M-Power

Wireless Convergence

A Test and Measurement Perspective

Francisco J. Garcia, PhD

Measurement Research Lab

Agilent Laboratories

Agilent Technologies

July 2007

Contents

- What is driving wireless convergence?
- What are the challenges towards convergence?
- Where do Wireless sensor networks fit in this space?
- How does this impact test and measurement?

Wireless Communications Market

Extraordinary growth for wireless data as Cellular and Wireless connectivity merge

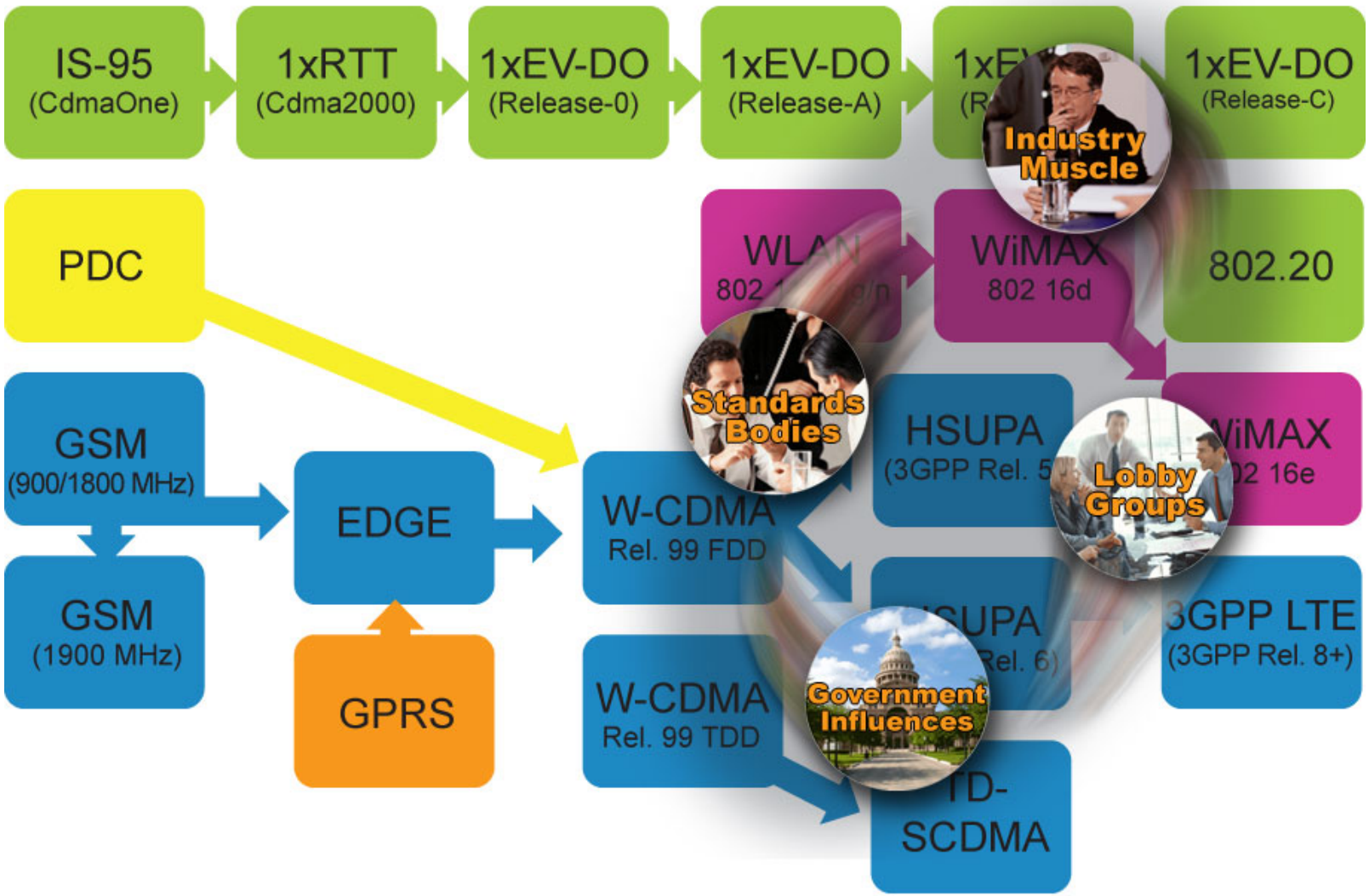
Over the next few years we will see an increasing number of devices that include a combination of wireless access technologies

Continual Evolution of Technologies

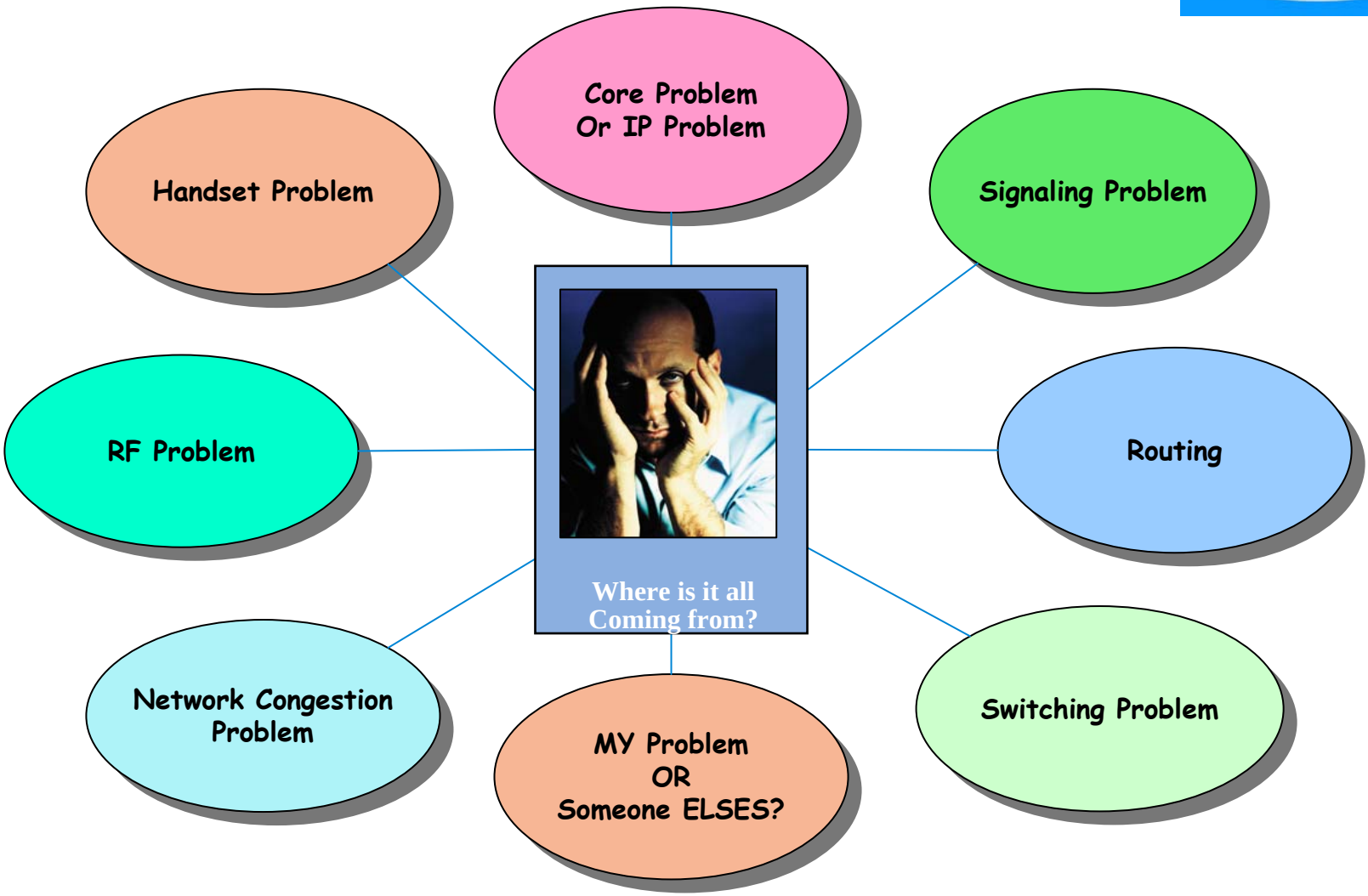
Agilent delivers the broadest test solution coverage

R&D	Validation	Manufacturing	Deployment

The Industry & Technology Access Standards



Problem Areas

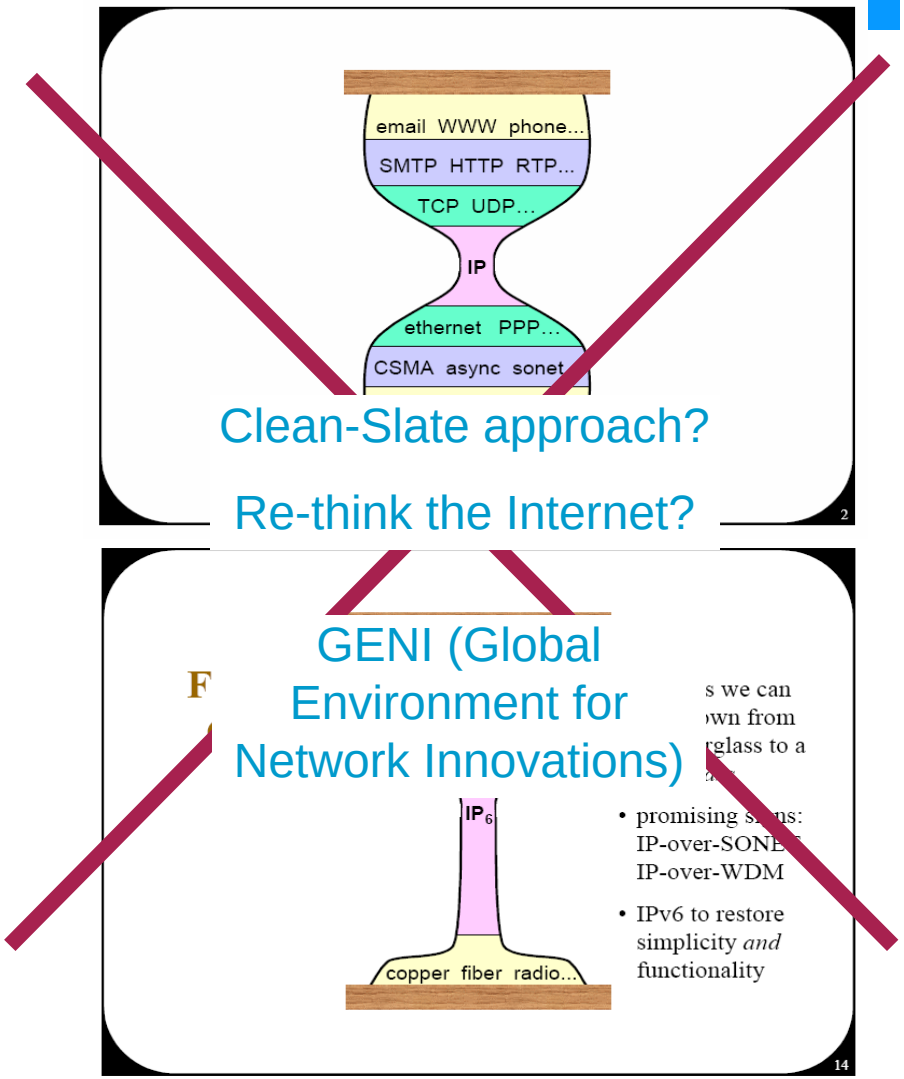


Seamless Integration of Radio Technologies

- A key concept in developing notions of 4G networks
- Great challenges since:
  - Each radio access technology differs in cell size, from a few m^2 to hundreds of kilometres with overlapping coverage areas;
  - Employ different architectures and protocols for routing, transport and mobility management;
  - Employ different authentication, key management and encryption schemes;
  - Different service demands from mobile users ranging from low-data-rate non real-time applications, to high-speed real-time multimedia applications
- Integration has to be achieved across this diversity while trying to make mobility both seamless and secure

All-IP Based Infrastructure

- Another key concept in developing notions of 4G networks
- Success of IP as a bridge for addressing the heterogeneity gap largely attributed to its *adaptability*
- To improve on spectral efficiency future wireless technologies will make use of:
  - Multiple Transmitters and Multiple Receivers (MTMR)
  - Adaptive modulation and coding
  - Advanced receivers
- Spectrum sharing – future RF hardware also adaptable
  - Cognitive algorithms atop software defined radio
- The link becomes a *tuneable* parameter, can no longer be viewed as a fixed link with some deterministic characteristics
- Mobility today only seen at the *edge*



Steve Deering – 51st IETF, London, August 2001

Mobility Management

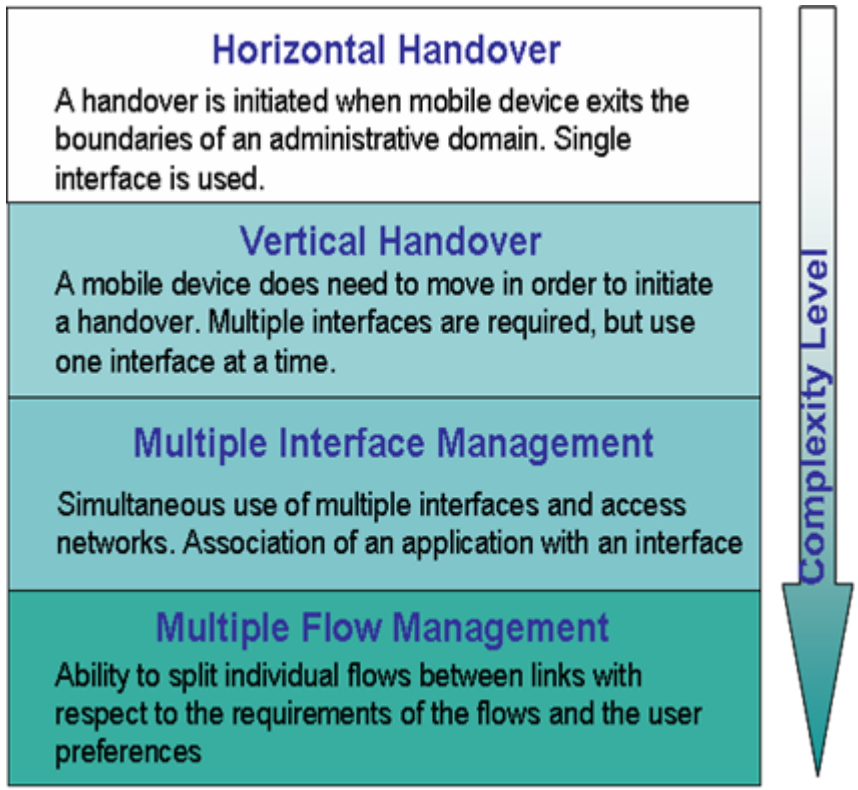
- Very active area of research fuelled by the emergence of multiple modality devices and drive towards wireless convergence
- Two co-operative components:
  - Location management – the ability to keep track of a mobile terminal and its movements
    - How does the terminal inform the system or network of its location?
    - How does the network or system locate the terminal for call or data delivery?
  - Handover management – the ability of the system or network to keep the mobile terminal best connected while seamlessly roaming
    - Many algorithms available today to perform handover in a seamless and secure manner
- Today most of this is done within a single homogeneous system or network
  - The challenges lie in how to develop the next generation techniques that will facilitate these important services across heterogeneous networks
  - Some techniques available today, however they remain un-proven, not fully deployed and there is a serious lack of detailed theoretical analysis to support them

Mobility Management Decomposition

Challenges in Location Management

- Co-ordinated techniques across heterogeneous networks
- Reduce signalling overheads
- Make better use of scarce radio resources
- Save power and computational resources on the mobile terminal
- Minimize requirement for paging in multiple networks
- Are wireless services partially or fully overlapped or adjacent?
- How does mobile terminal perform registrations and through which network?
- Where should location information be stored as mobile terminal roams?
- Impact on time to locate mobile terminal

Challenges in Handover Management



NIST: National Institute of Standards and Technology

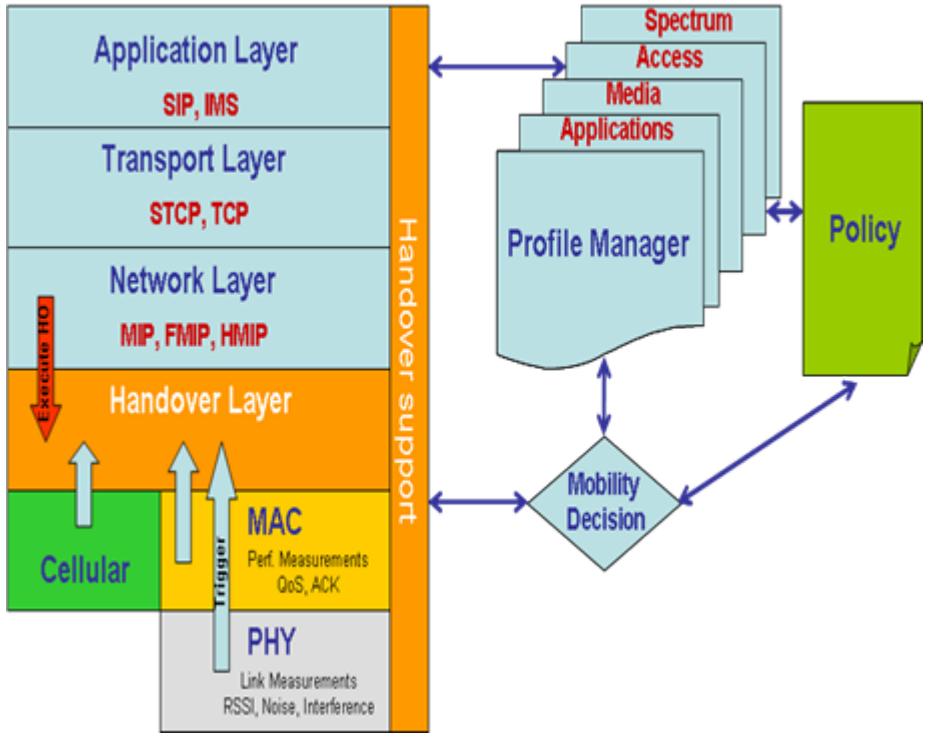
Dealing with Handovers

Handover Decision Making Today

- Three strategies adopted in homogeneous systems:
  - Network controlled – network makes measurements and decisions
  - Mobile assisted – mobile makes measurements network makes decisions
  - Mobile controlled – measurements and decisions made by mobile
- Simple quality metrics used – signal strength and channel availability of neighbouring cell

Handover Decision Making Tomorrow

Source: National Institute of Standards and Technology (NIST)



"Estimation accuracy of future metrics will be crucial to support seamless mobility and a variety of decision making algorithms"

The Industry & Technology Handover Standards

ternet Engineering Task Force - IETF

Layer 3

- MIPv4 / MIPv6
  - Mobile IP version four and six
- Detecting Network Attachment
  - Processing Layer 2 triggers
- Mipshop
  - MIPv6 signalling and Handoff Optimization
- Mobopts
  - IP Mobility optimizations research group
- Nemo
  - Network Mobility
- Netlmm
  - Network-based localized mobility management
- Hokey
  - Extensions to EAP to handle handovers

Higher Layers

Session Initiation Protocol

UMA Technology

IP Multimedia Subsystem

IEEE 802

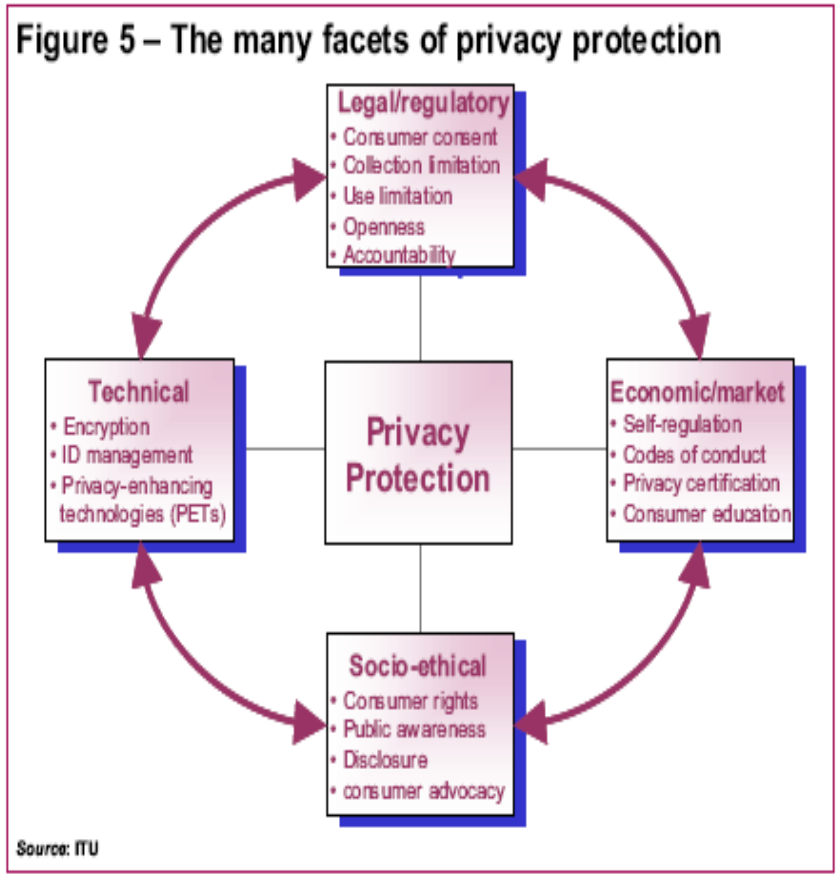
Layer 2

- IEEE 802.21
  - Media Independent Handovers
- IEEE 802.11r
  - IEEE 802.11 Fast Handovers
- IEEE 802.11u
  - Internetworking wit external networks
- IEEE 802.16 e
  - Mobile WiMAX

Source: National Institute of Standards and Technology (NIST)

Security further complicates things …

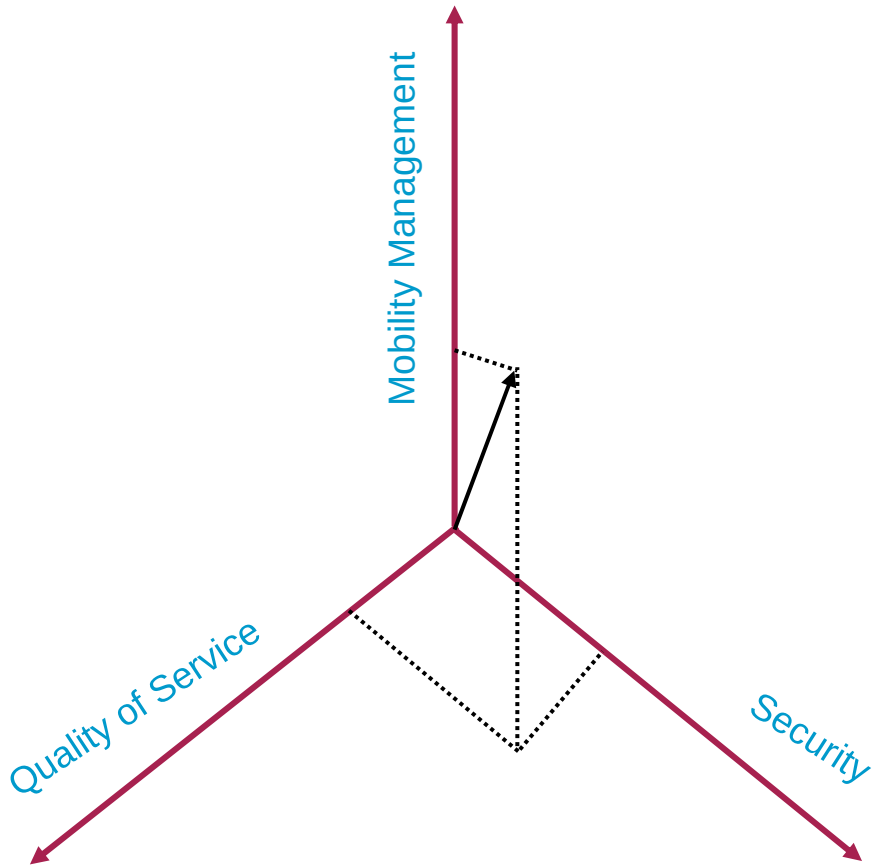
- Multiple Identities and credentials
- Accountability, deterrence, privacy, freedom from observation and tracking
- Mutual authentication
  - Devices, users, services, links, etc.
- Today, equipment vendors and service providers deal with this via menu driven security options to handle authentication, encryption and data integrity
  - Has lead to complexity (i.e. multiple exchanges, miss-match in capabilities, sign-on multiple times, etc.)
- Usage of device resources, associated performance tradeoffs, latency …
- Authentication and trust management in purely distributed environments, no central authority.



"Lots of mechanisms and protocols, no unified approach or architecture"

Mobility, Security and QoS …

- Traditionally mobility, security and QoS have been treated as orthogonal processes working in isolation
- Each impacting on the other with sub-optimal performance
  - Behaviour is unpredictable
- Need a unified approach to handling these dimensions to minimise negative interactions
- Dependent on threat environment, equipment capabilities and usage scenarios



The Internet of Things

Health Care

Health Management
(physical condition, movement)

Safety
(condition, location)

Security

Fire, earthquake, flood, building failure
(smoke, vibration, strain, water level, temperature)

Security, building status
(entry, strain, temperature,
Lighting, vibration)

Disaster response

Fire, landslide, tsunami
(temperature, smoke,
ground shift)

Widespread distribution of sensors and smart objects

Communications dominated by traffic from devices
Sensors and smart objects

Technology enablers: RFID, nanotechnology, wireless sensors
and smart technologies

Growing reliance on 'Mobile' platforms

Broken cables, loose bolts
(strain, vibration,
elastic waves)

Climate, water quality
(rainfall, water quality)

Atmospheric pollution
(SOx, NOx)

Fires, toxic gas
(SOx, NOx)

Environment and crop growth
(growth rate, temperature,
humidity, soil quality)

Quality control, automation

Control centre, services,
Distribution status, quality

Environmental risks

Agriculture & Production

Other

Test and Measurement Challenges

- What are the these mobility architectures?
- What protocols and mechanisms are being deployed?
- What are the various mobility scenarios envisaged?
- How do these protocols and architectures interact with each other in attempting to deliver seamless and secure global roaming?
- How will handover decisions be made and what measurements will aid this process?
- At what vantage points will these measurements be made?
- How will these measurements be shared and communicated?
- How will mobility performance be evaluated and quantified?
- What impact will security management have on mobility and how can we quantify it?
- How will we test these services and functionality?
- How will we discover the characteristics of varying wireless links?
- What monitoring and control information should be revealed to the application?
- How should we make security quantifiable in terms of performance?
- How will we determine the cause of failure in complex mobile environments? How will this be communicated?
- What other non traditional metrics do we need to consider? (manageability, configurability, diagnosability, trustability, etc.)
- How will devices and networks components be instrumented to make these metrics visible at multiple layers?
- etc.

Conclusions

Welcome to my world!

What test and measurement tools can we develop and provide you with to help you develop and grow your world?