# The Next Hops Towards Everywhere, Anytime, ….

**Moderator**
**Adnan Al-Anbuky**, EEE, AUT University, New Zealand,
adnan.anbuky@aut.ac.nz , http://sense.aut.ac.nz/adnan.cfm

**Panelists**
**Mohammed Abdul Hafez**, UAE University, United Arab Emirates
**Mari Carmen Aguayo-Torres**, University of Malaga, Spain
**Eugen Borcoci**, University Politehnica Bucuresti, Romania
**John An**, National Taiwan Ocean University, Taiwan, ROC

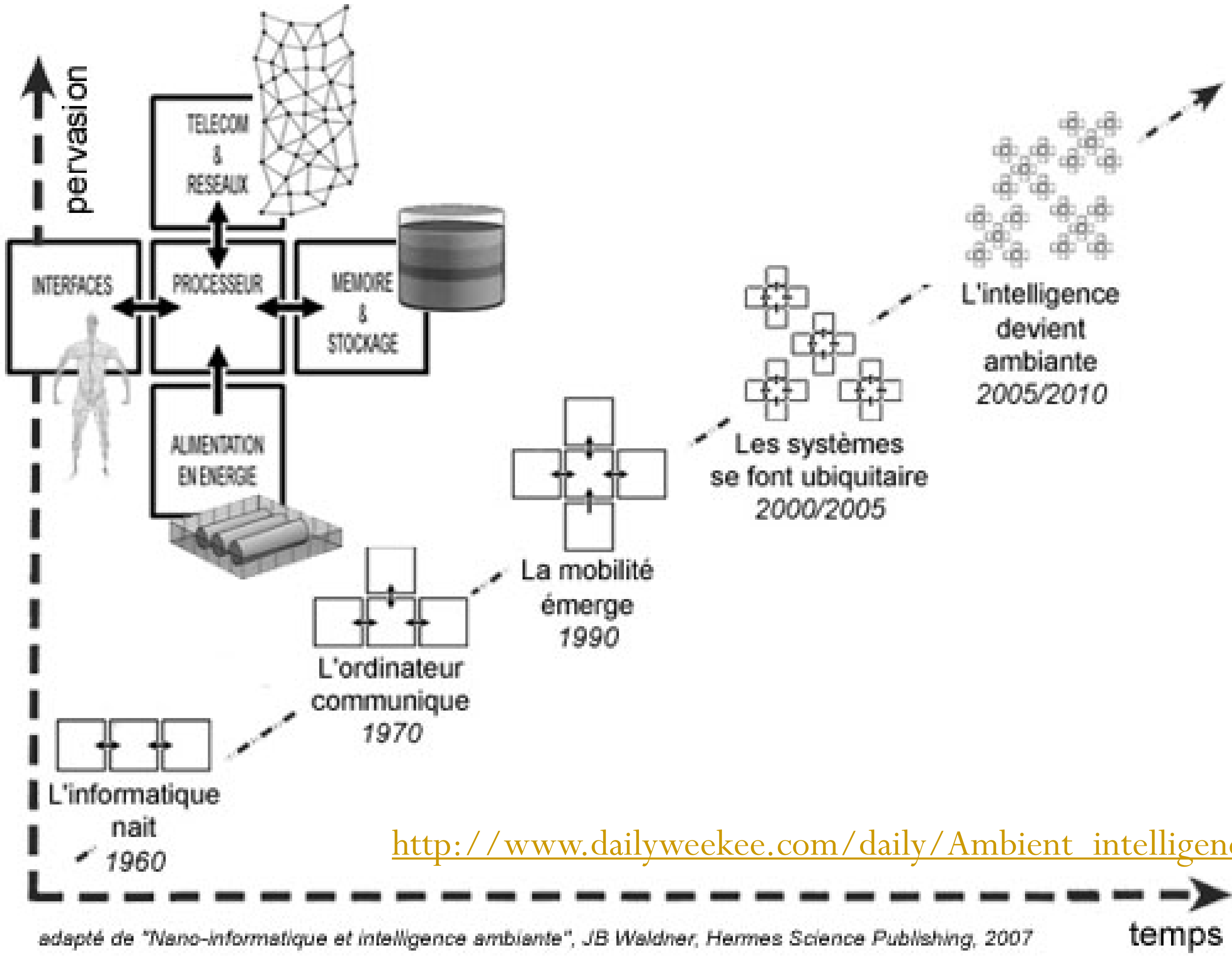
# Panelists

- **AProf. Dr. An John: Current Applications: *"Relay-aided cooperative wireless Communications" for LTE-A and IEEE802.16j/m WiMAX.***
  - Dr. An is currently an Associate Professor at National Taiwan Ocean University. He was working as a Vice President at Global Mobil Corporation (GMC) and a senior technical consultant (acting CTO) at VMAX, both positions for WiMAX network operation/designs in northern Taiwan region and strategic business plan, respectively. Dr. An has numerous publications and patent for MIMO antennas design for 4G wireless system and GPS-based surveillances system developments, as well as many hand-on projects for wireless communities.
- **Dr. Mari Carmen: Transmission technology convergence for global coverage wireless networks**
  - Dr. Mari Carmen Aguayo-Torres received the M.S. and Ph.D. degrees in Telecommunication Engineering from the University of Malaga, Spain, in 1994 and 2001, respectively. Currently, she is working at the Department of Communications Engineering, at the same university. For more than 10 years, she has been involved in a number of public and private funded research projects regarding adaptive modulation and coding for fading channels, OFDMA, SC-FDMA, crosslayer design and probabilistic QoS guarantees for wireless communications.

# Panelists

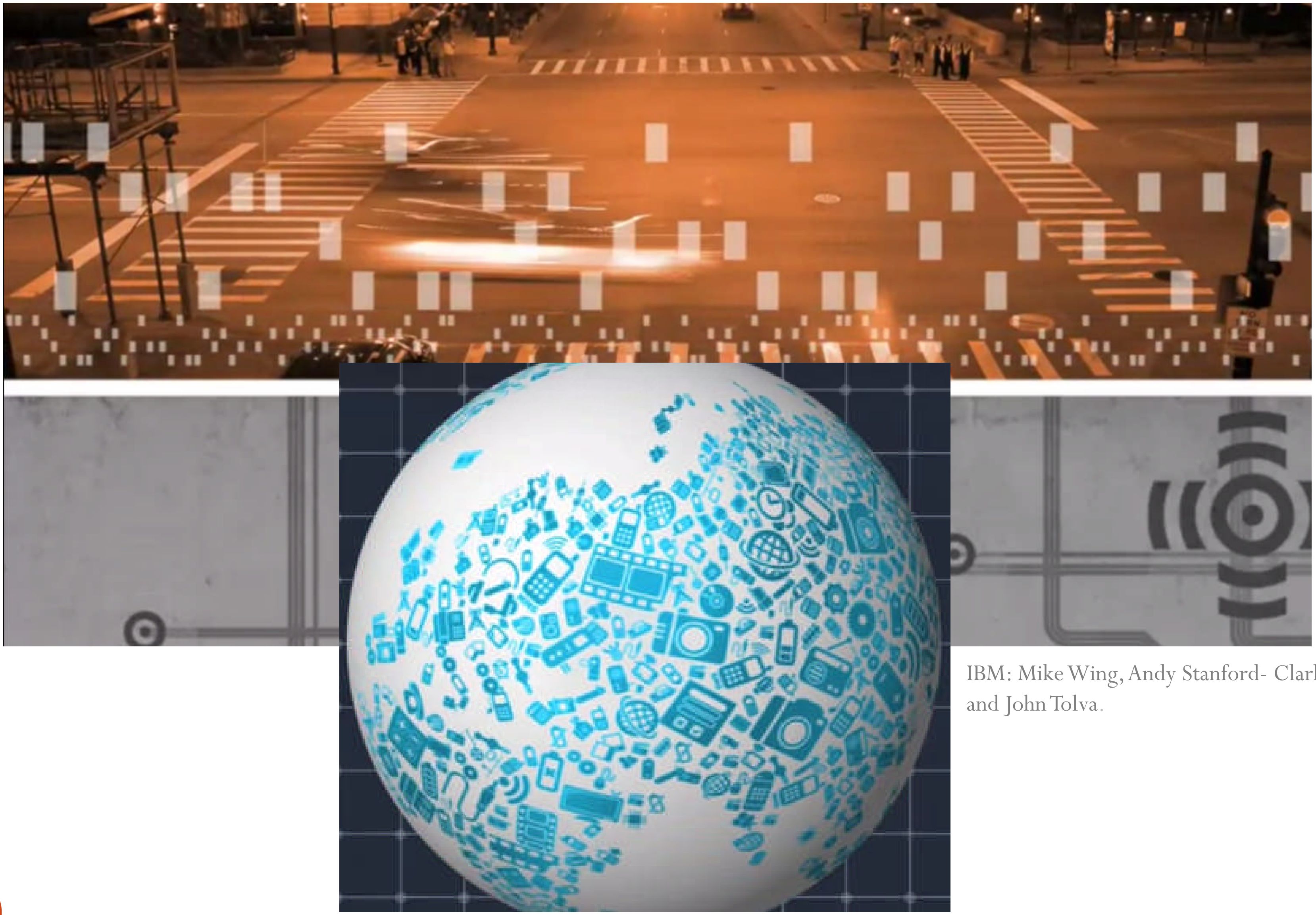
- **Prof. Eugen Borcoci: Future Internet perspectives**
  - Professor at University "Politehnica" Bucharest, Romania, Telecommunications Department. In the last decade, his research activity has been focused in QoS assurance and management over multiple domains networks, multicast and multimedia flows transportation over IP networks and heterogeneous wireline or wireless access. He has been and still is team leader in many research European projects FP4, 5, 6, 7. He was TPC member of many int'l conferences in the field. Eugen Borcoci is member of IEEE Communication Society, of the Technical Sciences Academy of Romania and IARIA fellow.
- **AProf. Mohammed Abdul Hafez: Cognitive Radio @ Smart Grid**
  - **Mohammed** received his B.Sc, M.Sc, and Ph.D degrees all in Electrical and Electronic Engineering from Eastern Mediterranean University, Northern Cyprus, and Turkey in 1992, 1994, and 1997, respectively. In August 1999, he joint Centre for Wireless Communications at the University of Oulu as senior research scientist and project manager. He is currently associate professor of Electrical Engineering at United Arab Emirates University. His research of interests includes performance analysis of mobile communication systems, future broadband wireless systems and Wireless cognitive radio, multicarrier CDMA, smart grid, and Ultra Wide Band (UWB) systems.

# Ambient Intelligence




http://www.dailyweekee.com/daily/Ambient_intelligence

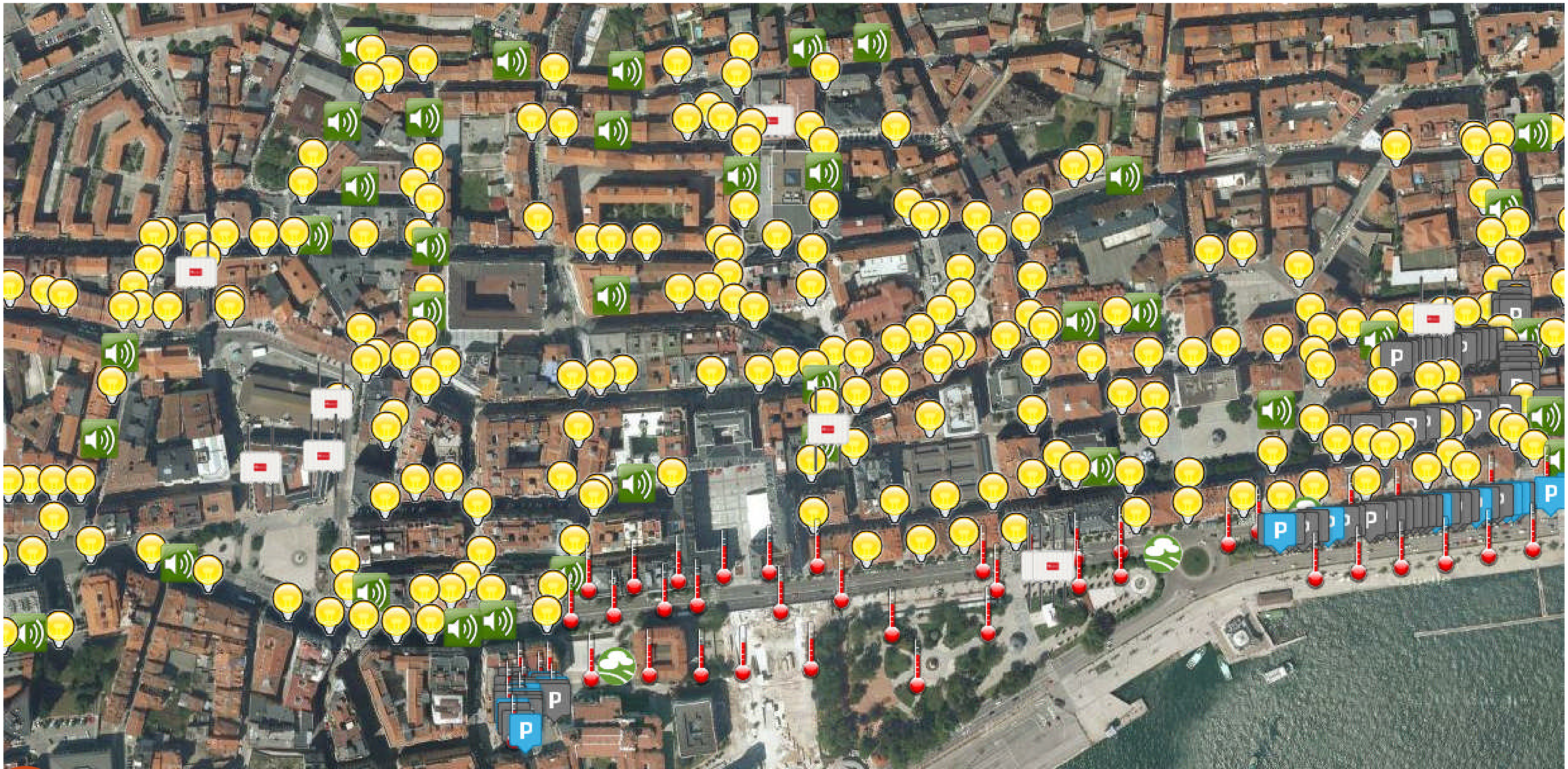
# Vision for the Internet of Things



IBM: Mike Wing, Andy Stanford- Clark and John Tolva.

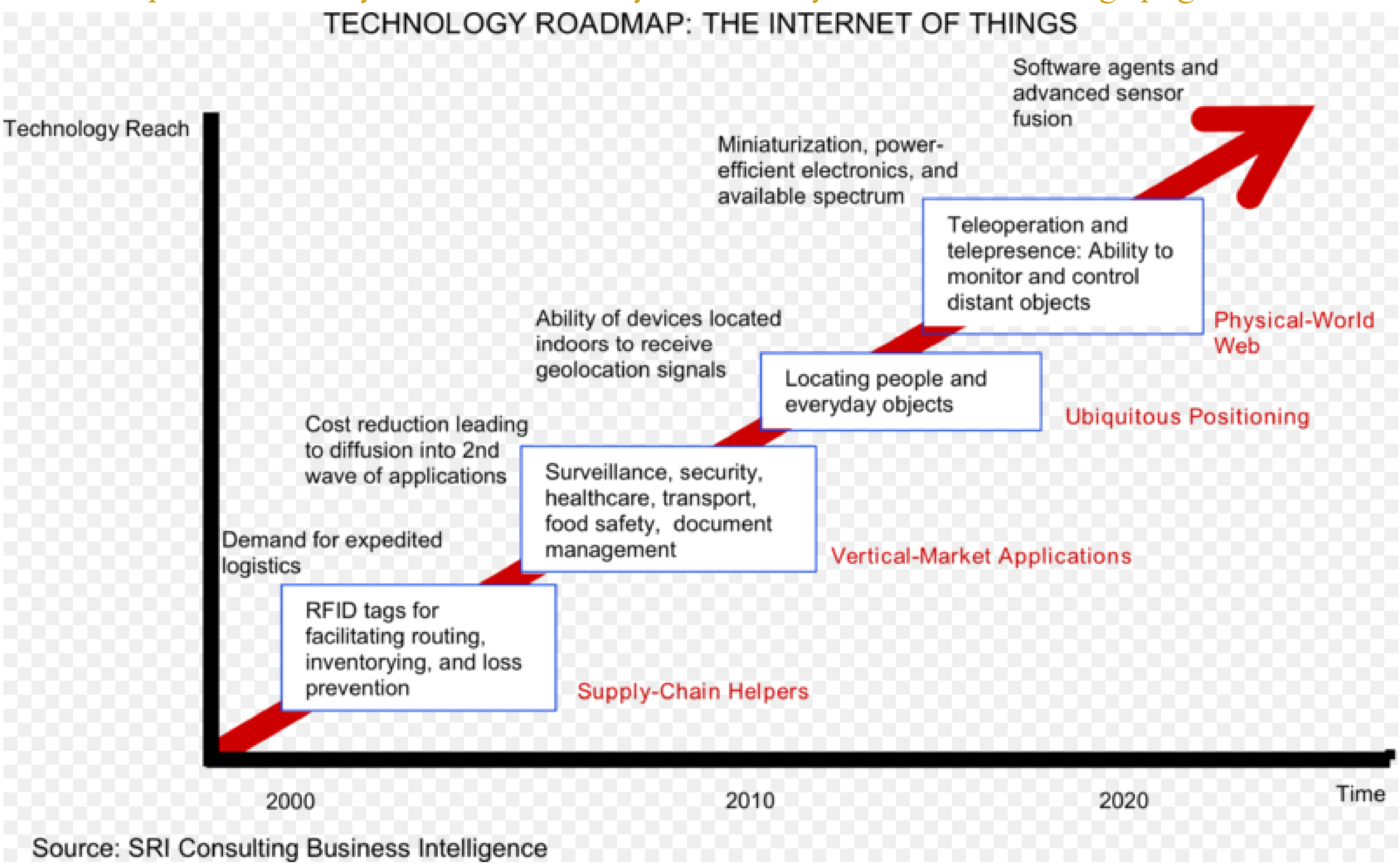
# Smart Santander Project

http://www.smartsantander.eu/map/



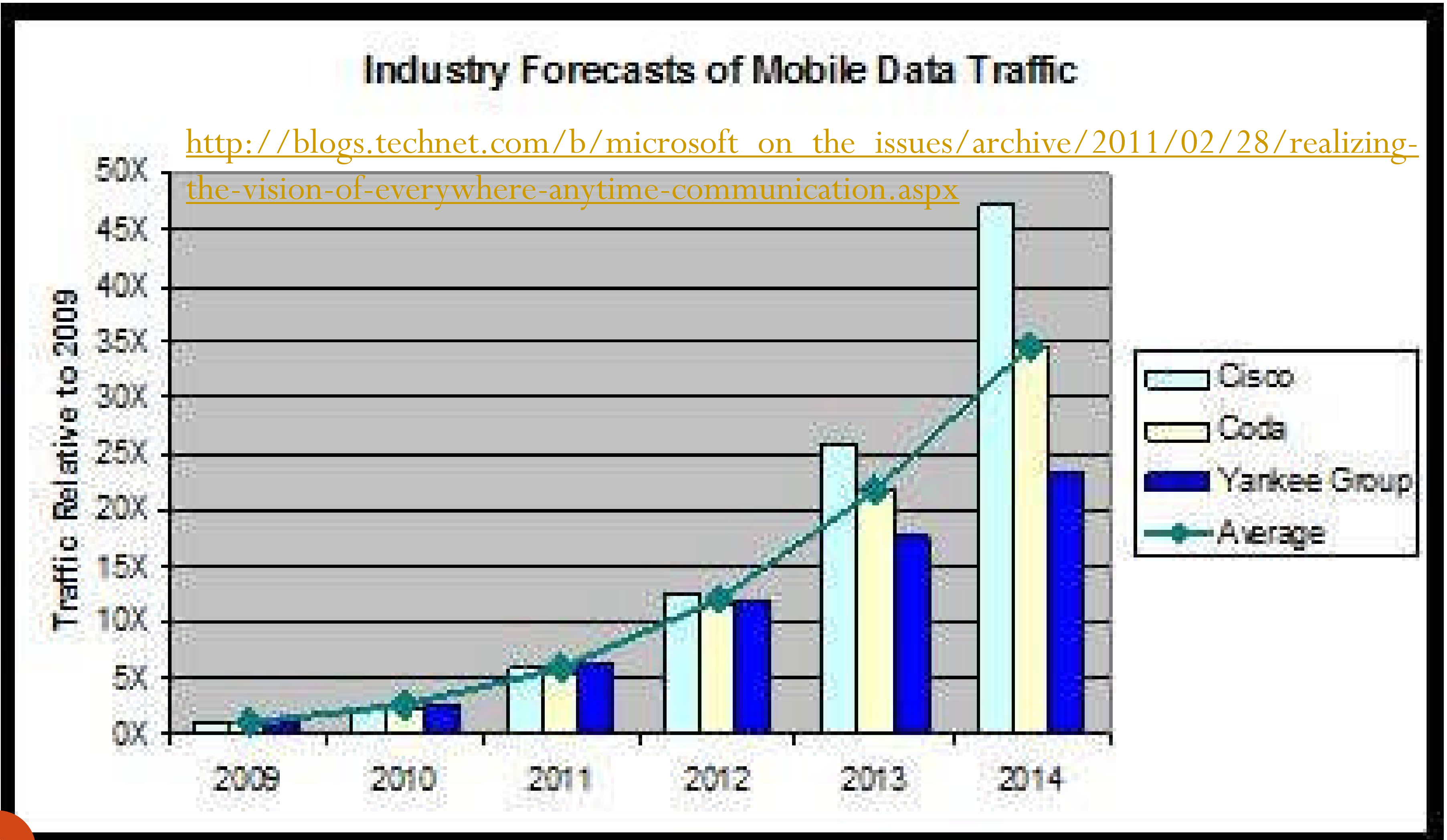
# Technology Progression

http://www.dailyweekee.com/daily/folderdaily:Internet_of_Things.png



# Projected wireless data traffic growth

source: Federal Communication Commission




http://blogs.technet.com/b/microsoft_on_the_issues/archive/2011/02/28/realizing-the-vision-of-everywhere-anytime-communication.aspx

# Points to Consider

- Role of Cognition (Radio and network), Ambient Intelligence & Awareness
- IoT, Planet Nervous System and Overlay of Services; Distributed SW Agents & Intention to Influence Cultural behaviour
- Impact of Collaboration, Federation, Social network, Cloud, etc.
- Trends in Growth of Radio and broadband
- Spectrum management and capacity utilization; e.g. TV white space "whiteFi" and similar approaches for available spectrum utilization
- Others?

# Cognitive Radio @ Smart Grid

Mohammed Abdel-Hafez
UAE University

# Cognitive Radio

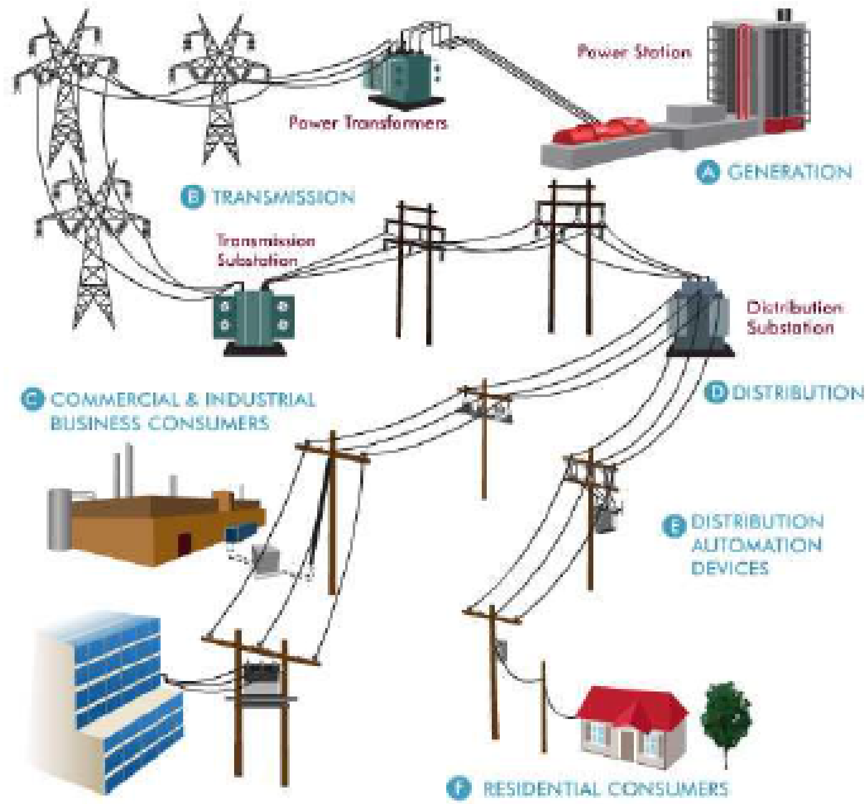
- Existing spectrum policy forces spectrum to behave like a fragmented disk
- Bandwidth is expensive and good frequencies are taken
- Unlicensed bands – biggest innovations in spectrum efficiency
- Recent measurements by the FCC in the US show 70% of the allocated spectrum is not utilized
- Time scale of the spectrum occupancy varies from msecs to hours

# Cognitive Radio

- Existing techniques for spectrum sharing:
  - Unlicensed bands (WiFi 802.11 a/b/g)
  - Underlay licensed bands (UWB)
  - Opportunistic sharing
  - Recycling (exploit the SINR margin of legacy systems)
  - Spatial Multiplexing and Beamforming
- Drawbacks of existing techniques:
  - No knowledge or sense of spectrum availability
  - Limited adaptability to spectral environment
- Fixed parameters: BW, fc, packet lengths, synchronization, coding, protocols, …
- New radio design philosophy: all parameters are adaptive
  - Cognitive Radio Technology: Cognitive radios require:
    - Sensing
    - Adaptation
    - Learning

# Smart Grid

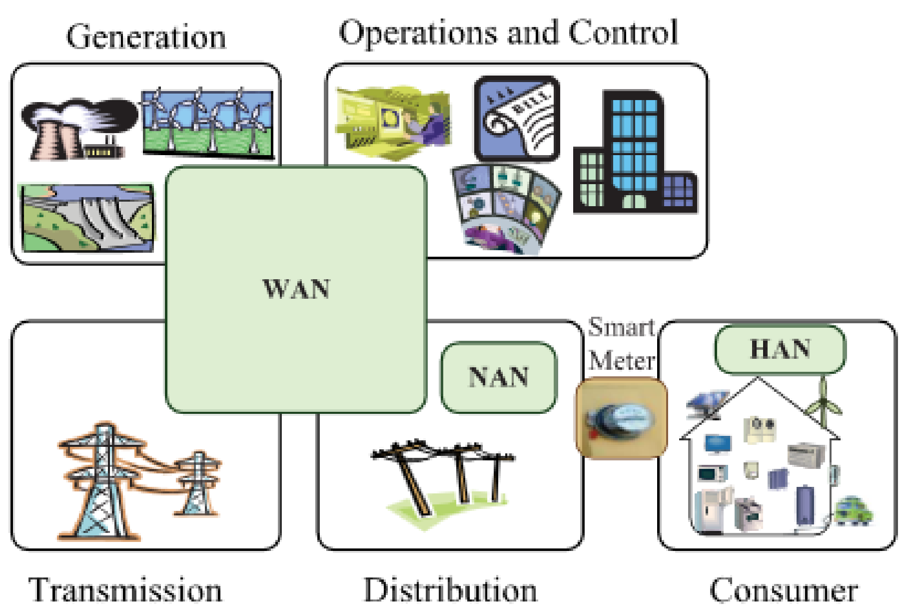
- Traditional Grid
- Problems with current Power Grid
  - It is not efficient
  - Transmission losses = 20%
  - Only 30% of the energy consumed is transmitted to consumers
- It has not kept pace with modern challenges
  - Limited alternative power generation sources
  - No solutions for conservative use of energy
  - Un-interruptible electricity supply
  - Poor situation awareness
  - Poor control and management of distribution network
- A “SMARTER” grid is needed!




Generation, transmission, distribution

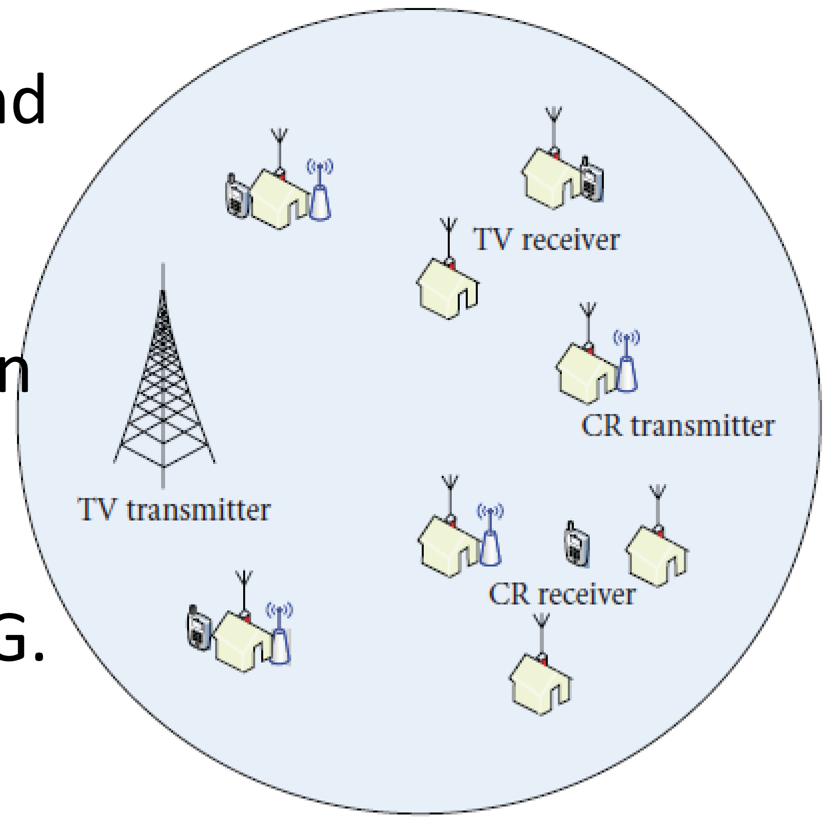
# Smart Grid

- Smart Grid is an application of digital information technology to optimize electrical power generation, delivery and use
  - Optimize power delivery and generation
  - Self-healing
  - Consumer participation
  - Resist attack
  - High quality power
  - Accommodate generation options

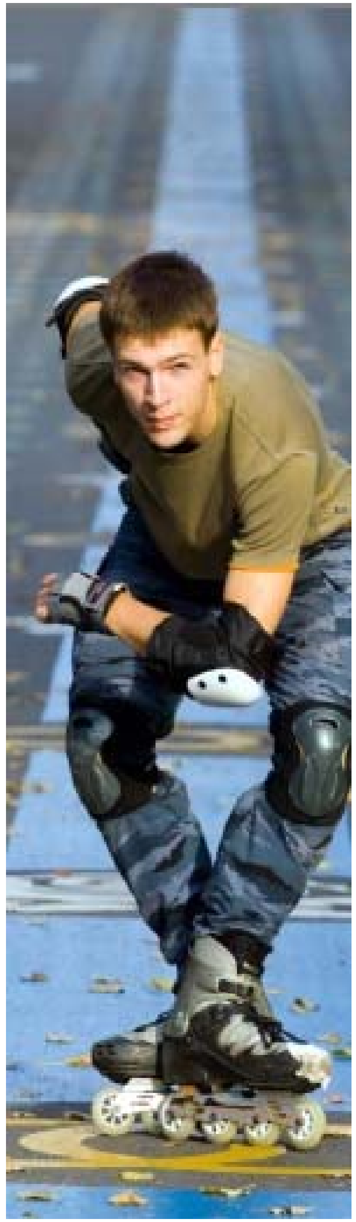


# Solution: Cognitive Radio over White TV Bands for Smart Grid

- The IEEE 802.22 standard is designed to provide broadband access o rural areas using the white space in TV bands.
- TV Band Has good propagation characteristics.
- Use of CR and will density adopt to the future need of SG.



# The Next "Hops" Towards Everywhere, Anytime, or Myth....



***Current Applications:***

*Relay-aided cooperative wireless communications for LTE-A and IEEE802.16j/m WiMAX.*

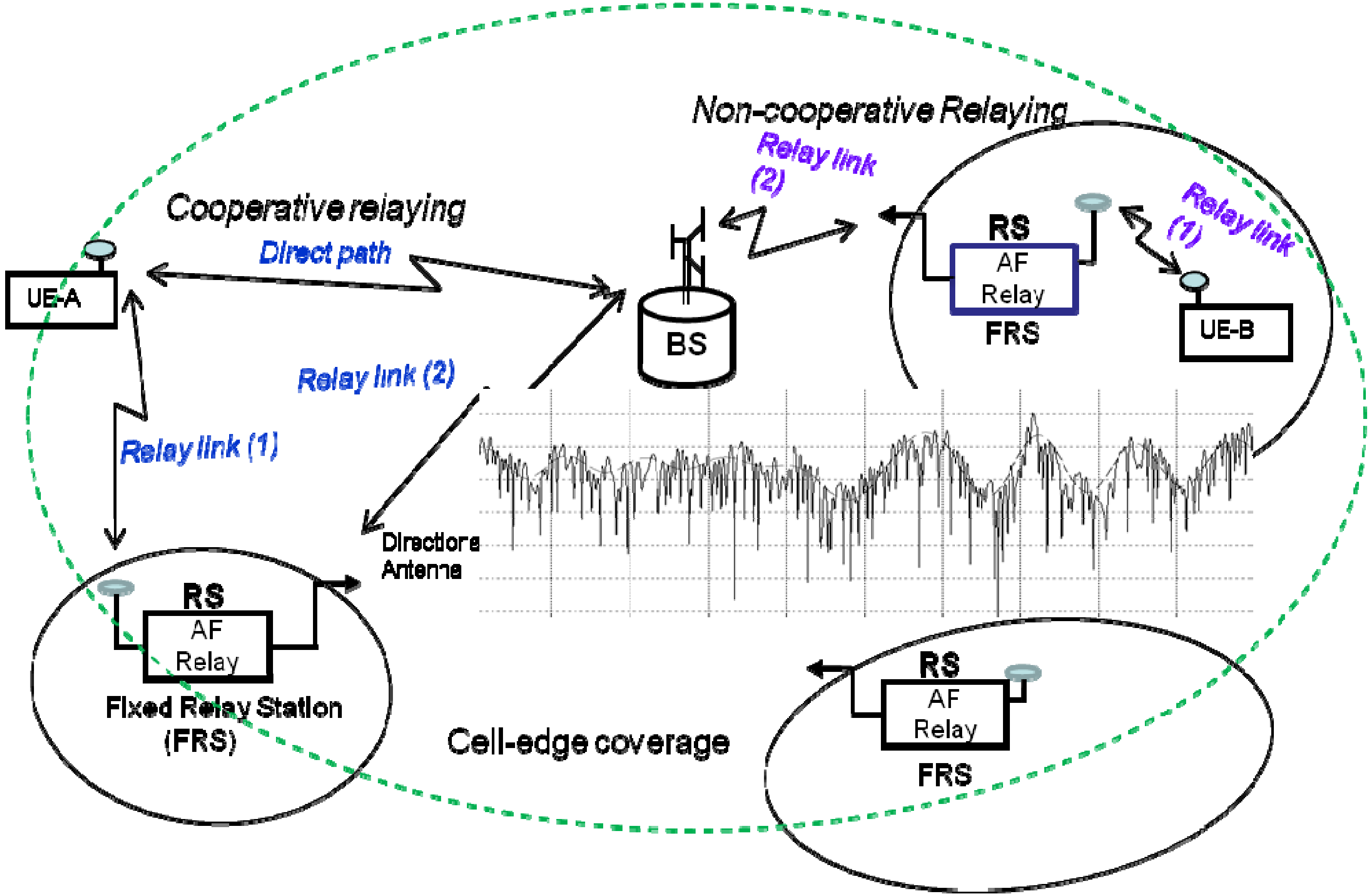
***Valuable or unattractive technology ?***

***by Dr. John F. An***

***National Taiwan Ocean University***

***Former Senior Consultant of VMAX and VP of Global Mobile Corp***

# One of special cases- Dual-hop  AF relaying model



## *Benefits:*

1. Spatial diversity
2. Coverage extension  in cell-edge and filling coverage hole
3. Capacity enhancement
4. Mitigate the outage probability

## *Challenges:*

1. System complexity/ cost issue
2. Dual-hop or Multi-hop/ semi-blind/ full CSI-assisted/ blind relaying
3. Relay selection algorithm (what is the  real “BEST” relay ?)
4. Imperfect CSI effects
5. Interference control
6. Performance gain depends on deployment scenarios

## *Questions:*

1. Is an unattractive and unrealistic technology in real-world implementation ?
2. Will be too optimistic for most research reports and  oversimplifying  radio propagation phenomena ?

InfoWare 2012

# PANEL: ICWMC
# The Next Hops Towards Everywhere, Anytime, ....

***Everywhere, Anytime, .. in the perspective of Future Internet***


***Eugen Borcoci,***
***University Politehnica Bucharest***
Eugen.Borcoci@elcom.pub.ro

# Everywhere, Anytime, .. in the perspective of Future Internet

- **Future Internet**
  - **How to achieve it**
    - Clean-slate, Evolutionary, “mid-way” approaches?
  - **Entities involved:** Research groups, Academia, Industry Standardization organizations Governments, Users
    - A lot of FI –oriented initiatives
  - Special topic: Universal access (***Anytime, Everywhere,..)*** – naturally included in the FI objectives- still open issue for research
    - Specific aspects: mobility – it is mandatory condition for E&A&..
      - Terminal mobility ( seamless - micro, macro-mobility, multi-RATs)
      - Users and service mobility
      - Network mobility ( vehicular)
      - While still support heterogeneous access technologies

# Everywhere, Anytime, .. in the perspective of Future Internet

- **Examples of challenges related to mobility**
  - The current E2E approach to Internet communication does not natively address any of these challenges
  - Current Internet protocols : assumption that wireless nodes are “last hops” that are best handled by the very edge of the network

- **1. Host/terminal mobility**
  - MSs connecting to the Internet -> increasing variance in the physical and topological characteristics of the network -> E2E perf is inefficient
  - Current techniques for macro-mobility : MobileIP - rely on a HA to tunnel the traffic-> inefficient: sub-optimal path towards the destination can result as well as overload the redirection points.

- **Examples of challenges related to mobility**
- **2. Varying Levels of Link Quality**
  - Wireless links  performance of individual networks – large variations
  - Current Internet protocols, such as TCP, not good to handle such fluctuations because it is E2E designed
  - The lack of immediate E2E ACKs are often seen as congestion indication – window reduction ( actually does not solve the problem)
  - Instead, hop by-hop transport and the ability to temporarily store data in the network are needed to overcome these issues.

# Everywhere, Anytime, .. in the perspective of Future Internet

- **Examples of challenges related to mobility**

- **3. Different and Varying Levels of Connectivity**
  - High mobility -> complete disconnections - > E2E TCP protocols fail (they need to first establish aconnection)
  - Some solutions: *delay tolerant networking*
  - Techniques such as message replication and hop-by-hop transport are utilized to bridge partitions in the network.
  - However: no comprehensive solution to bridge varying levels of connectivity:
    - DTN protocols are usually not sufficient in highly connected environments and MANET protocols fail in highly disconnected environments
- In progress work : merging DTN and MANET protocols:
  - -they consider DTN nodes as specialized entities useful only for extending MANET protocols
  - - or consider MANET clusters to be relatively static and simply bridged by DTN nodes
- More general vision: both DTN and MANET capabilities in *all* nodes,

# Everywhere, Anytime, .. in the perspective of Future Internet

- **Examples of challenges related to mobility**
- **4. Multi-homing**
  - Mobile devices may have multiple Radio Access Technologies (e.g., utilizing 3G,WiFi, and BlueTooth) -> and hence multiple network attachment points.
  -
  - **Advantages** : multiple I/Fs -> better throughput, increase fault tolerance, and experience lower latencies during handoff.
    - Currently, devices wishing to utilize multiple interfaces must do so at the application layer, and the device itself drives the HO
    - Allowing the network to drive the HO and the I/F selection - advantageous approach.
  - ***Media Independent Handover* + *Policy Based Handover*** management can partially solve the problem
- Fundamental difficulty in current Internet: *application data is bound to IP addresses, and not separate device names.*
  - Therefore, the current network cannot independently choose from multiple IP addresses belonging to the same device or entity.
  - Decoupling addresses from IDs- major current work today- in research and also standardization area (IRTF/IETF)

# Everywhere, Anytime, .. in the perspective of Future Internet

- **Examples of challenges related to mobility**
- **5. Context-Aware Routing Paradigms**
- Context sensitivity of applications need flexible routing : *anycast, multicast, and geocast.*
  - Examples
    - ability to contact any emergency responder in a disaster zone (not to a specific one)
    - ability to push content to *every* content subscriber
    - Geocast: able to send a message to all subscribers in an area
      - Here an optimal strategy could be to geographically route a copy of the message to the area (unicast) and then multicast in the target area
- **Such paradigms are useful for content-driven applications, prominent in the future Internet: ICN/CCN/CON/CAN (CCN= Content Centric Networking)**
  - CCN: aims to deliver content efficiently by using content-aware routing techniques at the core of the network.
  - The current Internet is based on 1-to-1 communication, limiting the ability of applications to specify group-based or context-based destinations.
  - IP Multicast - provide some flexibility, however is inappropriate for quickly changing topologies (MANET and DTN) environments.
- **Network-layer support for context-aware services is needed – open research issue.**

# Thank you !

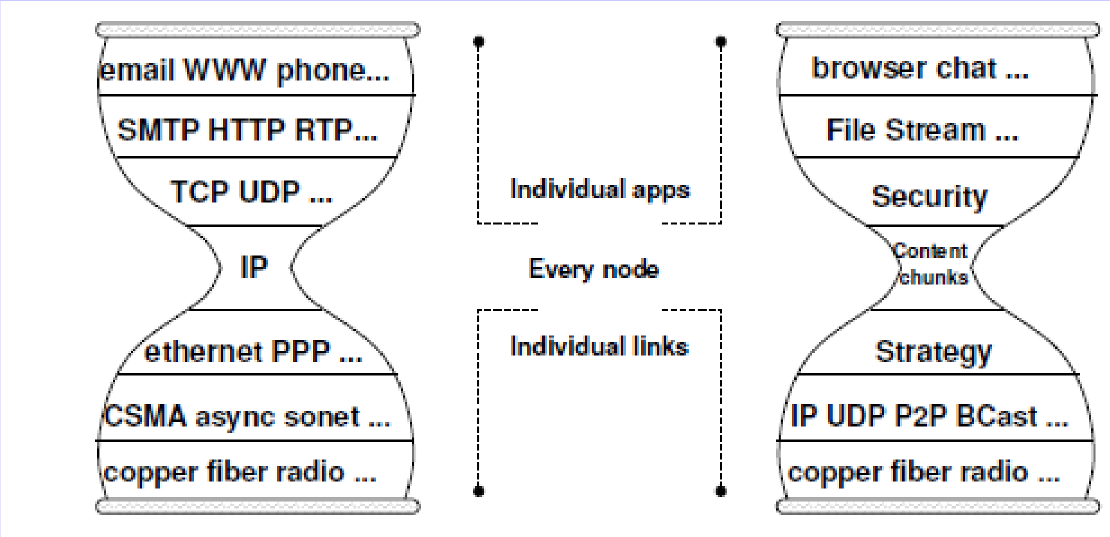
# Everywhere, Anytime, .. in the perspective of Future Internet

- **References**


1. **Samuel C. Nelson, Gautam Bhanage, Dipankar Raychaudhuri, WINLAB, Rutgers University GSTAR: Generalized Storage-Aware Routing for MobilityFirst in the Future Mobile Internet**
2. R. Wang et Al., Delay Tolerant Networking (DTN) Protocols for Space Communications, *icost.info/public_html1.1/Library/BookChapter/DTN.pdf*
3. J. Jackson, "The interplanetary Internet," *IEEE Spectrum*, vol. 42, No. 8, August 2005, pp. 31-35.
4. I. F. Akyildiz, O. B. Akan, C. Chen, J. Fang, and W. Su, "InterPlanetary Internet: State-ofthe-art and research challenges," *Computer Networks Journal (Elsevier)*, vol. 43, No. 2, pp.75-113, October 2003.
5. S. Burleigh and K. Scott, "Bundle protocol specification," IETF Request for Comments, RFC 5050, November 2007, [Online]:
6. **I. Psaras, et.al.,"Delay-/Disruption-Tolerant Networking -State of the Art and Future Challenges", 2009ee.ucl.ac.uk/~uceeips/dtn-srv-ipsaras.pdf**
7. Report from the National ICT Research Directors Working Group on Future Internet (FI) of the EC on Information Society and Media- Nov. 2008)
8. G. Tselentis et al. (Eds.), Towards the Future Internet, IOS Press, 2009, 2010, 2011
9. Future Internet – Towards Research Challenges – 07 APR 2009
10. **Pavlou G., Towards a Service-aware Future Internet Architecture, Future Internet Assembly – Madrid, Dec 2008**
11. **The FP7 4WARD Project , http://www.4ward-project.eu/**
12. **Van Jacobson Diana K. Smetters James D. Thornton Michael F. Plass, Nicholas H. Briggs Rebecca L. Braynard, Networking Named Content, Palo Alto Research Center, Palo Alto, CA, October 2009**

## CCN concepts Example

CCN transformation of the traditional network stack from IP to chunks of named content




Traditional TCP/IP stack

CCN

Source: Van Jacobson Diana K. Smetters James D. Thornton Michael F. Plass, Nicholas H. Briggs Rebecca L. Braynard, Networking Named Content, Palo Alto Research Center, Palo Alto, CA, October 2009

UNIVERSIDAD DE MÁLAGA

# On transmission technology convergence for global coverage wireless networks

Mari Carmen Aguayo-Torres

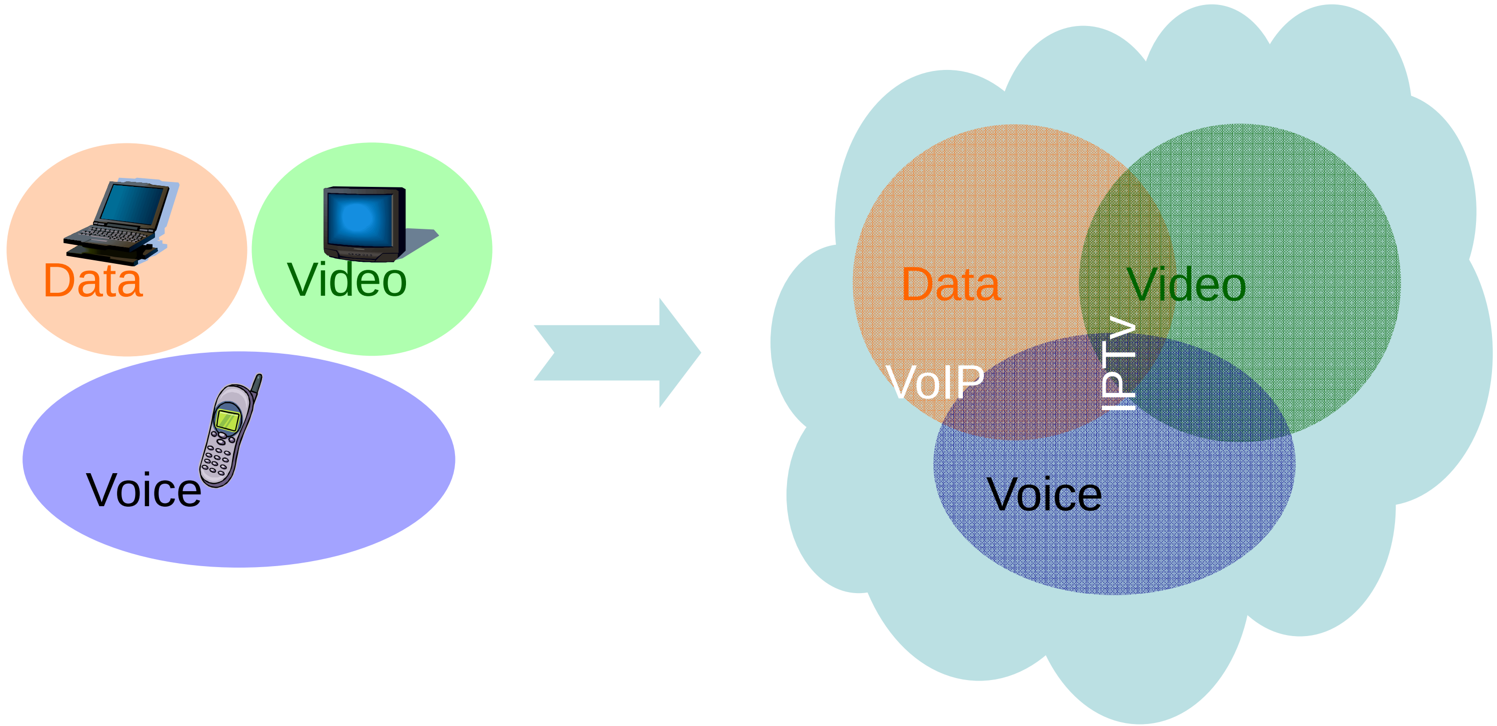
Ingeniería de Comunicaciones Department,
Universidad de Málaga, Spain

ICWMC, Venice, June 2012

# Convergence

- Interaction among previously separated technologies
  - Telephony, data exchange and television
  - Sharing resources and interacting with each other
- Complete different technologies could coexist in a single device but...
- Having the same or similar technologies for the physical and medium access control layers over the forecasted wireless heterogeneous network presents advantages

# Convergent Services



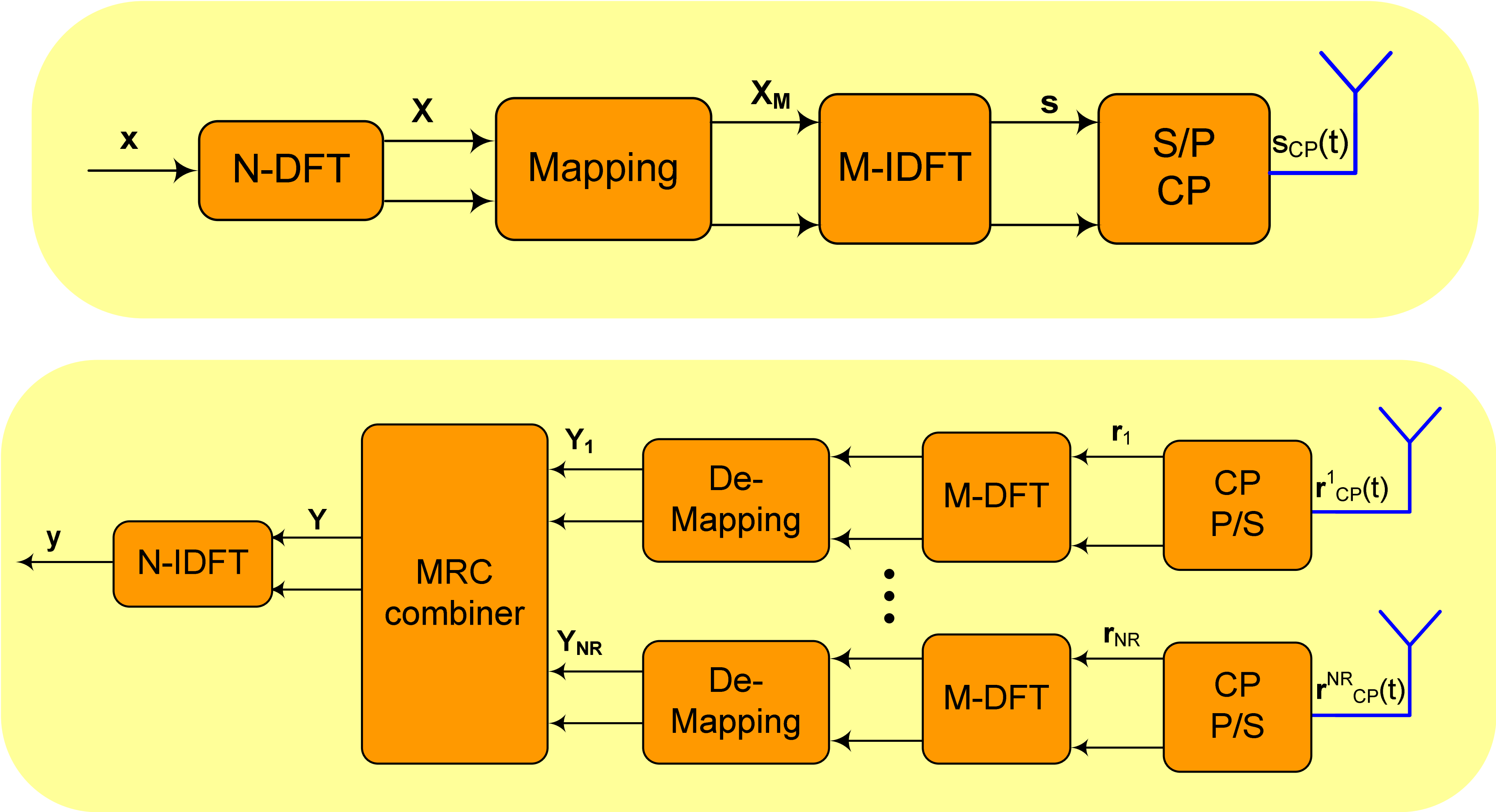
# Convergent Networks

- Convergence and
  co-existence with other communication systems
- Integration and evolution from legacy networks:
  Infrastructure reuse
- Heterogeneous networks: wired-cum-wireless

# Convergent transmission technologies?

- Orthogonal Frequency Division Multiplexing (OFDM) is the unique envisioned technology
- Advantages:
  - Flexible enough to cope with such diverse environments (DVB-T, IEEE 802.11x , IEEE 802.16x series, LTE)
  - Multiuser version: OFDMA
  - Easily combined to MIMO
  - Interference coordination/cancellation
- Disadvantage: high Peak-to-Average Power Ratio (PAPR)
  - Particularly troublesome in satellite communications or uplink transmissions in mobile networks.

# SC-FDMA Model



## SC-FDMA performance

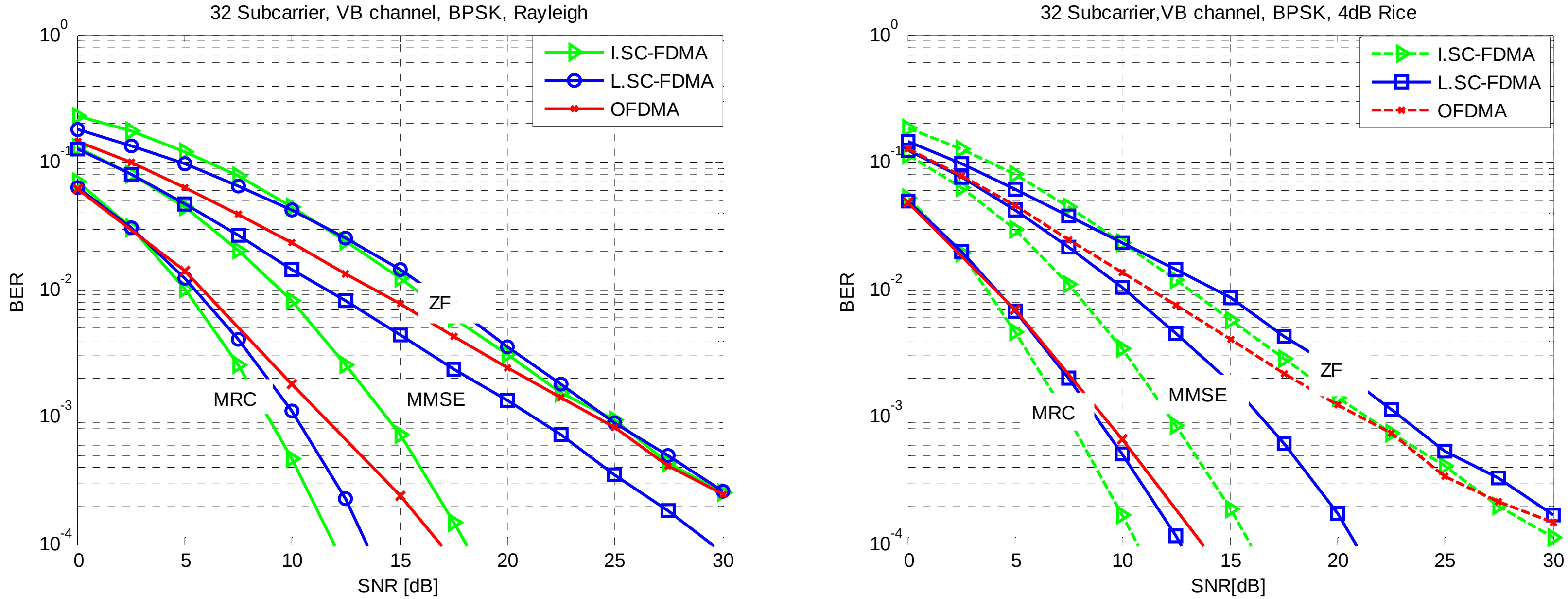
- SC-FDMA performance commonly accepted to be worse than that of OFDMA
  - Harmonic average of the channel response at allocated subcarriers
  - Under high probability deeply faded subcarriers, SC-FDMA basically behaves as the worst subcarriers
- Existence of a LOS greatly reduces the probability of deep fading
  - Without that burden, SC-FDMA is able to overtake OFDM system, reducing BER
- Coherent combination of signal received on two antennas improves SC-FDMA up to overtake OFDM for Rayleigh or Rice channels
- Specific fading frequency correlation function influences SC-FDMA performance
  - Still an open problem

# Simulation parameters

| Parameter | Value |
|---|---|
| FFT size | 2048 |
| Modulation Techniques | BPSK, 16QAM |
| Carrier frequency | 2.00 GHz |
| System Bandwidth | 20 MHz |
| Sampling Frequency | 30.72 MHz |
| Number of used subcarriers | 4, 32 |
| Channel model | ITU-R VA & PA channel |
| Equalizers | MMSE, ZF & MRC |
| Number of receiving antenna | 2 |

| Channel model | Delay spread (r.m.s.) | Coherence bandwidth |
|---|---|---|
| PA | 46 ns | 4.35 MHz |
| VB | 4001 ns | 50 KHz |

# Comparison to single antenna: SC-FDMA vs OFDMA

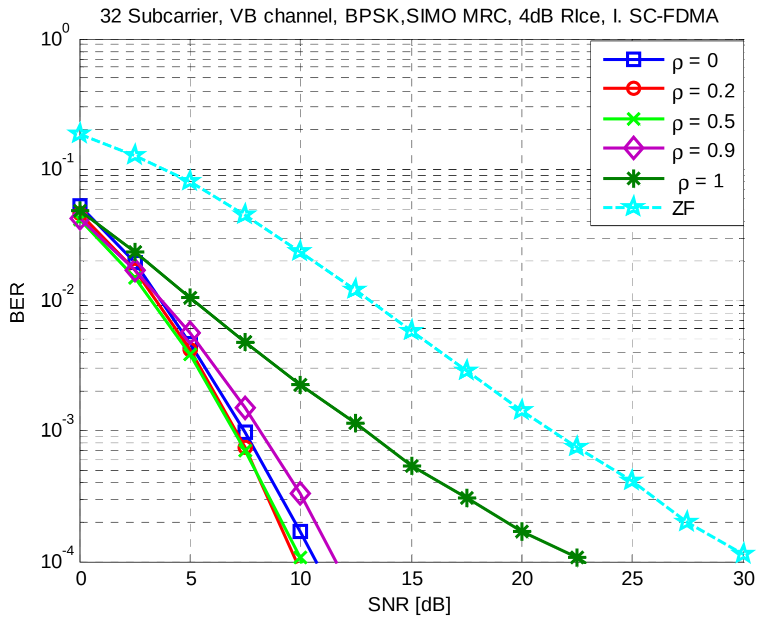


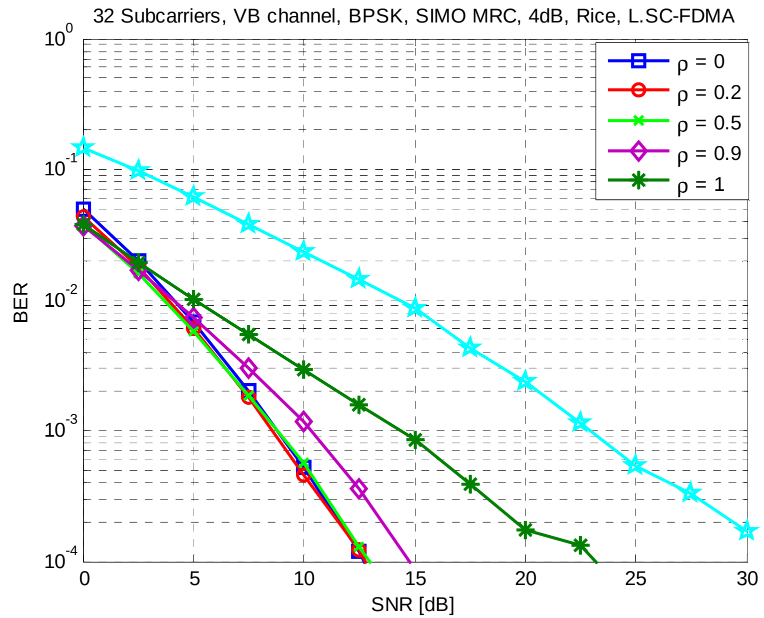

ZF: OFDMA lower bounds SC-FDMA

MMSE: SC-FDMA is better than OFDMA

MRC: SC-FDMA is better than OFDMA

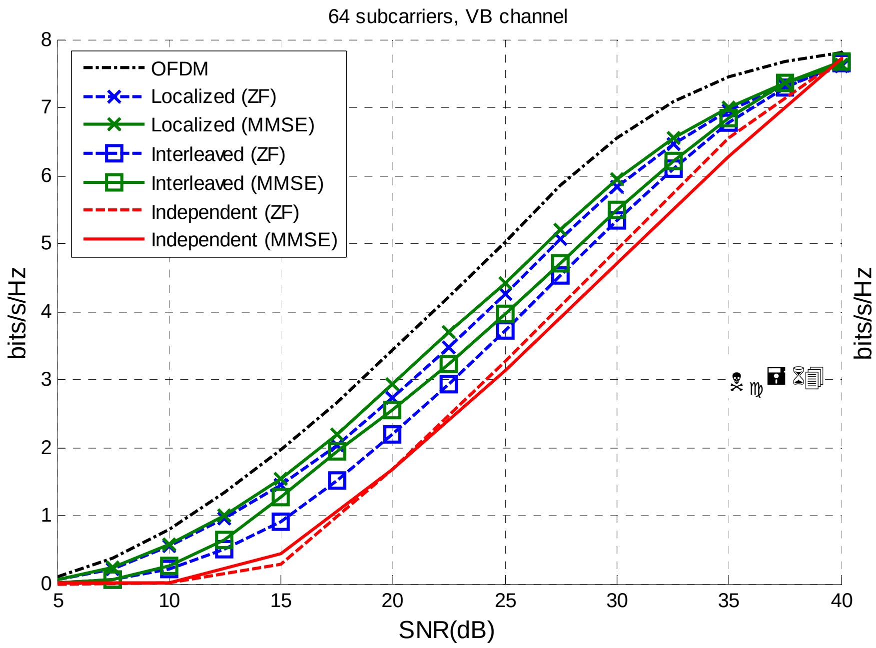
# Correlation factor: Interleaved vs Localized

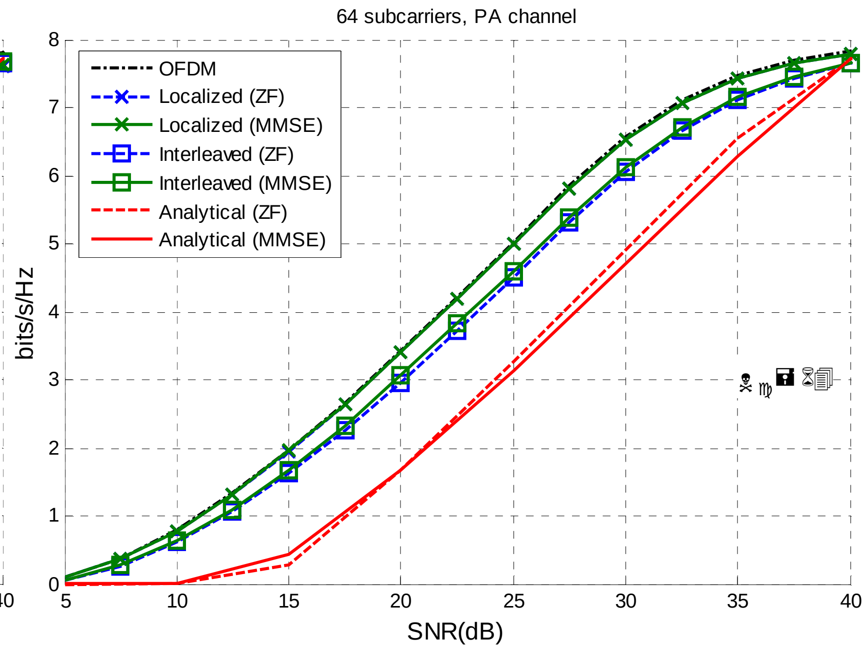



Localized or Interleaved influences less
SC-FDMA performance under a LOS

# Spectral Efficiency




Differences are

greater for more allocated subcarriers

smaller for Ricean channels

# Conclusion

- BER performance
  - ZF SC-FDMA behavior is worse than for OFDM

  However:
  - Coherent MMSE or combination of signal received on two antennas improves SC-FDMA up to overtake OFDM
- Spectral efficiency
  - SC-FDMA is worse than that of OFDM
- PAPR
  - Lower for SC-FDMA than for OFDM
- SC-FDMA and OFDM can be used as convergent transmission technique for wireless networks
  - OFDM when throughput is of utmost importance (DL cellular)
  - SC-FDMA for power limited links (UL cellular, downlink satellite)

# On transmission technology convergence for global coverage wireless networks


Mari Carmen Aguayo-Torres

Ingeniería de Comunicaciones Department,
Universidad de Málaga, Spain



ICWMC, Venice, June 2012