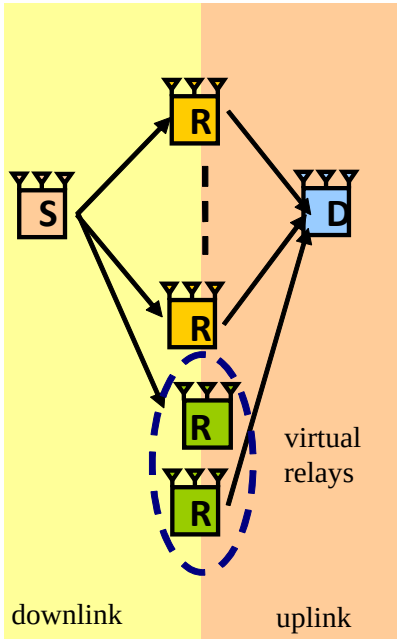
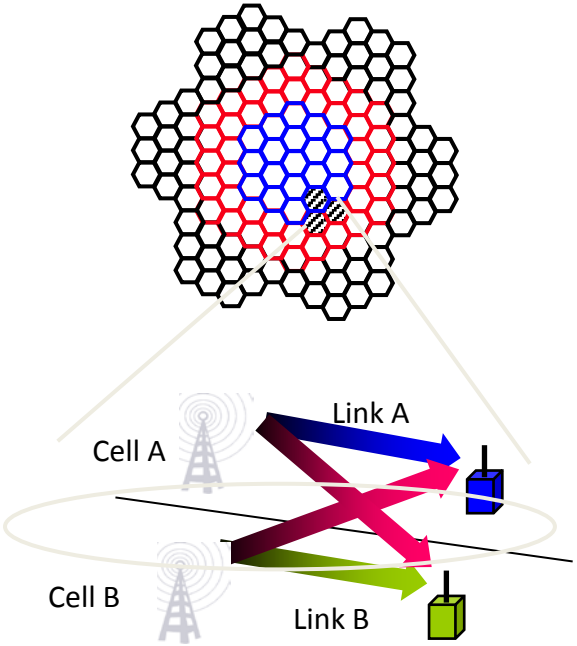
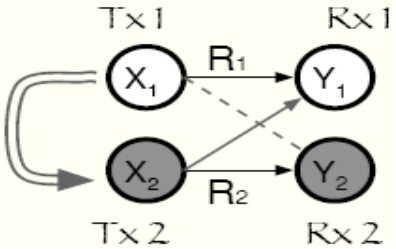
Cooperation



Coordination



Cognition



Promising research directions and critical technology innovations

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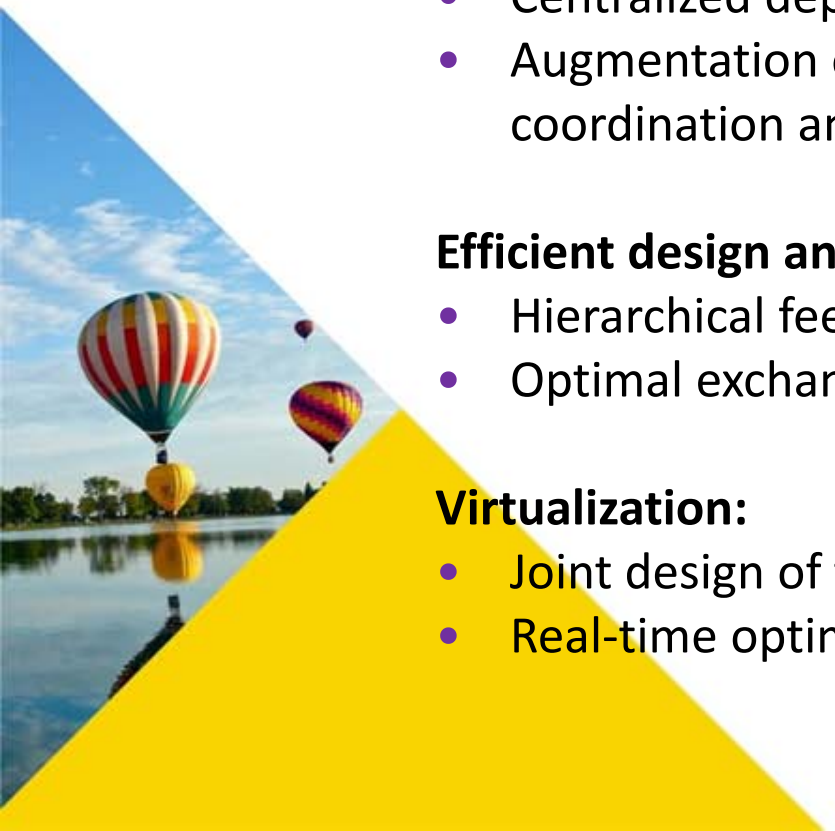

Advance resource management:

- Cross layer design
- Scheduled versus random or scheduled+random access?

Balancing centralized and distributed control:

- Centralized deployments with Cloud-based architectures
- Augmentation of the wireless world intelligence with SON coordination and cognitive networking

Efficient design and use of feedback signalling:

- Hierarchical feedback schemes
- Optimal exchange of contextual information among layers

Virtualization:

- Joint design of the physical and virtual substrates
- Real-time optimization of very large systems

Conclusions and the way ahead

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- Design hierarchical coordination and cooperation schemes able to strike the right balance between interference management and overhead signalling limitations
- Re-invent the network architecture towards a dense ‘user-centric’ network of low-complexity antenna units empowered by the cloud
- Jointly optimize the access and backhaul part of the network, which may need to be seen as one merged architecture
- Diminish the need for system planning and configuration phases
- Exploit virtualization principles and benefits

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www.wireless-world-research.org

WWRF Meetings in 2012/2013

WIRELESS WORLD RESEARCH FORUM®

WWRF29 Berlin, Germany 23 - 25 October 2012

Hosted by Nokia Siemens Network

Nokia Siemens Networks

WWRF30 Oulu, Finland 23 - 25 April 2013

Hosted by University of Oulu, Finland

UNIVERSITY of OULU
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Workshops on Wireless World 2020

Sept 4th 2012 – Quebec City, Canada
October 24th 2012 – Berlin, Germany