

OpenMIND & Case Study for Mobile TCP

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Ice Break

Ice-breaking

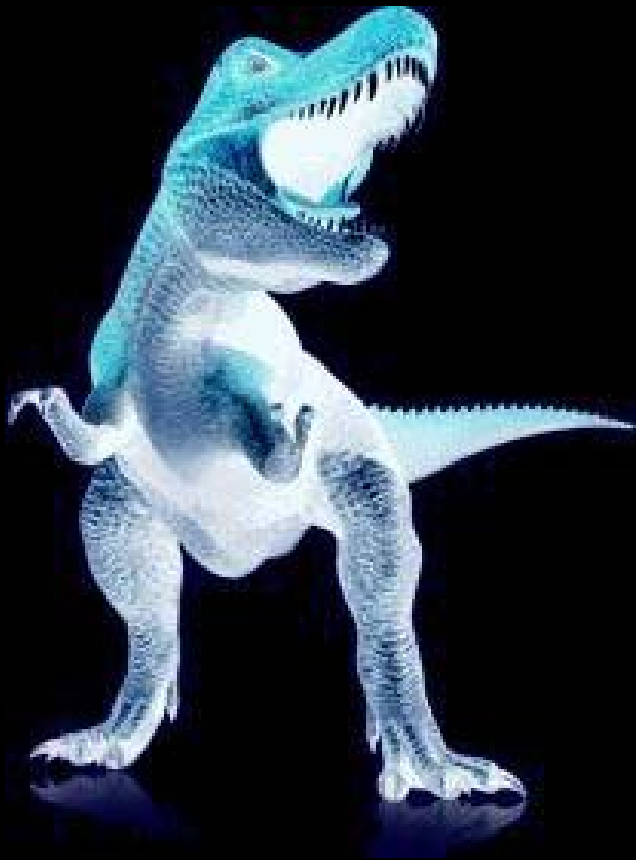
Future Internet?

Future of Internet?



Reference: Studio Gainax

Internet of Future?



Problems

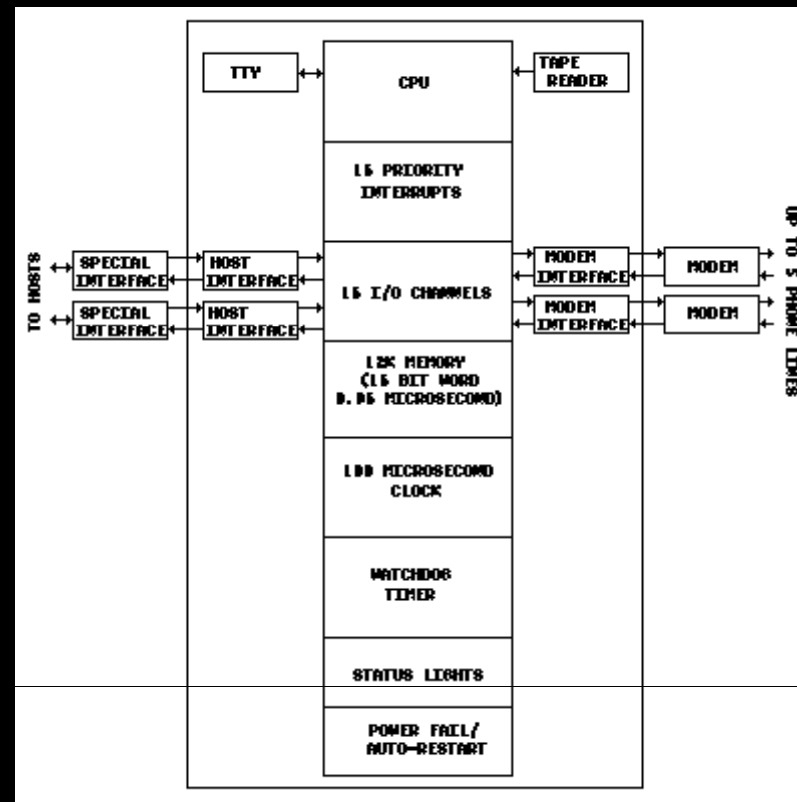
What's Wrong?

1 October 1969



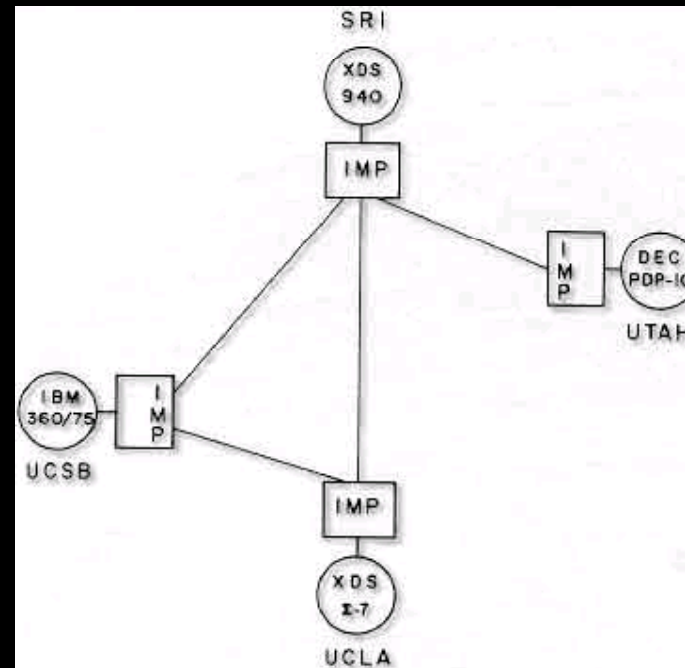
“World 1st Router”

Baby Router

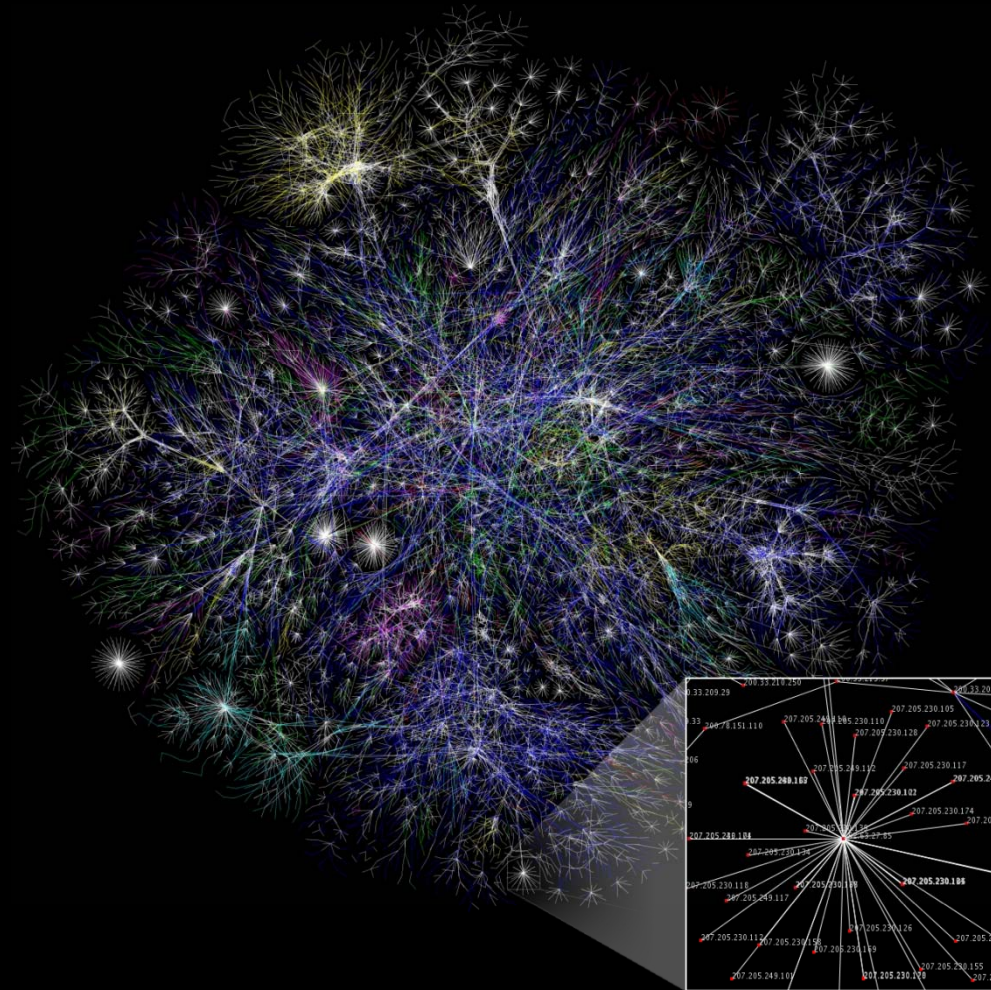


Baby Network

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

CISCO CARRIER ROUTING SYSTEM

MANY SERVICES. ONE NETWORK.
LIMITLESS POSSIBILITIES.



THIS IS THE POWER OF THE NETWORK. NOW.

SYSTEM SPECIFICATIONS

CHASSIS

16-Slot Single-Shelf System

Design, Slots, and Capacity

- Midplane design
- Line Card: 16x 40 Gbps slots
- Switch Fabric Card: 8 dedicated slots
- Route Processor: 2 dedicated slots
- Fan Controller: 2 dedicated slots

Dimensions

- (H x W x D) 84 x 23.6 x 36 in (213.36 x 59.94 x 91.44 cm)
- With cable management and front cover—(H x W x D) 84 x 23.6 x 36.7 in (213.36 x 59.94 x 100.84 cm)

Weight

- 639 lbs (295 kg) as shipped, chassis only with build in rack and fan trays installed
- 1058 lbs (485 kg) chassis only as shipped, including power shelves, without power modules, and with build in rack
- 1565 lbs (723 kg) chassis fully configured, using all card slots, power shelves, cosmetics, and with build in rack

Power

- Maximum DC power needed when chassis is fully configured with line cards with traffic running: 13.62kW
- Chassis power supply maximum DC output: 13.2kW

8-Slot Single-Shelf System

Design, Slots, and Capacity

- Midplane design
- Line card: Eight 40-Gbps slots
- Switch fabric card: 4 dedicated slots
- Route processor: 2 dedicated slots
- Fan tray: 2 fan trays

Dimensions

- (H x W x D) 38.5 x 17.5 x 36.6 in (97.76 x 44.45 x 92.964 cm) with base cosmetics
- With cable management and front cover—(H x W x D) 38.5 x 17.5 x 40.5 in (97.76 x 44.45 x 102.87 cm)

Weight

- 330.8 lb (148.86 kg) chassis with fan, PDU and blanks (as shipped)
- 650 lb (292.5 kg) chassis as shipped, including power shelf, fabric cards, and all line cards and route processors

Power

- Maximum DC power needed when chassis is fully configured with line cards with traffic running: 6.66kW
- Chassis power supply maximum DC output: 7.7kW

4-Slot Single-Shelf System

Design, Slots and Capacity

- Midplane design
- Line card: Four 40-Gbps slots
- Switch fabric card: 4 dedicated slots
- Route processor: 2 dedicated slots
- Fans: 4 fans, 1 fan tray

Dimensions

- (H x W x D) 30 x 17.6 x 30.28 in (76.2 x 44.813 x 76.91 cm) without doors and cosmetics

Weight

- 260 lb (117.93 kg) chassis with fan, power modules and blanks (as shipped)
- 360 lb (172.37 kg) chassis as shipped, including power shelf, fabric cards, and all line cards and route processors

Power

- AC input: 4270VA @ 16000 BTU/HR
- DC input: 4329W @ 16200 BTU/HR

CISCO NETWORK LIFECYCLE AND SUPPORT SERVICES

Cisco offers services that address the entire network lifecycle to assist in planning, design, implementation, operation, and optimization of the Cisco CRS-1 Carrier Routing System deployments. These service offerings include:

- Advanced services teams, using methodology and templates based on previous Cisco CRS-1 deployments, deliver and deploy the system in service provider environments.
- Technology support services are available for Cisco CRS-1 replacement warranty and spare for next-business-day or on-call hardware replacement support.
- Specially trained Cisco Technical Assistance Center (TAC) engineers provide global 24-hour support on the Cisco CRS-1 with practical experience on the support and features of the product.

Fabric Card Chassis

Design, Slots and Capacity

- Midplane design
- Switch Fabric Card: 24 slots
- Shelf Controller: 2 dedicated slots

Dimensions

- Without cable management and front cover—(H x W x D) 84 x 23.6 x 36 in (213.36 x 59.94 x 91.44 cm)
- With cable management and front cover—(H x W x D) 84 x 23.6 x 41 in (213.36 x 59.94 x 104.2 cm)

Weight

- 644 lbs (292 kg) as shipped, chassis only with fan trays installed
- 712.8 lbs (323 kg) chassis only as shipped, including power shelves, without power modules
- 1556 lbs (707 kg) chassis fully configured

Power

- Maximum DC: 6.1kW @ 31,050 BTU/HR
- Maximum AC: 10.4kW @ 32,988 BTU/HR

MEMORY

Modular Services Card

- 2 GB of default route memory
- 1 GB of packet buffer memory per side (2 GB total per line card (ingress and egress))

Route Processor

- 4 GB of default route memory
- 64 MB of boot flash memory
- 2 MB of nonvolatile RAM (NVRAM)
- One 1-GB flash drive (removable)
- One 40-GB hard drive

FEATURES AND FUNCTIONS

IP Features

- Control-plane packet handling
- IPv4
- IPv6
- QoS/ACLs
- QoS/class of service (CoS) using Modular QoS CLI (MQC)
- IP packet classification and marking
- Queuing (both ingress and egress)
- Policing (both ingress and egress)
- Diagnostic and network management support

Routing Features

- Multitoolbox (BGP) Version 4 (MP-BGPv4)
- Open Shortest Path First Version 2 (OSPFv2)
- OSPFv3
- IS-IS
- Static routes
- RPL
- Multicast
- MPLS
- High availability
- Security
- Manageability

IP-over-DM DM Features

- GRE, standard GRE, Reed-Solomon algorithm
- FEC standard GRE, two orthogonally concatenated BCH super-FEC code
- Full C-band tunable laser with 50-GHz spacing
- Router-to-router SONE/TSCM-like operations, administration, maintenance, and provisioning (OAM&P)

Note: For a full listing of features and functions, refer to Cisco CRS-1 data sheets at <http://www.cisco.com/go/crs>.

Reference: Cisco CRS Router Brochure

Fundamental Question

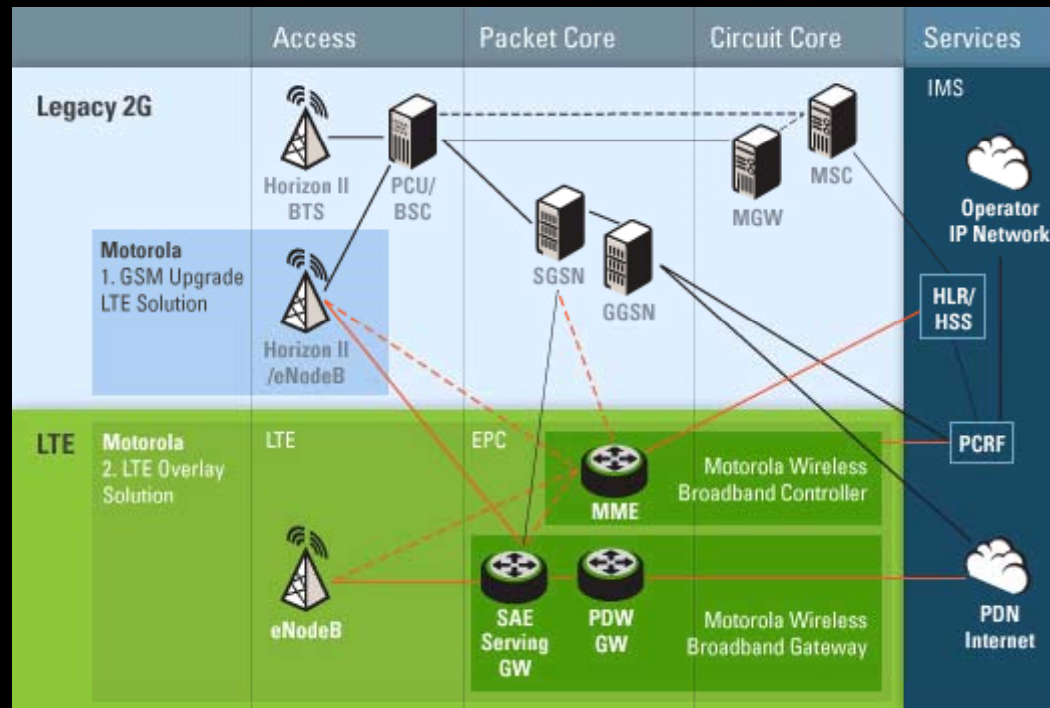
Evolution or
Revolution?

How about Mobile Network?



Reference: Ericsson Review

Different Way – Future is Simple?



Reference: Motorola "Long-Term-Evolution"

Propaganda

As IP defeated ATM/PSTN.

Propaganda

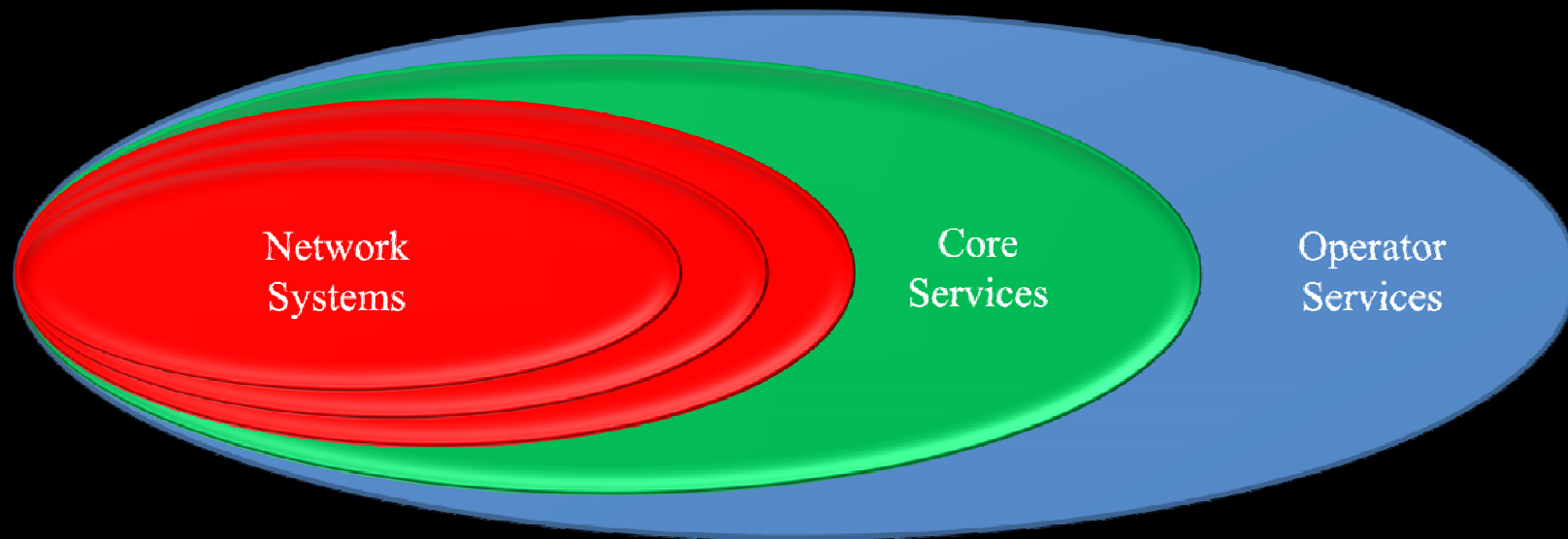
*Let's defeat The Wall by
Future Mobile Internet!*

Key-words

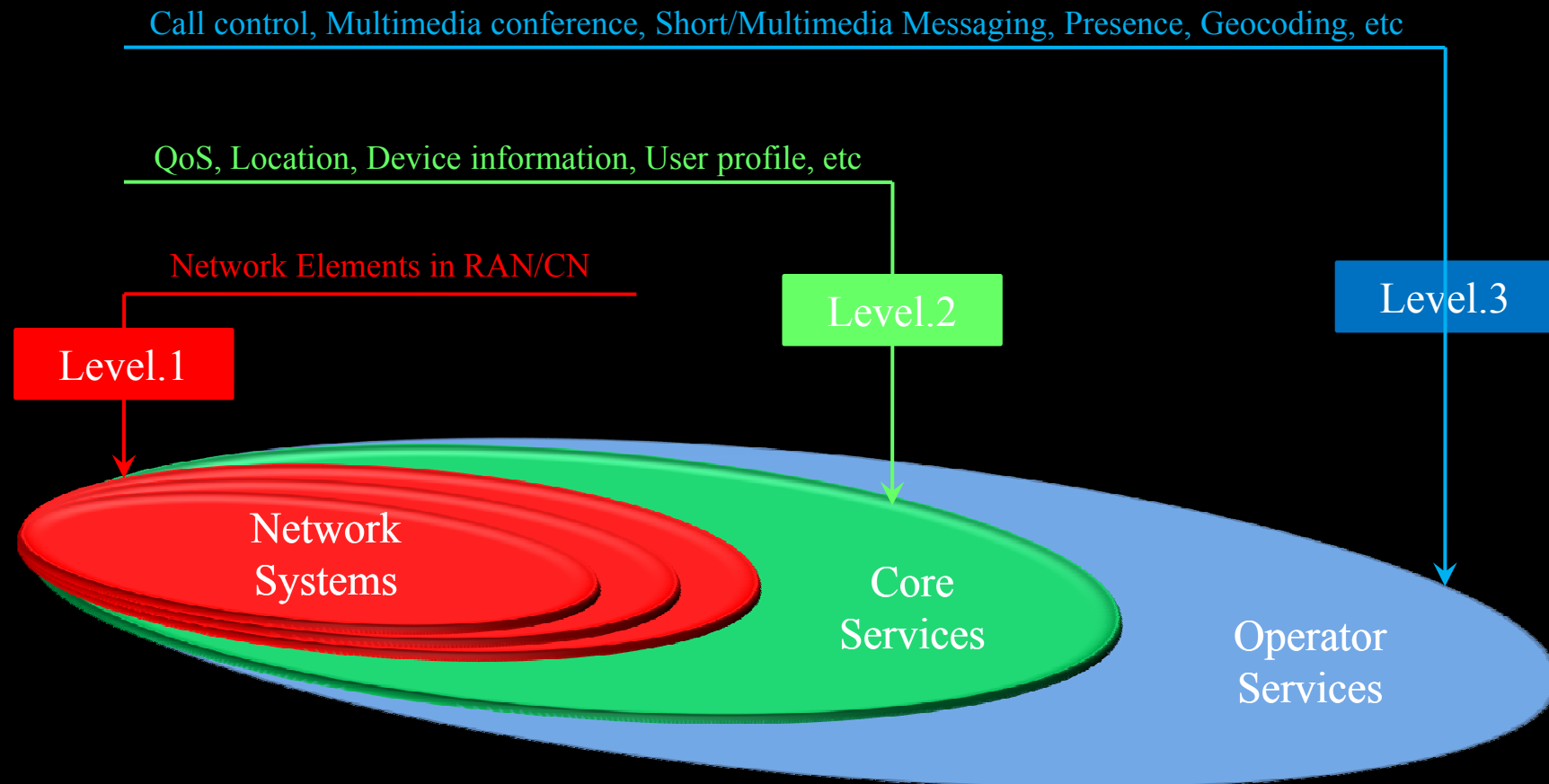
*Loosely Synchronized,
Multiple Air Technologies,
Open,
Programmable*

Open & Programmable

Layering Architecture of Network

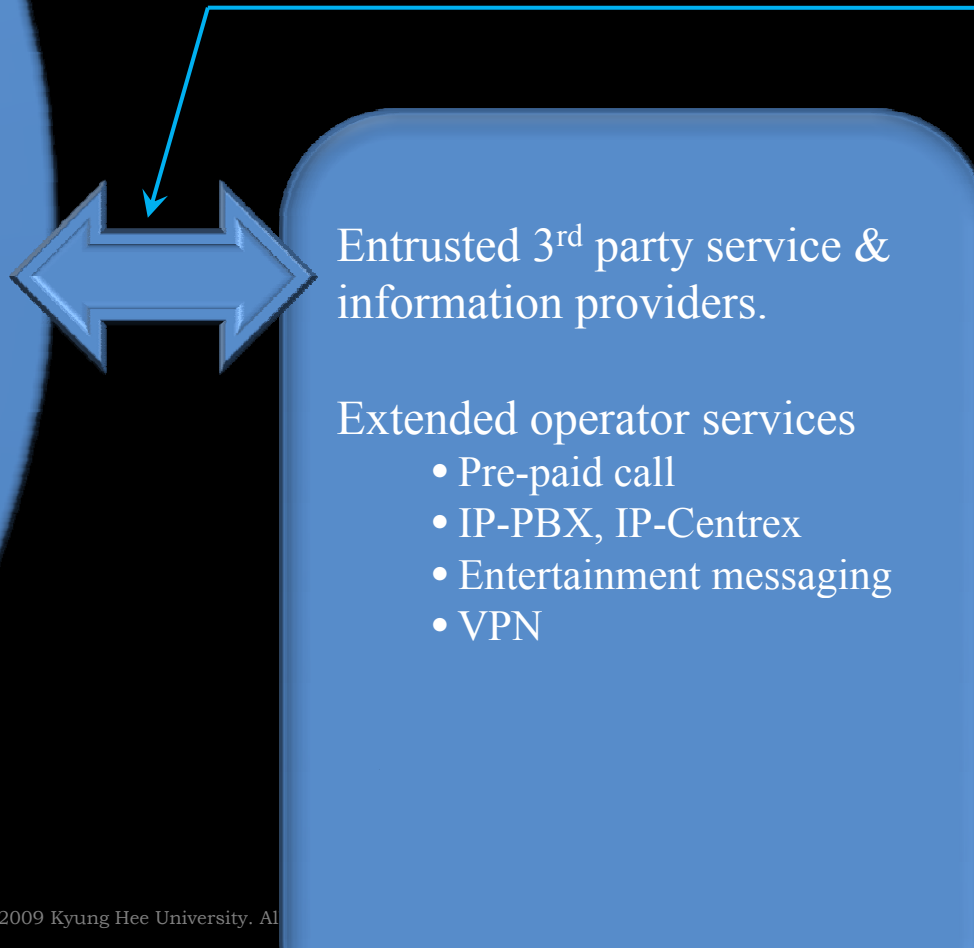


Three Levels of Open Network



Level.3 Standard Open Interface for Operator Services

Operator Services



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

Core Services

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

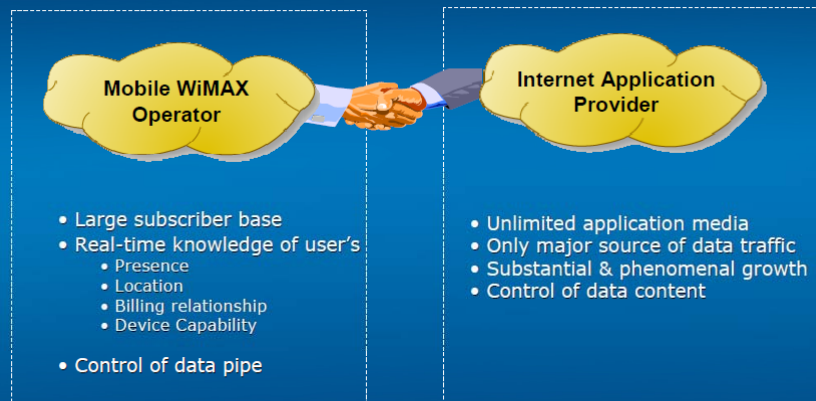
*“Mobile Network as a
Service Enabling Platform for
Internet+ & Mobile Web 2.0”*

WiMAX USI

First Open Network Interface for Mobile Wireless Broadband Network

(with limited features and capabilities)

Internet+ Model



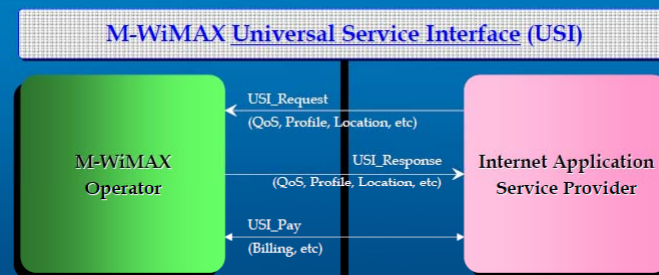
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Win-Win for Mobile WiMAX operator and Internet application provider



WiMAX Universal Service Interface (USI)

- SP provides information and capability to be used for value added Internet services (e.g. QoS, location based service)
- IASP & WiMAX operator share revenue
- Simple Internet-friendly interfaces



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Level.1 Standard Open Interface for Network Systems

No Existing References

Network Systems

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)*



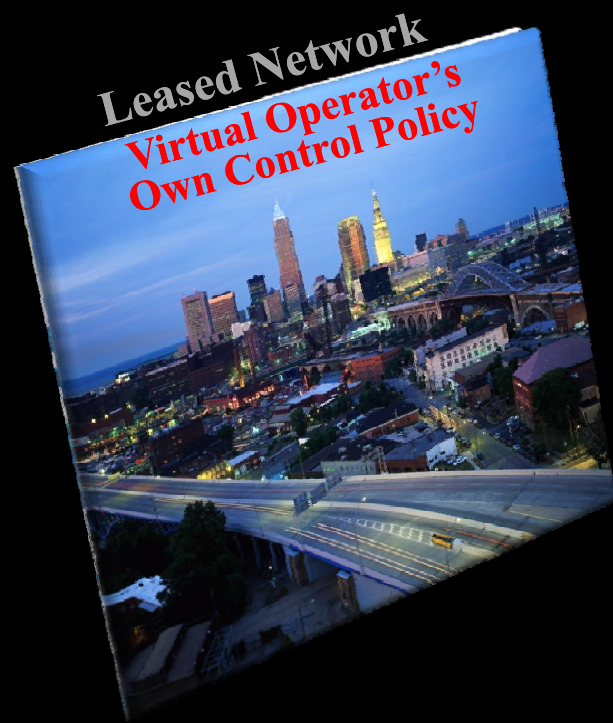
Same services with *JUST low cost*.
No new creative services and researches.



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

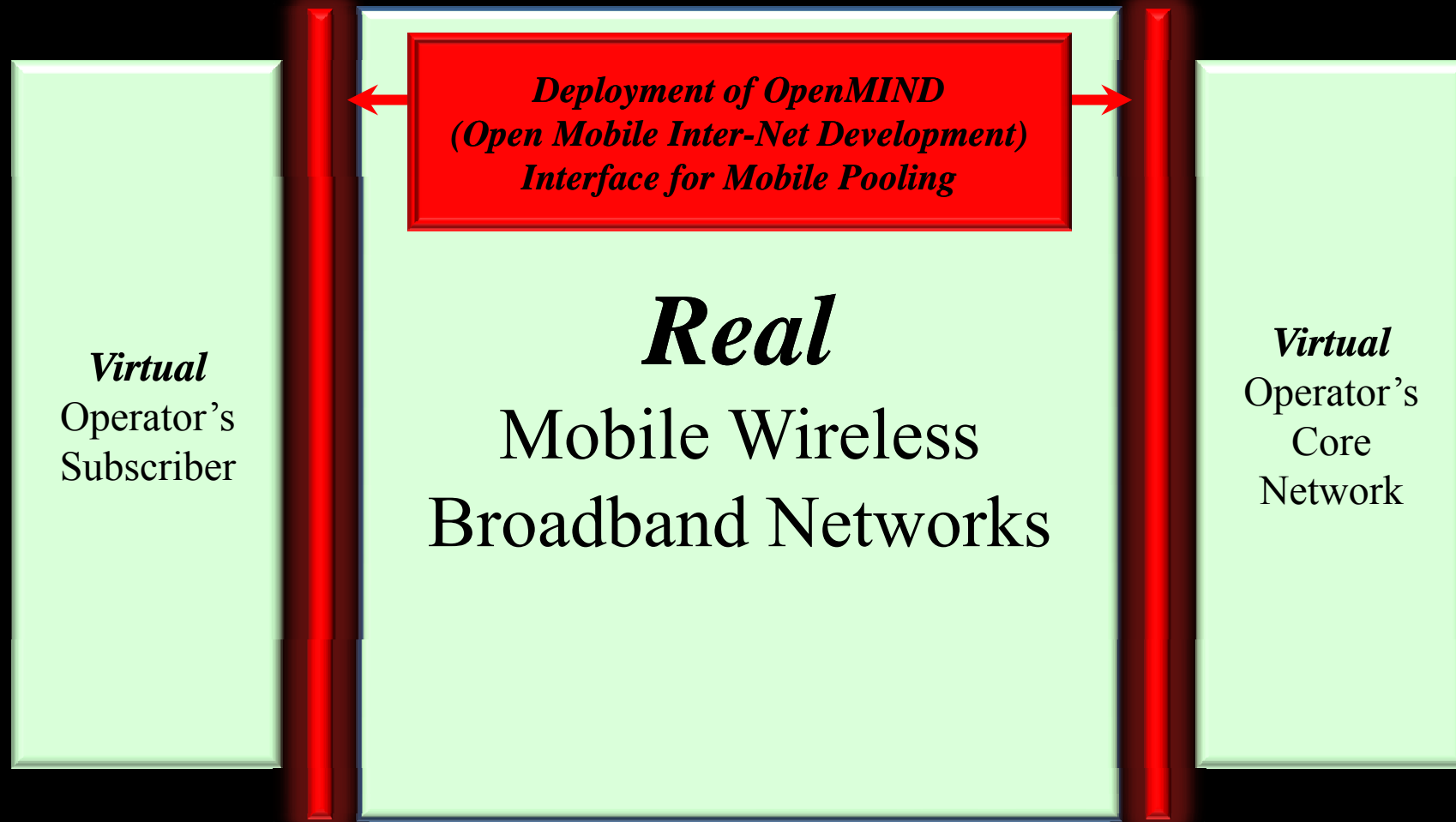
What will be done?

Virtual
Operator's
Subscriber

Real
Mobile Wireless
Broadband Networks

Virtual
Operator's
Core
Network

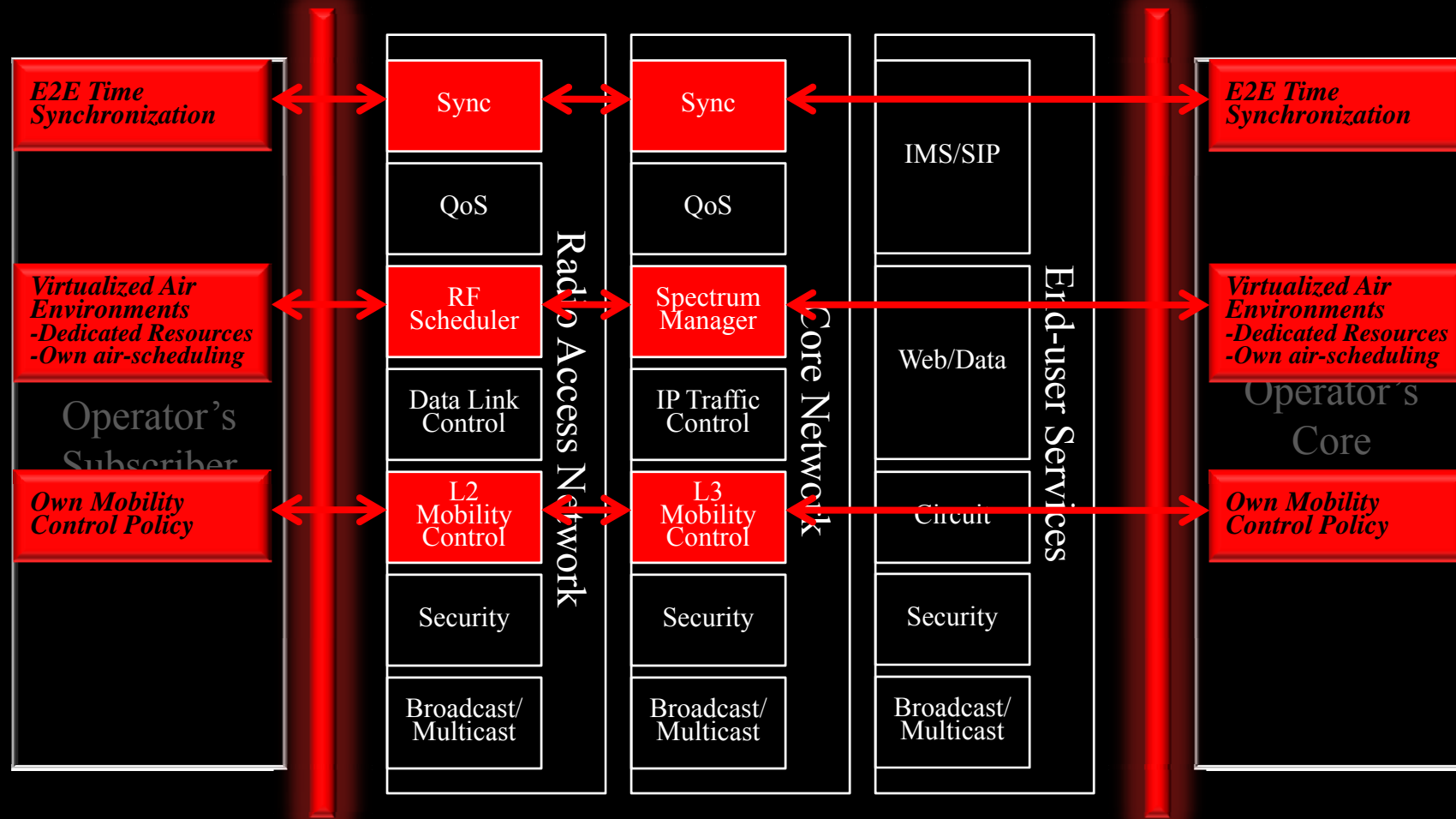
OpenMIND Interface



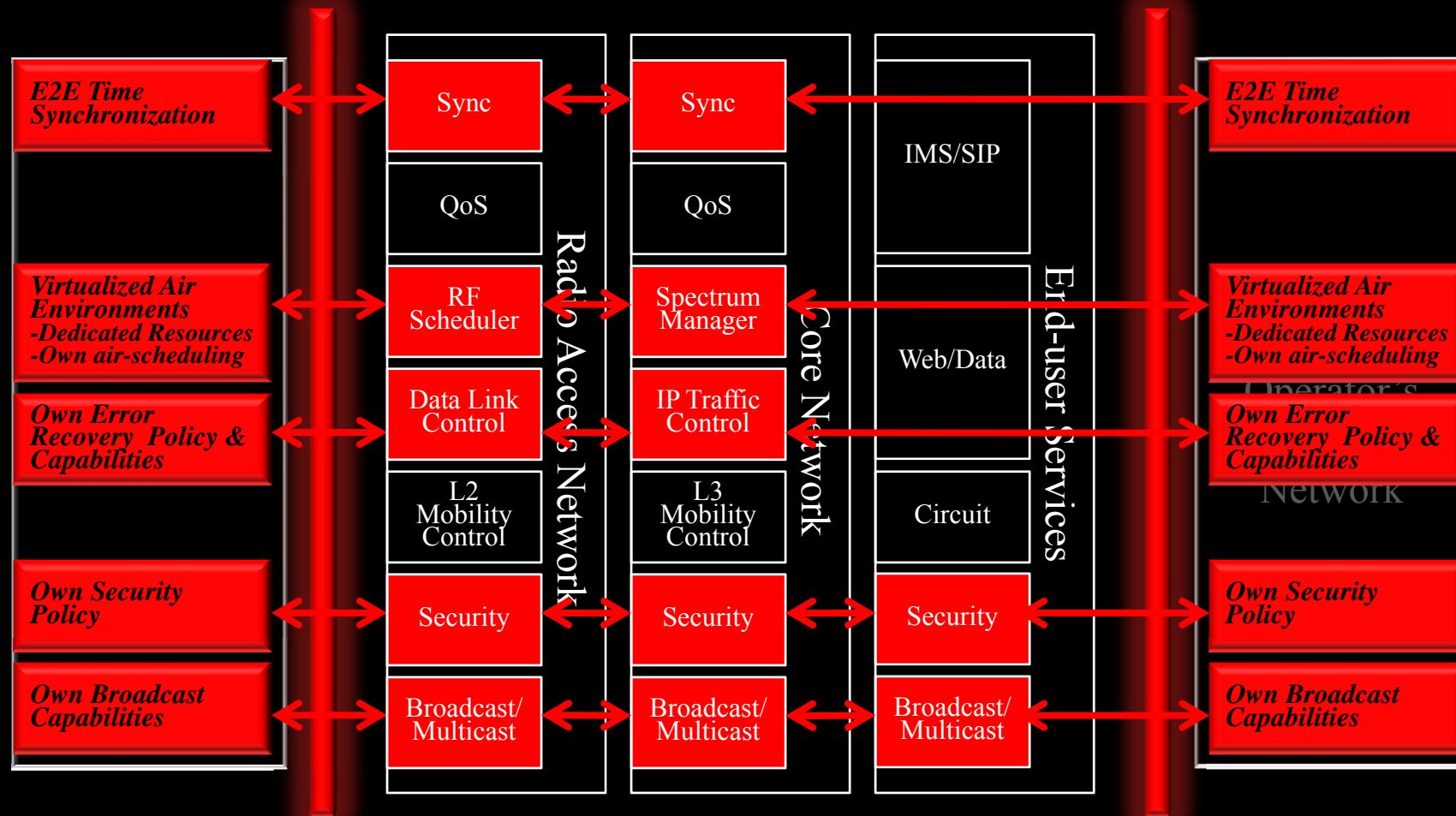
Realization of Virtualized Mobile Network

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

Example.1 Virtualized Mobility Control

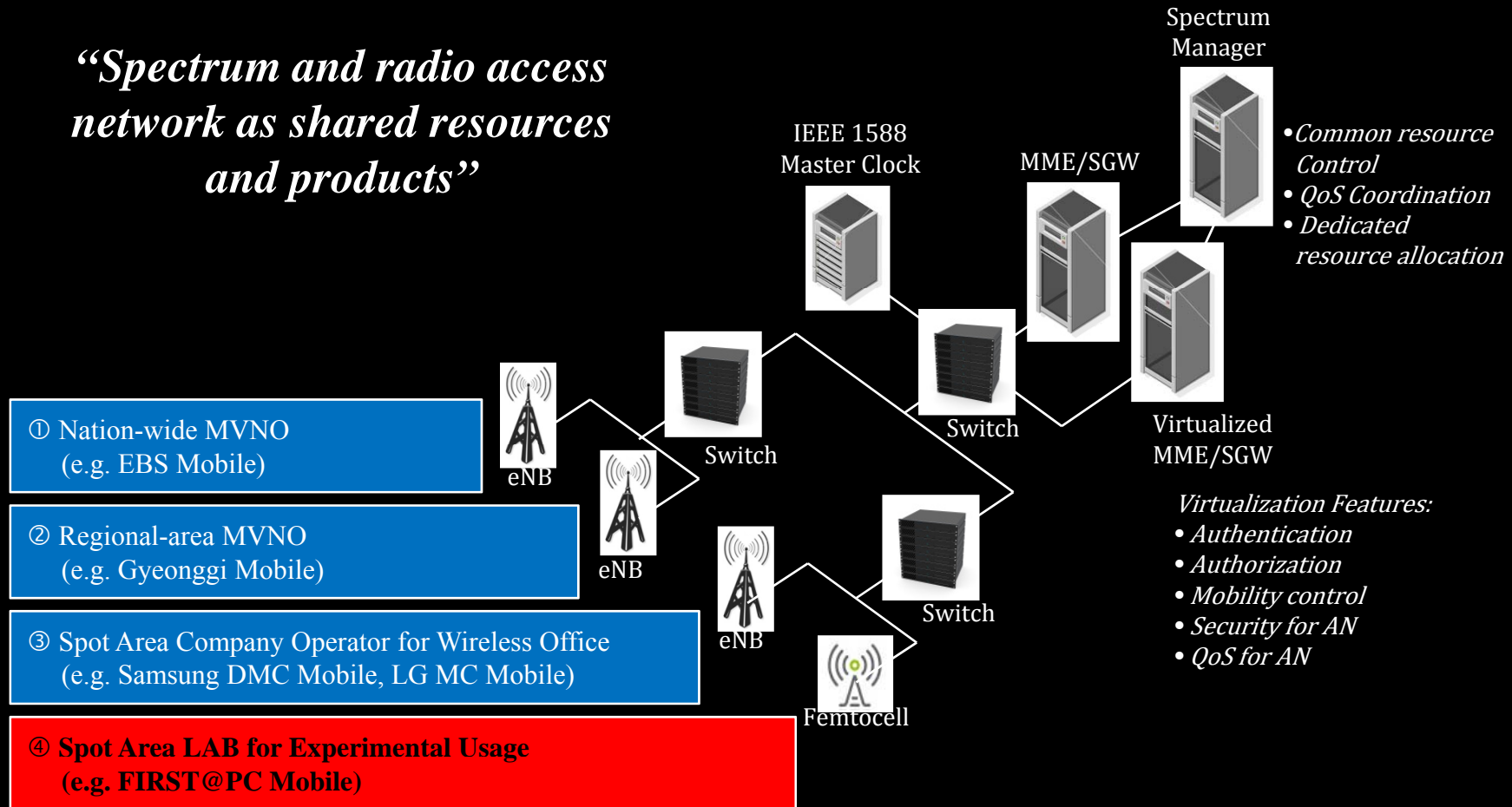


Example.2 Virtualized QoS Multimedia



So What ?

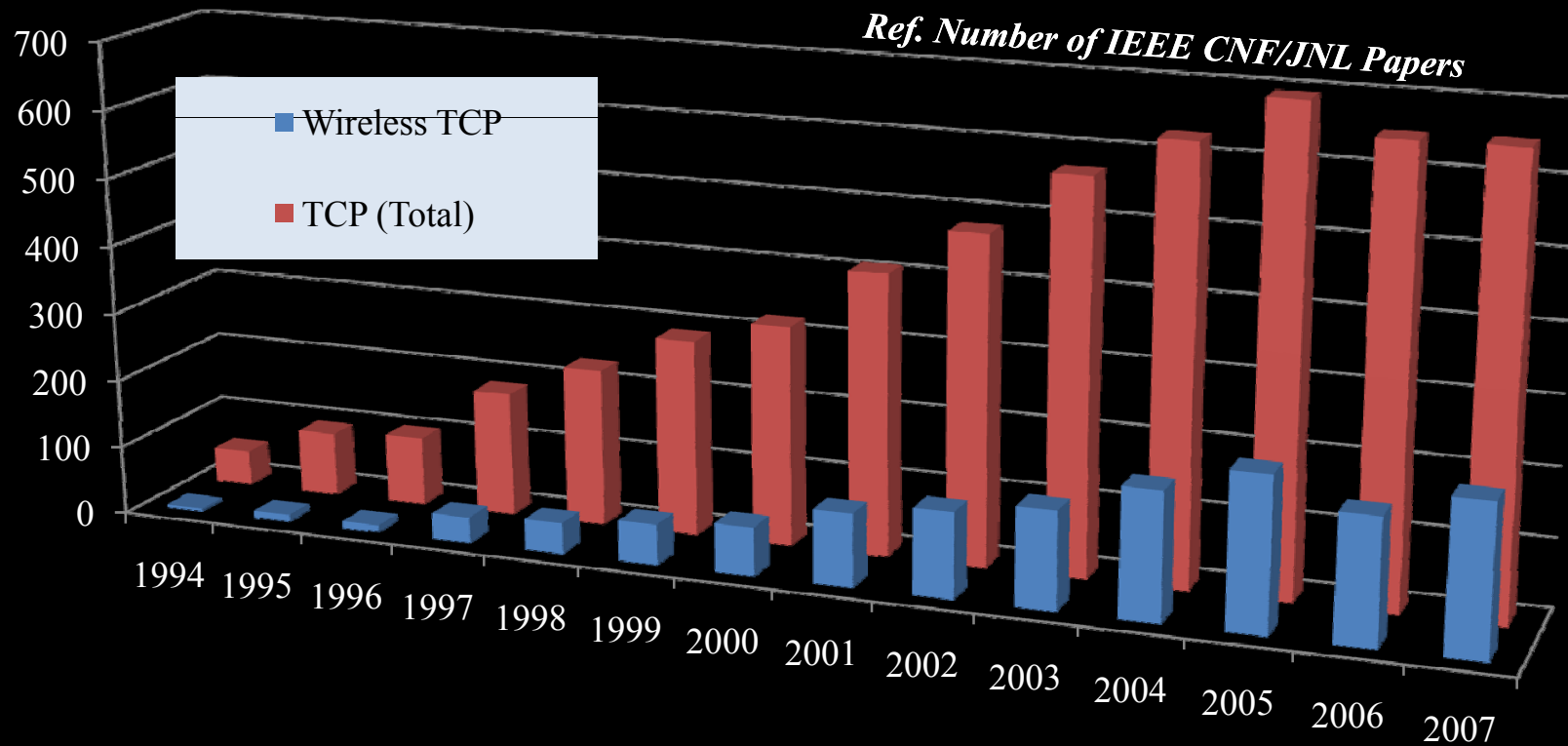
“Spectrum and radio access network as shared resources and products”



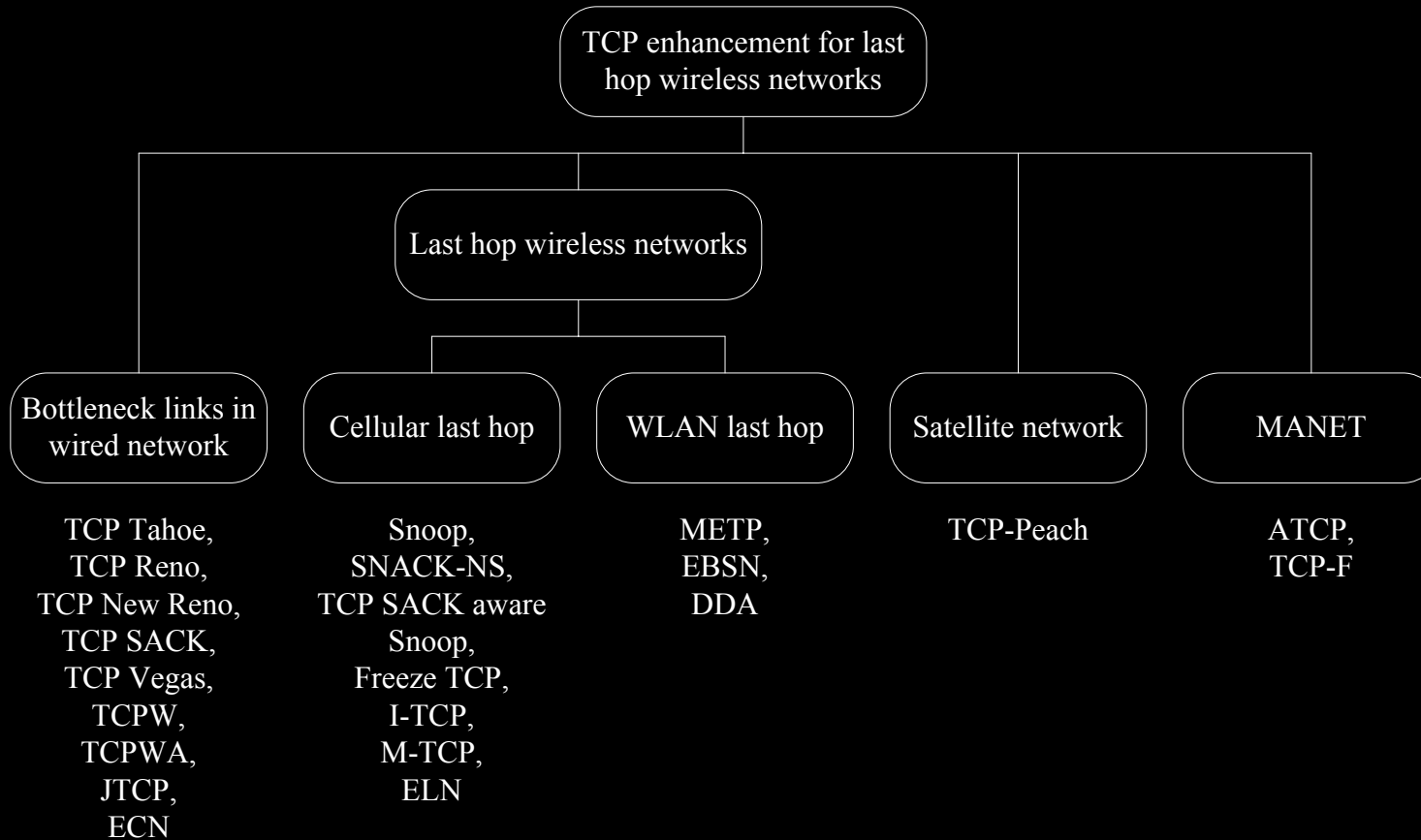
Case Study

OpenMIND for Mobile TCP

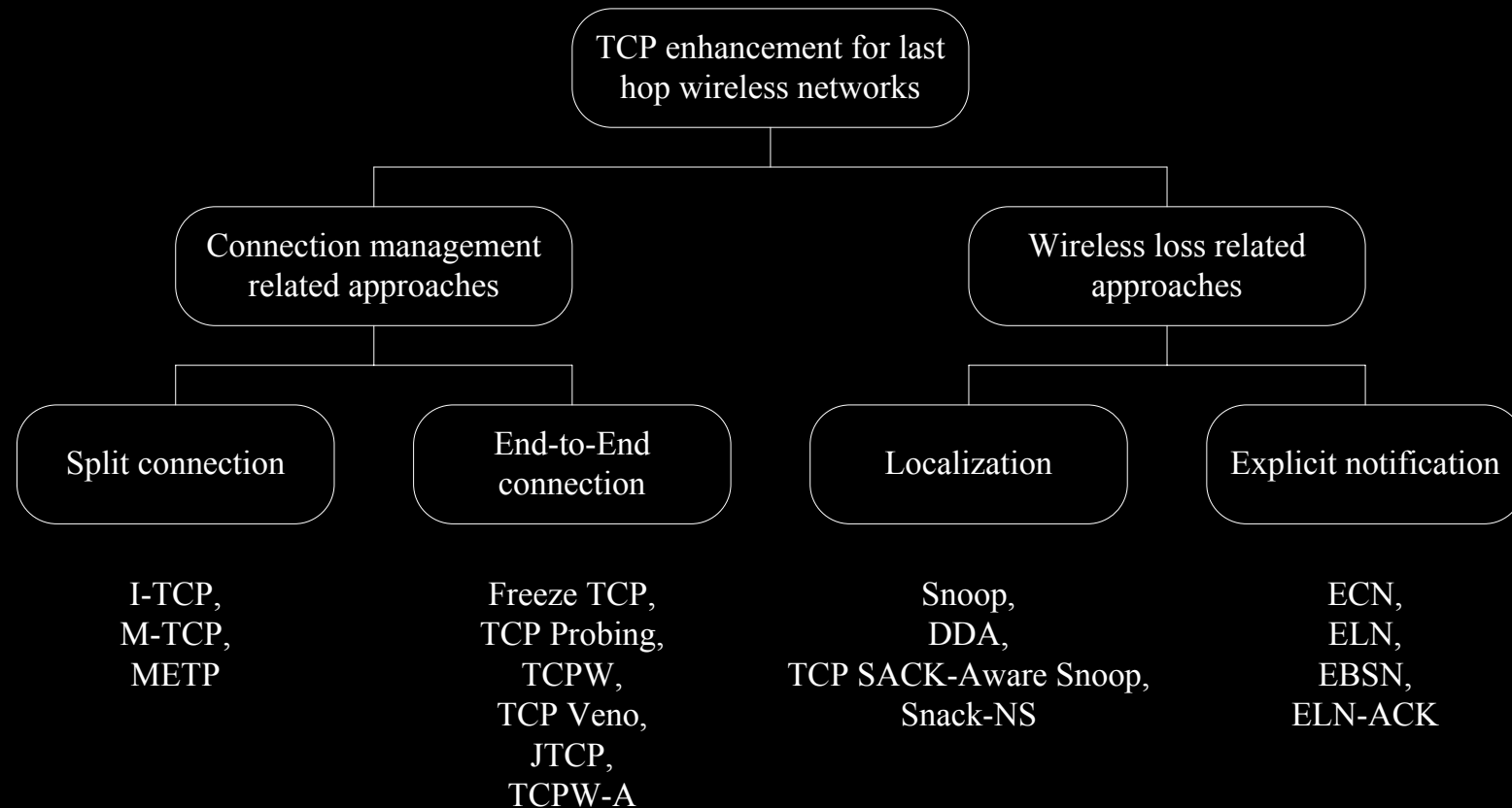
Increasing Research on TCP



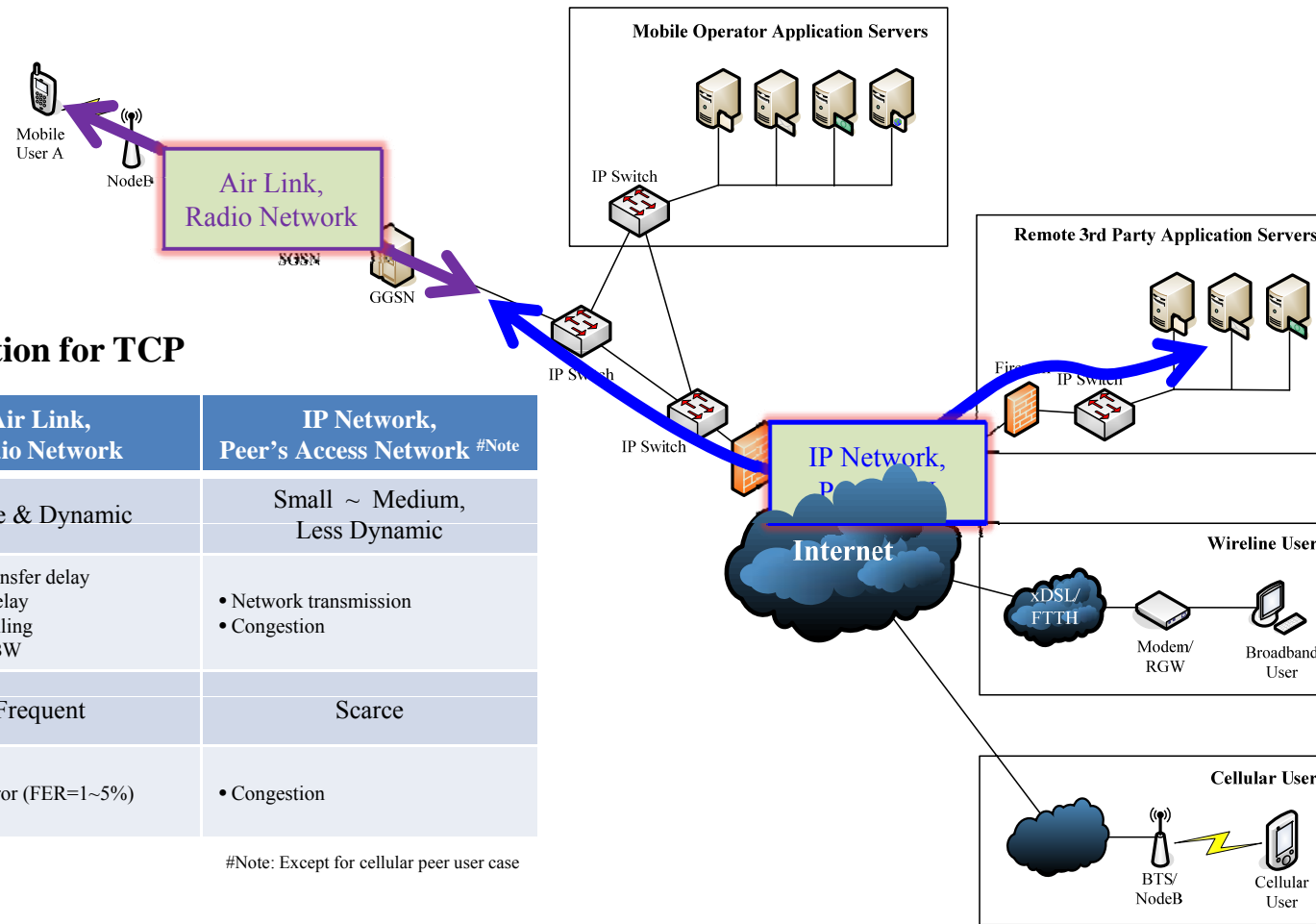
Researches on TCP



Conventional Researches on Wireless TCP



TCP Performance Degradation Impacts

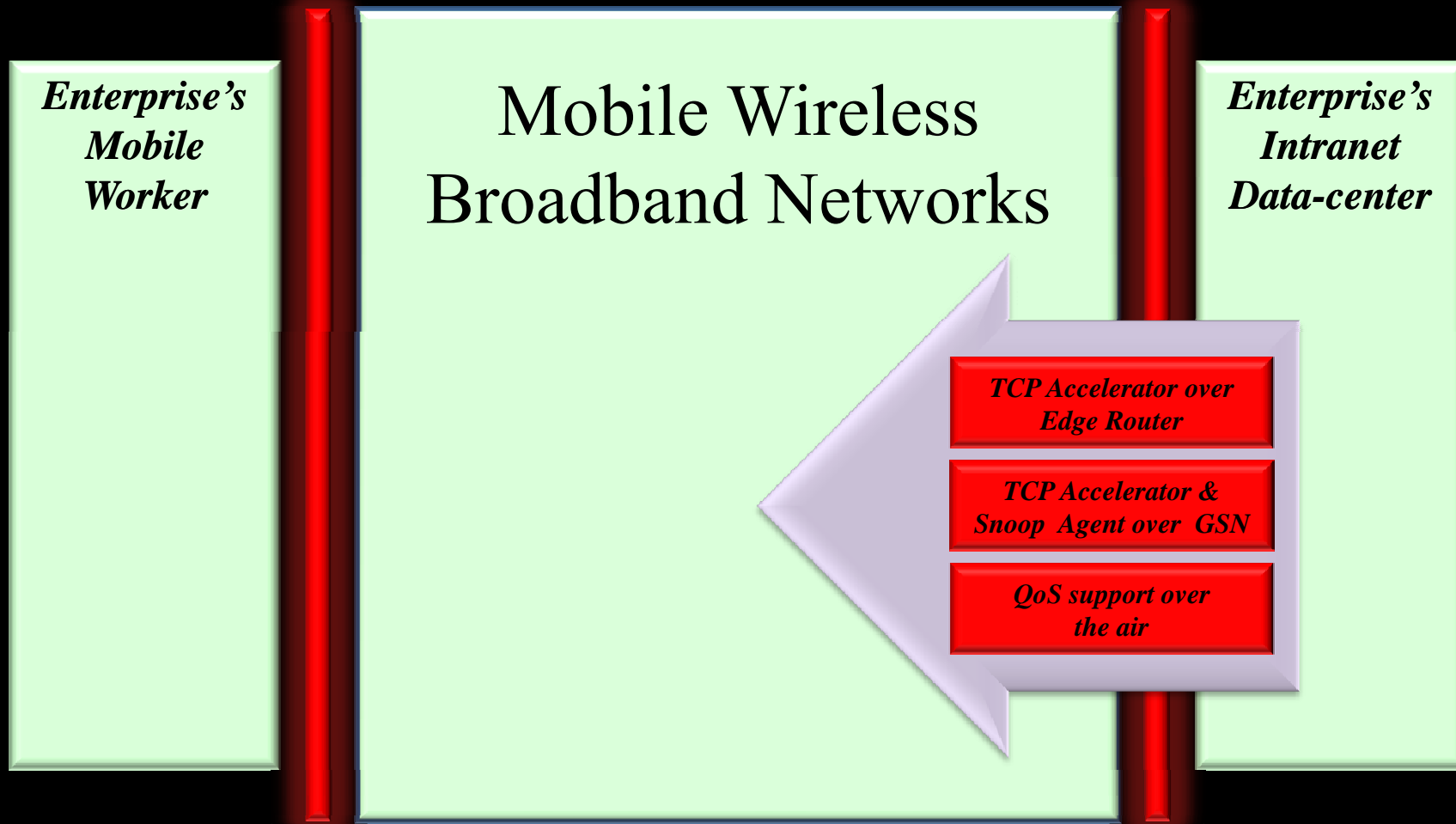


● Practical Condition for TCP

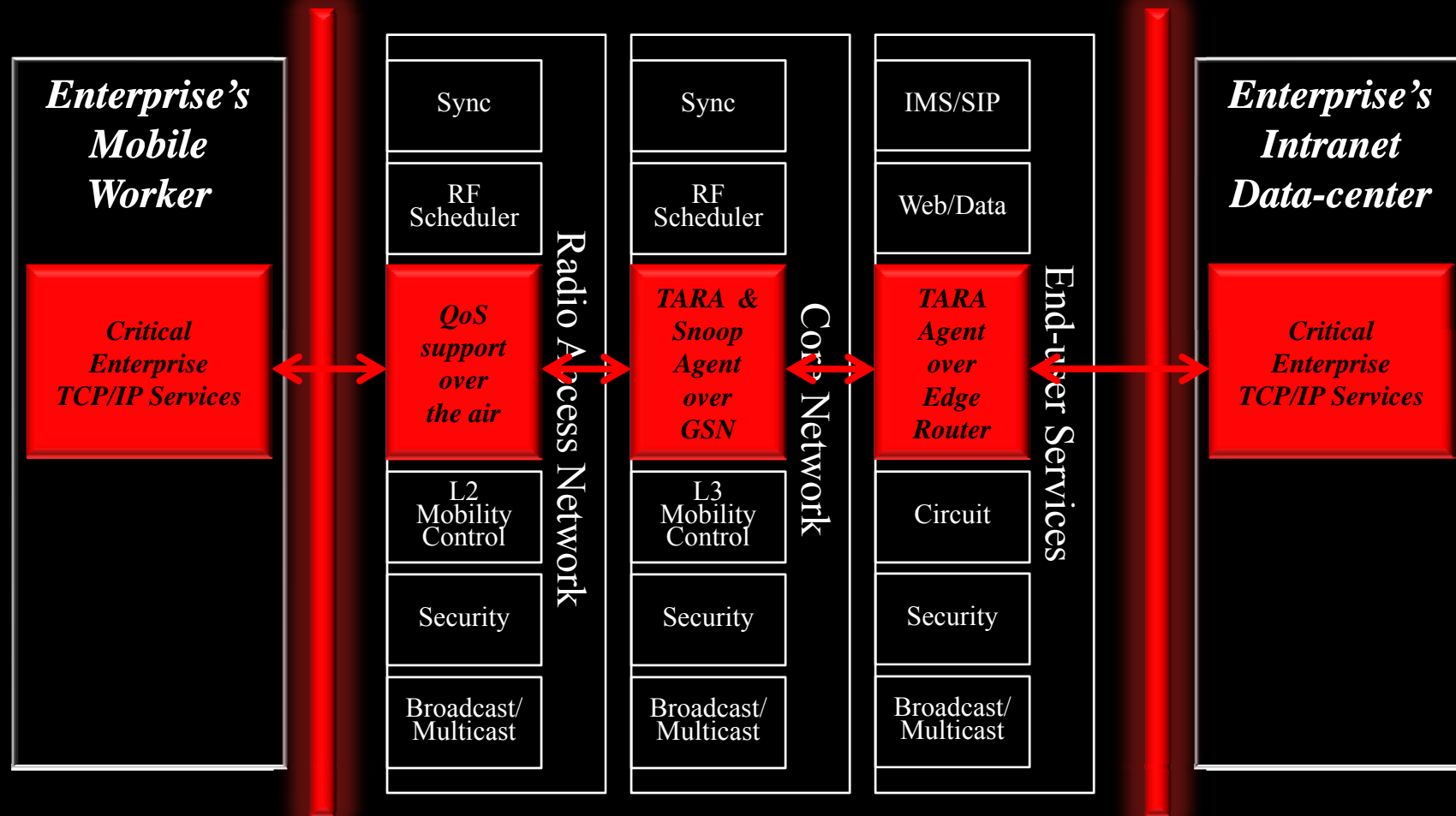
	Air Link, Radio Network	IP Network, Peer's Access Network #Note
RTT/Delay	Large & Dynamic	Small ~ Medium, Less Dynamic
	<ul style="list-style-type: none"> • Air link transfer delay • Queuing delay • RF-Scheduling • Dynamic BW 	<ul style="list-style-type: none"> • Network transmission • Congestion
Loss	Frequent	Scarce
	<ul style="list-style-type: none"> • Mobility • Air link error (FER=1~5%) • Handoff 	<ul style="list-style-type: none"> • Congestion

#Note: Except for cellular peer user case

Intranet Enhancement over OpenMIND



Intranet Enhancement over OpenMIND



Intranet Enhancement over OpenMIND

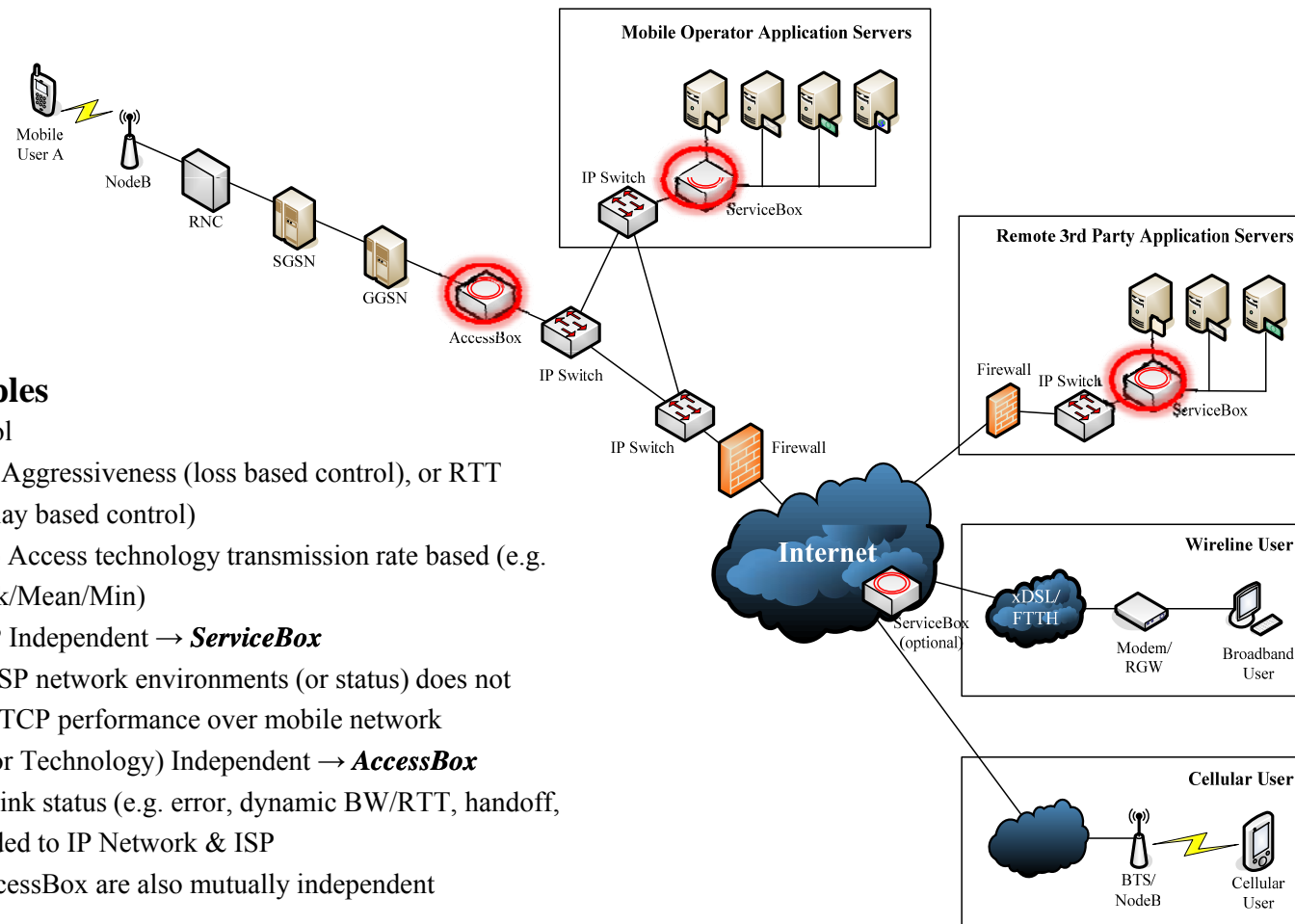
*Enterprise's
Mobile
Worker*

Mobile Wireless
Broadband Networks

*Enterprise's
Intranet
Data-center*



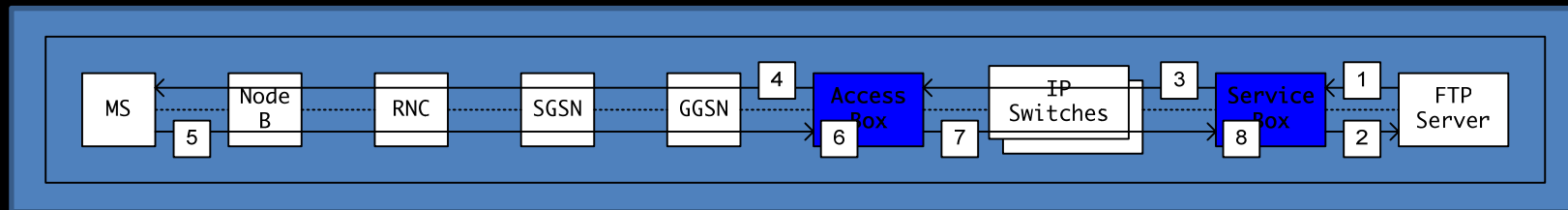
Proposed Network Architecture



● 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 hid 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 \times 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

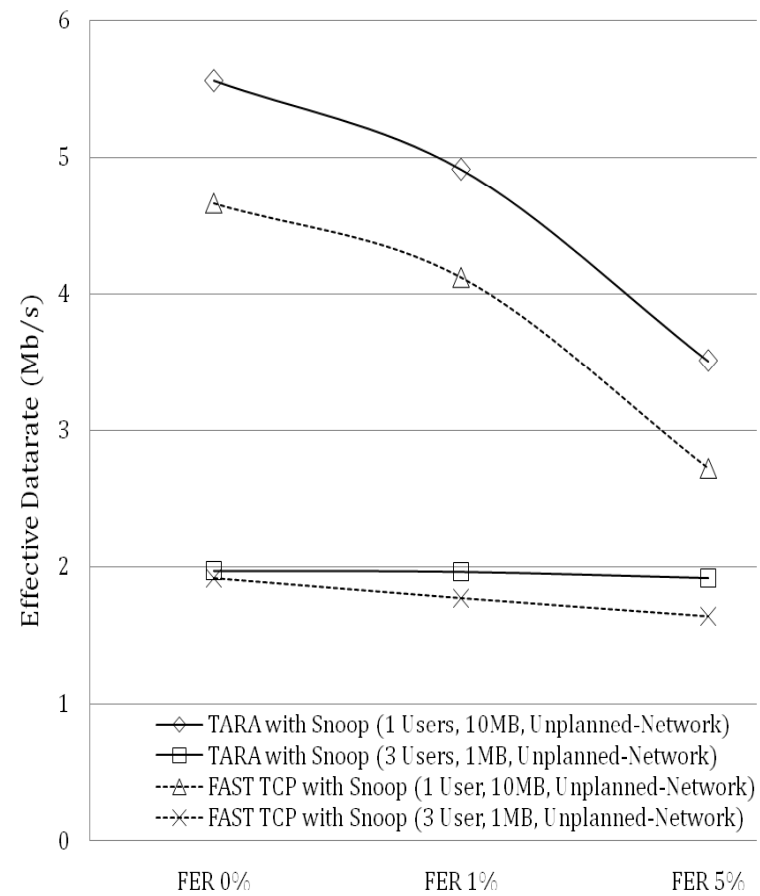
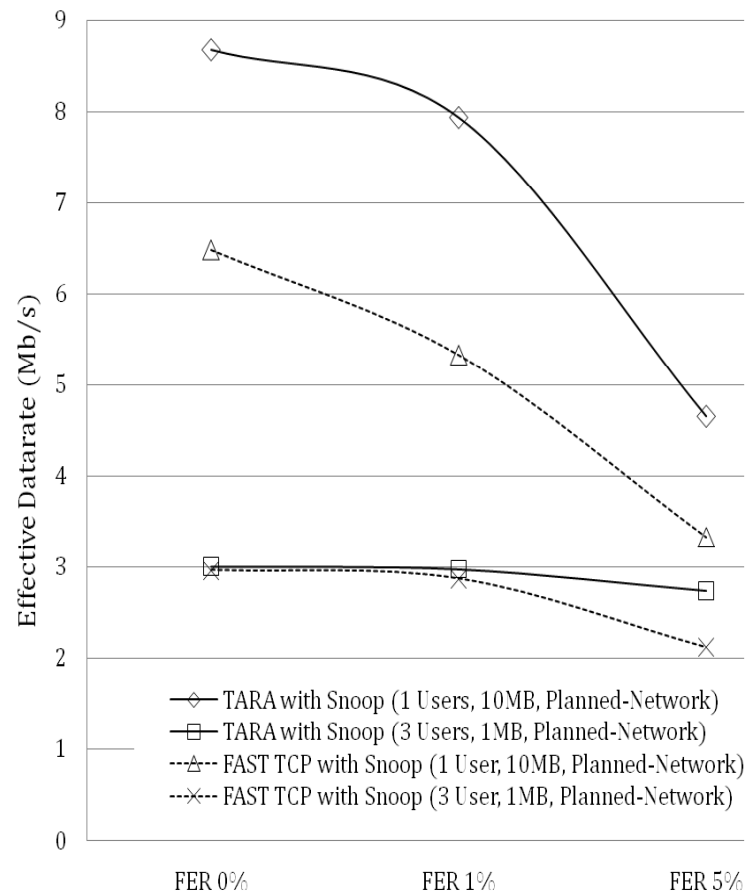
- **Planned Network**

- 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