OpenMIND & Case Study for Mobile TCP

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Ice Break

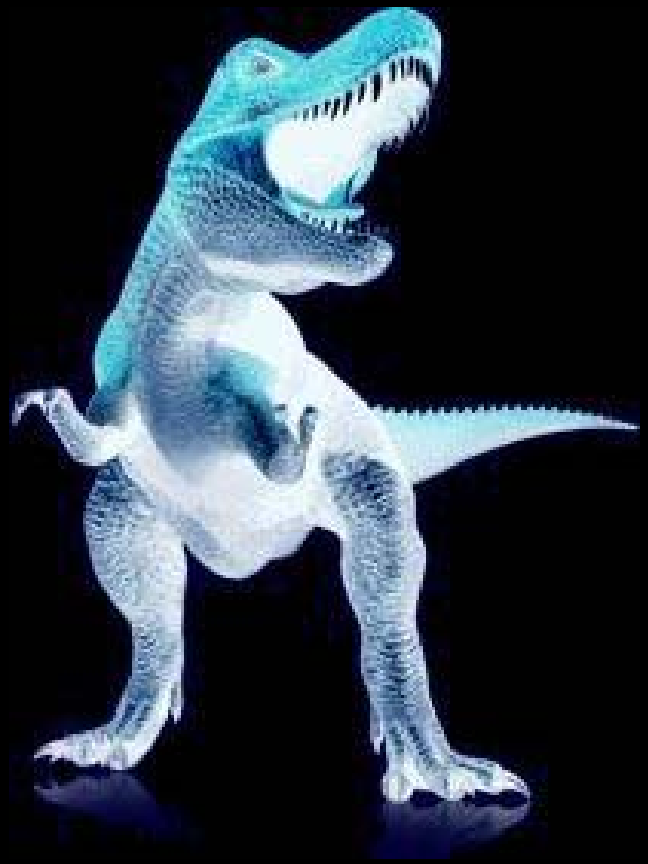
Ice-breaking

Future Internet?

Future of Internet?

Reference: Studio Gainax

Internet of Future?



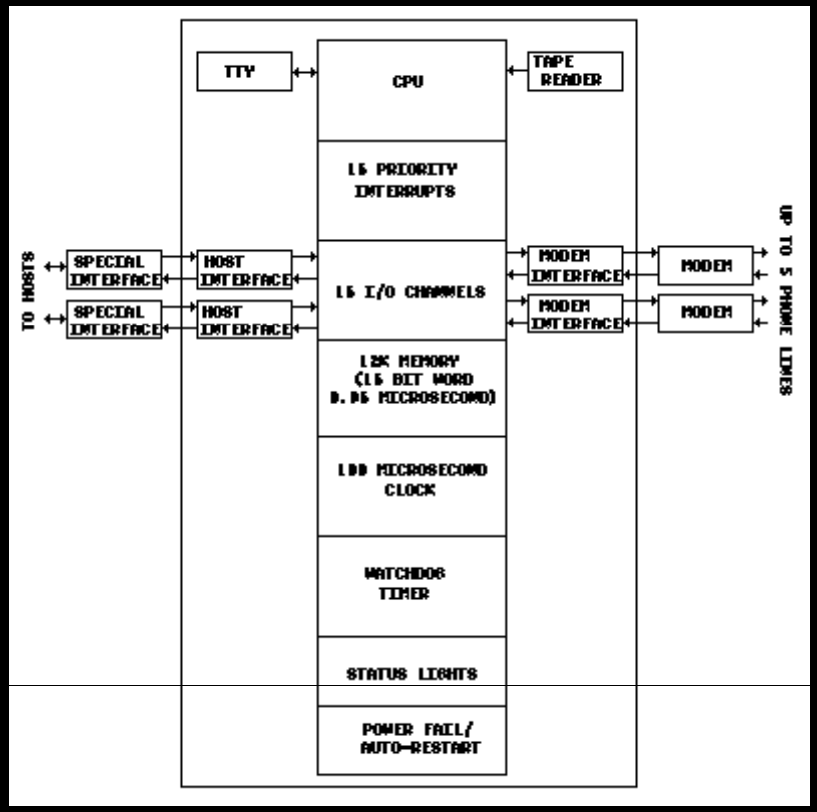
Problems

What's Wrong?

1 October 1969

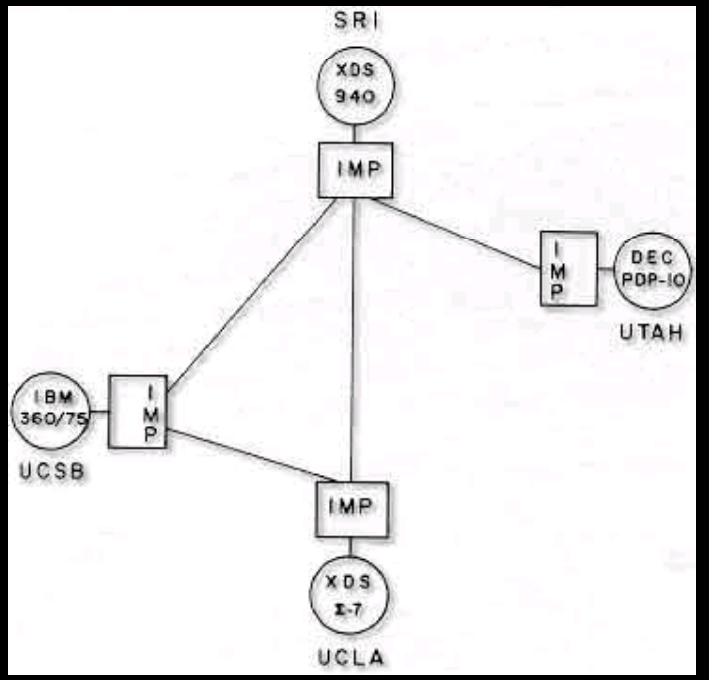
“World 1st Router”

Baby Router

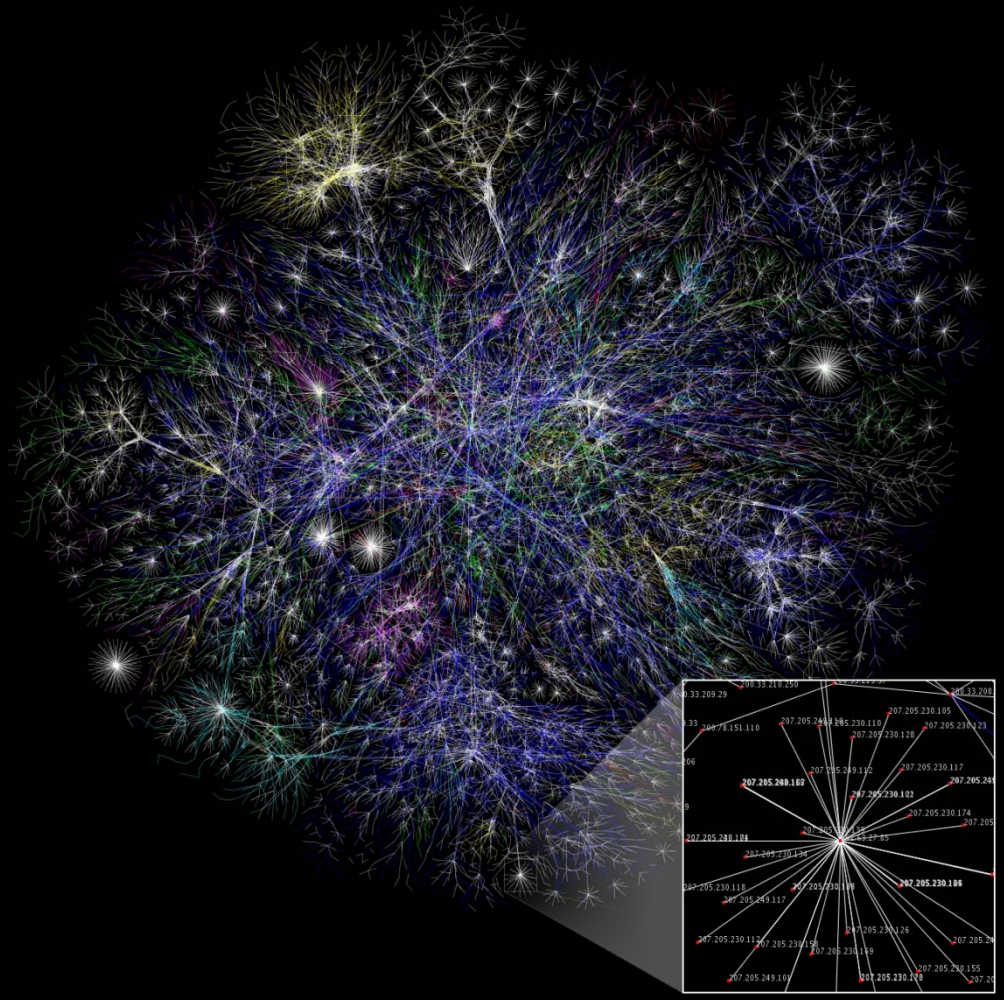


Baby Network

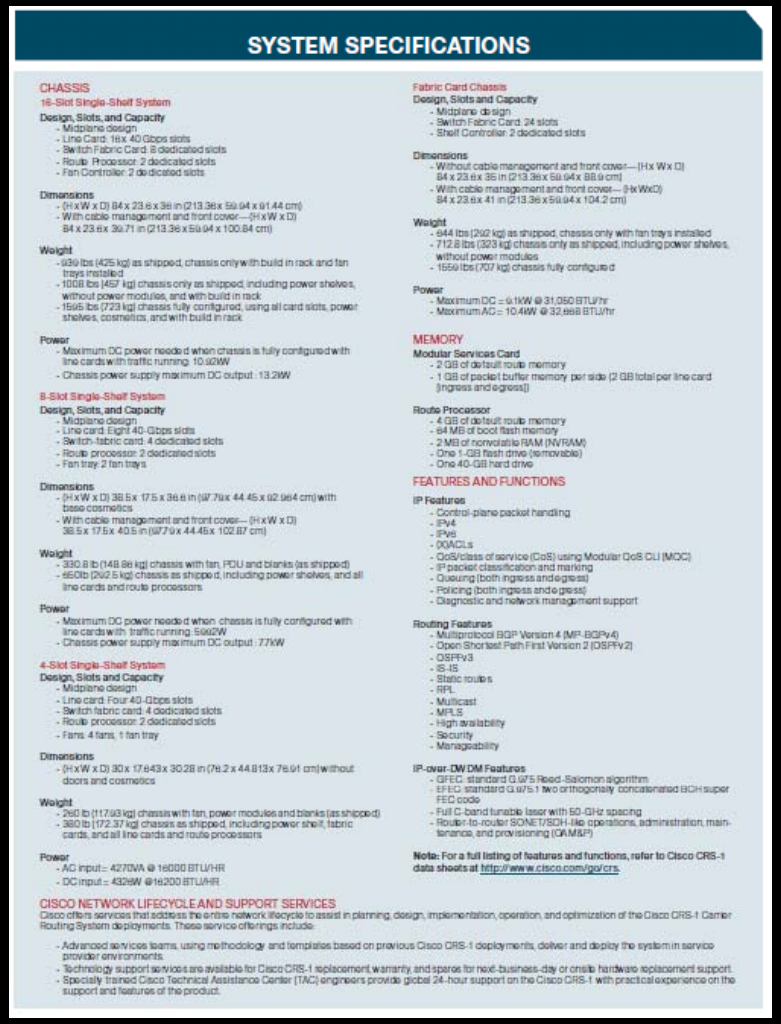
Around Labor Day in 1969, BBN delivered an Interface Message Processor (IMP) to UCLA that was based on a Honeywell DDP 516, and when they turned it on, it just started running. It was hooked by 50 Kbps circuits to two other sites (SRI and UCSB) in the four-node network: UCLA, Stanford Research Institute (SRI), UC Santa Barbara (UCSB), and the University of Utah in Salt Lake City.



40 Years Old Uncle - *Internet*



Router – The Almighty Machine



Reference: Cisco CRS Router Brochure

Fundamental Question

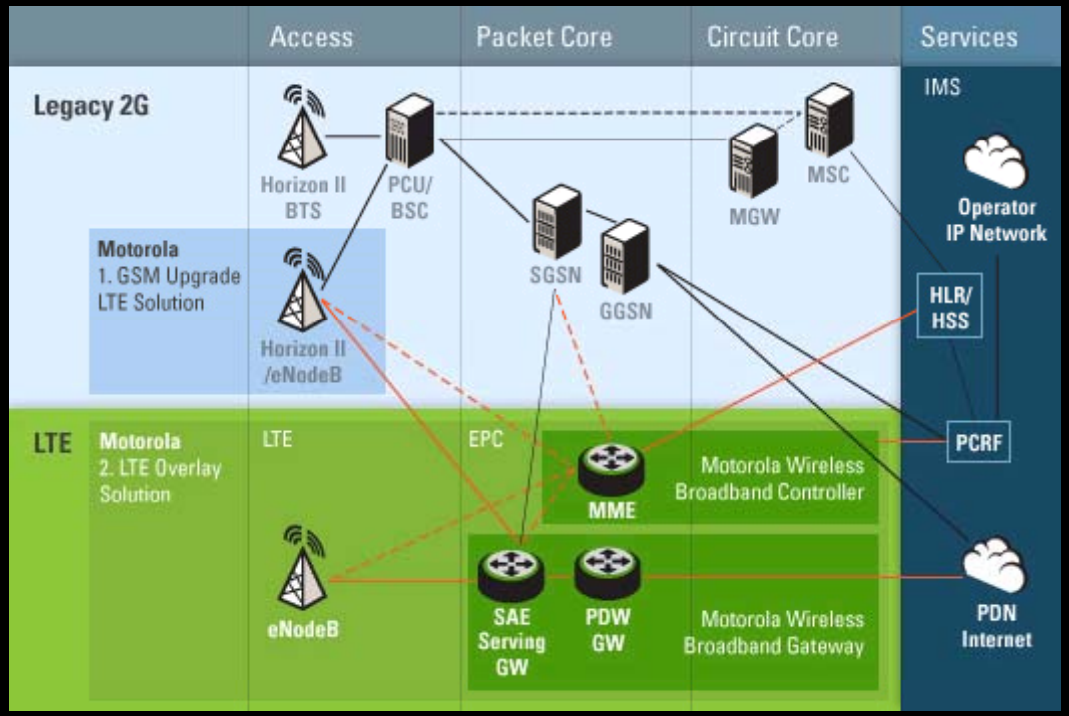
Evolution or Revolution?

How about Mobile Network?

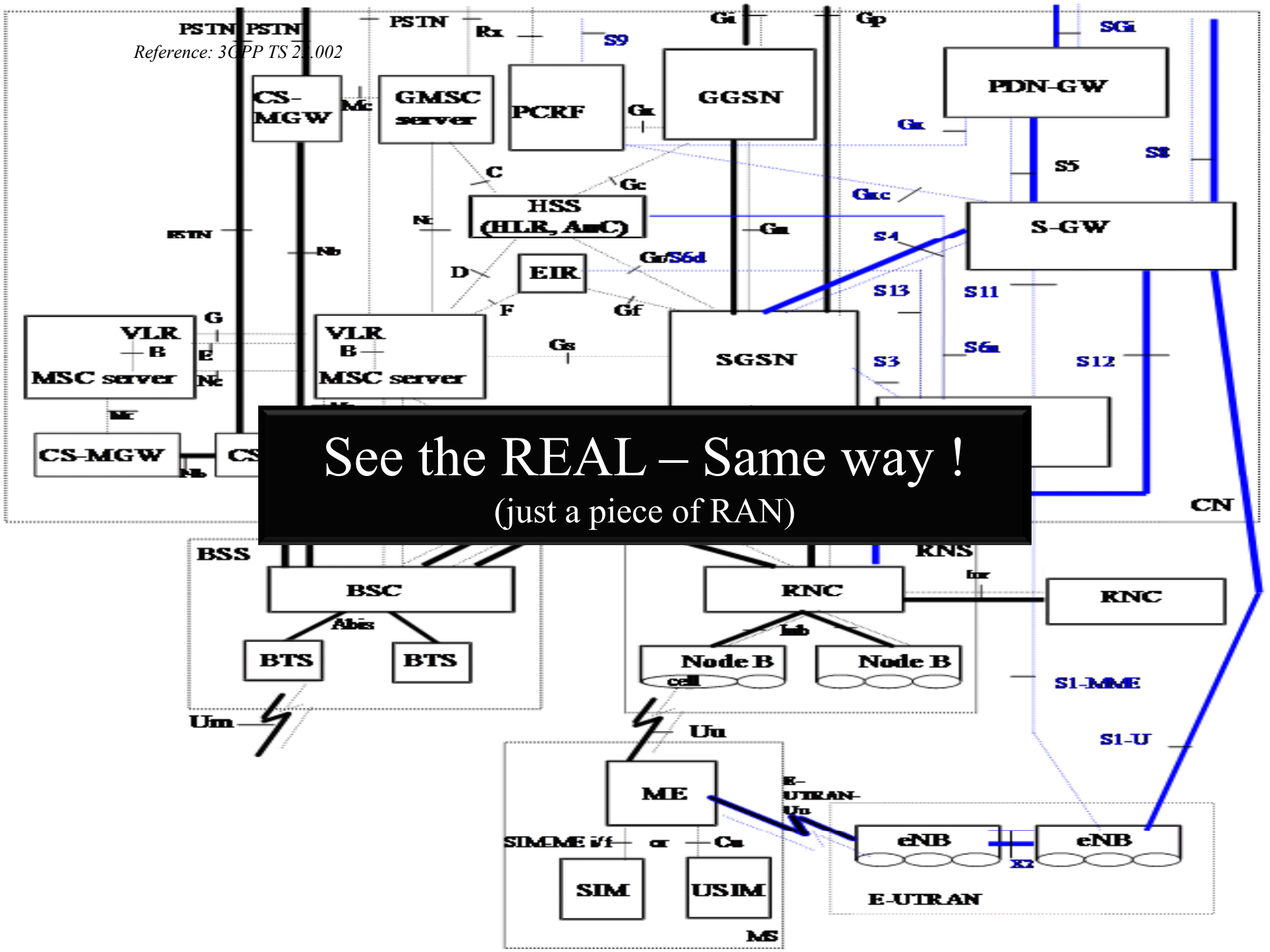
30 Years Old

Reference: Ericsson Review

Different Way – Future is Simple?



Reference: Motorola "Long-Term-Evolution"


Reference: 3GPP TS 23.002
PSTN
PSTN
PSTN
Rx
S9
Gi
Gp
SGi
CS-MGW
Mc
GMSC server
PCRF
Gx
GGSN
PDN-GW
Gx
S8
S5
C
Gc
Gxc
HSS (HLR, AuC)
Nc
Gn
S-GW
S4
PSTN
Nb
D
EIR
Gr/S6d
S13
S11
F
Gf
G
VLR
B
MSC server
Gs
SGSN
S3
S6a
S12
Nc
CS-MGW
See the REAL – Same way !
(just a piece of RAN)
CN
BSS
RNS
BSC
RNC
RNC
Abis
Iub
BTS
BTS
Node B
Node B
cell
S1-MME
Um
Uu
S1-U
ME
E-UTRAN-Uu
SIM-ME i/f
or
Cu
eNB
eNB
X2
SIM
USIM
E-UTRAN
MS

Propaganda

As IP defeated ATM/PSTN.

Propaganda

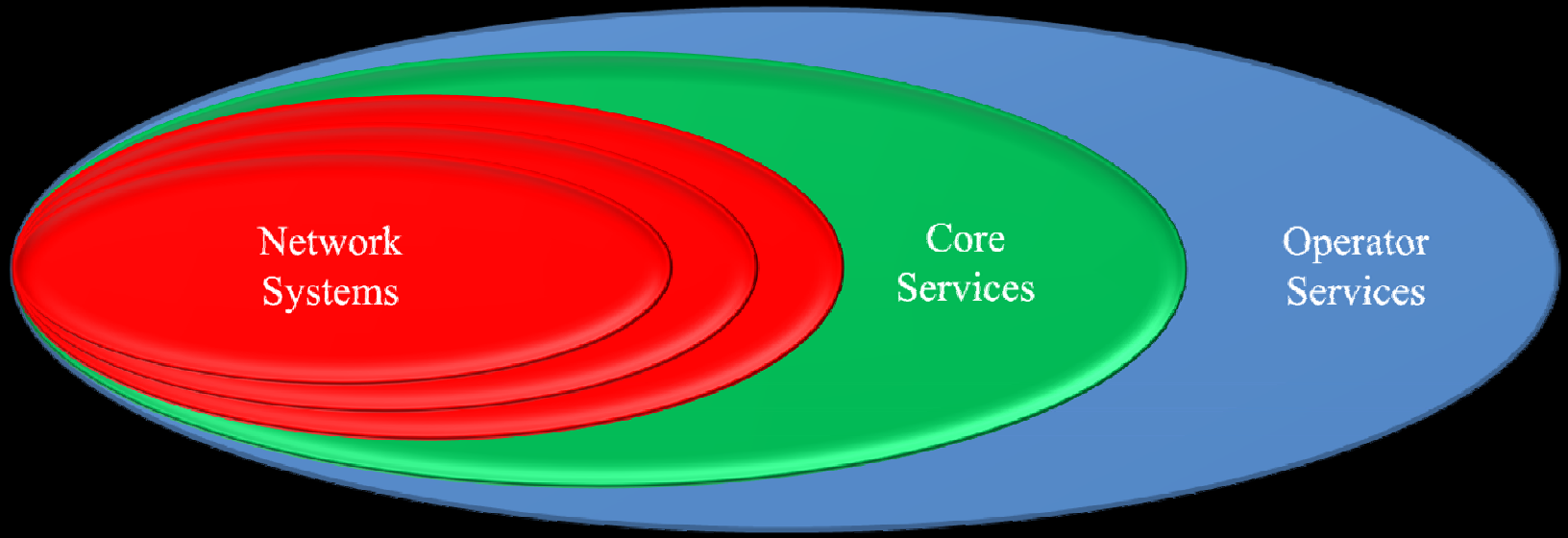
Let's defeat The Wall by Future Mobile Internet!

Key-words

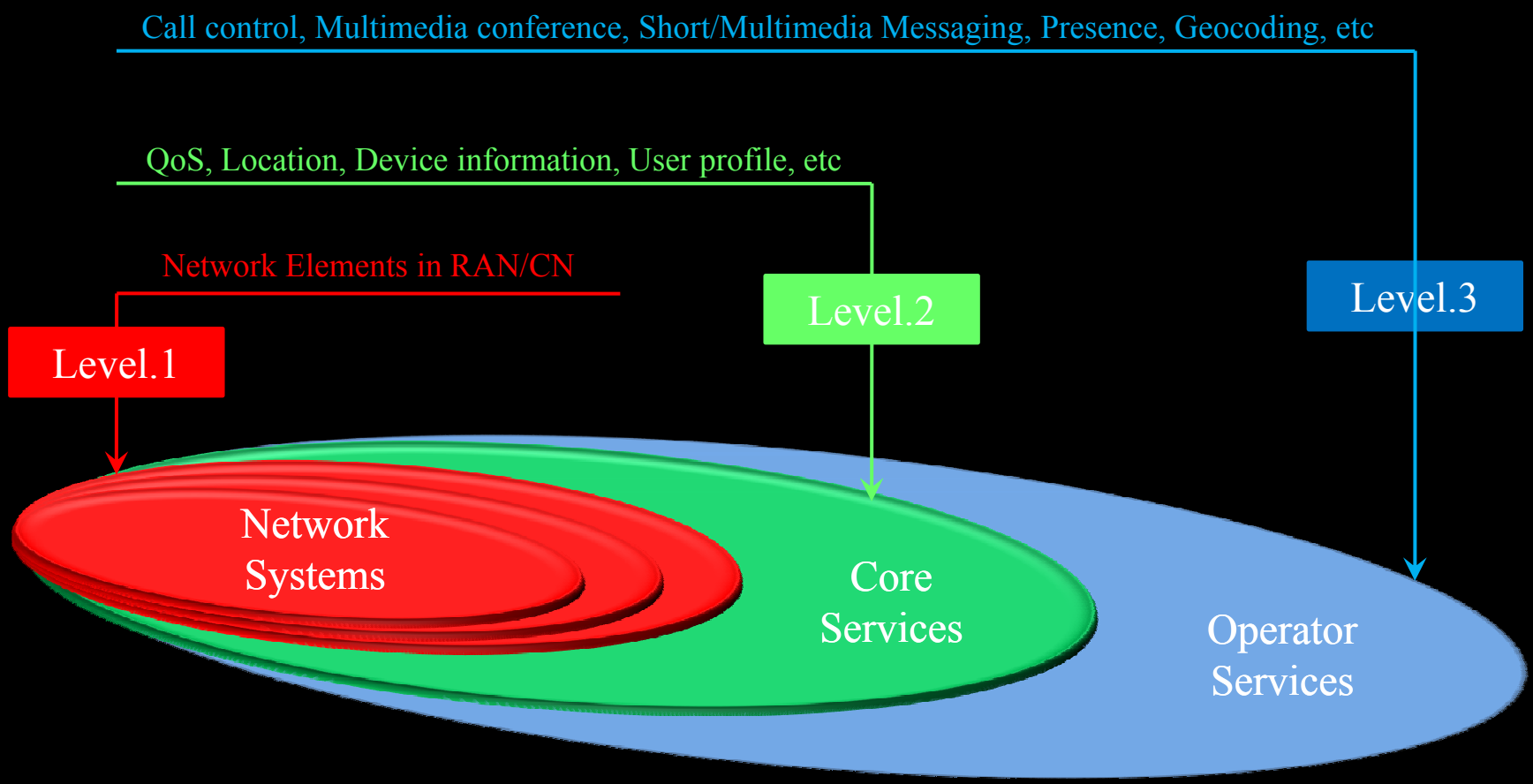
Loosely Synchronized,
Multiple Air Technologies,
Open,
Programmable

Open & Programmable

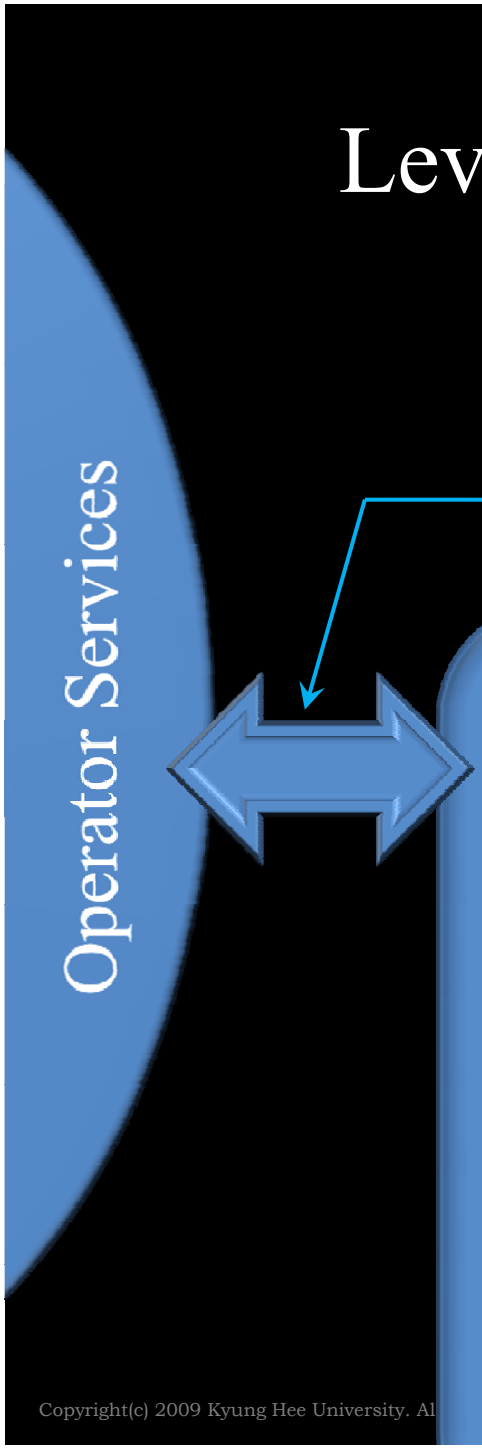
Layering Architecture of Network



Three Levels of Open Network



Level.3 Standard Open Interface for Operator Services



Entrusted 3rd party service & information providers.

Extended operator services
- Pre-paid call
- IP-PBX, IP-Centrex
- Entertainment messaging
- VPN

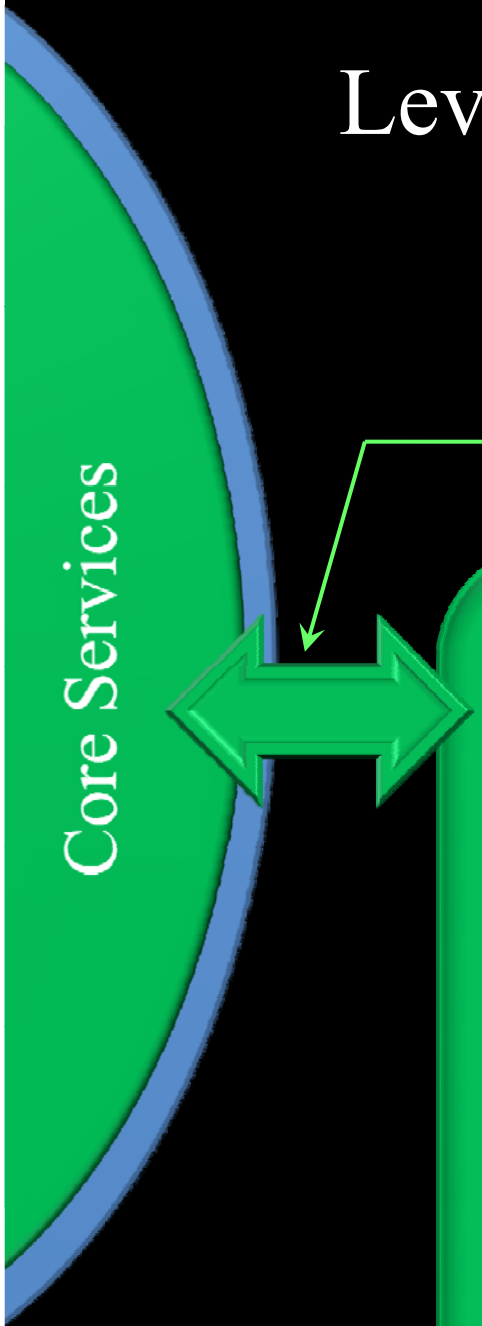
Parlay & Parlay X

ETSI TISPAN OSA Project, jointly with 3GPP CT5 (OSA : Open Service Access API).

Parlay X 3.0 available from Nov 2007.

Corresponds with 3GPP TS 29.199 Rel.7 Specifications from Nov 2007.

Level.2 Standard Open Interface for Core Services



USI

WiMAX Forum NWG
(Network Working Group) Release 1.5
Universal Service Interface.

"Mobile Network as a
Service Enabling Platform for
Internet+ & Mobile Web 2.0"

Internet Service Provider,
Application Service Provider,
Enterprises.

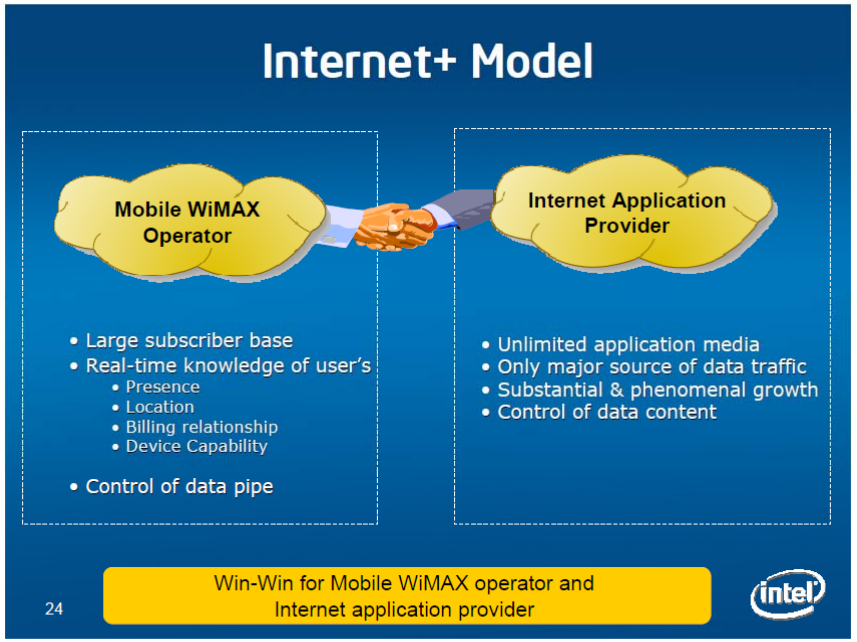
Enhanced ISP/ASP Services

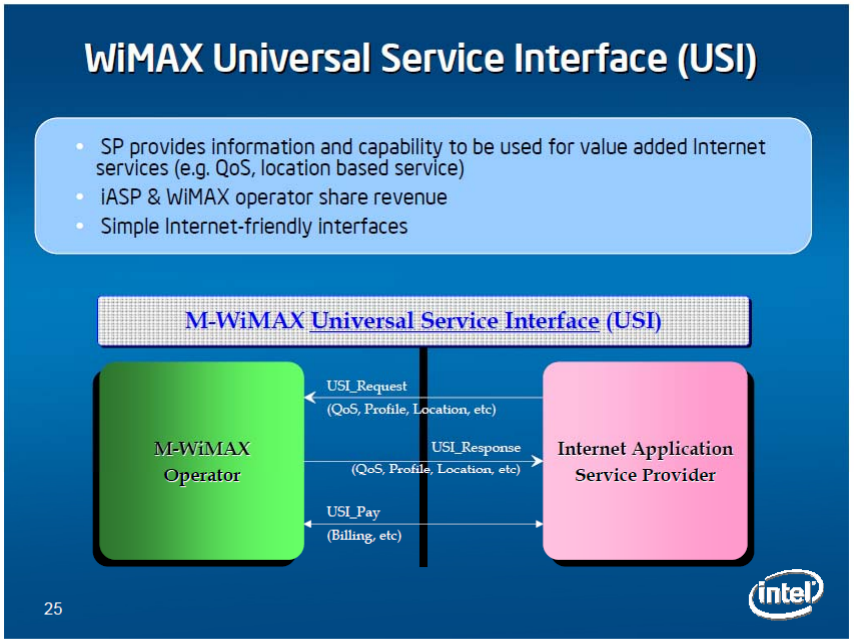
- QoS guaranteed IP-PBX
- QoS guaranteed P2P Voice
- QoS guaranteed Web TV
- Location based Web Search
- Device capability based Multimedia/Web contents
- Targeted marketing

WiMAX USI

First Open Network Interface for Mobile Wireless Broadband Network

(with limited features and capabilities)





Level.1 Standard Open Interface for Network Systems

Network Systems

No Existing References

MVNO,
Enterprises with hosted network,
R&D technology innovators.

Customer Configured Networks and Innovative Services

- Service differentiated MVNO : QoS, Security, Contents, etc.
  (Most MVNOs targeted to Cost-driven business)
- Private mobile wireless enterprise network with privacy
  (e.g. own security scheme, enterprise AAA, mobile/wireless VPN)
- Customized TCP performance enhancement for classified users
  (e.g. TCP acceleration, Snoop)
- New innovative technology
  (e.g. new addressing / mobility / networking / routing / etc algorithms)

Virtualization == Open & Programmable?

Virtualization *is not a new brand name in the Mobile Network.*

MVNO

Mobile ***Virtual*** Network Operator

What is the Problems?

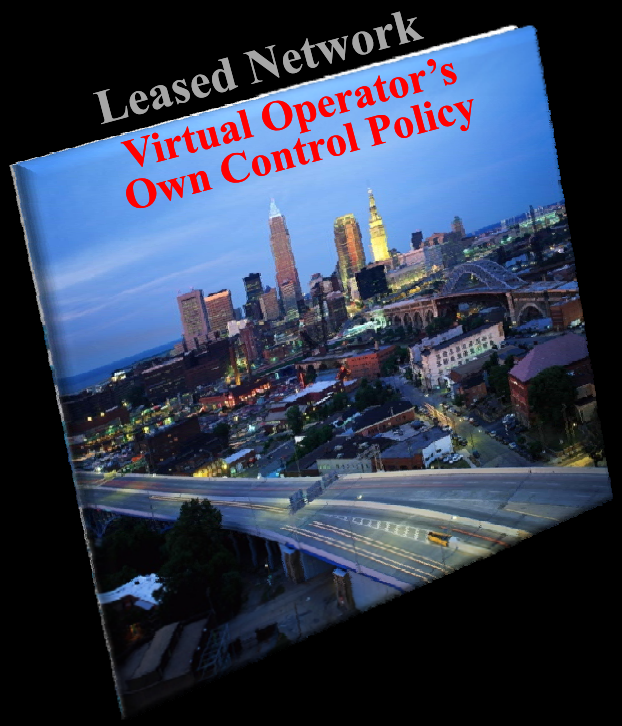
No REAL virtualization technologies
(As a result, no revenue creation Biz models)

Same services with *JUST low cost.*
No new creative services and researches.

MVNOs, 3rd Parties, R&Ds

Goal of *Mobile-Pooling*

Technical background for Open Mobile Network enabling Win-Win business strategies



Physically shared, but logically independent mobile wireless networks.

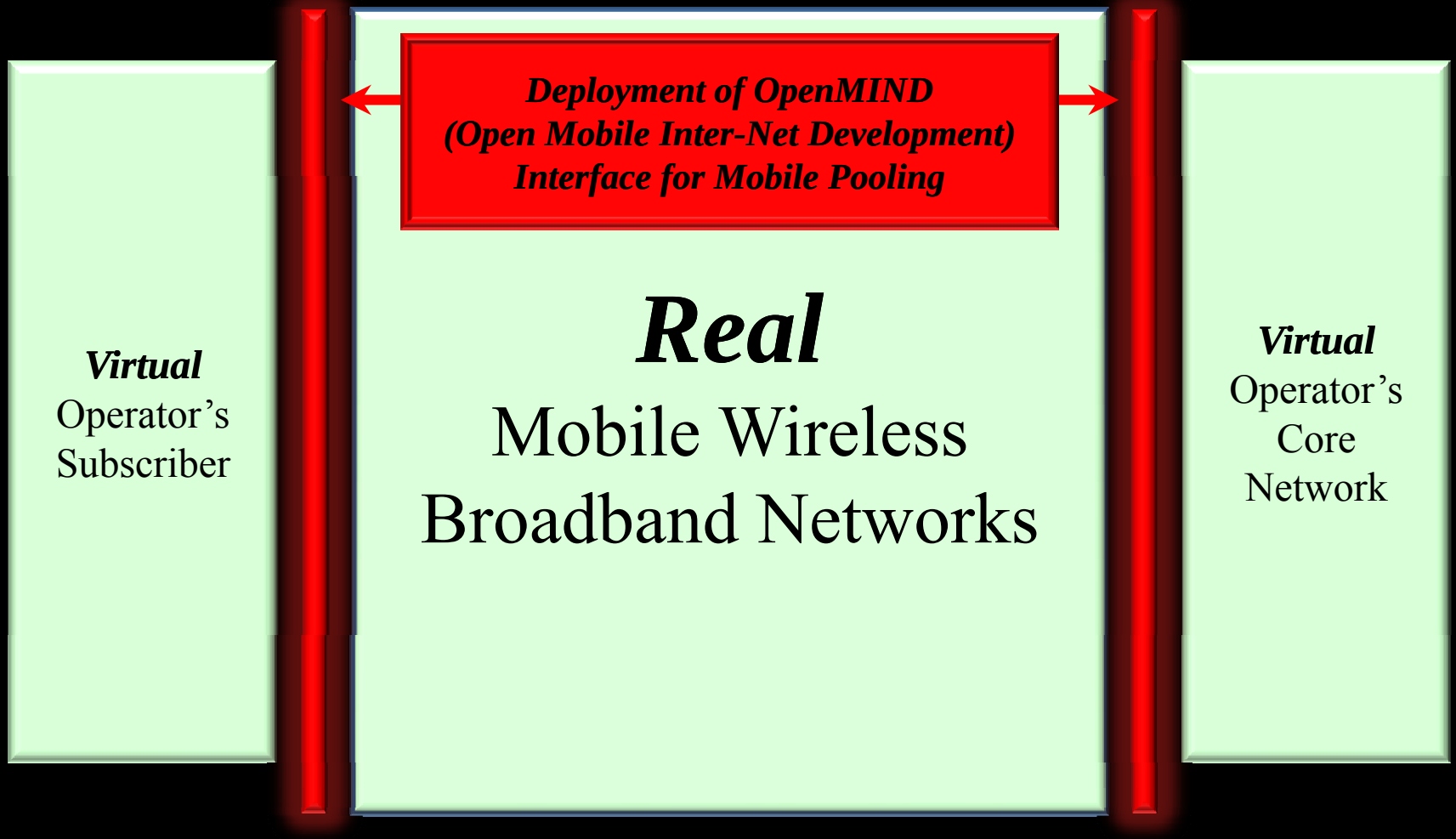
Deep-touchable open programmability.
(e.g. air scheduling, data-link, mobility, etc)

MVNOs, 3rd Parties, R&Ds

OpenMIND

What will be done?

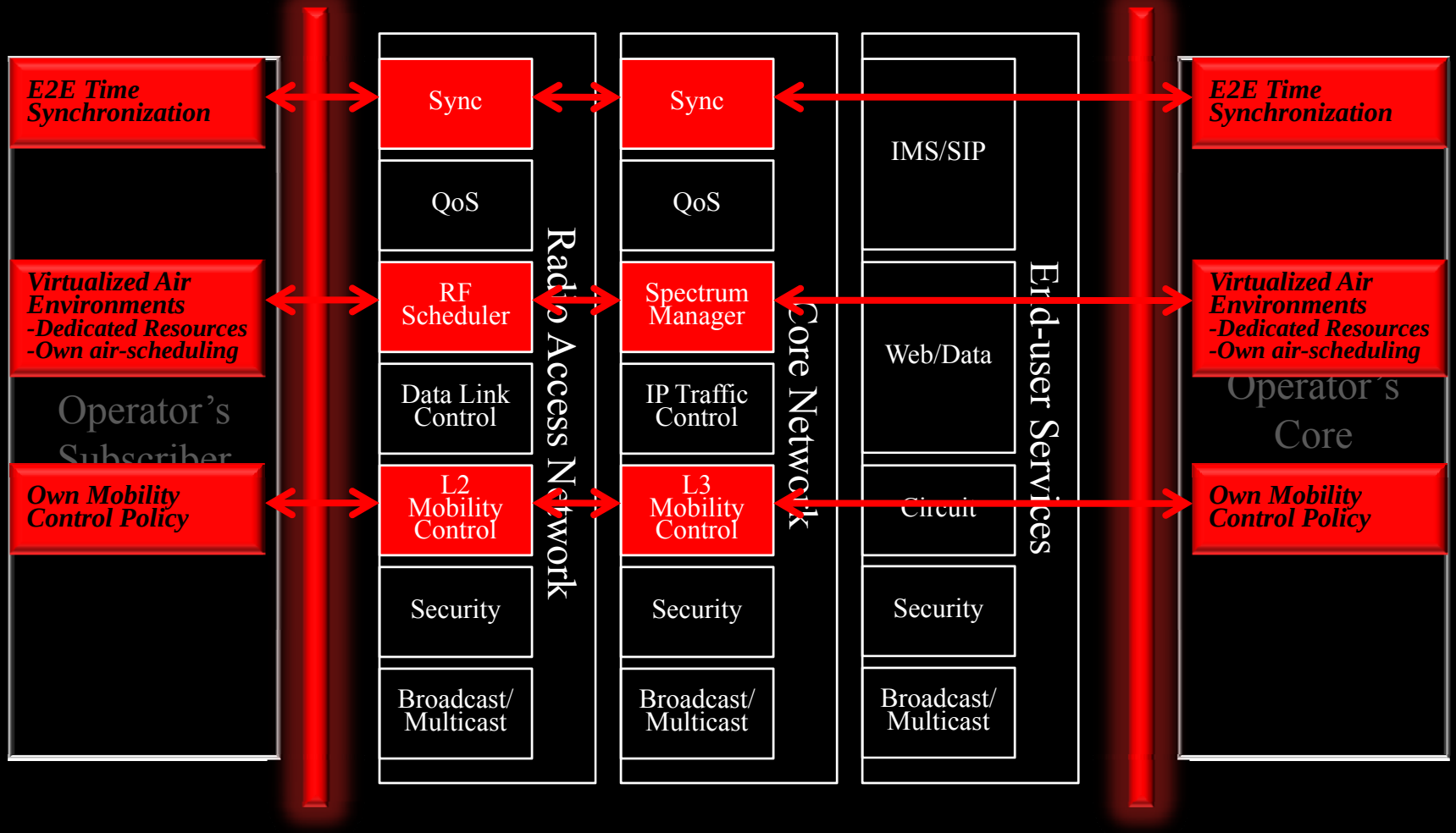
OpenMIND Interface



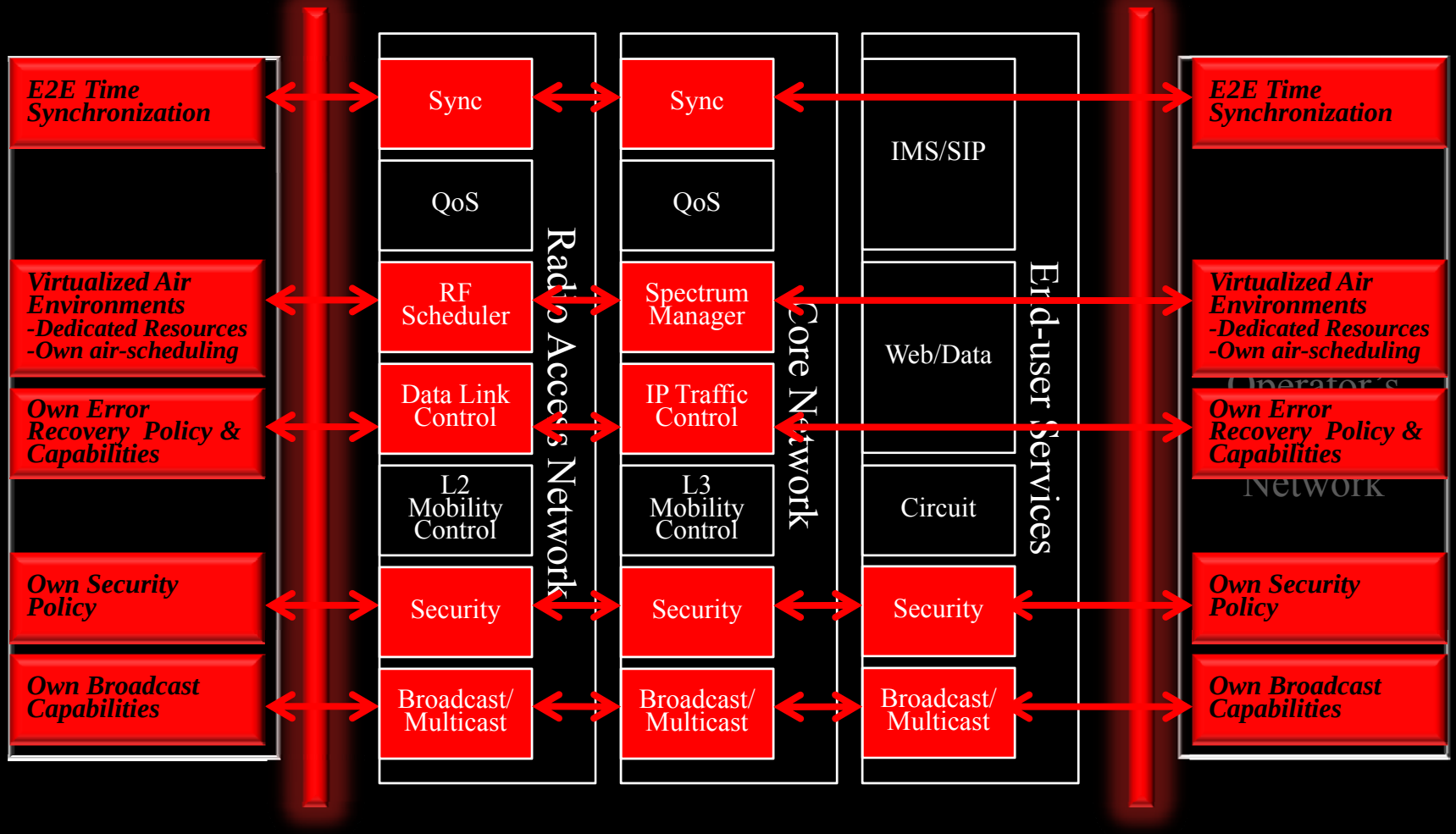
Realization of Virtualized Mobile Network

Virtualized Mobile Wireless Networks
for
Experimental, 3rd-Party, Enterprise, MVNO

Example.1 Virtualized Mobility Control

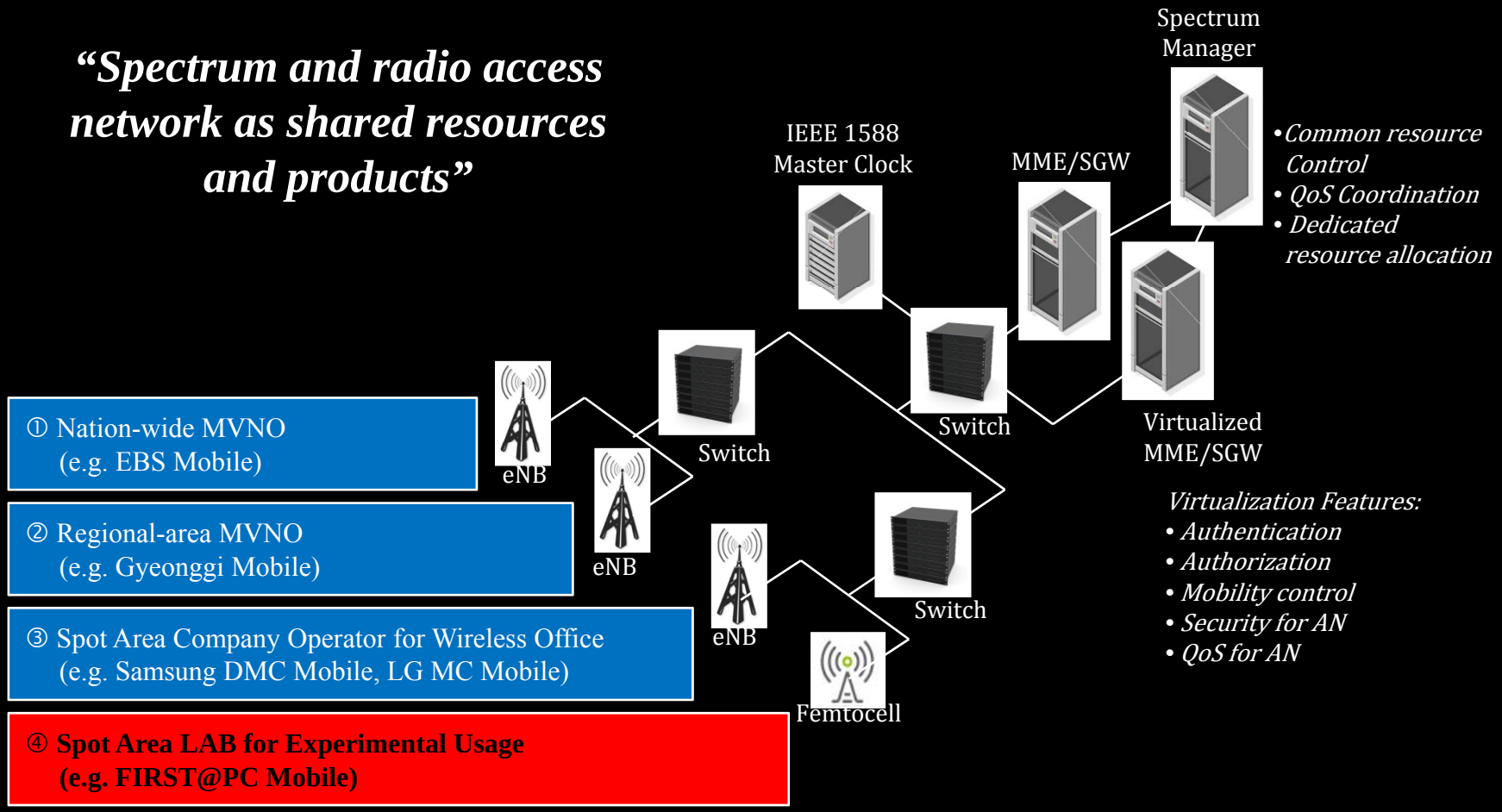


Example.2 Virtualized QoS Multimedia



So What ?

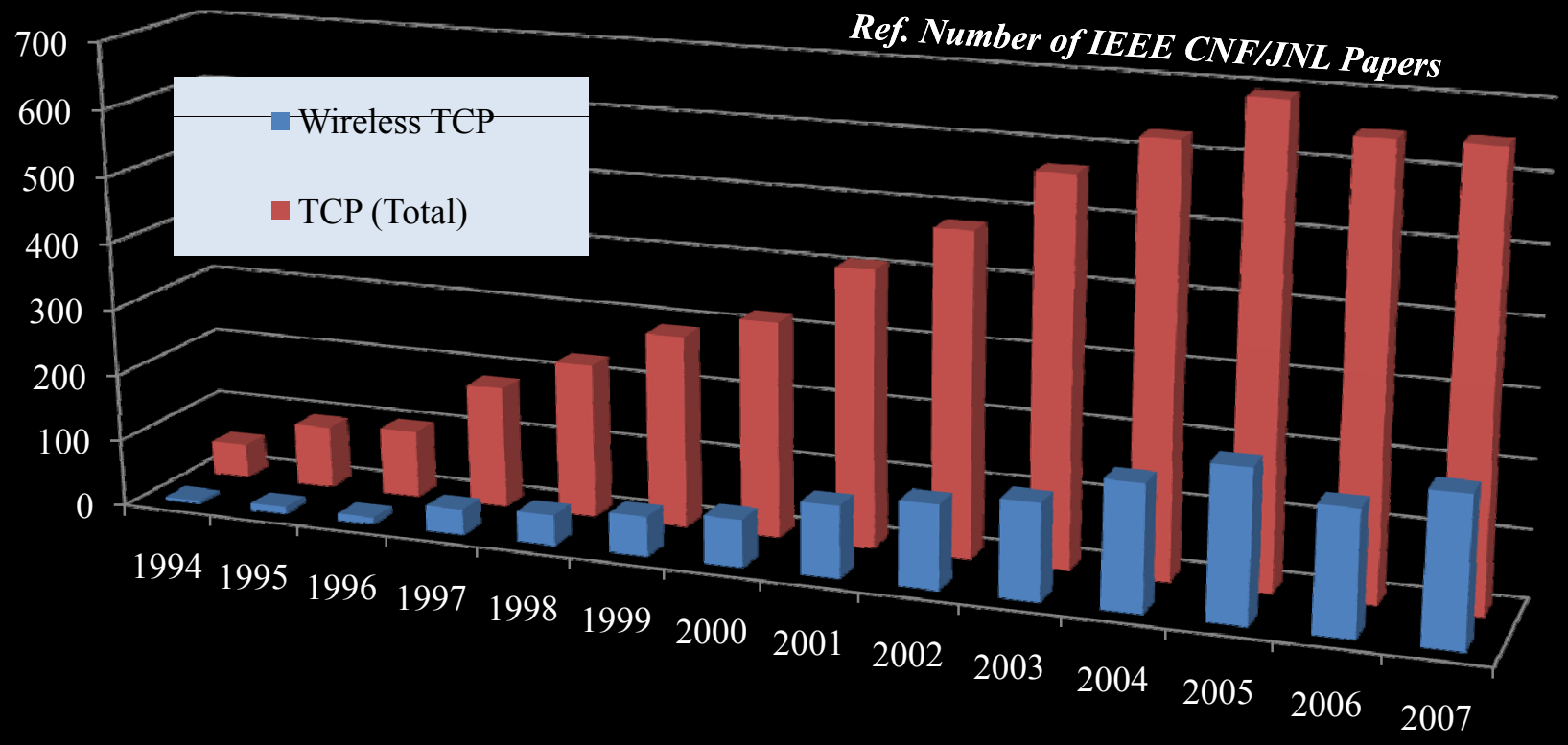
"Spectrum and radio access network as shared resources and products"



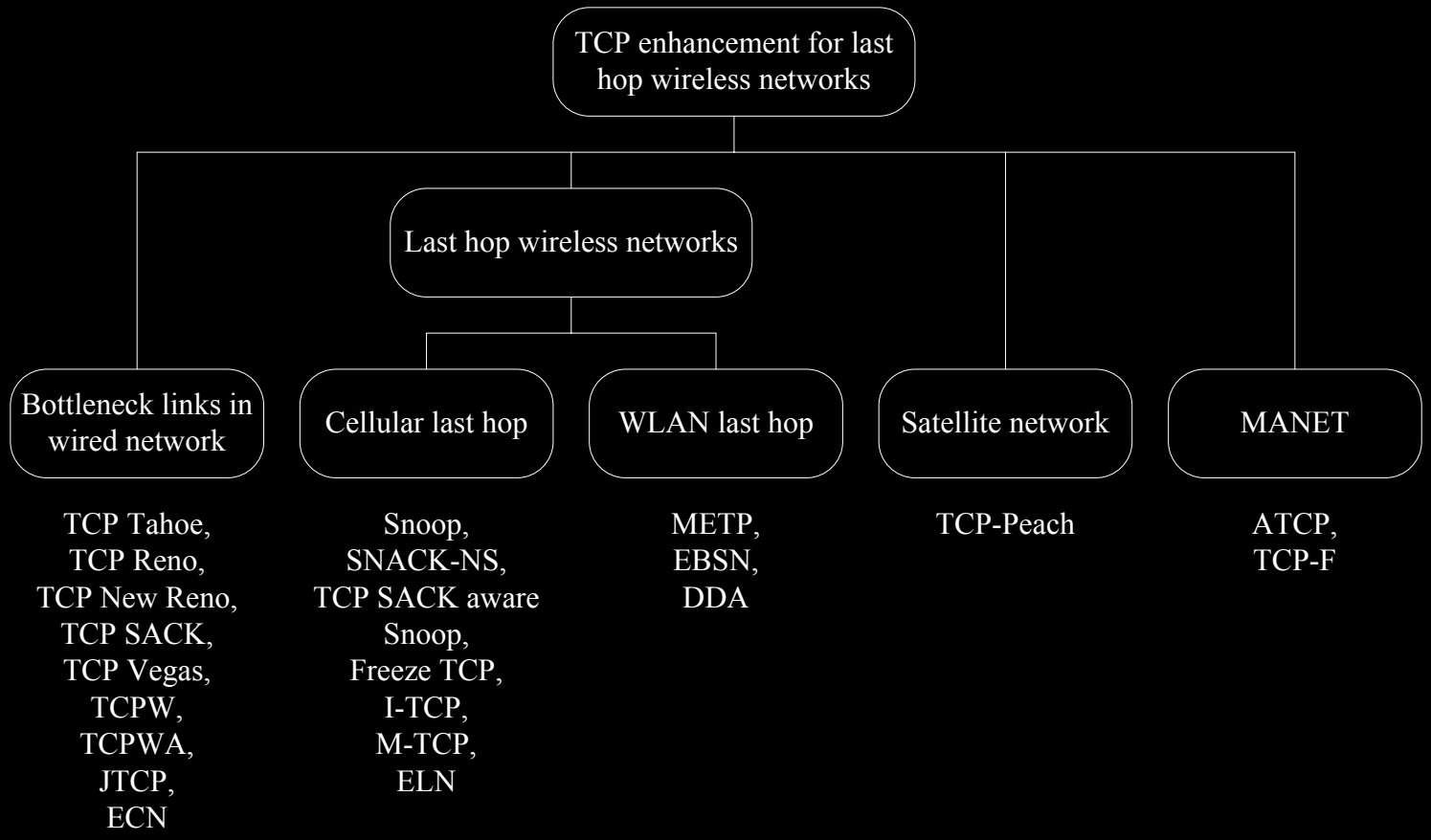
Case Study

OpenMIND for Mobile TCP

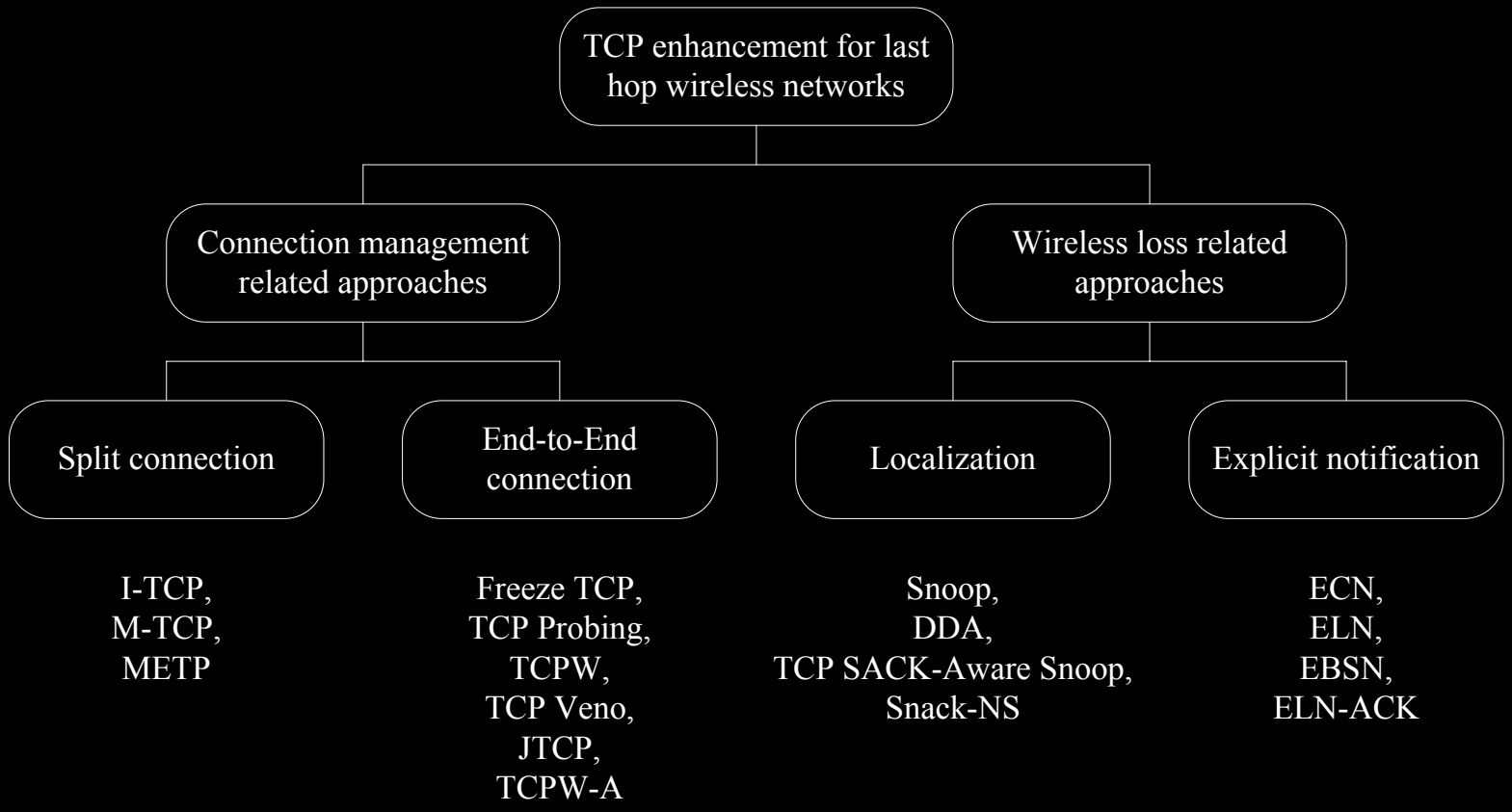
Increasing Research on TCP



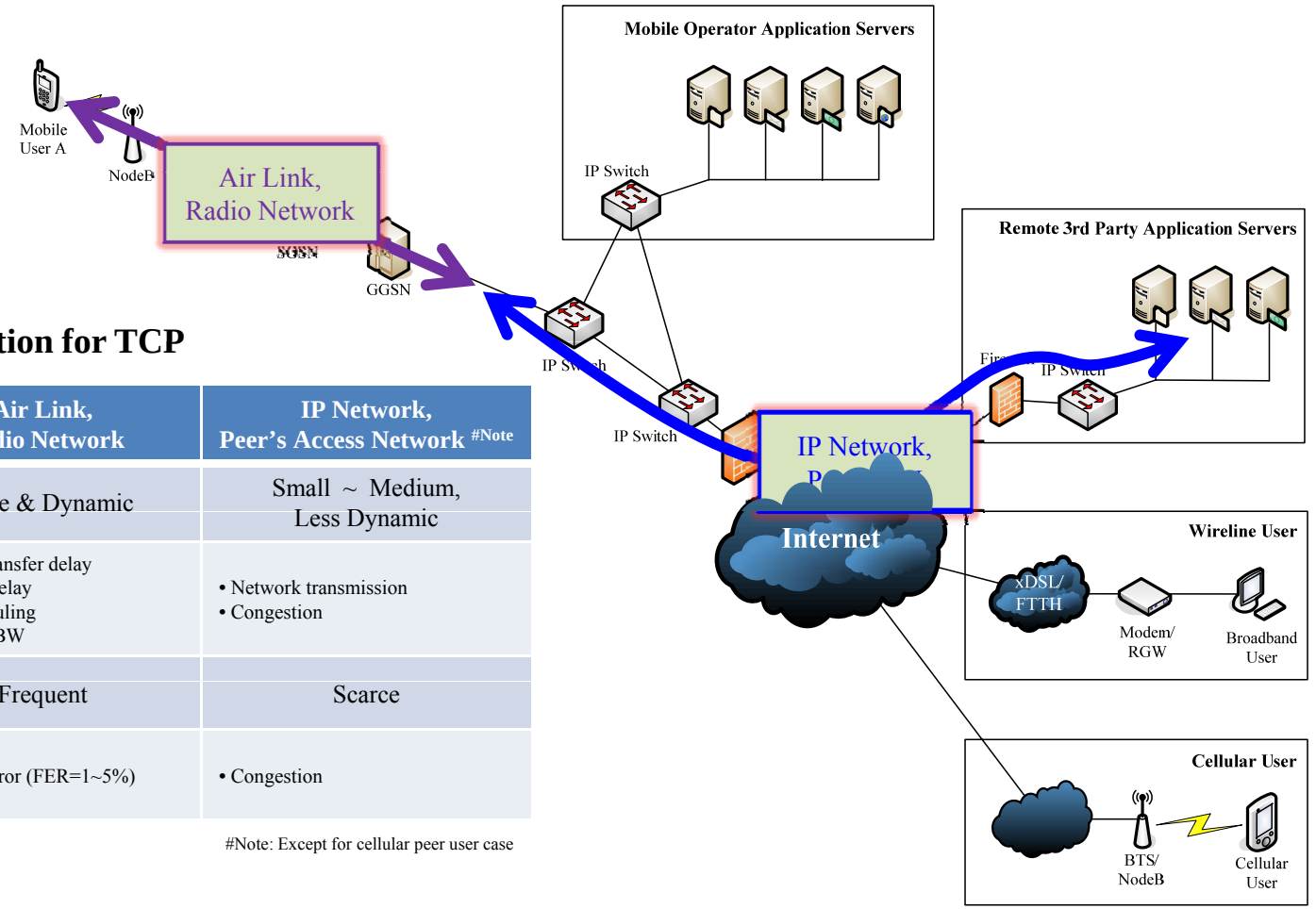
Researches on TCP



Conventional Researches on Wireless TCP



TCP Performance Degradation Impacts

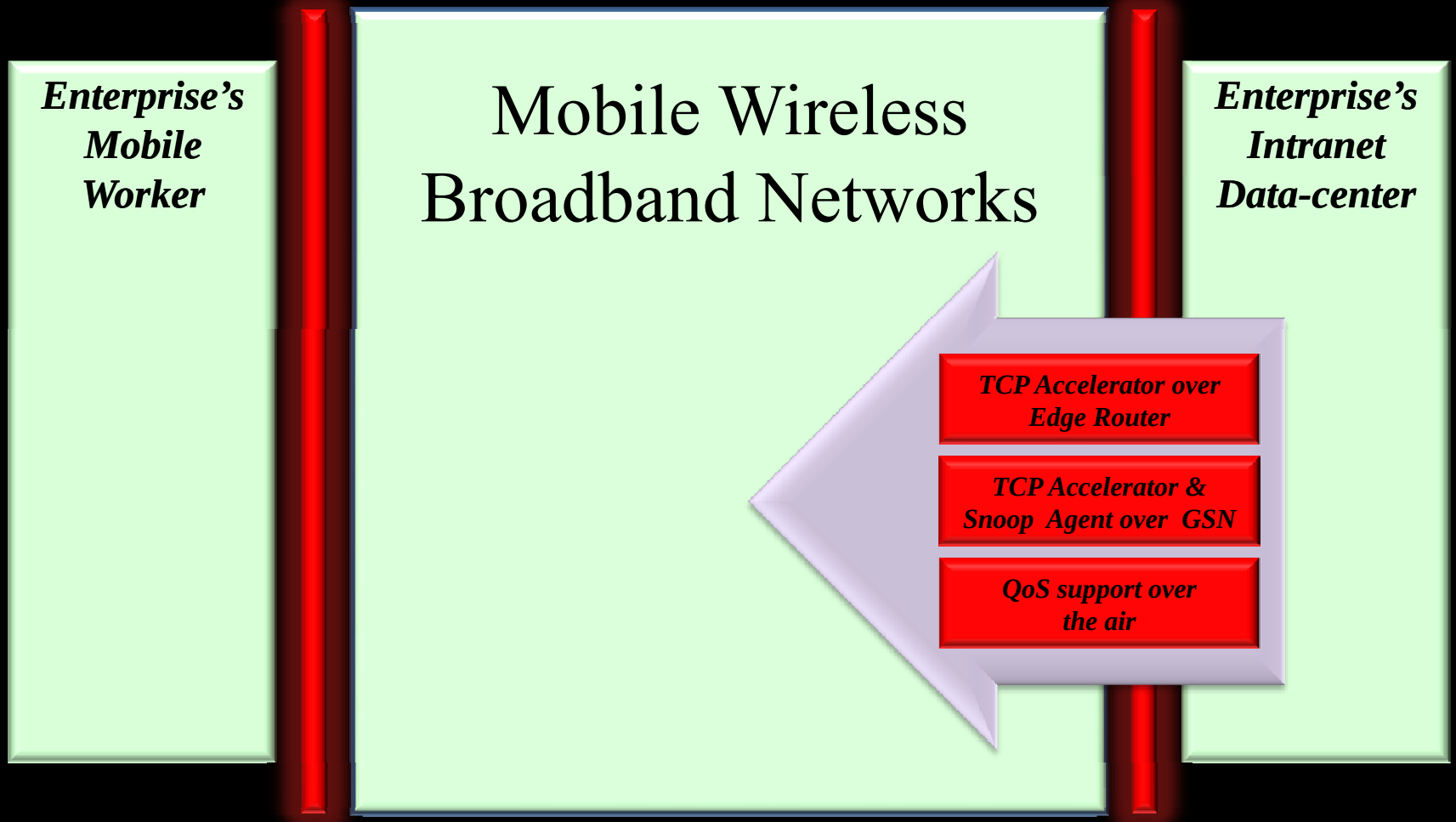


- **Practical Condition for TCP**

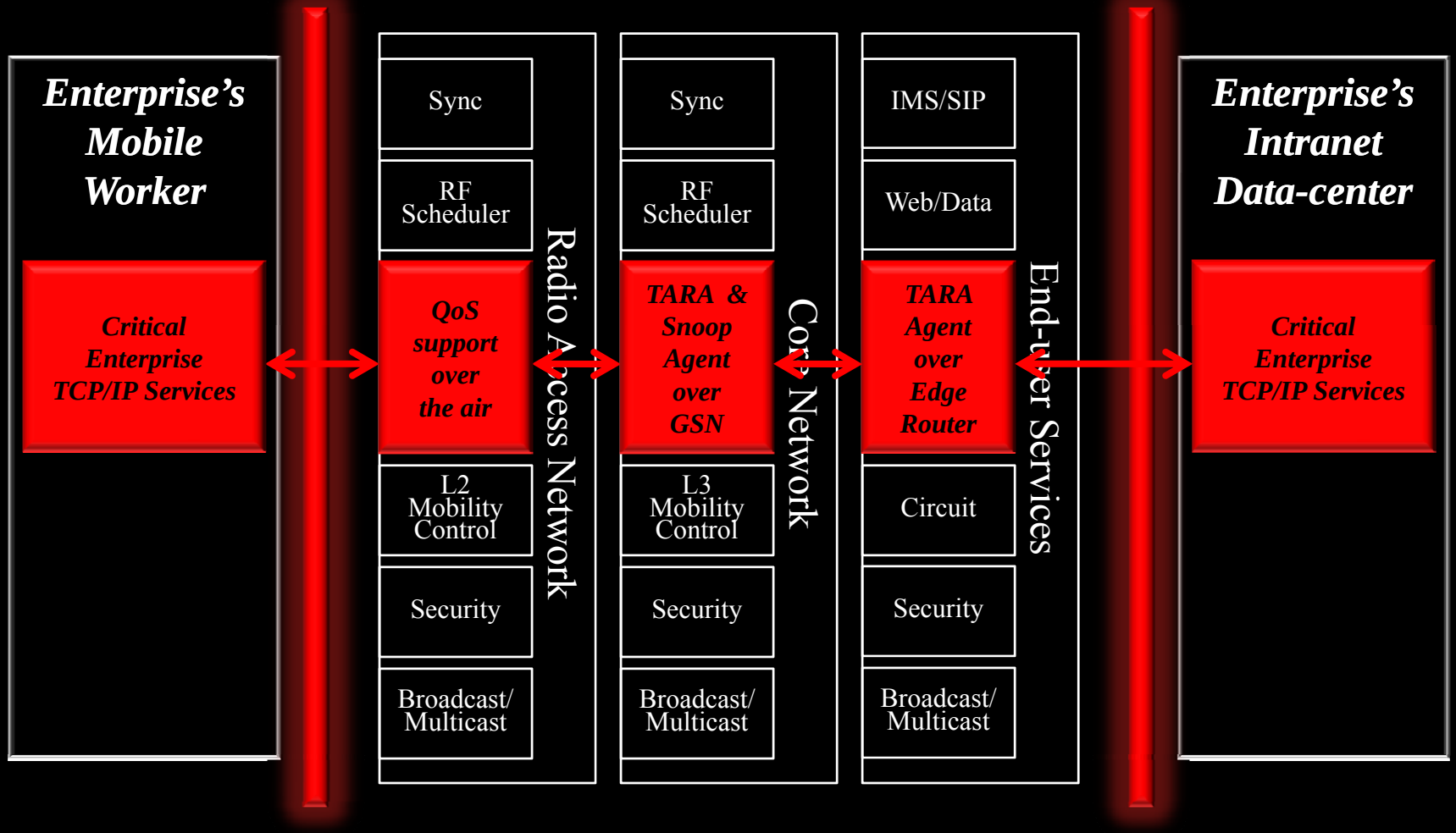
	Air Link, Radio Network	IP Network, Peer's Access Network #Note
RTT/Delay	Large & Dynamic	Small ~ Medium, Less Dynamic
	• Air link transfer delay • Queuing delay • RF-Scheduling • Dynamic BW	• Network transmission • Congestion
Loss	Frequent	Scarce
	• Mobility • Air link error (FER=1~5%) • Handoff	• Congestion

#Note: Except for cellular peer user case

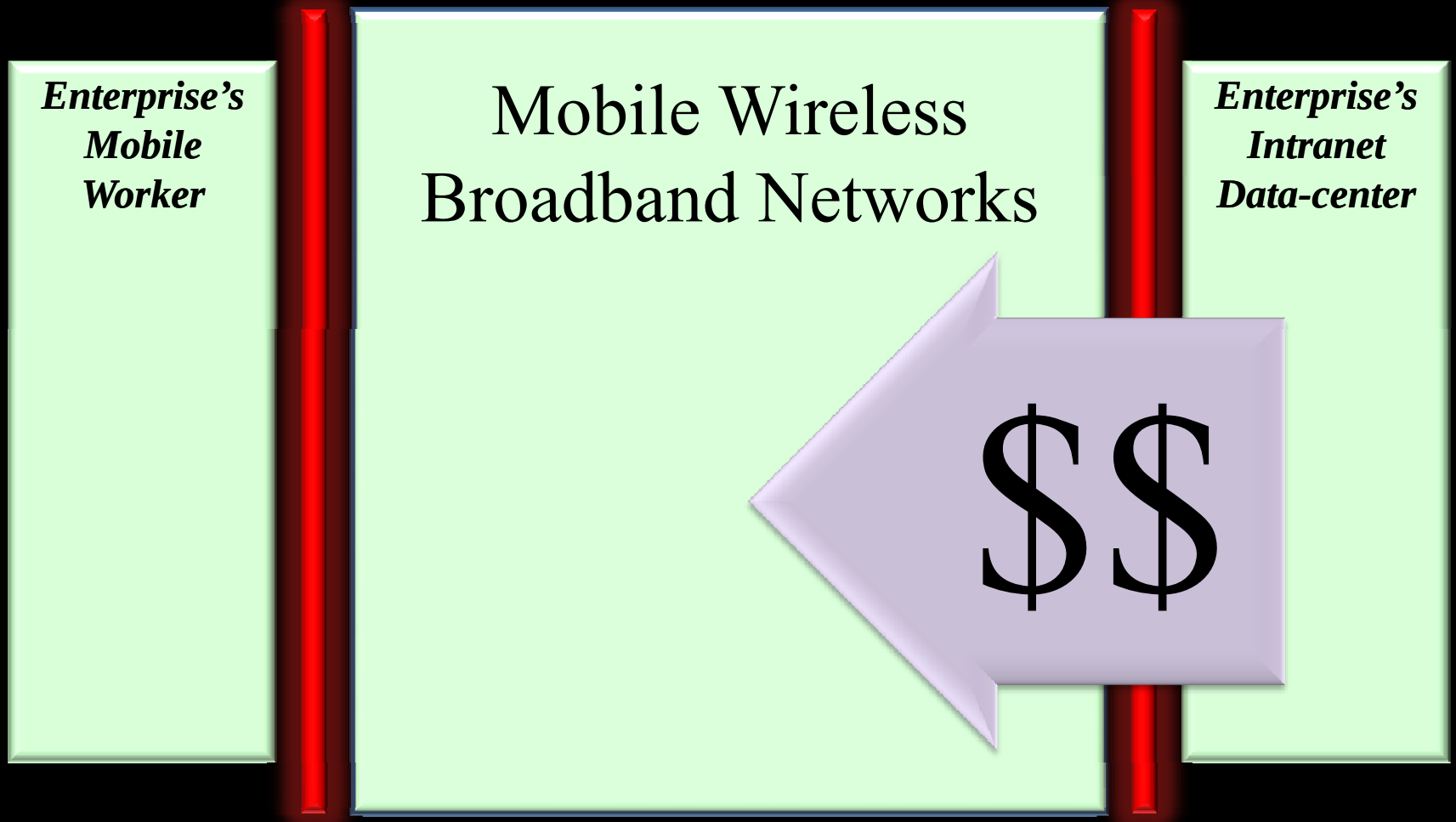
Intranet Enhancement over OpenMIND



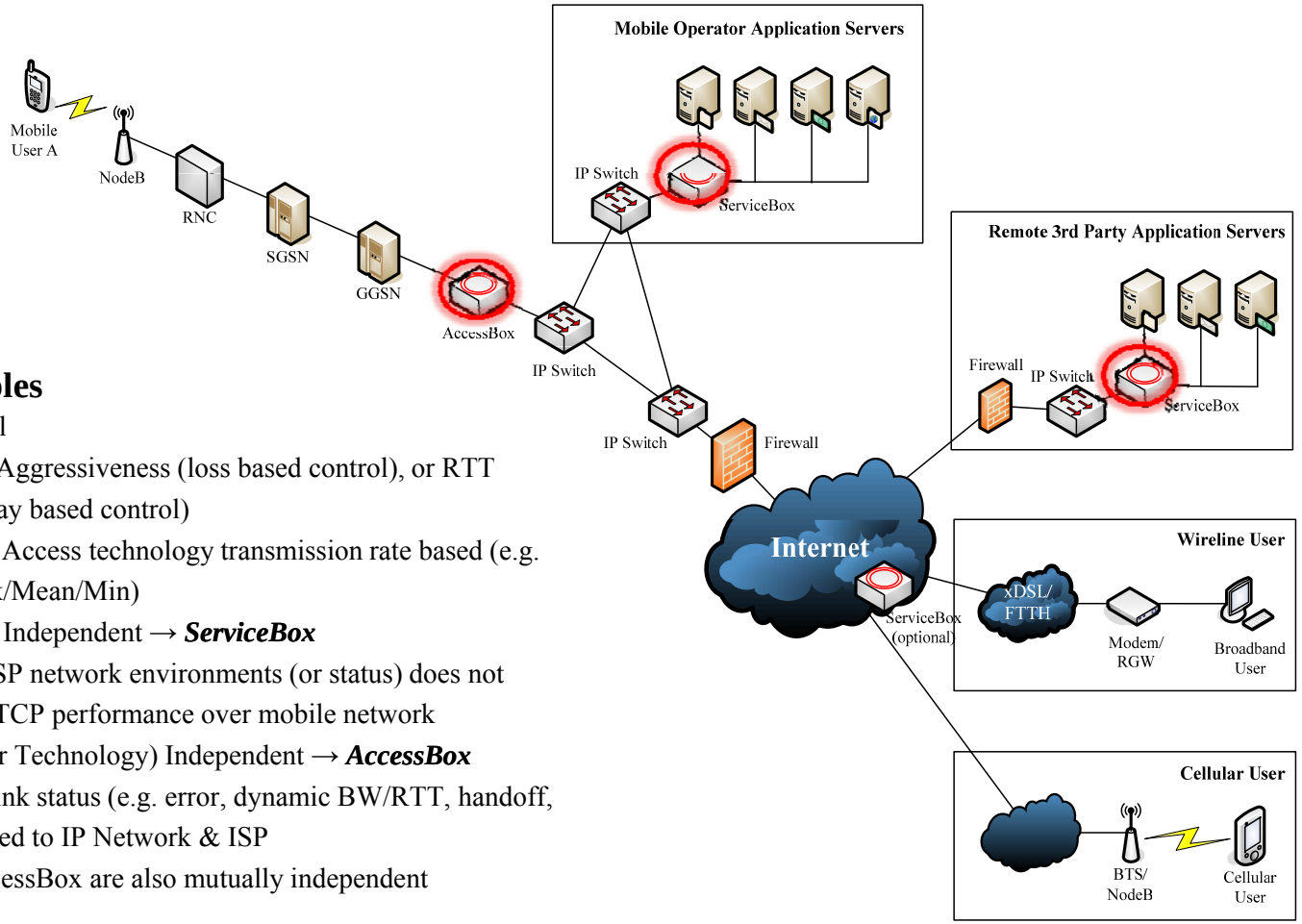
Intranet Enhancement over OpenMIND



Intranet Enhancement over OpenMIND

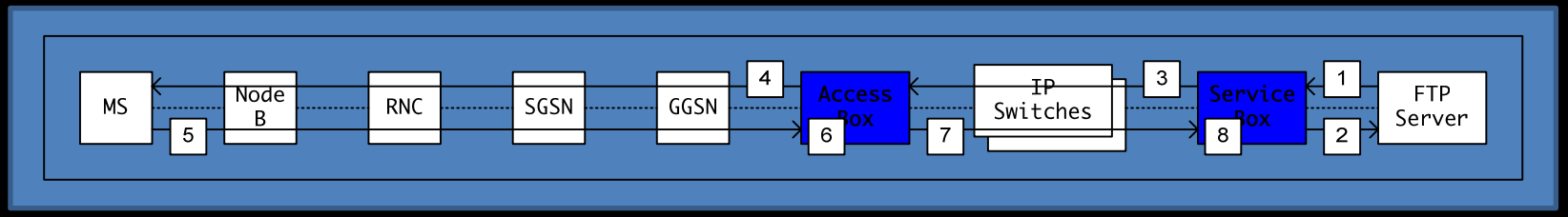


Proposed Network Architecture



- **Basic Design Principles**
  - ① Rate-based Control
    - Previous) Aggressiveness (loss based control), or RTT based (delay based control)
    - Proposed) Access technology transmission rate based (e.g. SLA, Peak/Mean/Min)
  - ② IP Network & ISP Independent → ***ServiceBox***
    - Internet, ISP network environments (or status) does not impact to TCP performance over mobile network
  - ③ Access Network(or Technology) Independent → ***AccessBox***
    - Wireless link status (e.g. error, dynamic BW/RTT, handoff, etc.) is hided to IP Network & ISP
  - ④ ServiceBox & AccessBox are also mutually independent

Proposed Operation Scenario Overall



① FTP Server sends TCP/IP packets

② Service-Box virtually terminates TCP session through ACK transfer
(if buffer size exceeds pre-configured threshold, ACK transfer is suspended)

③ Service-Box sends TCP/IP packets to Access-Box according to estimated data-rate

④ Access-Box stores and sends TCP/IP packets to MS

⑤ MS sends ACK for received TCP/IP packets (or request retransmission for corrupted TCP packets)

⑥ Access-Box modifies RWND field of TCP packet using own session buffer size
(if required, re-transmit corrupted TCP packets to MS. SNOOP algorithm is used for retransmission)

⑦ Access-Box sends ACK packet to Service-Box

⑧ Service-Box terminates ACK packet, and re-estimate data-rate using RWND & experienced RTT

Data Rate Estimation at ServiceBox

$$R_{new}\,(b/s) = \frac{V\text{-}RWND\ (bits)}{RTT\ (ms)} \times \theta$$

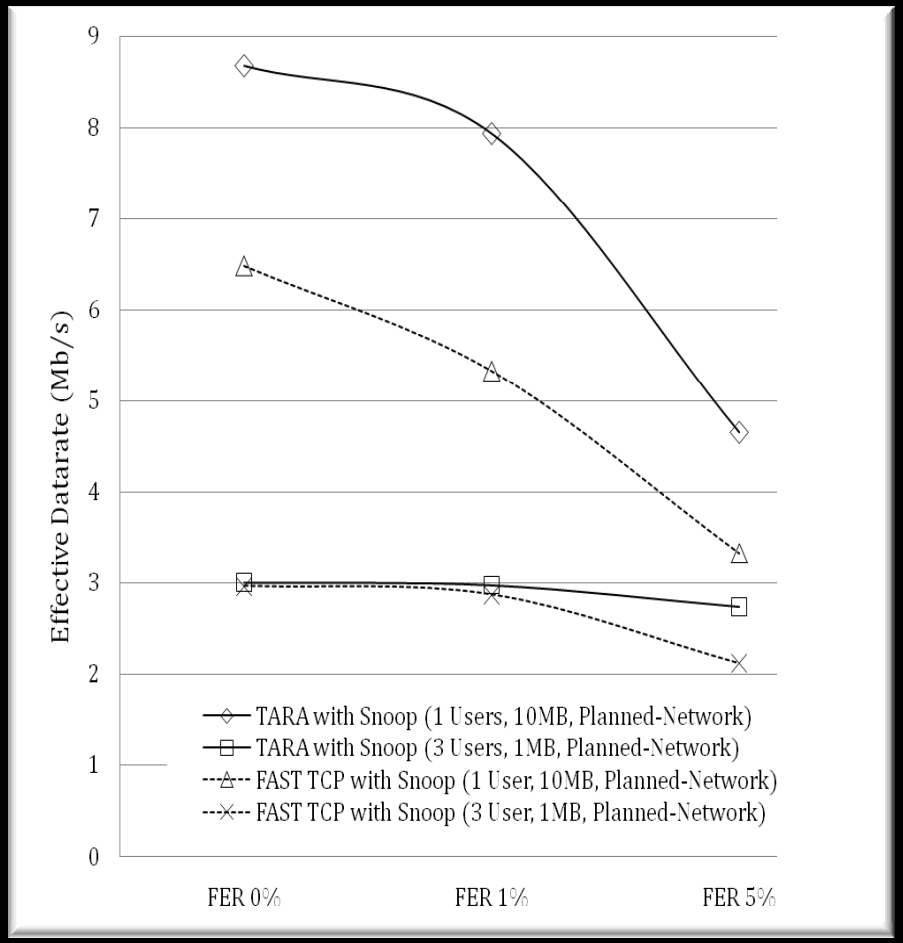
- V-RWND Size (in bits)
  - Receiver windows size at AccessBox
  - Number of packets × packet size
- RTT (in seconds)
  - Measured RTT at ServiceBox from ACK packet
- TE_sensitivity (θ)
  - Weighting factor used to limit the maximum transmission rate of a TCP session

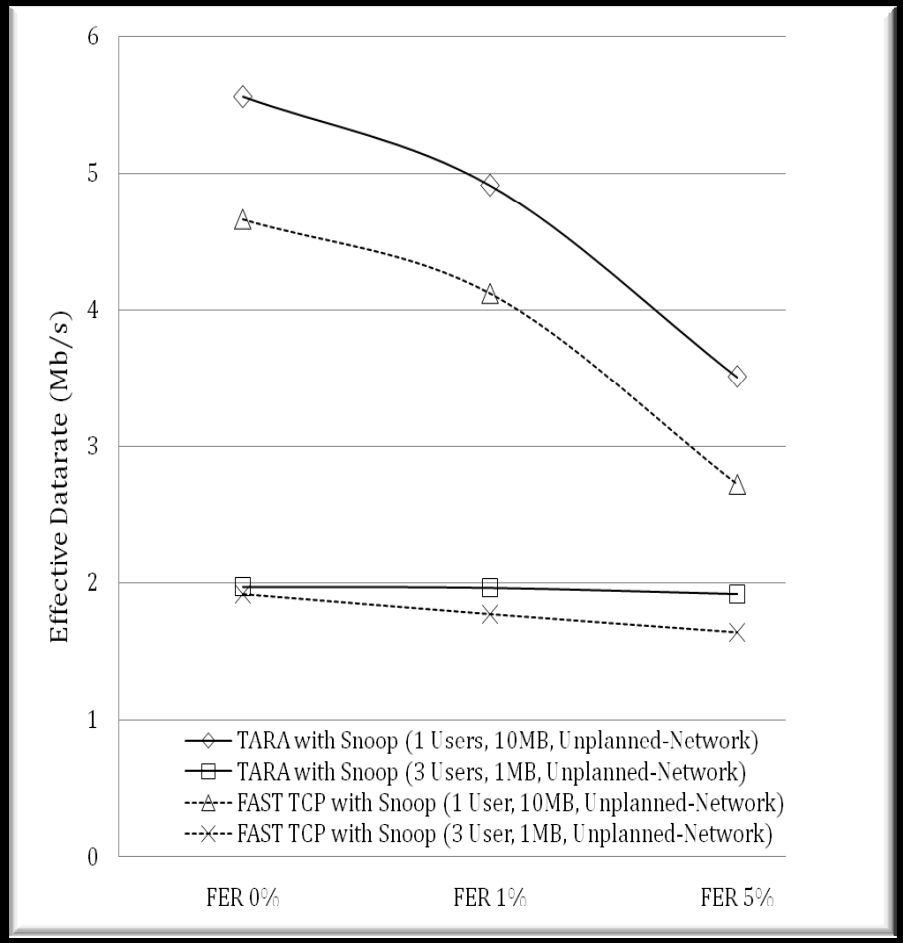
Performance Evaluation Environments

- **Planned Network**
  - Well planned radio cell (e.g. urban center, suburban outdoor)
  - Guaranteed medium to high datarate with small datarate fluctuation and targeted FER
  - Peak rate: 10 Mb/s, Minimum rate: 8 Mb/s, and Mean rate: 9 Mb/s (uniform distribution.)

- **Un-planned Network**
  - Poor quality radio cell, high speed mobile mover (e.g. shadow, inter-radio-cell)
  - Abrupt datarate change with high datarate fluctuation and large FER
  - Peak rate: 10 Mb/s, Minimum rate: 1 Mb/s, and Mean rate: 5.5 Mb/s (uniform distribution.)

Performance Analysis





Wrapup

OpenMIND Researches

- OpenMIND interface design, implementation and standardization
- OpenMIND based service scenario development
- Network sync. protocol based synchronous operation
  - Between Terminal, physical network and virtual operator
  - Between Virtual operators (who share the same physical network)
- Shared mobile resource mgnt., scheduling, QoS support among operators
  - Same and/or different technology
  - Same and/or different frequency
- Demo system development and field trial

and other challenging issues …

OpenMIND for Mobile TCP

“Easy and cost-effective way of performance improvement, supplement to air technology enhancement and radio cell planning”

- Improved performance
  - User-experienced effective datarate can be impressively increased
- Feasible approach
  - Legacy network & client independent deployment (Service/Access-Box)
  - Easy for traffic engineering
- Ready for fixed-mobile-converged environments
  - Seamless appliance for Macro network, Femtocell, Broadband and Hot-spot


Thanks