Future Internet and the
Mobile World

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I do not know what the Future Internet will be.

I assume that it is what
will come after the
Internet of today, though.

well, I do not know what
the Internet of today really
is, either….

Future Internet

- The debate started around five years ago, in the US.
- This was a revamp of the much older discussion on the next IP protocol.
  - IPv6 was (sort of) there already
  - IPv6 was not really taking up
  - Non-US countries were much more active than US
- The new discussion started on very different lines – a Clean Slate approach
  - "Post-IP" became a word

Future Internet – the Clean Slate discussion

- "Given what we know today, if we were to start over with a Clean Slate, how would we design a global communications network?"

- "Ideally, how will the network look in 15-20 years, and how will we get there from here?"

- A **mobile** network trustable to be always there, always on, easy to use, universally accessible, secure, and economically viable ?

Internet features and its relevance

- **Open standardized architecture**
  ➔interoperability and globalisation
  (early interconnection of all media, all networks, all countries)
  ➔innovation and economic growth

- **Separate** network, service and content **layers**
  ➔innovative and flexible business models
  (free access, advertising, community, flat fees, etc…)
  ➔innovation and economic growth

- **Distributed e2e architecture**
  ➔intelligence centered at the edges
  ➔ large number and types of contributors
  ➔peer-to-peer applications
  ➔innovation and economic growth

Internet features and its relevance

- **Technology-neutral access**
  ➔   infrastructure competition
  ➔   explosion of broadband coverage
  (all types of new access, xDSL, cable, fiber, wireless)
  ➔   innovation and economic growth

- Remarkable demonstrated **resilience**
  ➔   global usage (regardless of efficiency)
  (lack of efficiency in wireless, optics, satellite…)
  ➔   economies of scale and economic growth

Recall slide for engineers

The Internet is now a social reality.

Not a technological playground anymore.

Has society treated well our technology?

FEATURE	Disruptive TREND
Distributed architecture	Next Generation Networks (3GPP) Mass entertainment
End-to-end characteristic	Self –Management Middleboxes
Openness	Political intervention Critical infrastructure provision Network neutrality
Technology neutrality	Web/service adaptation Bandwidth requirements Access Cost Sensors Wireless networks
Separate business and technology	Next Generation Networks Vertical clustering Regulation
Resilience	Lack of QoS

Clean-Slate
the fashion words

- Clean Slate is a means, not an end
  - Do not expect direct adoption of *radical* ideas
- It is the insight that will have impact, by guiding the Internet's incremental evolution

  Clean-slate designs $\Rightarrow$ Insights $\Rightarrow$ Better Internet

- NSF's FIND program supports Clean-Slate research
- GENI followed up in the States

- EU FP7 supports this approach in Europe

Recall slide for engineers

Our technology is now much more complex.

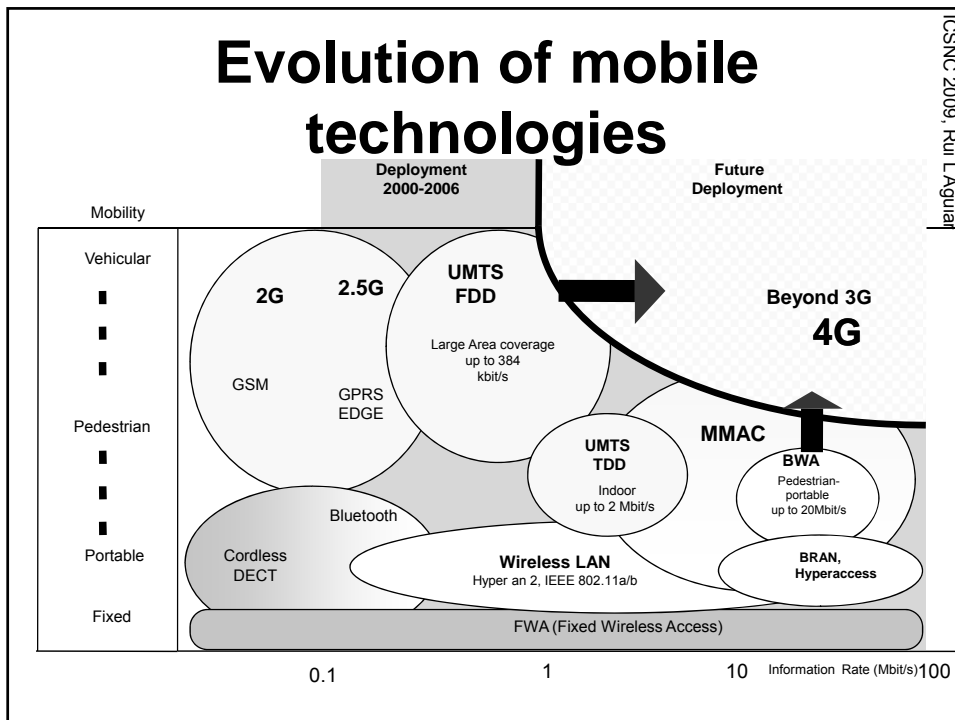**What can we expect in the future?**

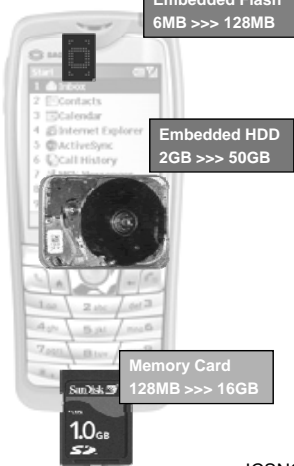# (very) Basic Trends in our (Mobile) world

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Dec/2004 → Sep/2008

- Global Mobile Users **1.52/3.80 billion (**Analogue Users **34/0.31m)**
- Global GSM users **1.25/3.06 billion**
- Global CDMA Users **202/401m** Global TDMA users **120/2.19m**
- US Mobile users **140/286m**
- Total European users **342.43/425.01m**
- Total African users **53/340.7m**
- Total 3G users **130m**
- #1 Mobile Country **China (300/608m)** (GSM **282/582m)**
- #1 Network In Europe **T-Mobil (28m)**
- #1 In Infrastructure **Ericsson**
- Global monthly SMS **36/user**
- SMS Sent Global 1Q04 **135 billion**
- SMS sent in UK 3/2004 **2.1 billion**

7

Evolution of mobile technologies

Deployment 2000-2006

Future Deployment

Mobility

Vehicular

- Pedestrian
- Portable
- Fixed

2G GSM

2.5G GPRS EDGE

UMTS FDD Large Area coverage up to 384 kbit/s

Beyond 3G 4G

MMAC

UMTS TDD Indoor up to 2 Mbit/s

BWA Pedestrian-portable up to 20Mbit/s

Bluetooth

Cordless DECT

Wireless LAN Hyper an 2, IEEE 802.11a/b

BRAN, Hyperaccess

FWA (Fixed Wireless Access)

0.1 1 10 Information Rate (Mbit/s) 100
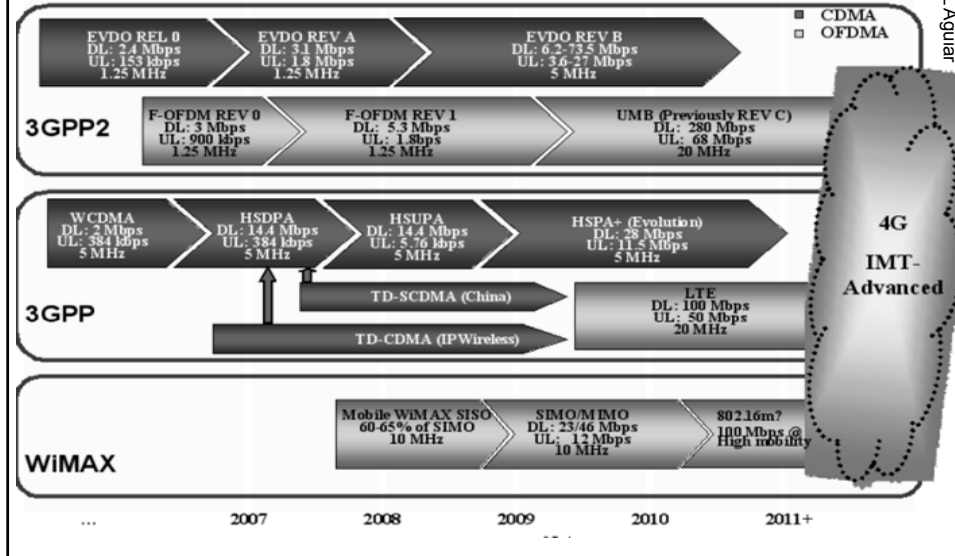

A Mobile Storage Revolution …..

Embedded Flash 6MB >>> 128MB

- Small size to minimise handset cost
- Used for storing system data: applications, messages, contacts, ring-tones

Embedded HDD 2GB >>> 50GB

- Large storage for user content
- But high impact on terminal cost

Memory Card 128MB >>> 16GB

- Large and removable storage for easy transfer of user content
- Interoperable with other consumer electronic devices
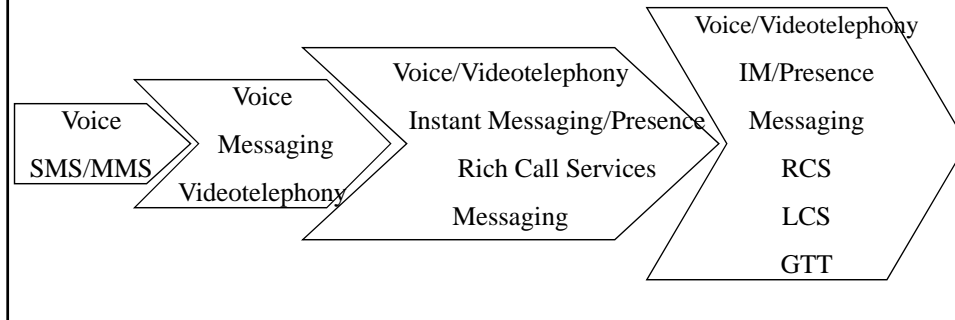- Provides a distribution channel for selling content

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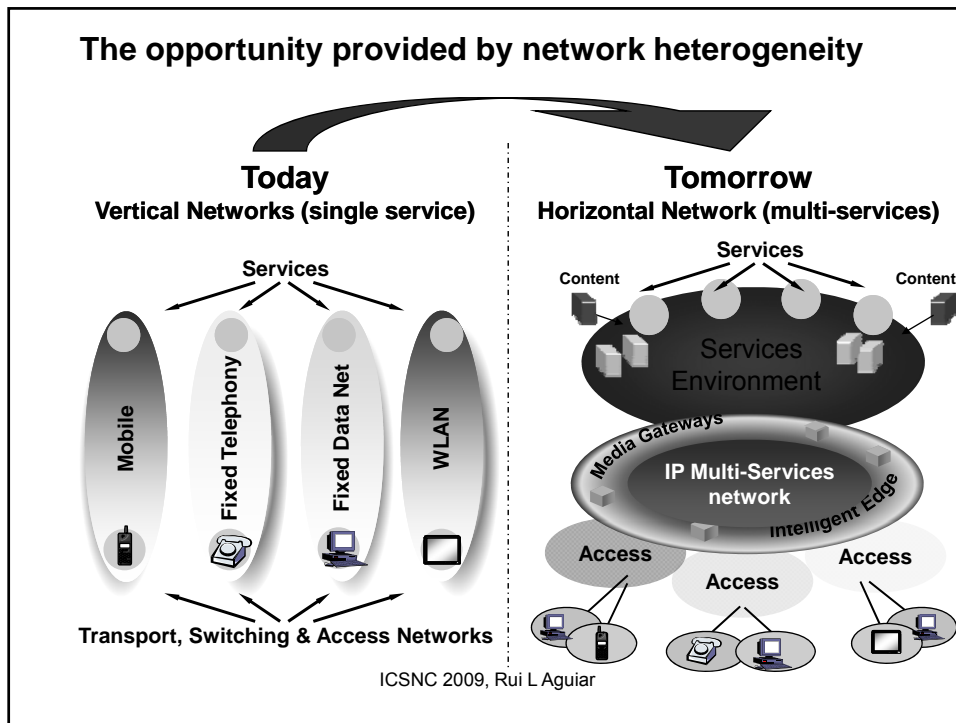
FI *1* - Integrated Future Mobile Networks

CDMA
OFDMA

3GPP2

EVDO REL 0
DL: 2.4 Mbps
UL: 153 kbps
1.25 MHz

EVDO REV A
DL: 3.1 Mbps
UL: 1.8 Mbps
1.25 MHz

EVDO REV B
DL: 6.2-73.5 Mbps
UL: 3.6-27 Mbps
5 MHz

F-OFDM REV 0
DL: 3 Mbps
UL: 900 kbps
1.25 MHz

F-OFDM REV 1
DL: 5.3 Mbps
UL: 1.8bps
1.25 MHz

UMB (Previously REV C)
DL: 280 Mbps
UL: 68 Mbps
20 MHz

3GPP

WCDMA
DL: 2 Mbps
UL: 384 kbps
5 MHz

HSDPA
DL: 14.4 Mbps
UL: 384 kbps
5 MHz

HSUPA
DL: 14.4 Mbps
UL: 5.76 kbps
5 MHz

HSPA+ (Evolution)
DL: 28 Mbps
UL: 11.5 Mbps
5 MHz

TD-SCDMA (China)

TD-CDMA (IPWireless)

LTE
DL: 100 Mbps
UL: 50 Mbps
20 MHz

4G
IMT-Advanced

WiMAX

Mobile WiMAX SISO
60-65% of SIMO
10 MHz

SIMO/MIMO
DL: 23/46 Mbps
UL: 12 Mbps
10 MHz

802.16m?
100 Mbps @
High mobility

... 2007 2008 2009 2010 2011+

Services evolution in UMTS R99/R4/R5/R6 networks

Release	Services
R99	MMS, streaming, LCS (cell), MExE, SAT, VHE,
R4	TrFO, VHE, OSA, LCS in PS and CS,
R5	VoD, IMS, HSDPA, Wideband AMR, GTT
R6	MBMS, IMS phase 2

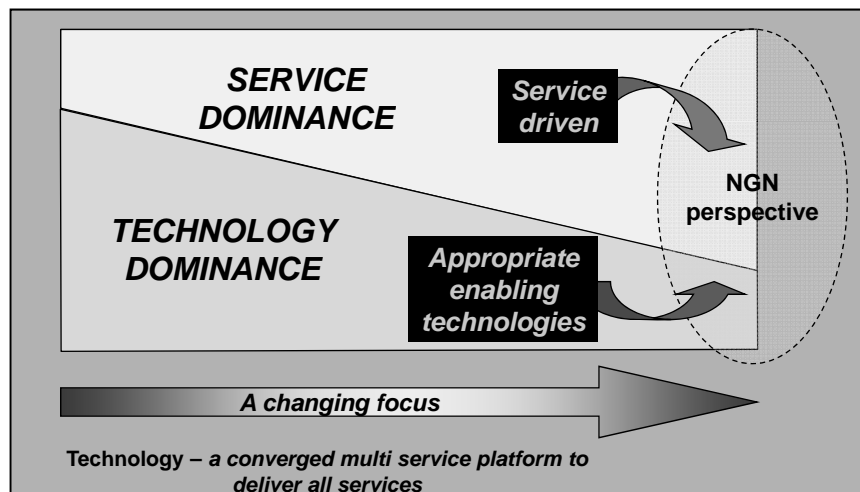Evolution of the services (voice and interpersonal services)

Voice
SMS/MMS

Voice
Messaging
Videotelephony

Voice/Videotelephony
Instant Messaging/Presence
Rich Call Services
Messaging

Voice/Videotelephony
IM/Presence
Messaging
RCS
LCS
GTT

The opportunity provided by network heterogeneity

Today
Vertical Networks (single service)

Services

Mobile
Fixed Telephony
Fixed Data Net
WLAN

Transport, Switching & Access Networks

Tomorrow
Horizontal Network (multi-services)

Content
Services
Content

Services Environment

Media Gateways

IP Multi-Services network

Intelligent Edge

Access
Access
Access

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Network Evolution — Future Orientation – *Service Driven*

SERVICE DOMINANCE

Service driven

NGN perspective

TECHNOLOGY DOMINANCE

Appropriate enabling technologies

A changing focus

Technology – *a converged multi service platform to deliver all services*

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FI *2* - Internet of Services, Service Web

- Collective End-user Intelligence
- Multi-Channel Access
- Discovery
- Mashup
- Tagging
- Resources

Professional Business Applications

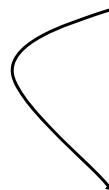Value-Added Services

Interopera-bility Service
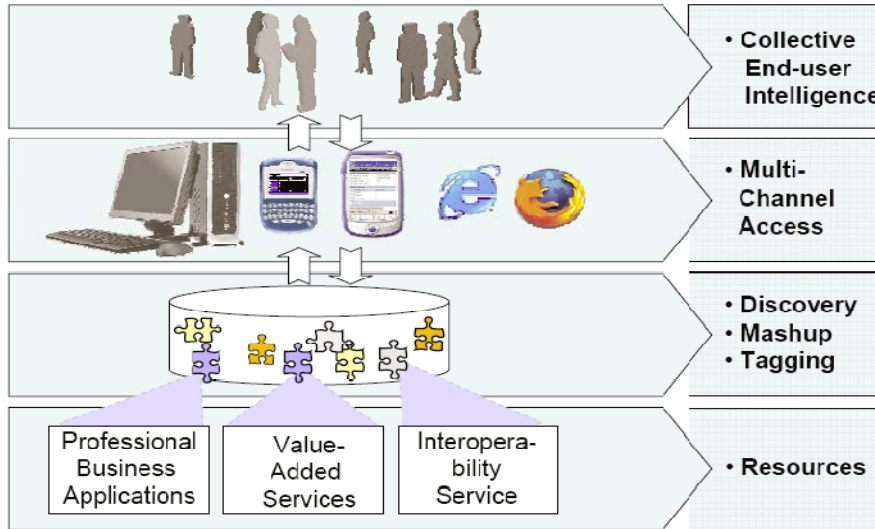
Disposable products
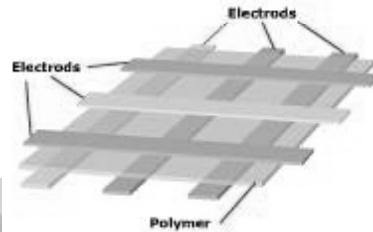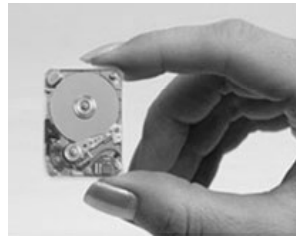
The disposable camera
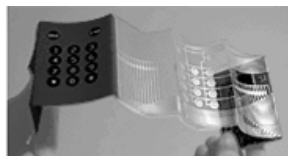
The plastic calculator

The PAPER LAP TOP

The disposable PC

The Emergence of Local Information
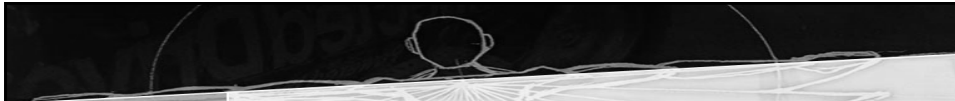
FI *3* - Internet of Things

New interfaces

New virtual connections

FI *4* - 3D virtual Internet

# well, I do not know what the Internet of today really is, either….

it seems I am not the only one.

What will the *(four?)* network of the future be?

- Will the network nodes still require the same communication capacities?
  - E.g. Will we have cell phones as the major terminal?
- Will communication sources and sinks still be the same?
  - E.g. With sensors, cars and packages connected?
- Will the usage of the devices remain the same?
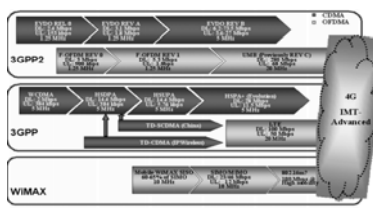 - E.g. If M2M is common?
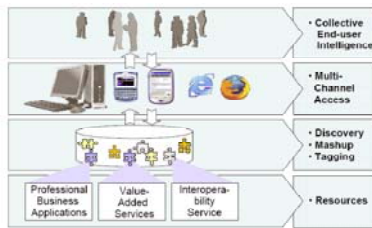
3D Internet

Internet of Services, Service Web

Integrated Networks of the Future

Internet of Things

Sources: 3GPP, 3GPP2, Qualcomm, WiMAX Forum
http://www.alexandria.unisg.ch/EXPORT/DL/38496.pdf
http://www.itu.int/osg/spu/publications/internetofthings/
Second Life

Major trends at a glance

❑ **Advance of the Internet**
The Internet has become a mass medium and IP the leading network protocol.

❑ **Advance of mobile communication**
Communication via mobile radio networks is still increasing enormously.
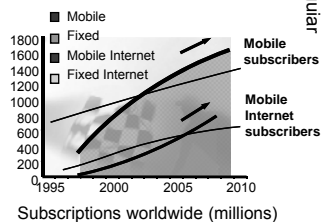
❑ **Bandwidth evolution**
The available bandwidth is exploding and the prices for bandwidth decreases dramatically.

Subscriptions worldwide (millions)
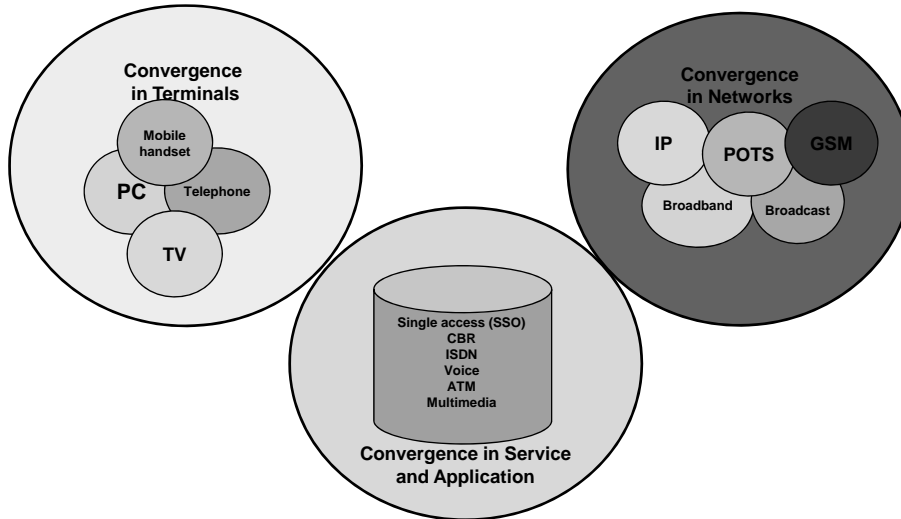
❑ **Convergence of digital industries**
The converging digital industry brings together parts of the broadcasting, consumer electronics, communication, information technology, media and entertainment industries.

❑ **Services and applications are key**
The end user is interested in services and applications only, the underlying technology is not relevant.
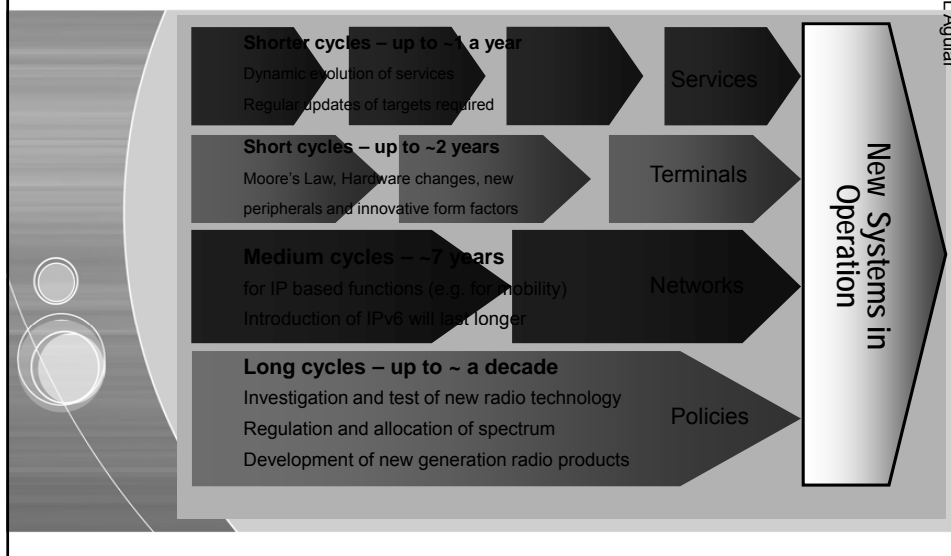
Where is convergence taking place?

Convergence in Terminals

Mobile handset

PC

Telephone

TV

Convergence in Networks

IP

POTS

GSM

Broadband

Broadcast

Single access (SSO)
CBR
ISDN
Voice
ATM
Multimedia

Convergence in Service and Application

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Cycles of innovation

Shorter cycles – up to ~1 a year
Dynamic evolution of services
Regular updates of targets required

Services

Short cycles – up to ~2 years
Moore's Law, Hardware changes, new peripherals and innovative form factors

Terminals

Medium cycles – ~7 years
for IP based functions (e.g. for mobility)
Introduction of IPv6 will last longer

Networks

Long cycles – up to ~ a decade
Investigation and test of new radio technology
Regulation and allocation of spectrum
Development of new generation radio products

Policies

New Systems in Operation

Recall slide for engineers

**Changing fundamental
technologies takes TIME.**

**Solutions to society appear with
the building blocks at hand.**

**Do not expect Post-IP to mean
« no IP technology »**

4G networks

A 4G system (a Future Internet system?) will be able to provide a complete converged solution where voice, data and streamed multimedia are provided to users on an "Anytime, Anywhere" basis.

Data rates should be dynamic, resorting to the "always best connected" paradigm,

with **IP technology** as a common denominator between all of them.

Conclusions

- "Future Internet" will be mobile, mobile, mobile
- "Future Internet" will be **society-driven**
  - Technology will have to cope!
- Regardless of the "Post-IP" studies…
  - FI will be IP based for long time
    - Think how to incrementally improve it.
  - And we will know it as a "4G network"

And still we will have a complex network to plan, manage, control
  - IP does not really solve the problem….

Questions?

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