

Long Future Group – Global Wireless Virtual Network/Computing Services

# Application's Virtual Network

2015.9.4.

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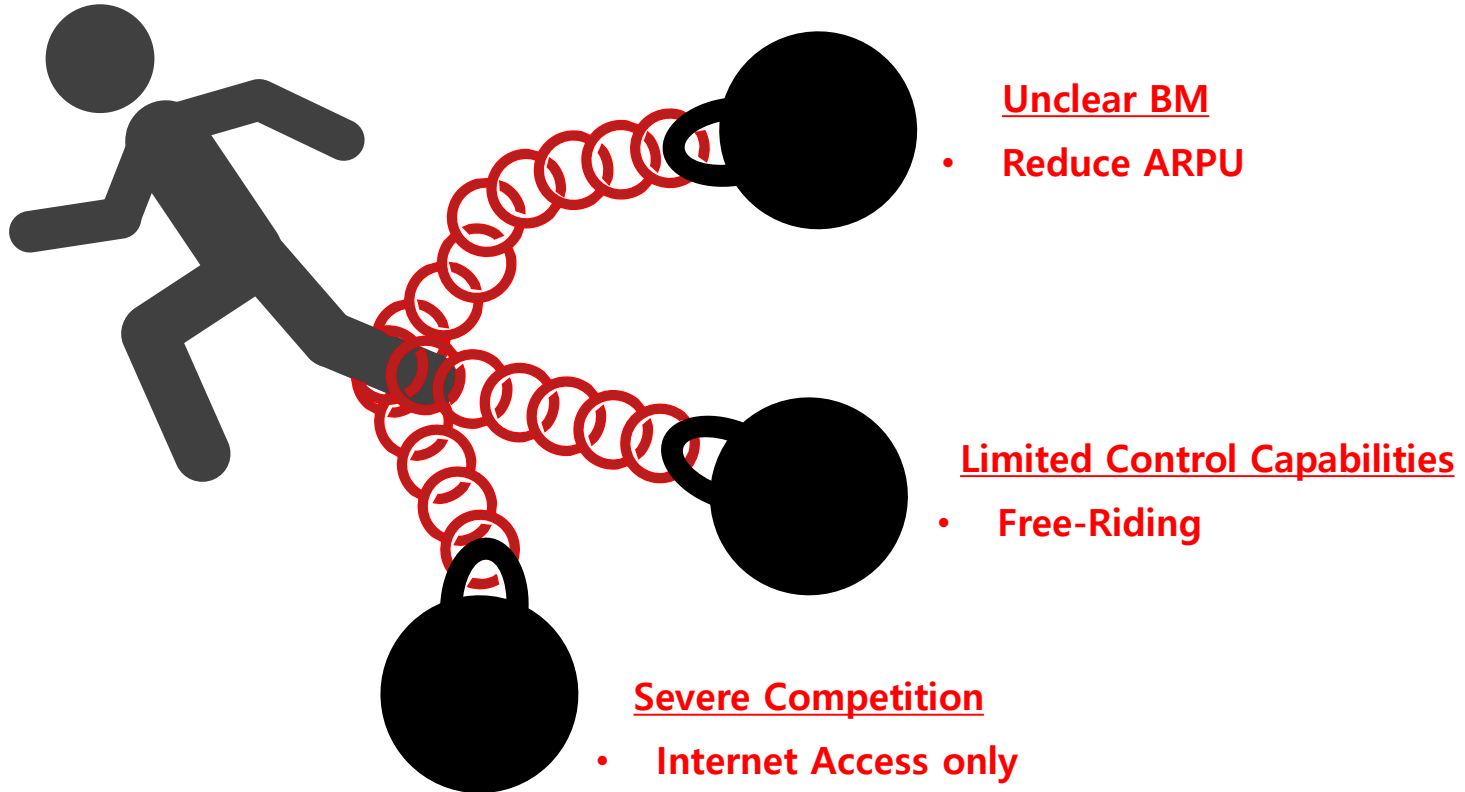
# 1. Background

# Wireless Carrier's Dilemma - Unclear Business Model



## Limited End-to-End Control Capabilities

### Wireless Carrier's Dilemma



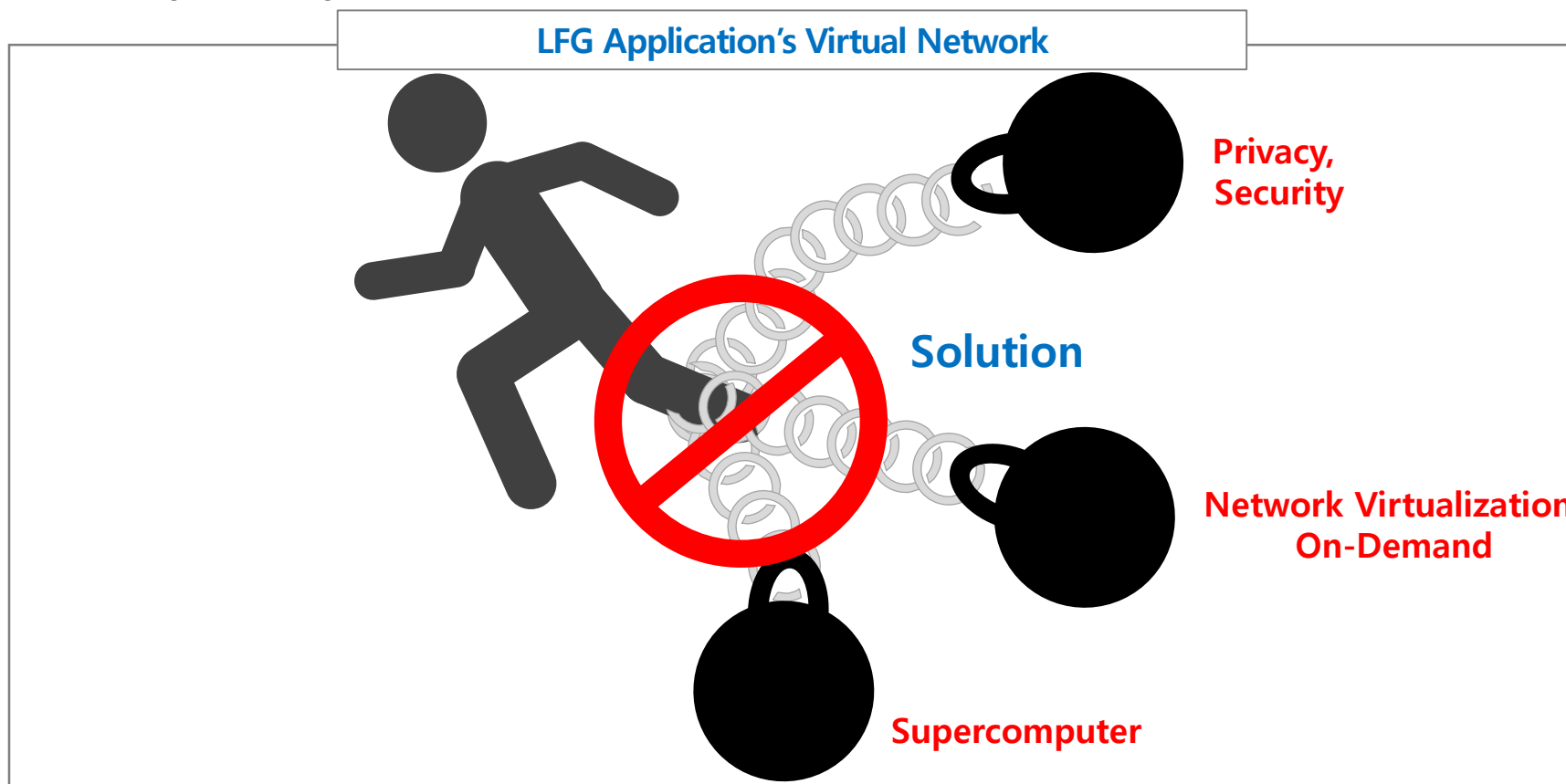
## 2. LFG's Global Wireless Network Services

# LFG's Global Wireless Virtual Network Services



## Global Unique Solution : Application's Virtual Network

- Supercomputer : FTL
- Network Virtualization : Mobile Convergence/Sable
- Privacy/Security : LFG Development Consortium



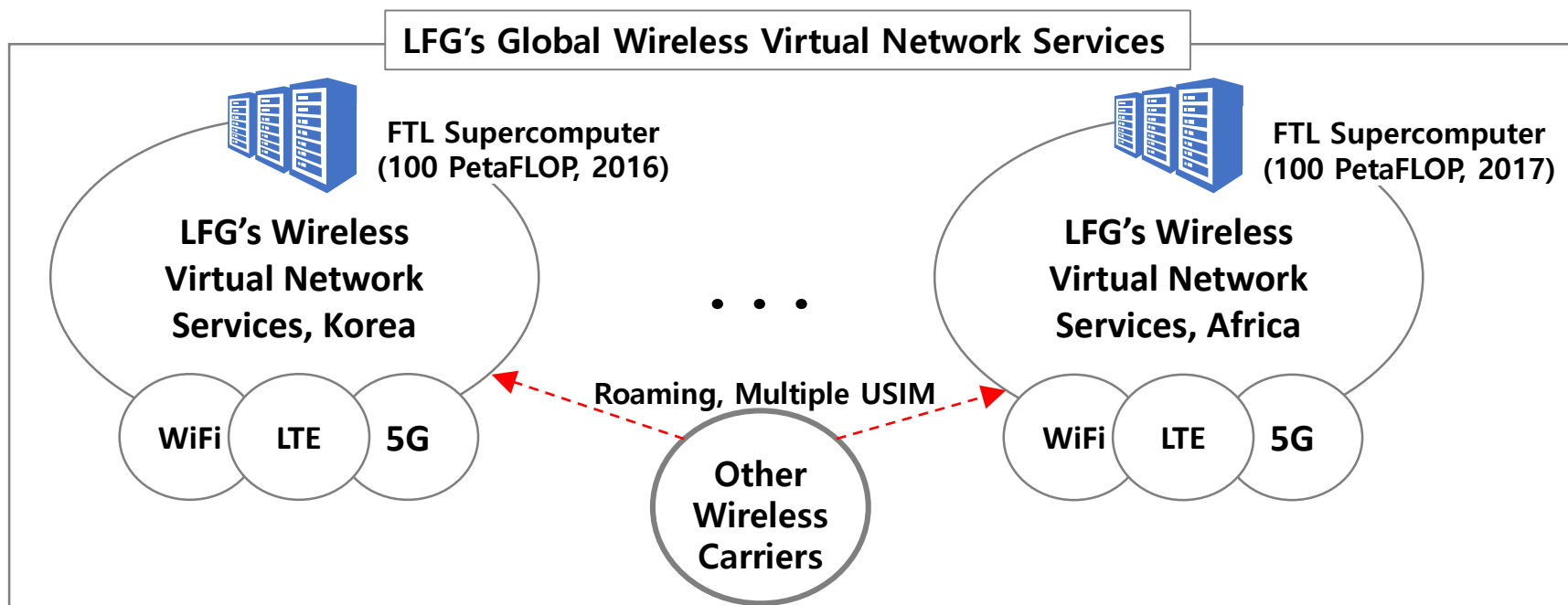


# LFG's Global Wireless Virtual Network Services



## Application-specific On-Demand TIPN

- Key Differentiations
  - Supercomputer
  - TIPN (Trusted IP Network)
  - Virtual TIPN On-Demand
  - LTE, 5G and beyond
- Virtual TIPN On-Demand



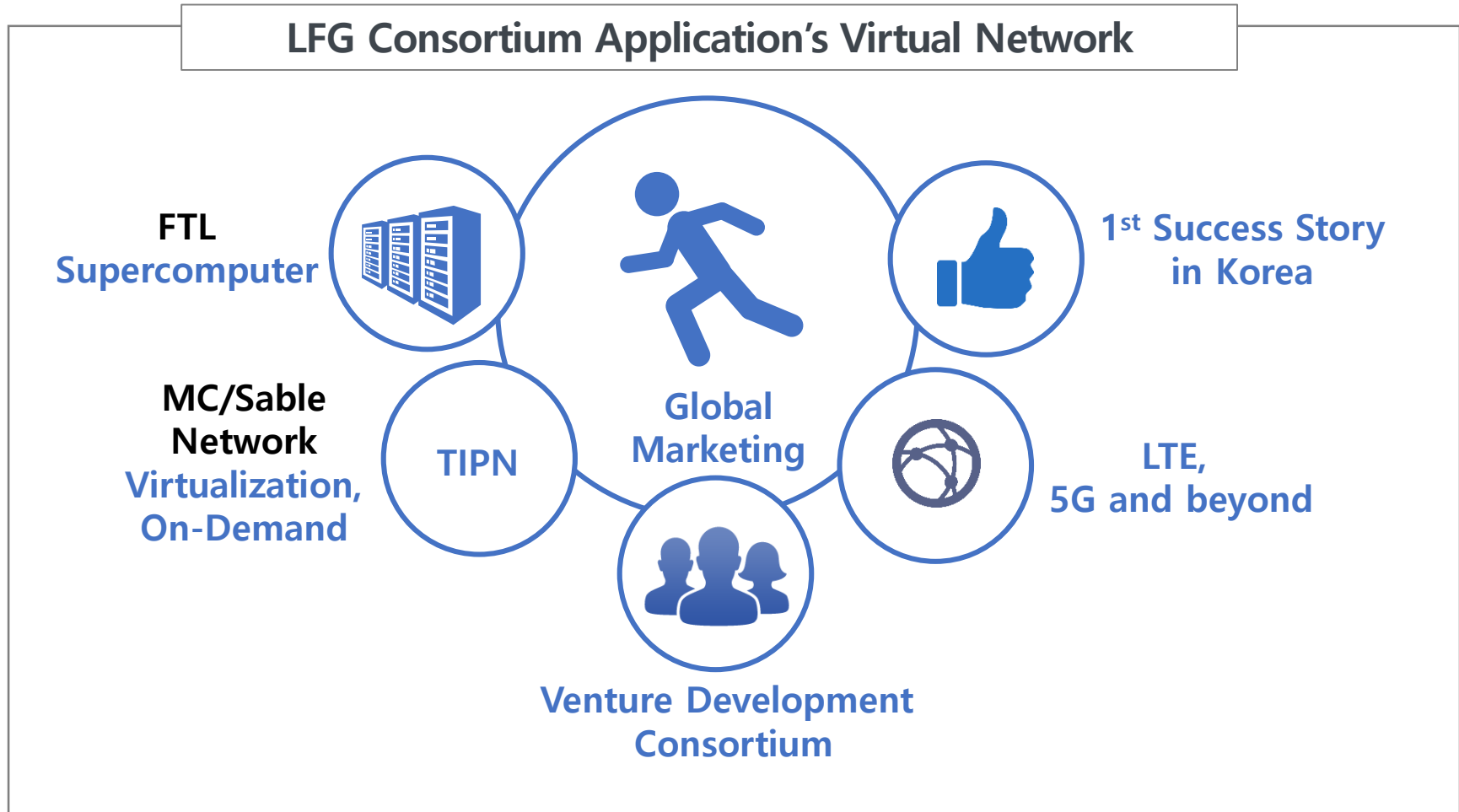


# LFG's Global Wireless Virtual Network Services



## LFG Consortium

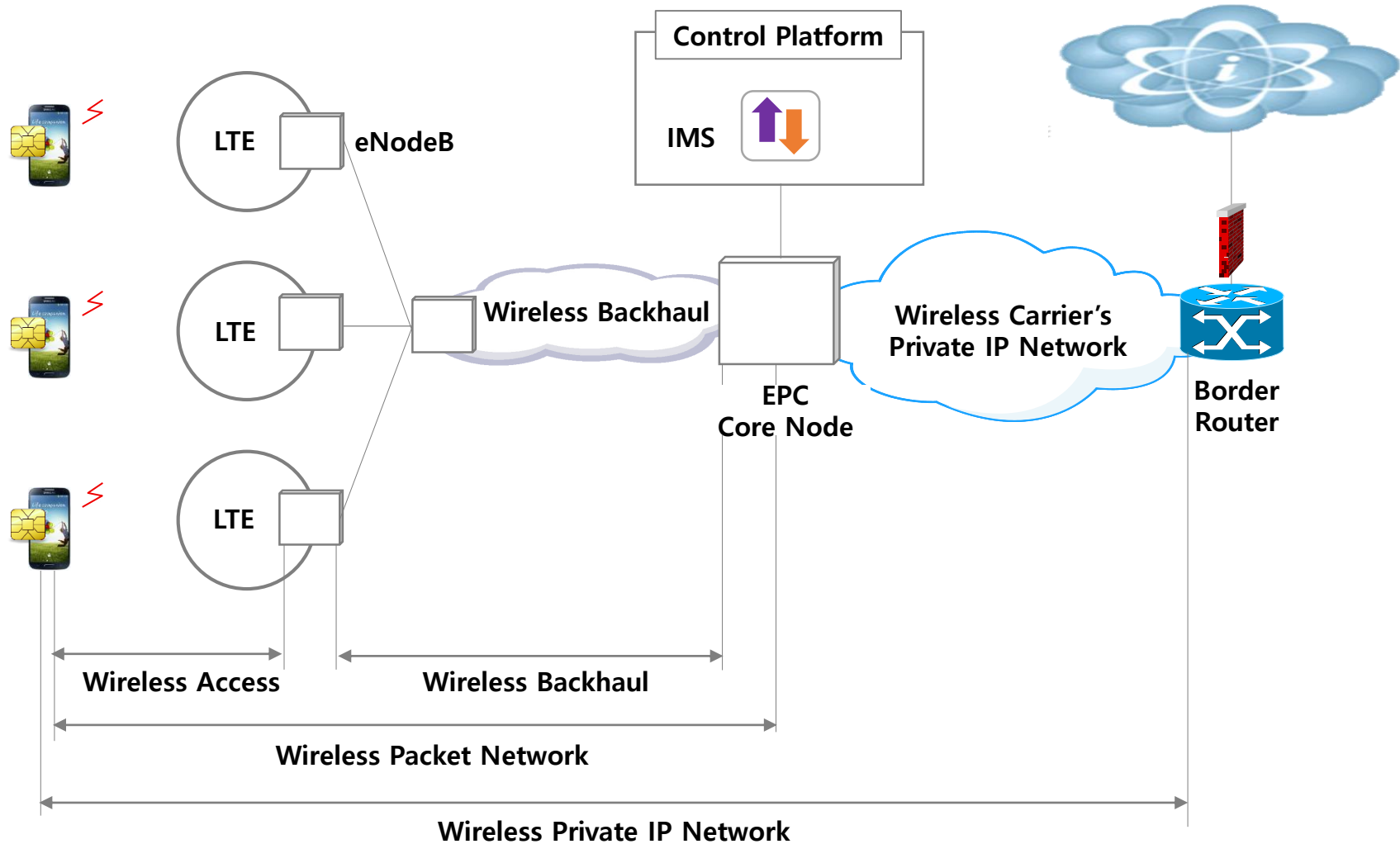
- Application's Virtual Network



## 3. Wireless IP Network Analysis

# Wireless IP Network Analysis

## Typical Wireless IP Network

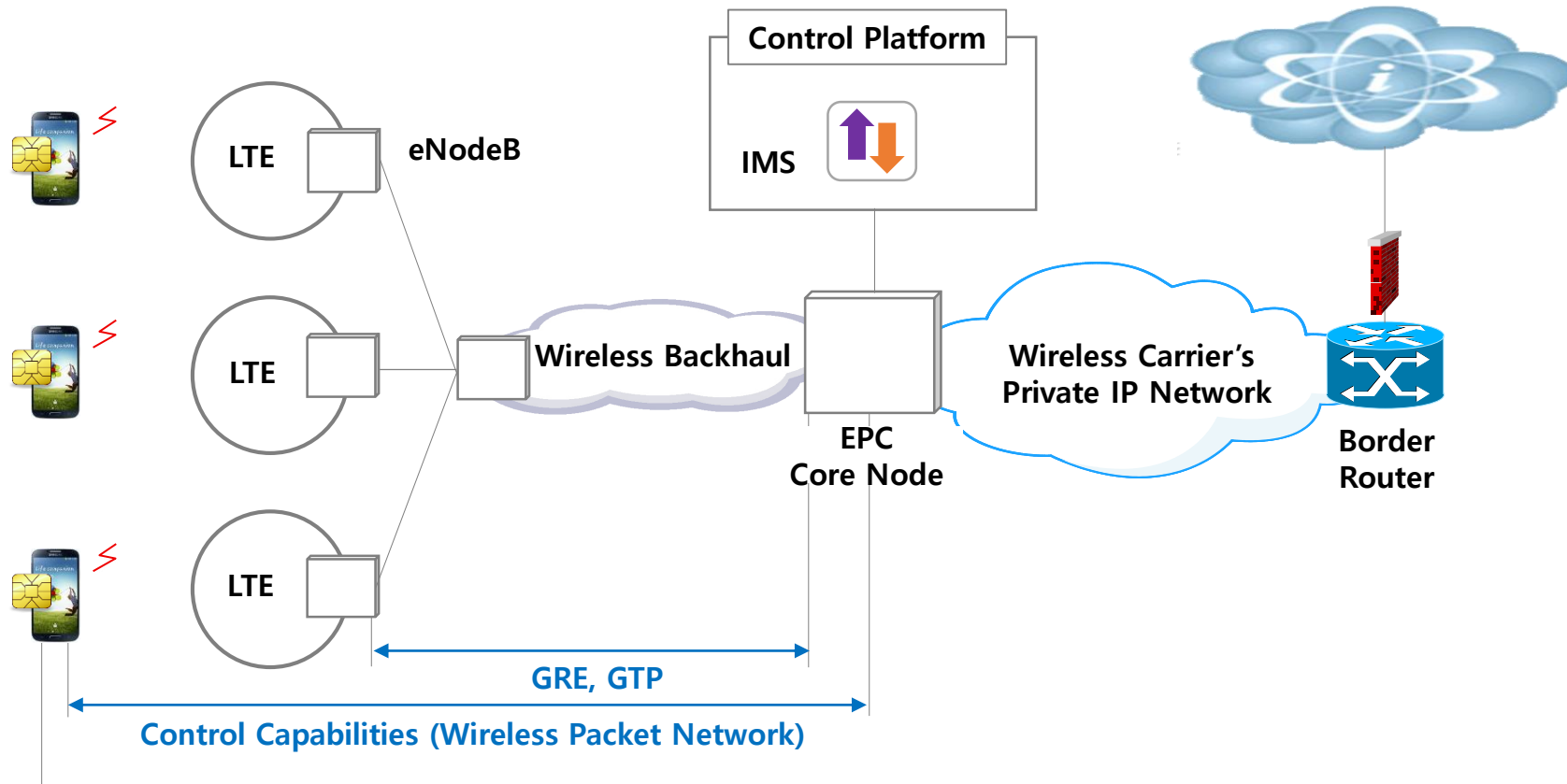


# Wireless Packet Network Analysis (1)



## E2E Control Capabilities

- Control Platform : IMS
  - USIM
  - Subscription DB per USIM



# Wireless Packet Network Analysis (2)



## E2E Control Capabilities

- Summary of Differentiations
  - Frequency
  - Management/Control Capabilities
  - Terminal
  - Wireless Packet Network
- Frequency
- Management/Control Capabilities : IMS
  - Isolated Management/Control Domain : 3GPP
- Terminal
  - USIM
  - Subscriber's Circuit
  - Location
  - Device Control Capabilities

# Wireless Packet Network Analysis (3)



## E2E Control Capabilities

- **Wireless Packet Network**
  - **Resource Allocation and Traffic Management : Subscription DB**
    - CoS
  - **Control Capabilities**
    - USIM
    - Authentication
    - Subscriber's Circuit
    - Valid IP Address
    - GRE/GTP Tunnel
  - **Encryption : Terminal ↔ Base Station (eNodeB, etc.)**
  - **Private IP Network**
  - **IP Address Portability : PMIP, etc.**

# Wireless Packet Network Analysis (4)



## Wireless IP Network : Wireless Carrier's View

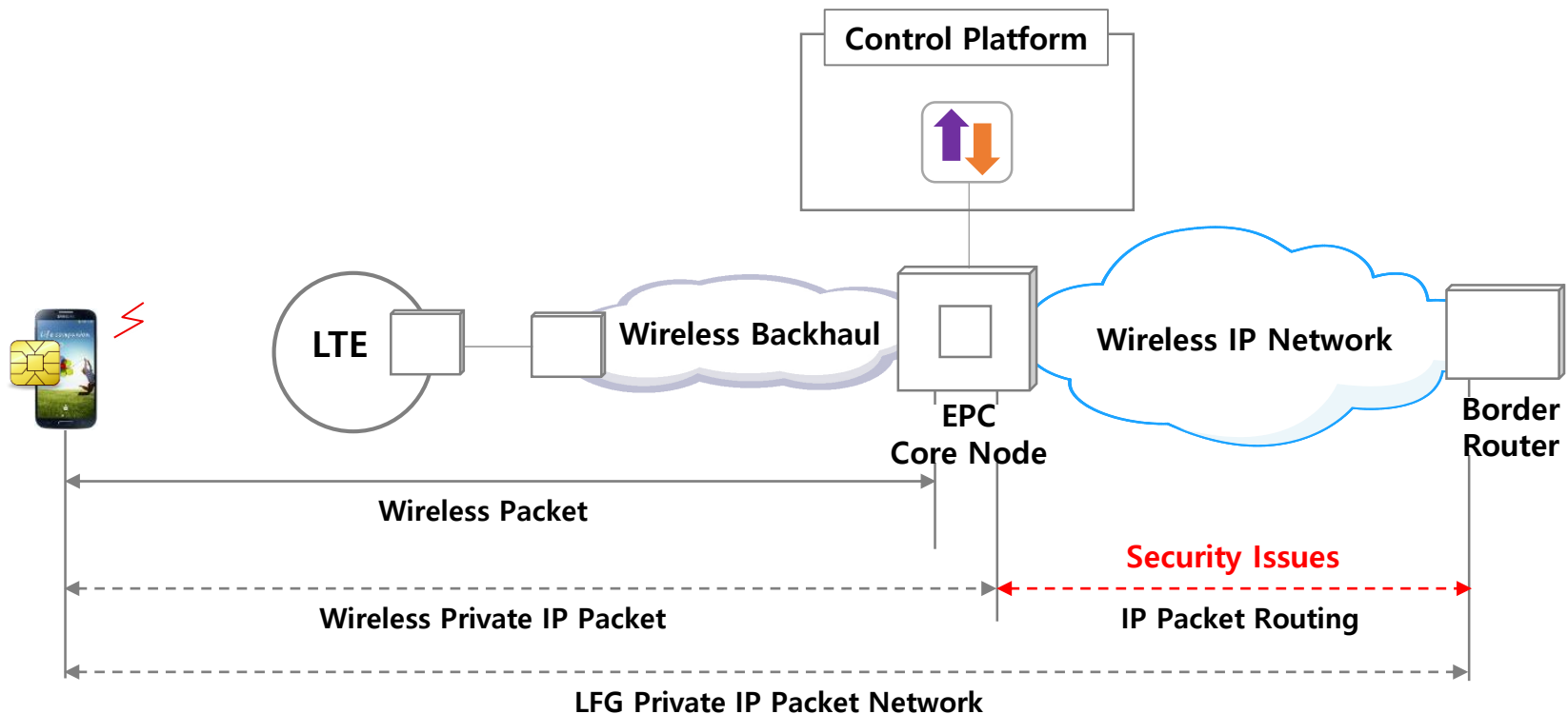
Descriptions		Wireless IP Network Wireless Carrier's View	Comments
Security		○	
Privacy		○	
Resistance to Distributed Denial of Service (DDoS) attacks		△	
End-to-End QoS/QoE		△ (CoS : Class Of Service)	
Mobility		○ (PMIP)	
Location		○	
IP Address Portability		○	
Identification	Terminal	○ (USIM)	
	Subscriber	○	
Network Virtualization		○ (Flow Type)	
CUG (Closed User Group)		○ (USIM)	
Private Routing Domain per Organization		-	

# Wireless IP Network Analysis - Service View (1)



## Wireless IP Network : One Private IP Network

- All Visibility
  - Wireless Private IP Network is open among Terminals with specific USIM
- All Connectivity
  - Any-to-Any Connectivity among Terminals with specific USIM

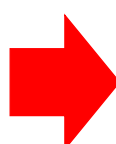




# Wireless IP Network Analysis - Service View (2)

## Wireless IP Network Analysis – Service View (Limited Control Capabilities)

### ● Wireless IP Network Carrier's View vs. Service View

Descriptions		Wireless IP Network Carrier's View		Wireless IP Network Services View	Comments
Security		○		X	
Privacy		○		X	
Resistance to Distributed Denial of Service (DDoS) attacks		△		X	
End-to-End QoS/QoE		△ (CoS)		X	
Mobility		○ (PMIP)		X	
Location		○		X	
IP Address Portability		○		X	
Identification	Terminal	○ (USIM)		X	
	Subscriber	○		X	
Network Virtualization		○ (Flow Type)		X	
CUG (Closed User Group)		○ (USIM)		X	
Private Routing Domain per Organization		–		X	

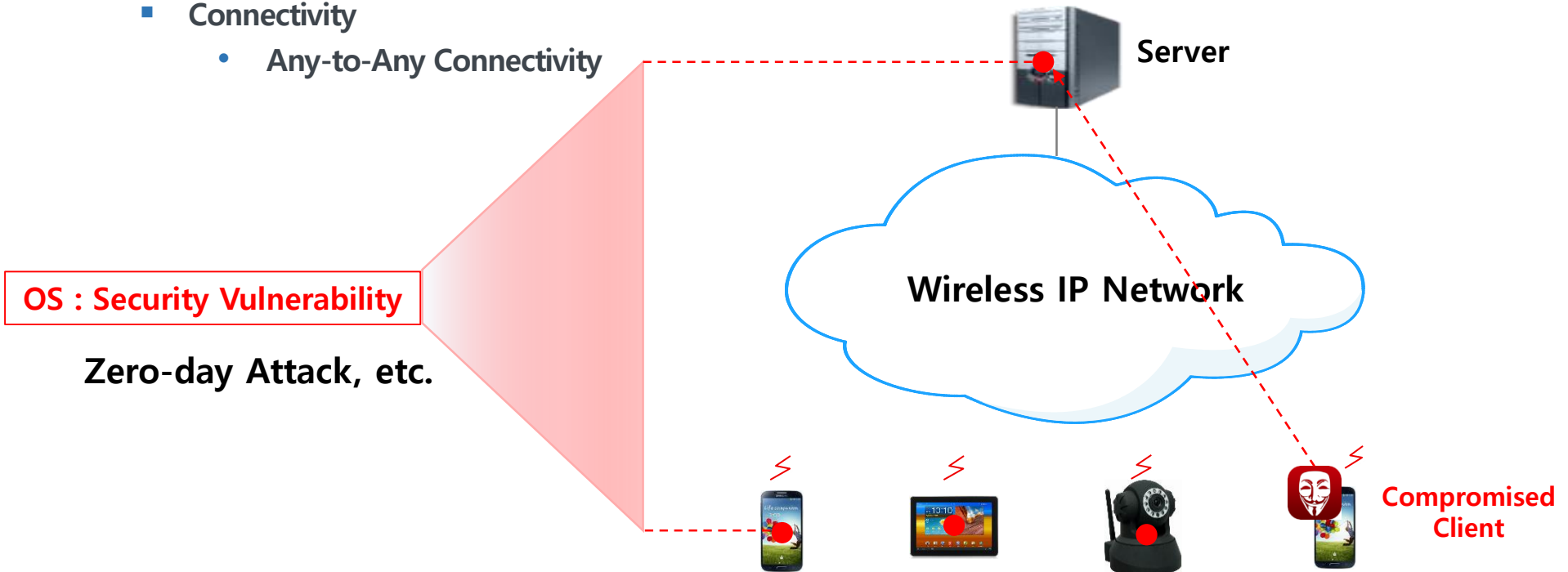
## 4. Wireless Carrier - Security Service Issues

# Wireless IP Network - Negative Impact (1)



## IP Network : Expand Security Vulnerability

- Computer
  - OS : Security Vulnerability
- IP Network
  - Visibility
    - IP Network is open.
  - Connectivity
    - Any-to-Any Connectivity

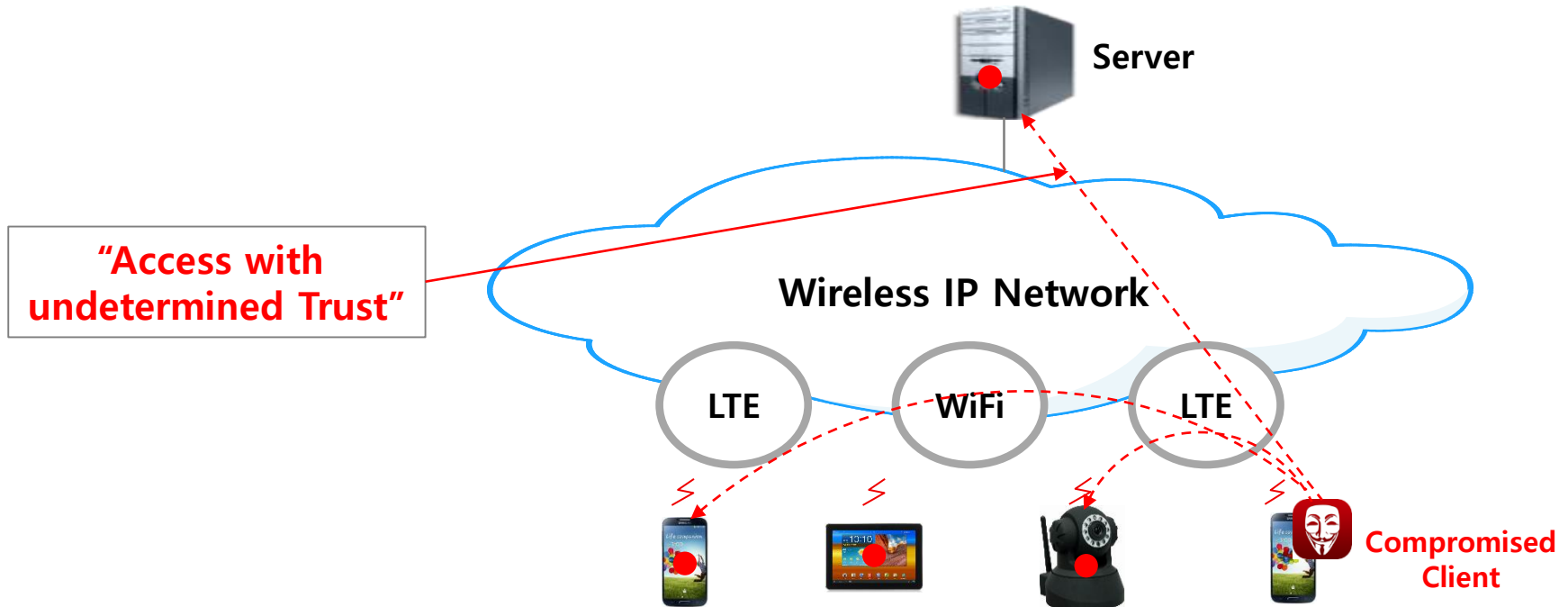


# Wireless IP Network - Negative Impact (2)



Devices connect to the server via TCP/IP

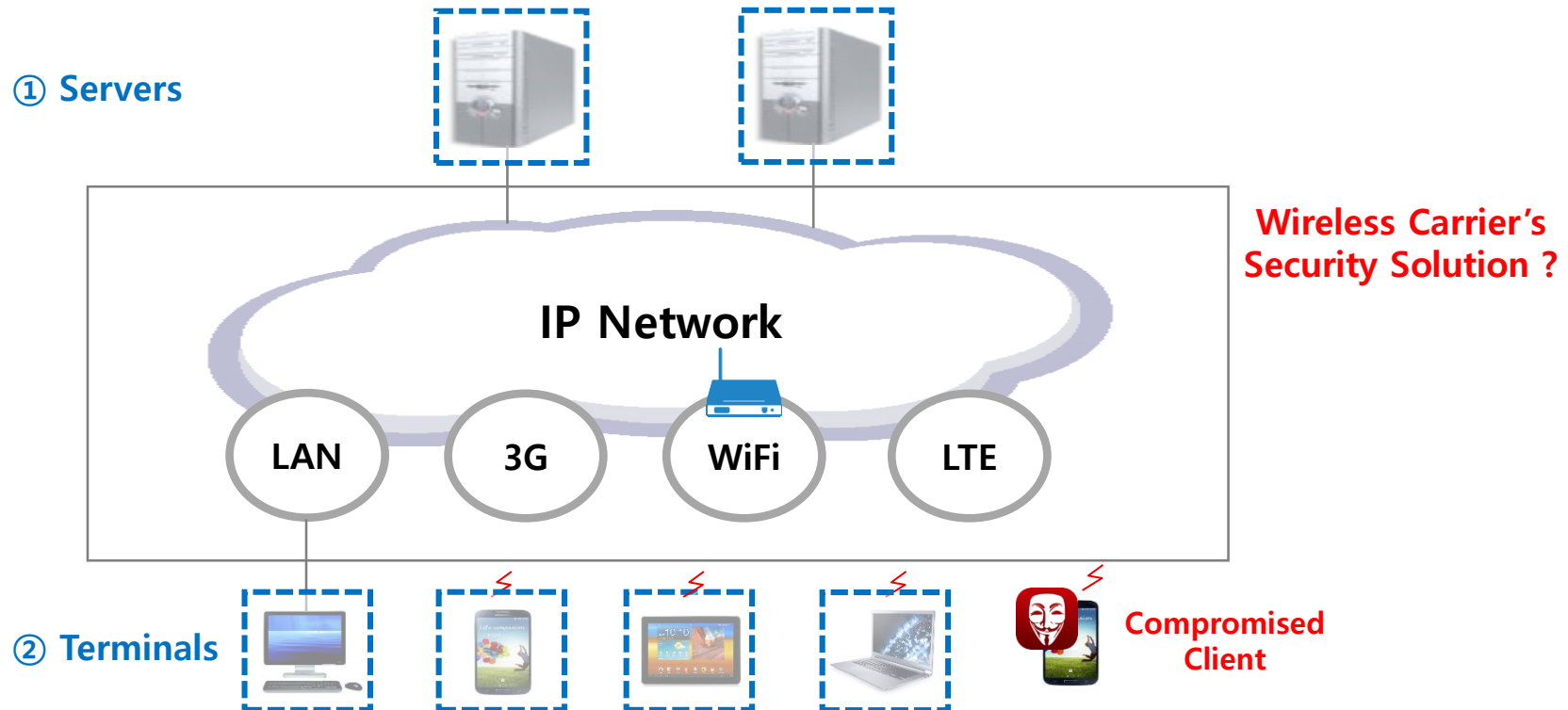
- TCP/IP Connection : **"Access with undetermined Trust"**
  - Devices connect to the server via TCP/IP
  - The server and terminal starts to determine whether the request is coming from an authorized user or not.
- **Cyber attackers have used the period of "Access with undetermined Trust"**



# Wireless IP Network - Security Solution

## Security Solution : Protection Server and Terminal

- Security Solution : Low Consolidation Effect
  - ① Servers Protection : Firewall, IDS/IPS, DDoS, etc.
  - ② Terminals Protection : Anti-Virus, Firewall, Virtualization, etc.



## 5. Wireless Carrier - Virtualization

# Wireless Carrier - Virtualization



## Server Virtualization vs. Network Virtualization

- Symbiotic Relationship of Computer & Network

Descriptions	Server Virtualization	Network Virtualization
Speed	Few Seconds	Days, weeks, or longer
Automation	Fully automated provisioning	Network configuration state is spread across a multitude of disparate network devices (physical and virtual)
Mobility	Truly mobile	No mobility – the network configuration is anchored to hardware
Computer portion of the application	Anchored to the non-virtualized network	

# Wireless Carrier - Server Virtualization

## Basic act of decoupling an infrastructure service from the physical assets on which that service operates

- **Server Virtualization : Decoupling and Automation**
  - where the familiar attributes of a physical server are decoupled and reproduced in virtualization software (hypervisor) as vCPU, vRAM, vNIC, etc., and assembled in any arbitrary combination producing a unique virtual server in seconds.
- **Service**
  - Described in a data structure
  - Exists entirely in a software abstraction layer reproducing the service on any physical resource running the virtualization software
  - The lifecycle, identity, location, and configuration attributes of the service exists in software with API interfaces
  - Unlocking the full potential of automated provisioning



# Wireless Carrier - Network Virtualization



## The same type of decoupling and automation by Server Virtualization

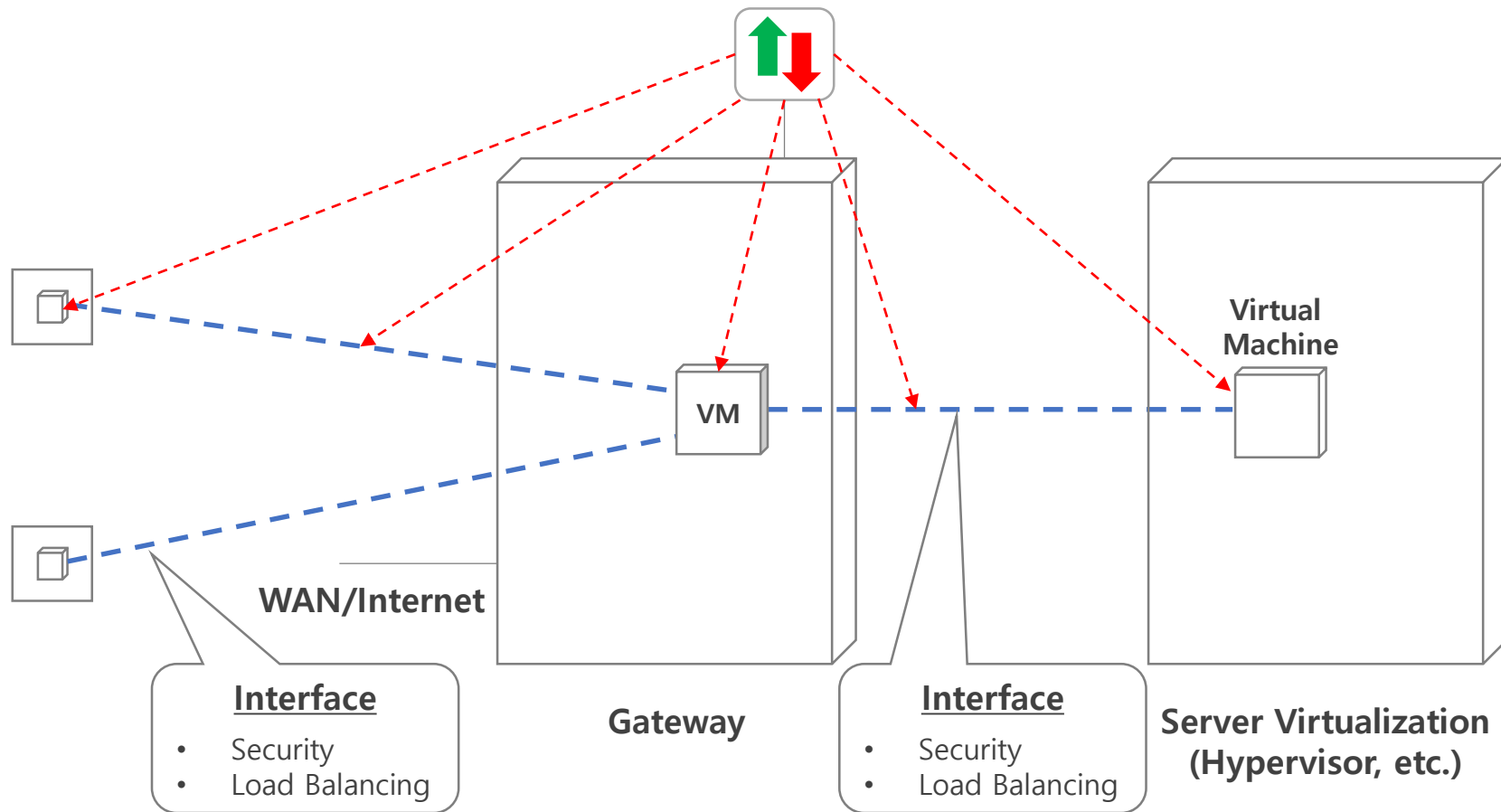
- Virtual machines supporting the application
  - Require network connectivity (switching and routing) to other virtual machines
  - Outside world (WAN/Internet) with security and load balancing
- The first network device virtual machines
  - Attached to is a software virtual switch on the hypervisor
- “Network”, we want to virtualize
  - Trusted IP Network per Virtual Machine, On-Demand
  - The network relevant to the virtual machines is sometimes more specifically referred to as the virtual network.

# Wireless Carrier - Application's Virtual Network



## On-Demand Virtual Network per Virtual Machine

- Automated Virtual Network Provisioning
  - Interface : Security, Load Balancing, etc.



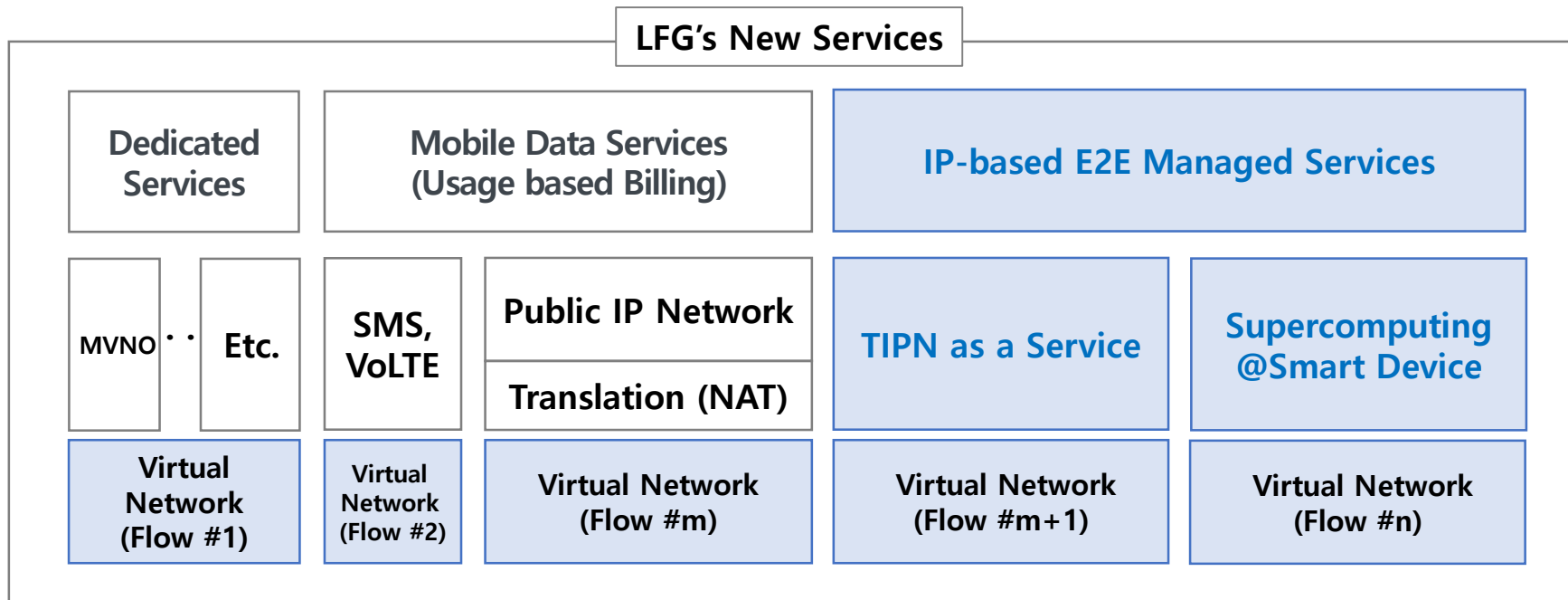
## 6. LFG Wireless IP Network Virtualization

# LFG Wireless Network Virtualization



## IP Network Virtualization : Flow

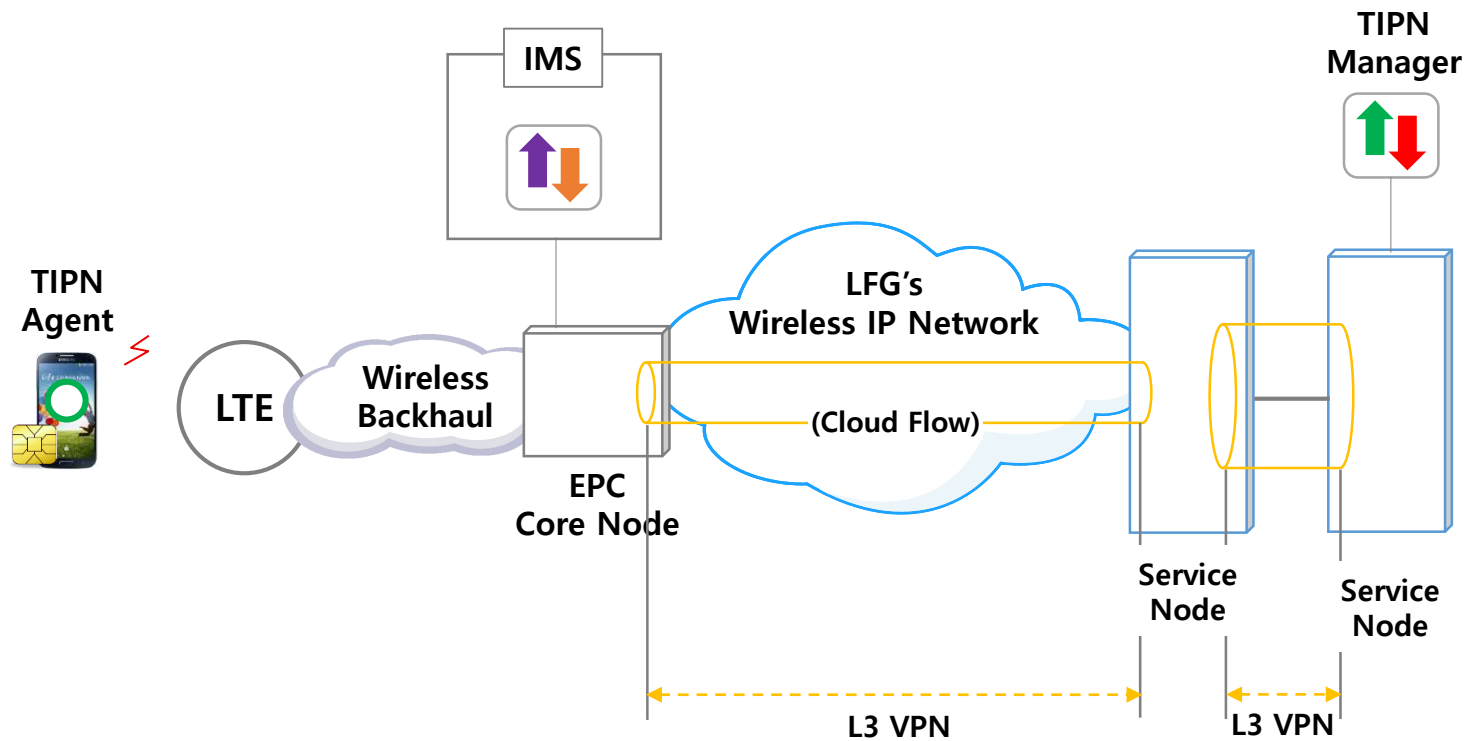
- TIPN as a Service
  - No Visibility
  - No Connectivity
  - Access with "Trust" only
- Application's Network Virtualization
  - LFG IP Network : Flow Aggregation and Transport per Flow Type



# LFG Wireless Network Virtualization - IP Network

## L3 VPN : EPC Core Node, Service Node, Cloud Service Node

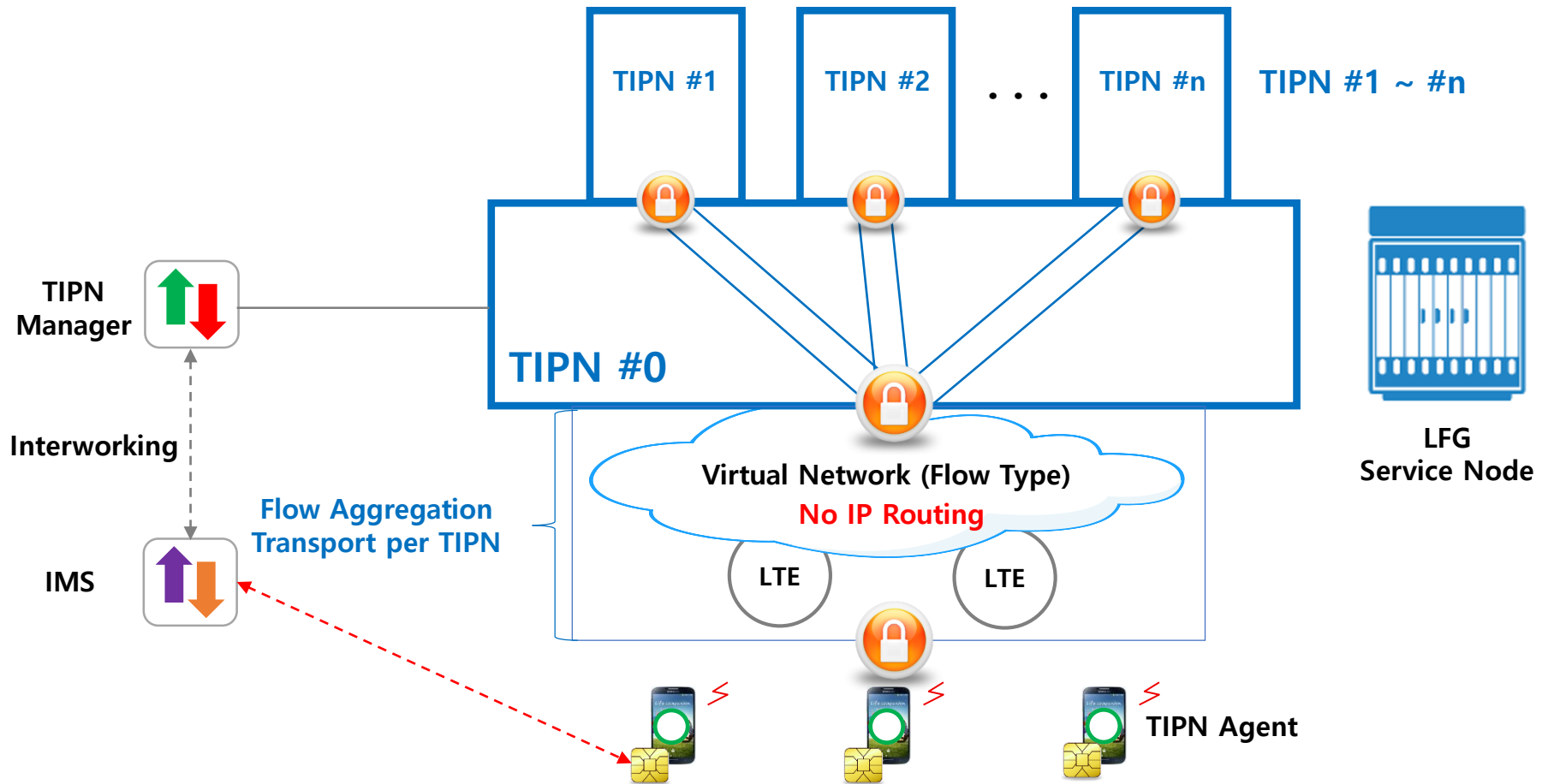
- Wireless Private IP Network : Network Virtualization
  - Virtual Network per Flow Type
- Inter-Networking
  - L3 VPN : EPC Core Node, Service Node



# LFG Wireless Network Virtualization - LTE Transport Network

## LTE Transport Network : No IP Routing

- EPC Core Node : No IP Packet Routing
  - Network Virtualization per Flow



# Private Wireless IP Network Comparison



## Legacy Wireless Carrier vs. LFG

구분		Legacy Wireless Carrier Private IP Network	VS.	LFG Private IP Network	Comments	
Security		X			○	
Privacy		X			○	
Resistance to Distributed Denial of Service (DDoS) attacks		X			○	
End-to-End QoS/QoE		X			○	
Mobility		X			○	
Location		X			○	
IP Address Portability		X			○	
Identification	Terminal	X			○	
	Subscriber	X			○	
Network Virtualization		X			○	
CUG		X			△	
Private Routing Domain per Organization		X			○	

## 7. LFG - TIPN as a Service

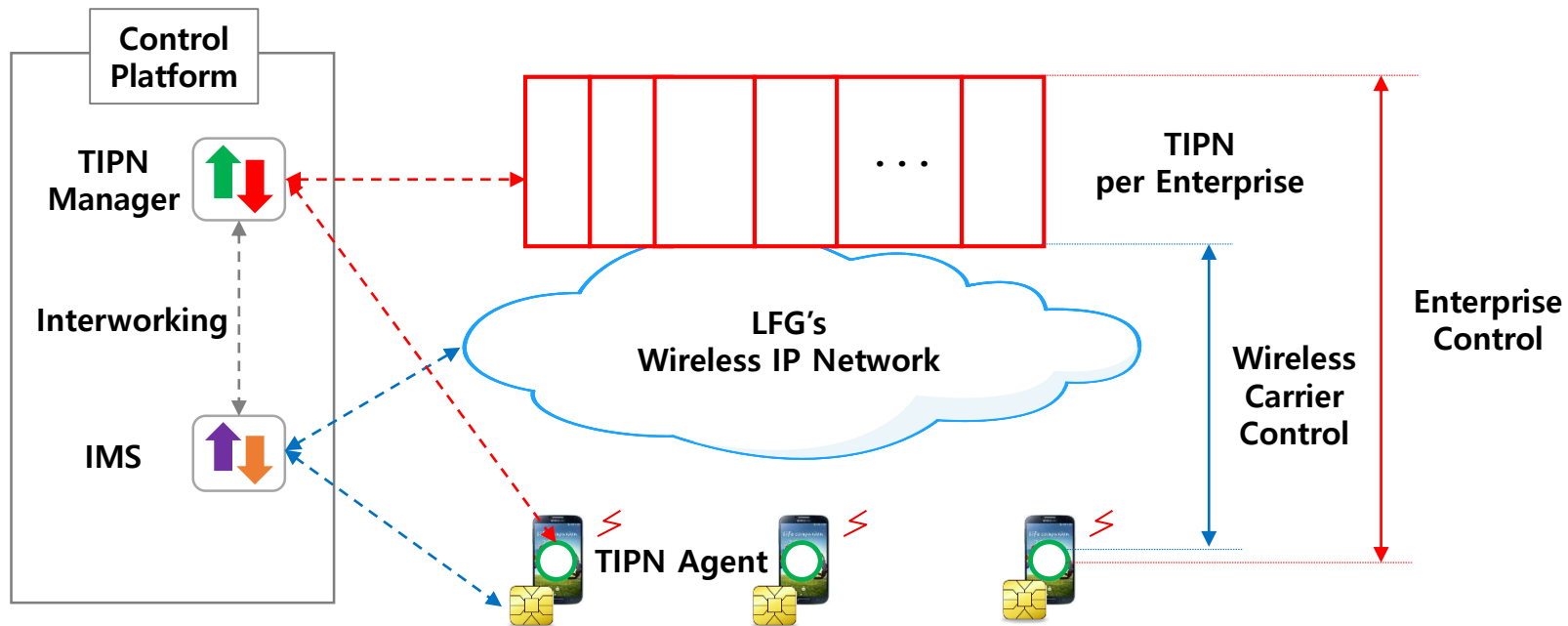


# TIPN as a Service - Enterprise



## Architecture : TIPN over LFG Private IP Network

- End-to-End Control Capabilities
  - Separated Management/Control Domain
    - LFG
    - Per Enterprise
  - Interworking between IMS and TIPN Manager
- TIPN per Enterprise
  - TIPN over LFG Private IP Network

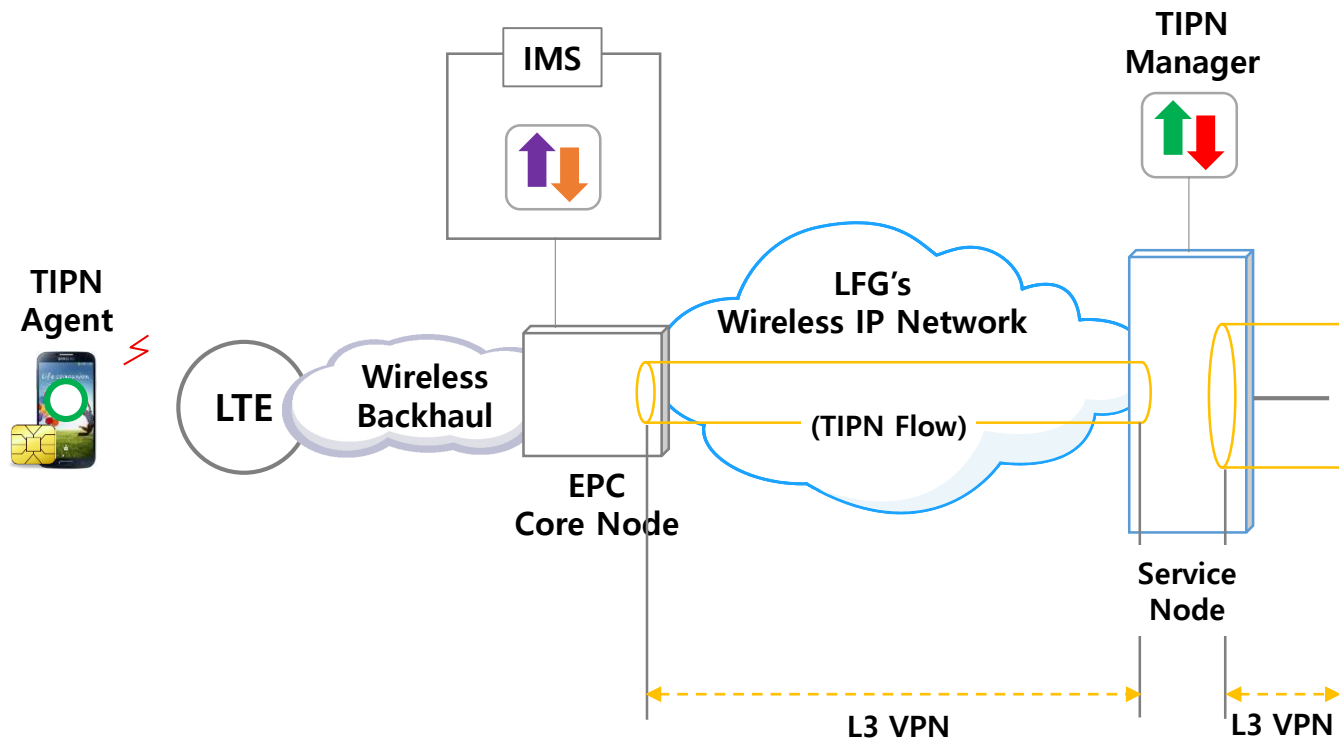


# TIPN as a Service - Enterprise (1)



## L3 VPN : EPC Core Node, Service Node

- Wireless Private IP Network : Network Virtualization
  - Virtual Network for TIPN Flow
- Inter-Networking
  - L3 VPN : EPC Core Node, Service Node

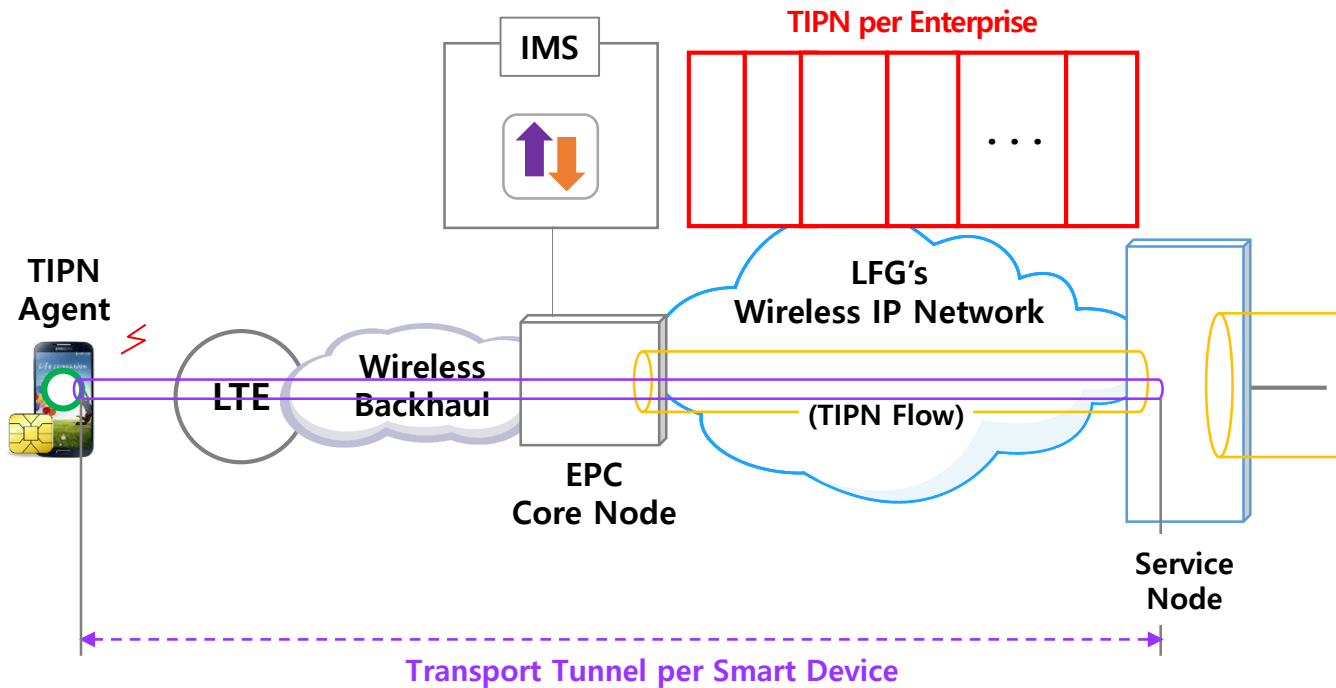


# TIPN as a Service - Enterprise (2)



## Transport Tunnel per Smart Device

- Smart Device ↔ Service Node
  - Transport Tunnel per Smart Device
    - Mobile IP VPN

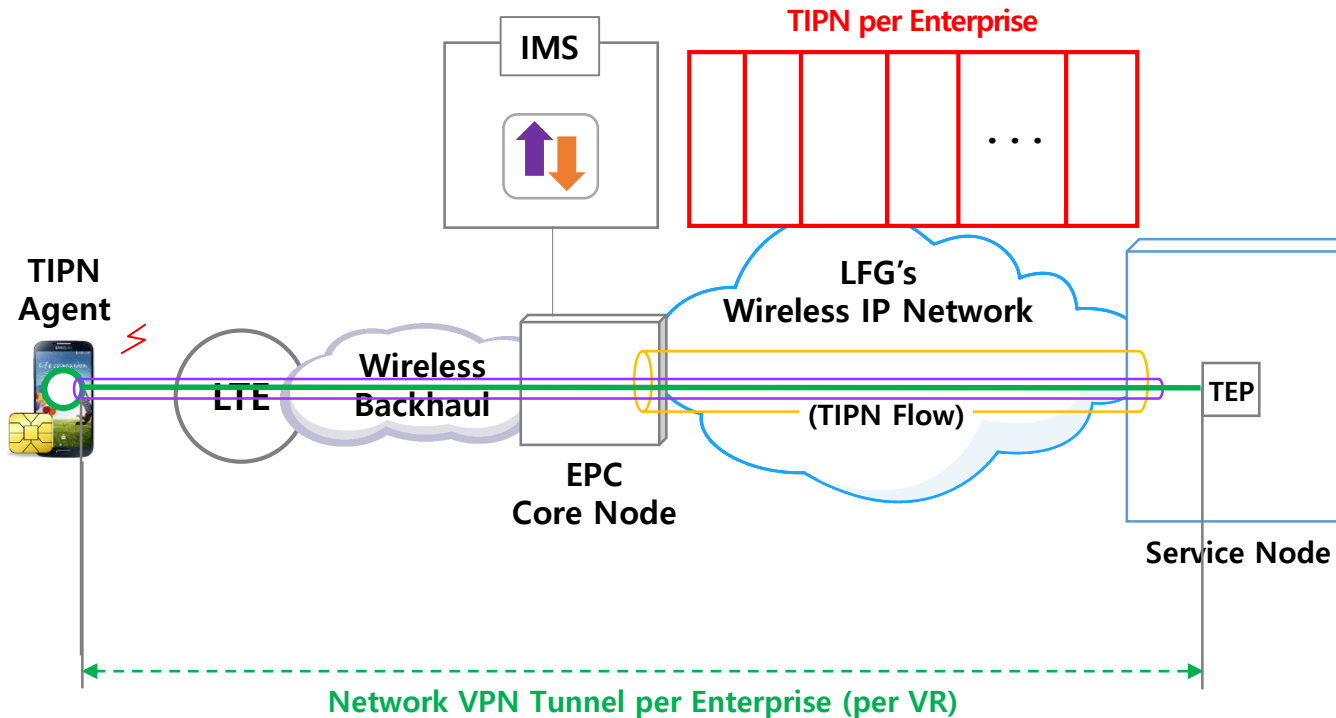


# TIPN as a Service - Enterprise (3)



## TIPN per Enterprise : High Consolidation Margin

- Network VPN Tunnel per Smart Device
  - TIPN Agent ↔ TEP (VR)
  - Mobile IP VPN

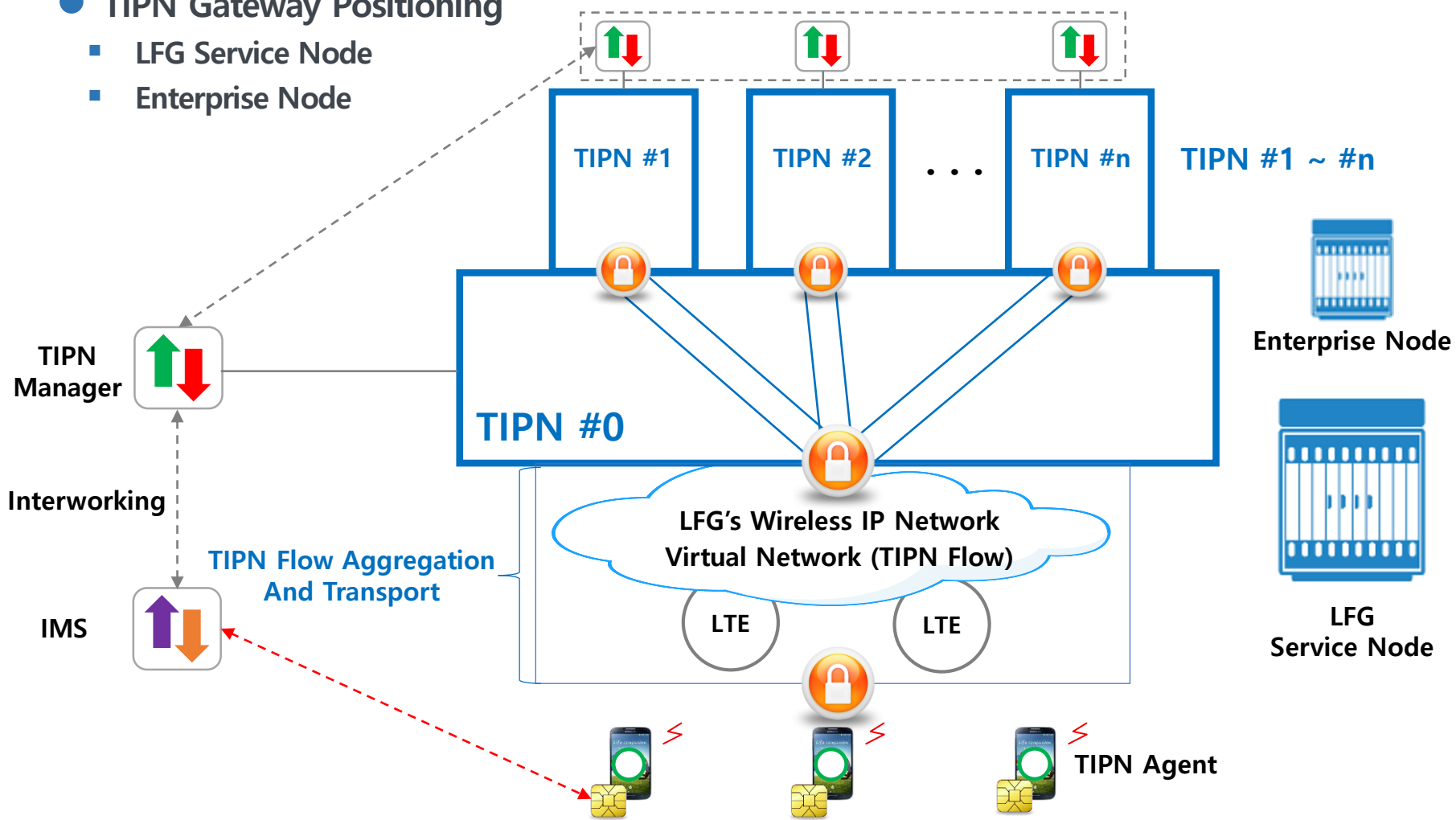


# TIPN as a Service - Enterprise (4)

## TIPN per Enterprise

- TIPN Gateway Positioning

- LFG Service Node
- Enterprise Node



## 8. Cloud over TIPN using Supercomputer

# Supercomputer (1)



## Supercomputer : Strategic Technologies

### Supercomputers: Obama orders world's fastest computer

By Chris Baraniuk  
Technology reporter

🕒 30 July 2015 | **Technology**



The president has asked US scientists to build the fastest supercomputer

# Supercomputer (2)



## Supercomputer Share by Countries (June 2015)

Top 10 positions of the 45th TOP500 on June 2015

Rank ↕	Rmax Rpeak (PFLOPS) ↕	Name ↕	Computer design Processor type, interconnect ↕	Vendor ↕	Site Country, year ↕	Operating system ↕
1	33.863 54.902	<i>Tianhe-2</i>	<b>NUDT</b> Xeon E5-2692 + Xeon Phi 31S1P, TH Express-2	NUDT	National Supercomputing Center in Guangzhou 🇨🇳 China, 2013	Linux (Kylin)
2	17.590 27.113	<i>Titan</i>	<b>Cray XK7</b> Opteron 6274 + Tesla K20X, Cray Gemini Interconnect	Cray Inc.	Oak Ridge National Laboratory 🇺🇸 United States, 2012	Linux (CLE, SLES based)
3	17.173 20.133	<i>Sequoia</i>	<b>Blue Gene/Q</b> PowerPC A2, Custom	IBM	Lawrence Livermore National Laboratory 🇺🇸 United States, 2013	Linux (RHEL and CNK)
4	10.510 11.280	<i>K computer</i>	<b>RIKEN</b> SPARC64 VIIIfx, Tofu	Fujitsu	RIKEN 🇯🇵 Japan, 2011	Linux
5	8.586 10.066	<i>Mira</i>	<b>Blue Gene/Q</b> PowerPC A2, Custom	IBM	Argonne National Laboratory 🇺🇸 United States, 2013	Linux (RHEL and CNK)
6	6.271 7.779	<i>Piz Daint</i>	<b>Cray XC30</b> Xeon E5-2670 + Tesla K20X, Aries	Cray Inc.	Swiss National Supercomputing Centre 🇨🇭 Switzerland, 2013	Linux (CLE)
7	5.537 7.235	<i>Shaheen II</i>	<b>Cray XC40</b> Xeon E5-2698v3, Aries	Cray Inc.	King Abdullah University of Science and Technology Saudi Arabia, 2015	Linux (CLE)
8	5.168 8.520	<i>Stampede</i>	<b>PowerEdge C8220</b> Xeon E5-2680 + Xeon Phi, Infiniband	Dell	Texas Advanced Computing Center 🇺🇸 United States, 2013	Linux (CentOS) <sup>[11]</sup>
9	5.008 5.872	<i>JUQUEEN</i>	<b>Blue Gene/Q</b> PowerPC A2, Custom	IBM	Forschungszentrum Jülich 🇩🇪 Germany, 2013	Linux (RHEL and CNK)
10	4.293 5.033	<i>Vulcan</i>	<b>Blue Gene/Q</b> PowerPC A2, Custom	IBM	Lawrence Livermore National Laboratory 🇺🇸 United States, 2013	Linux (RHEL and CNK)



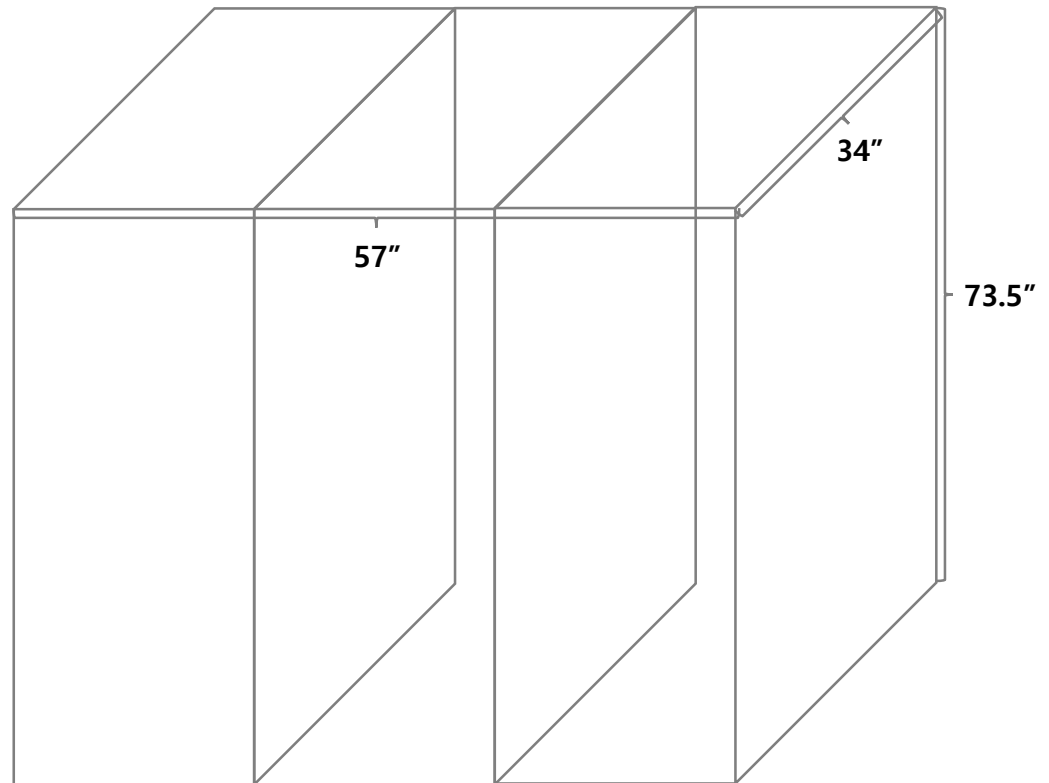
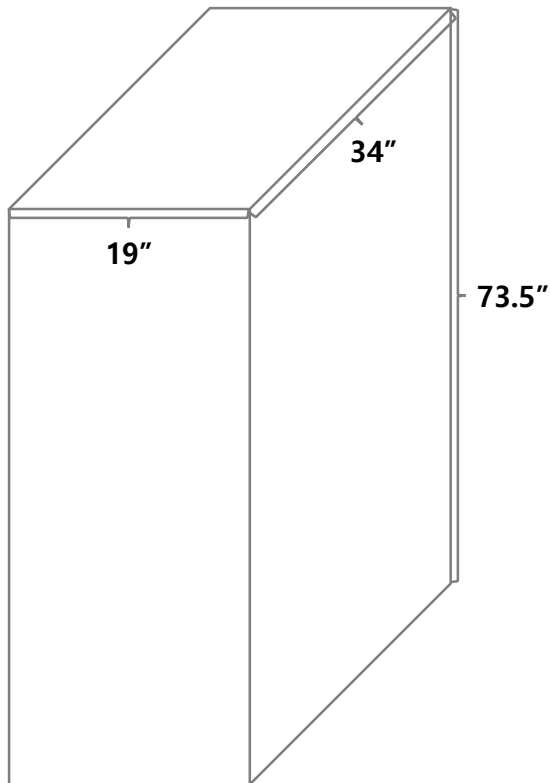
# Supercomputer - FTL (1)



## 5 PetaFLOP (Floating-point Operations per Second)

### ● Size

- 3 X 19" Rack
- Rack Size : 19" X 34" X 73.5"



# Supercomputer - FTL (2)



## 5 PetaFLOP (Floating-point Operations per Second)

- Processors
  - 450 cores of an upcoming Systems general purpose, HPC processor
- Main Memory
  - 1.6T Bytes ECC memory (other memory configurations available)
- Rotating Hard Drive
  - 25 x 240G solid state drives & 80x 3T Byte drives under hardware RAID control Interfaces are NFS V4 with Samba attachment for legacy Windows clients
- USB 3.0 I/O
  - 50 ports
- Audio
  - Yes
- 1080p Video Port
  - 25x stereo ports at 4K video resolution (each port)
- Network
  - 100G, 10G & 1G Ethernet options

# Supercomputer - FTL (3)



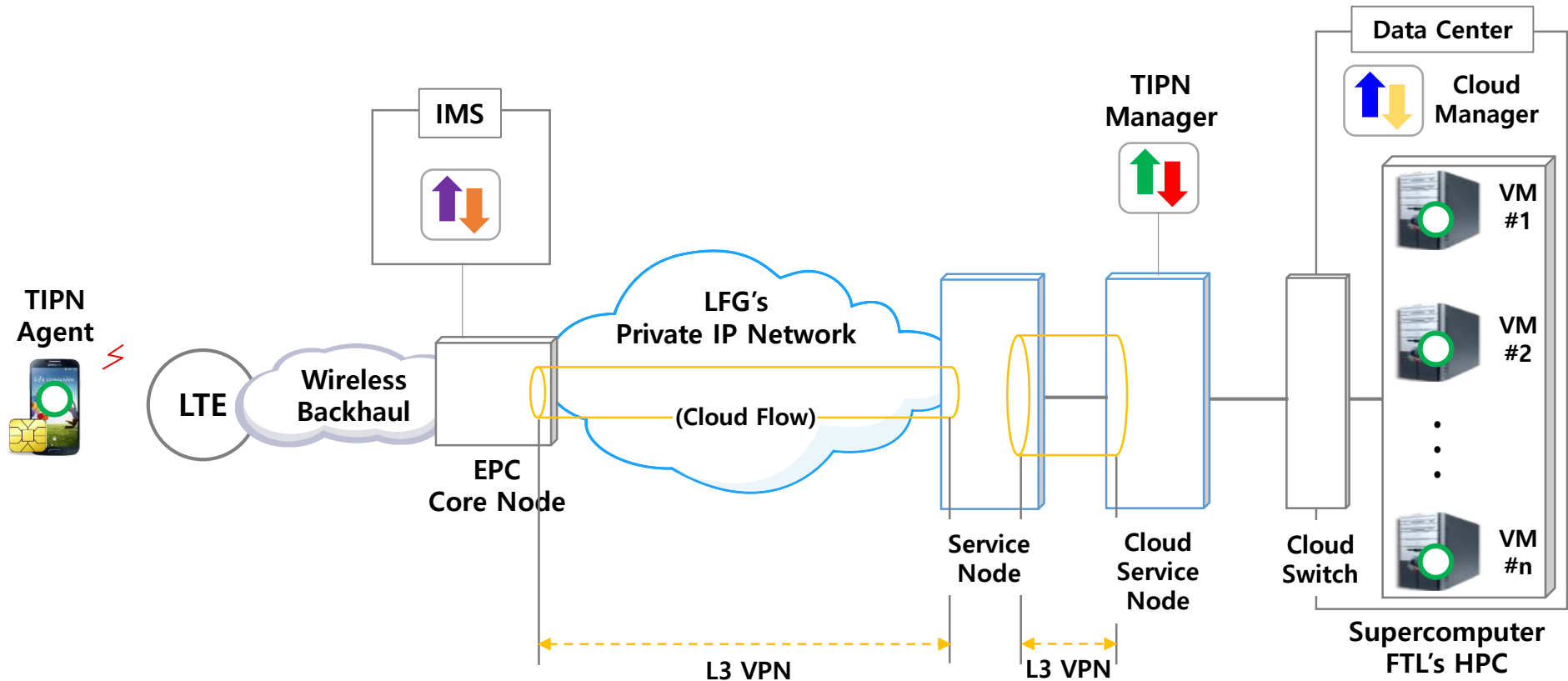
## 5 PetaFLOP (Floating-point Operations per Second)

- Operating System
  - Linux
- Compilers
  - C, C++, Java-compatible
- Software Development Tools
  - Unicode Editors, Source level debug, Profiling, Artificial Intelligence Assistants
- Applications
  - Conventional Linux suites as well as new commercial suites from partners
- Power
  - 100V → 240V, 50/60 Hz, Estimated 100KWatt maximum
- Chassis
  - 3x rack mount, 34" deep, 42U high, standard 19" rack width. An option is available for external, water cooling in an alternative chassis.
- Availability
  - End of 2016 : 100 PetaFLOP
  - End of 2017 : 1 ExaFLOP (USA, 1 ExaFLOP, 2025)

# Cloud over TIPN using Supercomputer Services (1)

## L3 VPN : EPC Core Node, Service Node, Cloud Service Node

- Wireless Private IP Network : Network Virtualization
  - Virtual Network for Cloud Flow
- Inter-Networking
  - L3 VPN : EPC Core Node, Service Node, Cloud Service Node

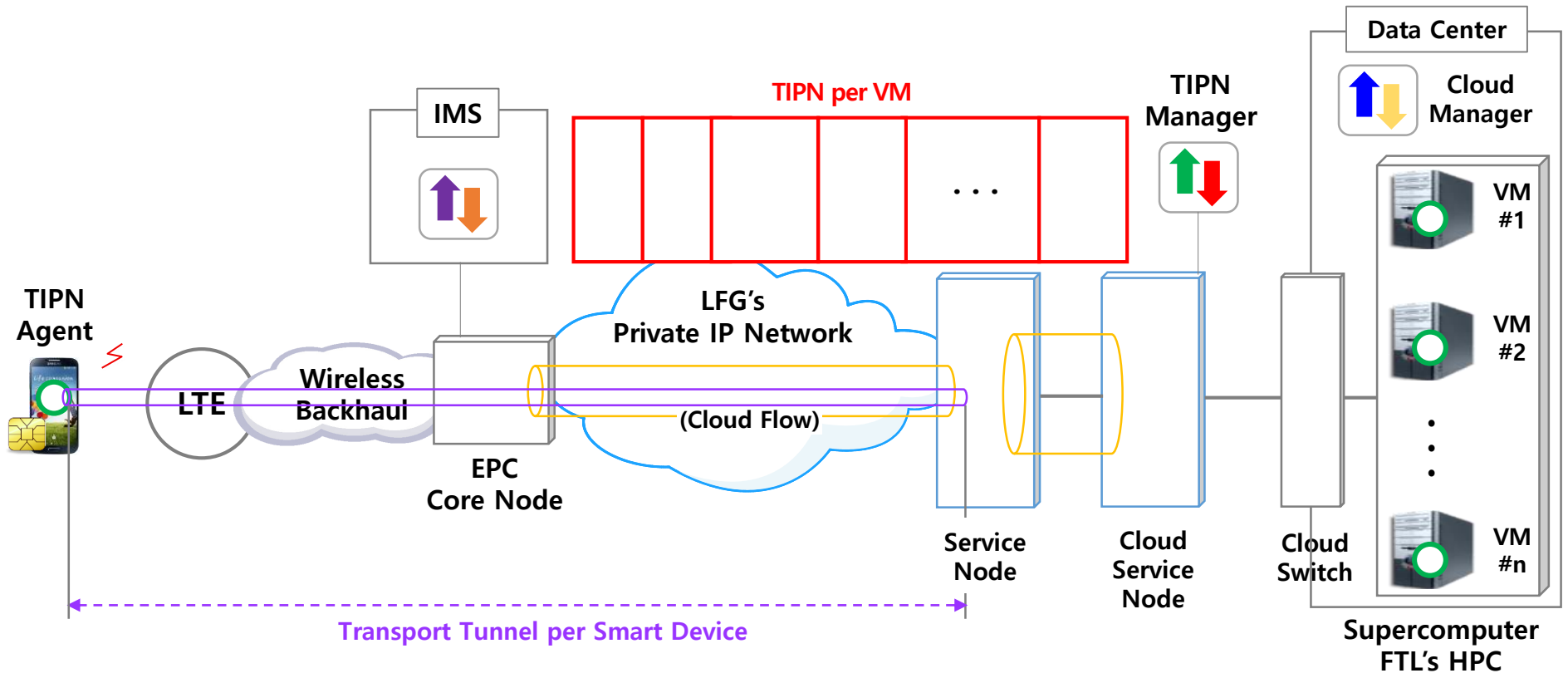


# Cloud over TIPN using Supercomputer Services (2)



## Transport Tunnel per Smart Device

- Smart Device ↔ Service Node
  - Transport Tunnel per Smart Device
    - Mobile IP VPN

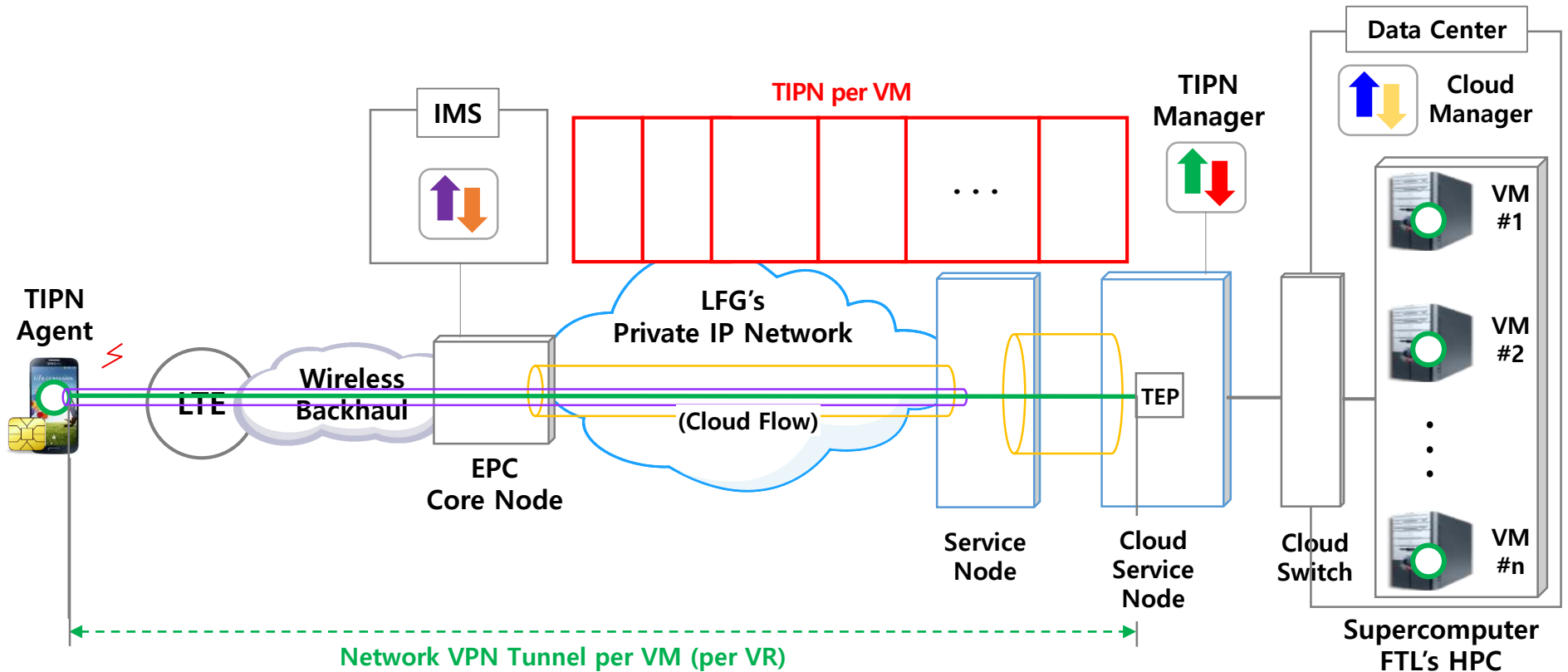


# Cloud over TIPN using Supercomputer Services (3)



## TIPN per Server : High Consolidation Margin

- Network VPN Tunnel per Smart Device
  - TIPN Agent ↔ TEP (VR)
  - Mobile IP VPN

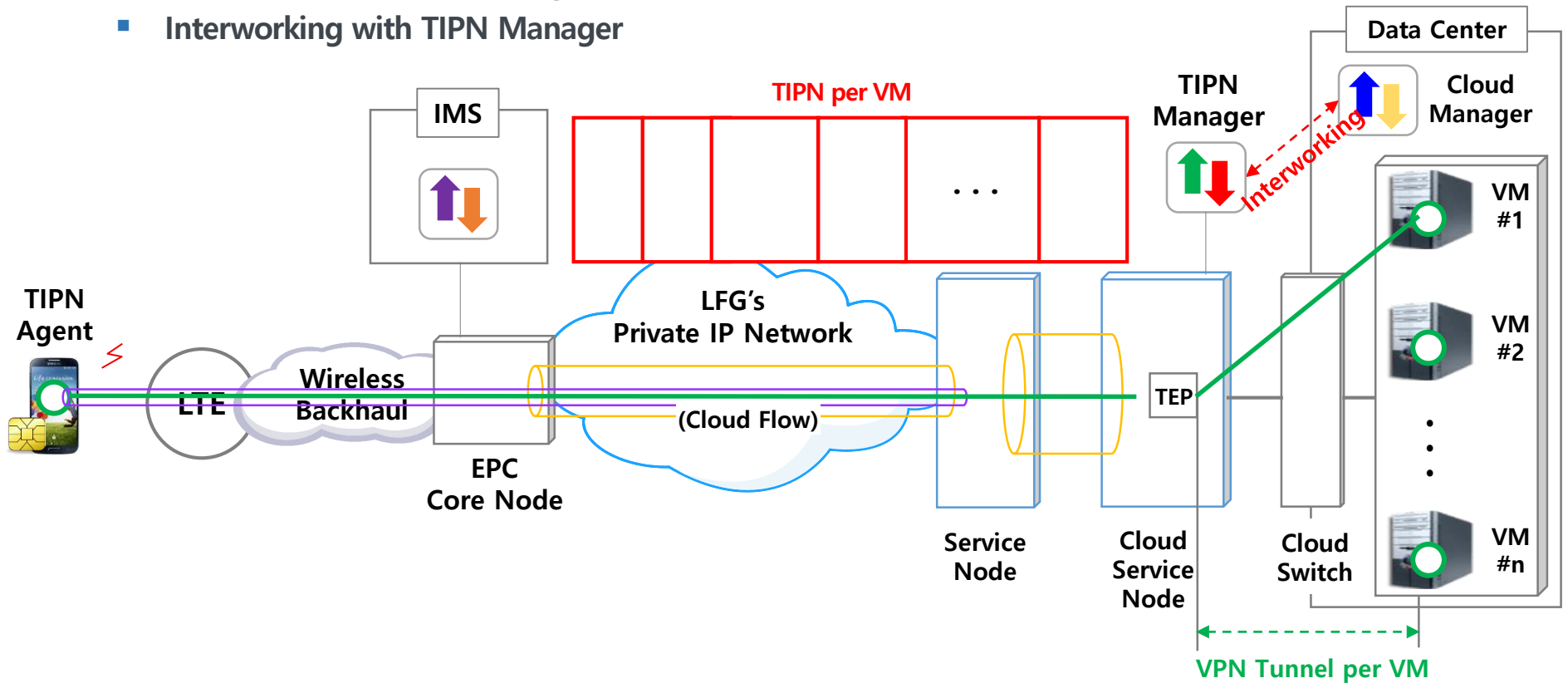


# Cloud over TIPN using Supercomputer Services (4)



## TIPN per Server : High Consolidation Margin

- VPN Tunnel per Server
  - VM(TIPN Agent) ↔ TEP (Cloud Service Node)
- Cloud Manager
  - VPN Tunnel (per VM) Management
  - Interworking with TIPN Manager

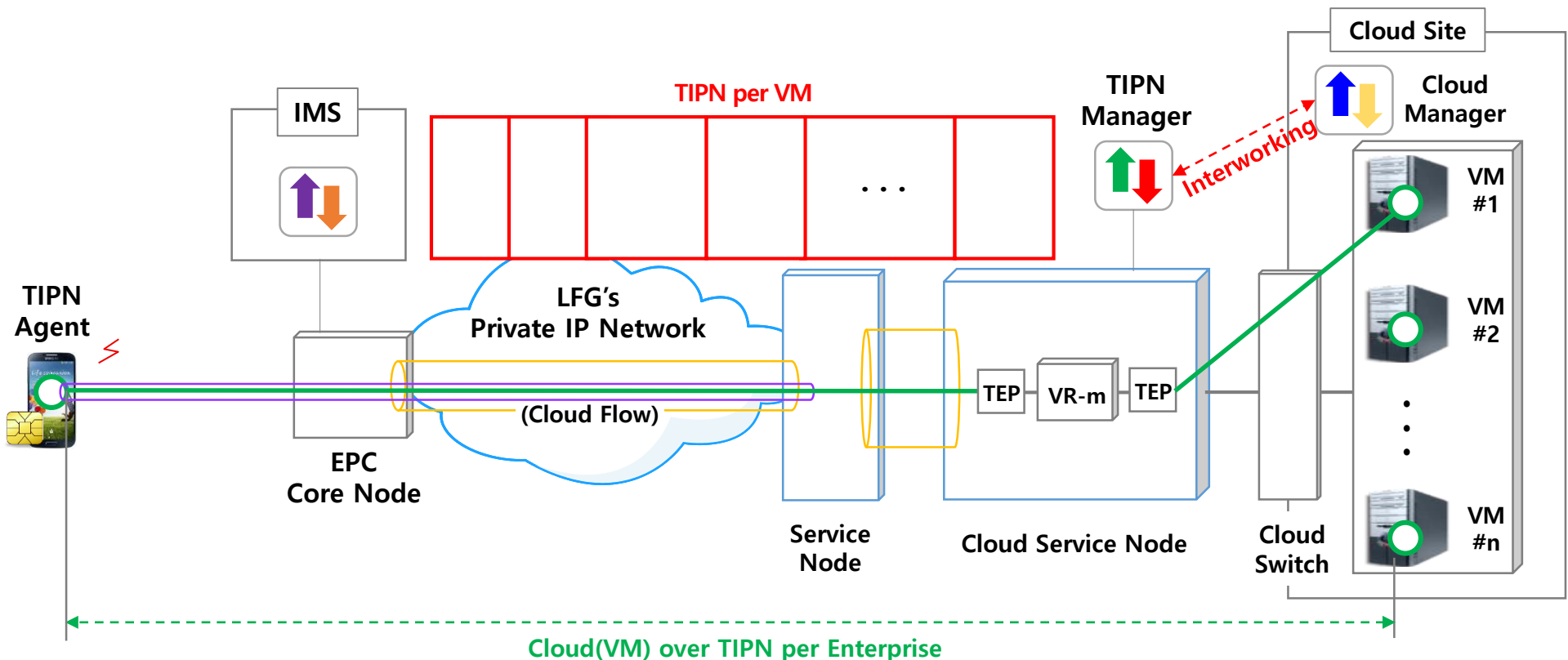


# Cloud over TIPN using Supercomputer (5)



## Cloud(VM) over TIPN : High Consolidation Margin

- TIPN per VM
  - TIPN Agent (VM) ↔ Cloud Service Node
- Cloud(VM) over TIPN per Cloud Service Provider
  - Cloud Manager per Cloud Service Provider

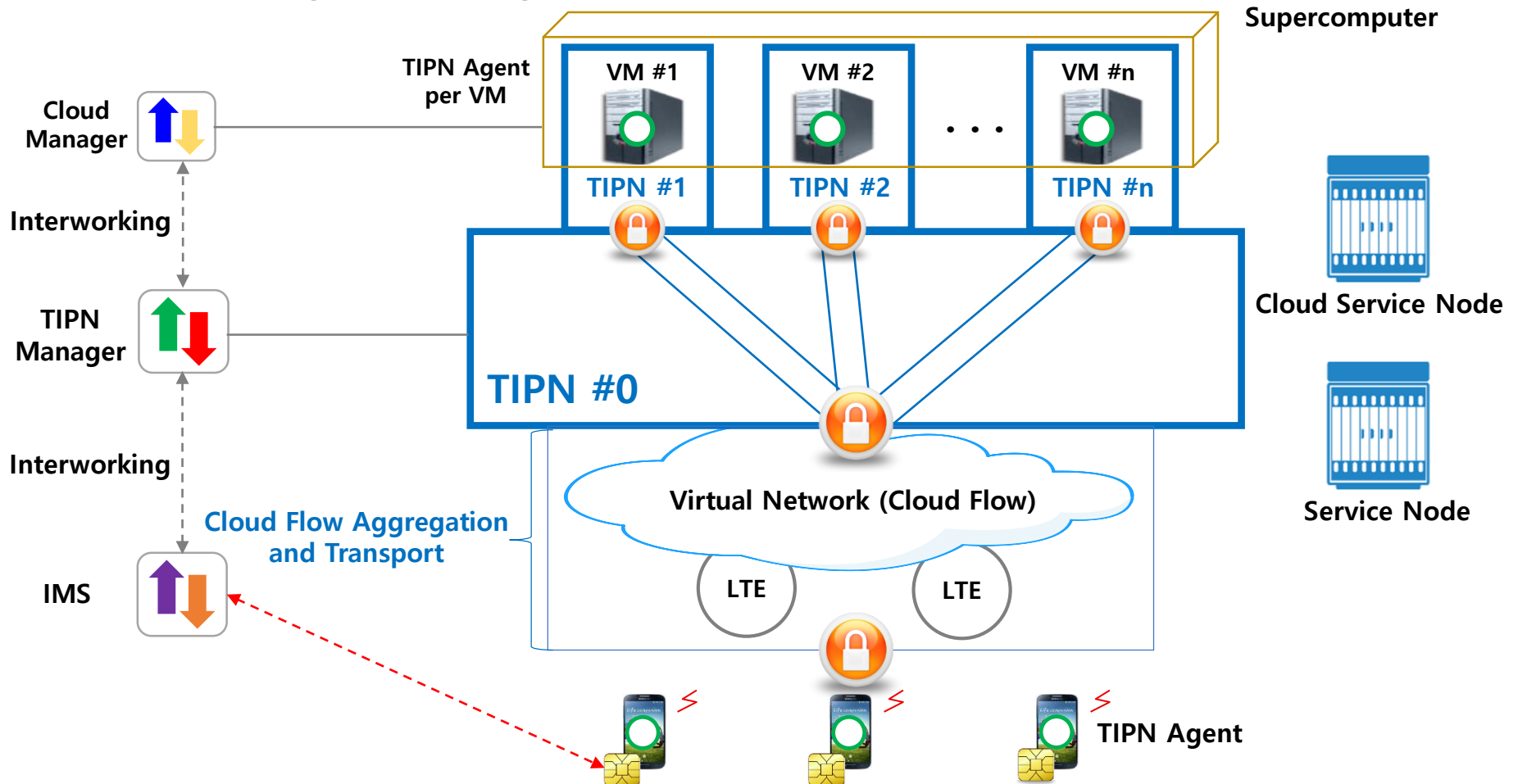




# Cloud over TIPN using Supercomputer (6)

## E2E Control Capabilities : Smart Device ↔ VM

- Interworking
  - Cloud Manager, TIPN Manager, IMS



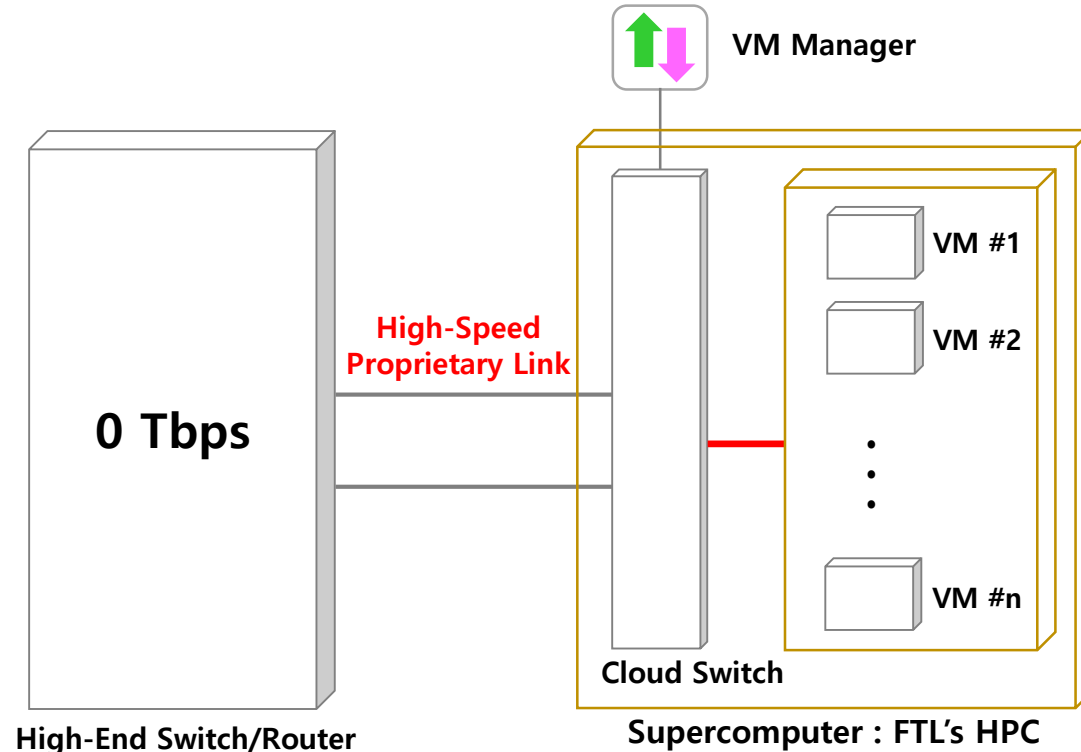
## 9. HPC Service @Thin Client

# HPC Service @Thin Client (1)



## Physical Interface, Capacity Planning

- Bandwidth Requirement per Thin Client
  - 300 M ~ 1 Gbps
- Max No. of Concurrent Users : 100,000 Users



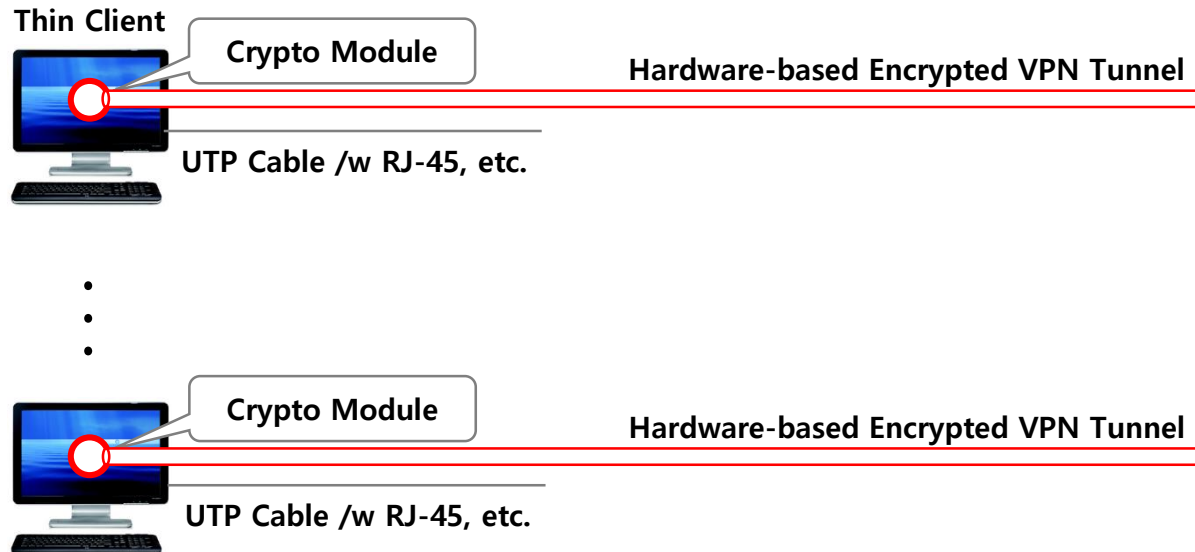
\*HPC : High-performance computing

# HPC Service @Thin Client (2)



## Thin Client : Hardware-based E2E VPN

- Hardware-based VPN Agent
  - Thin Client : Crypto Module
  - Interface : UTP Cable /w RJ-45, etc.

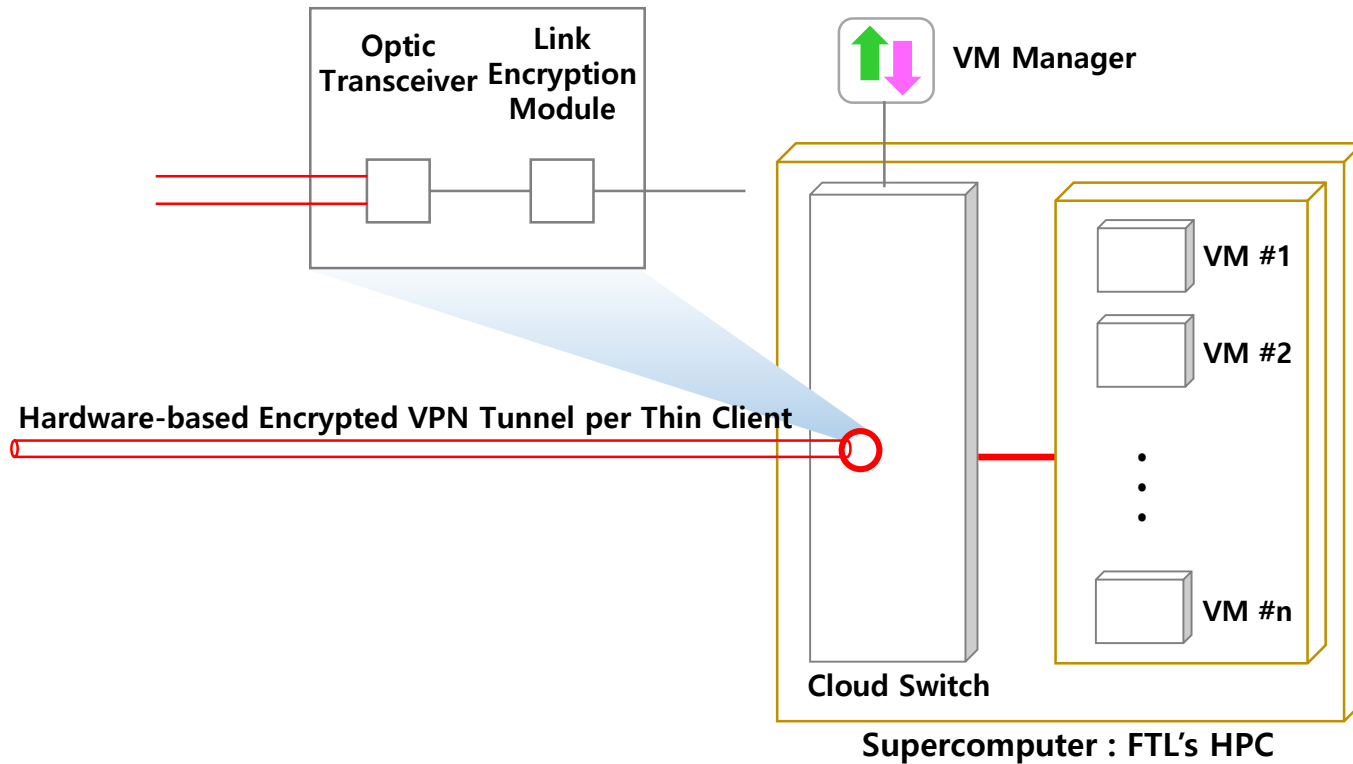


# HPC Service @Thin Client (3)



## Supercomputer : Hardware-based E2E VPN

- Hardware-based VPN Agent
  - Cloud Switch : Optical Transceiver /w Hardware-based VPN
  - Interface : Fiber Optic, etc.

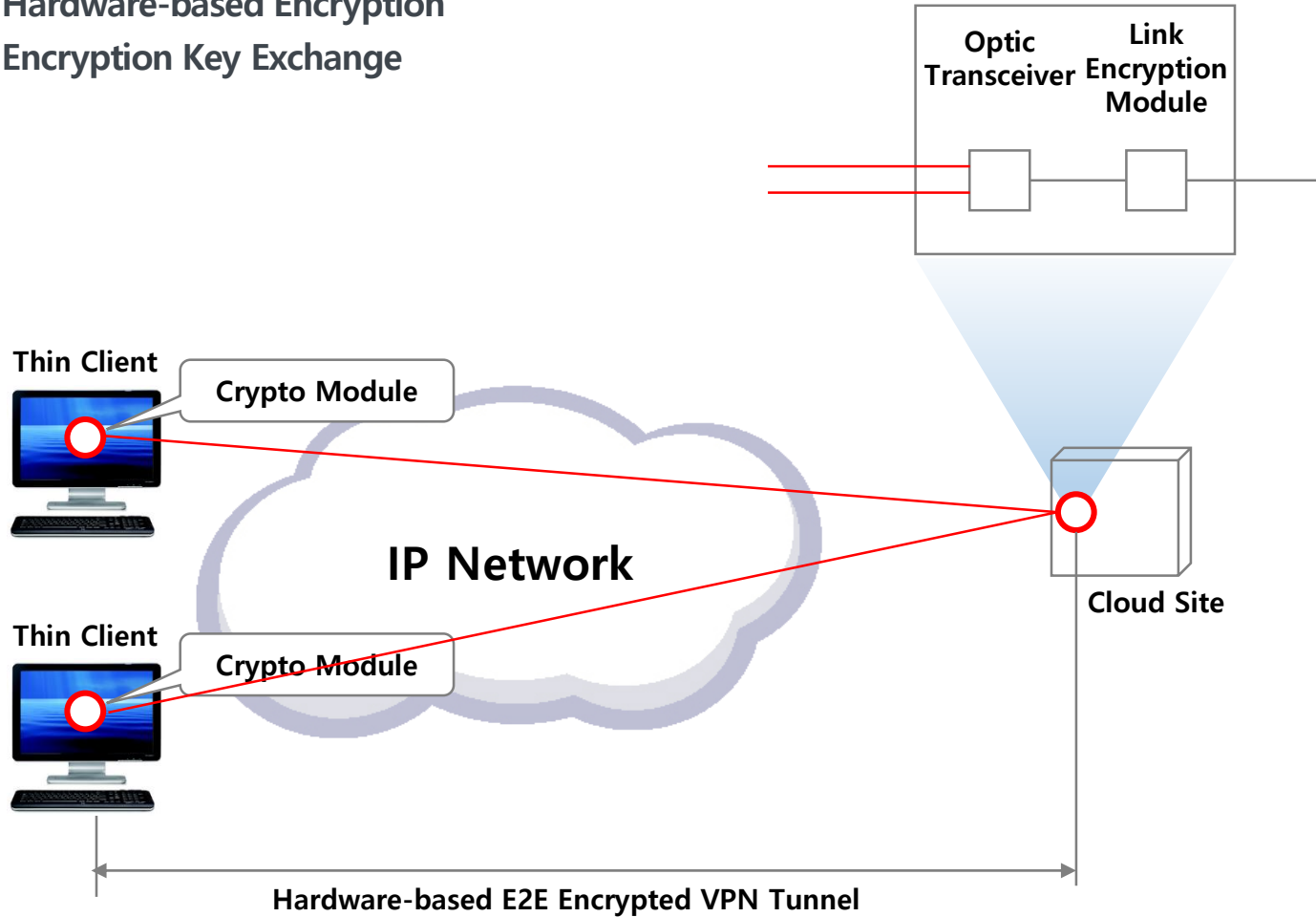


# HPC Service @Thin Client (4)



## Hardware-based E2E VPN : Link Encryption

- E2E Link Encryption
  - Hardware-based Encryption
  - Encryption Key Exchange

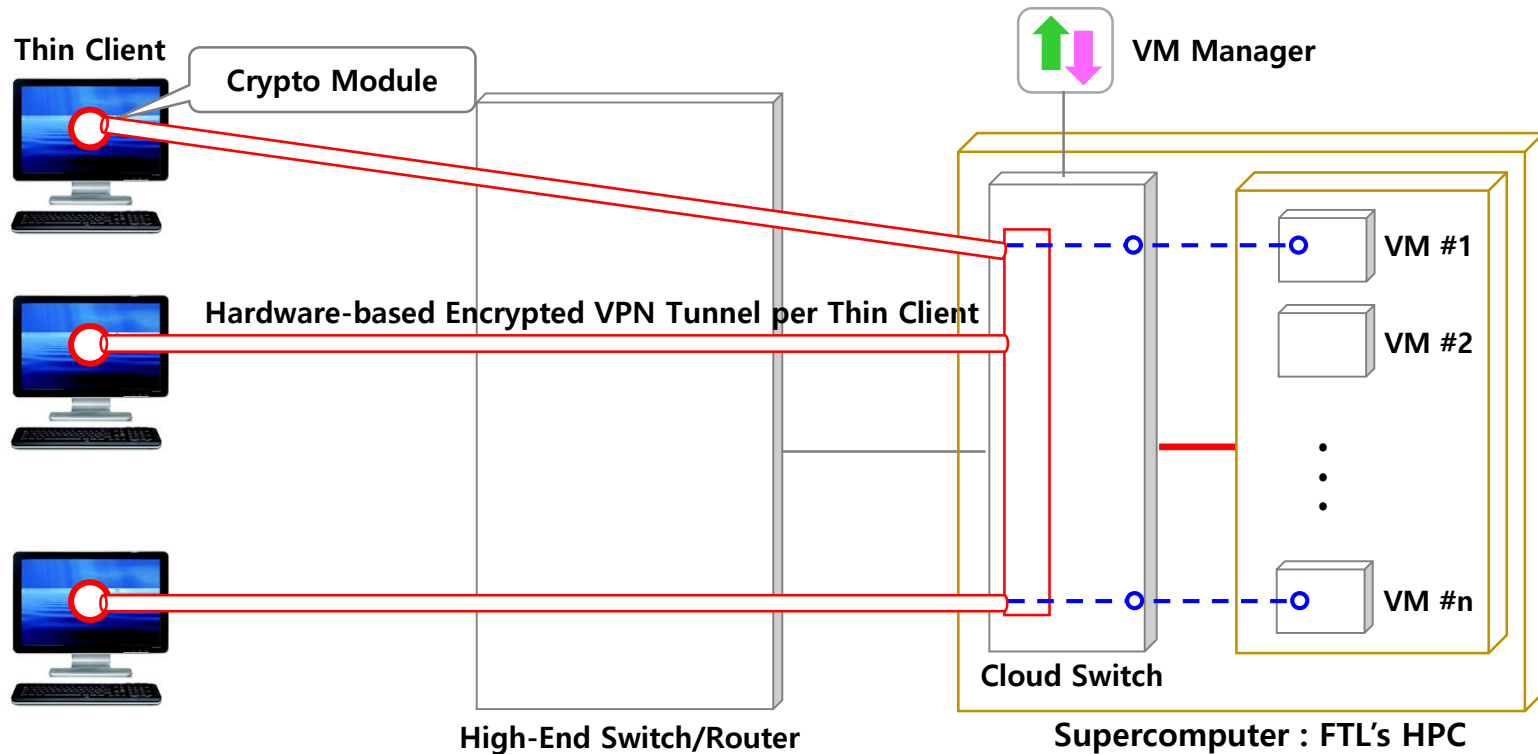


# HPC Service @Thin Client (5)



## Thin Client ↔ Supercomputer(VM) E2E VPN Connectivity

- Hardware-based Encrypted VPN Tunnel per Thin Client
- VM based Supercomputer
  - Hardware-based Encrypted VPN Tunnel Map to Designated VM



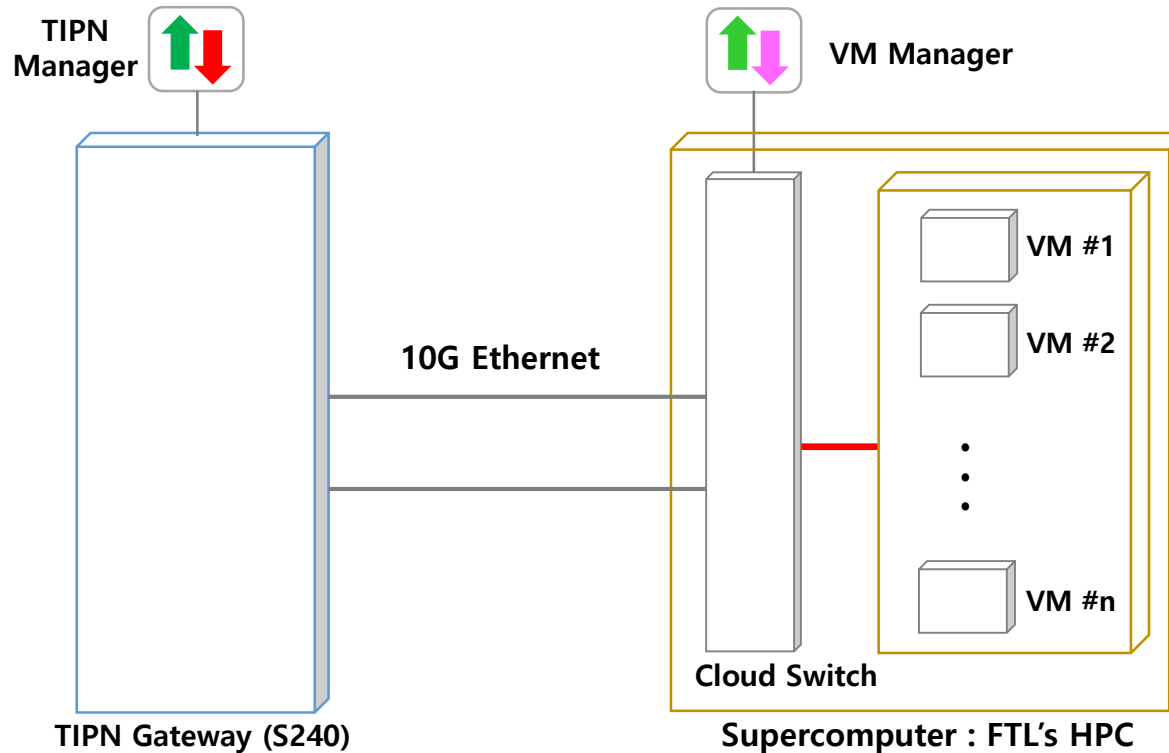
## 10. Supercomputing @Smart Device



# Supercomputing @Smart Device (1)

## TIPN Gateway ↔ Supercomputer Physical Interface : 10G Ethernet

- TIPN Gateway ↔ Supercomputer
  - Physical Interface : 10G Ethernet

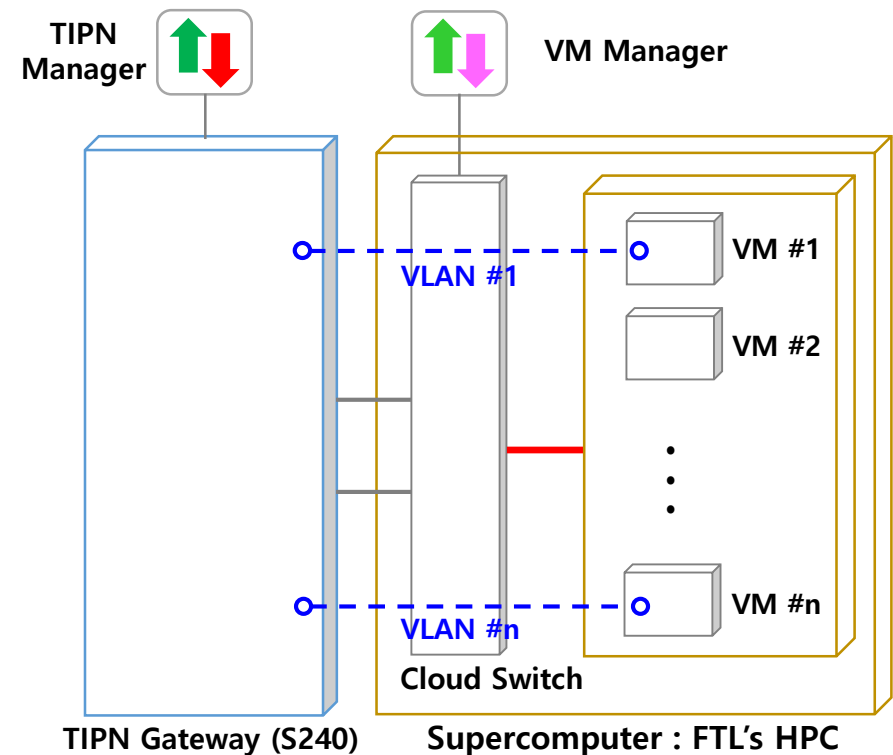


# Supercomputing @Smart Device (2)



## TIPN Gateway ↔ Supercomputer Interface : VLAN

- Supercomputer
  - Cloud Switch
  - Per VM
    - VLAN ID
- Per VM
  - More than one VLAN
  - More than one MAC/IP Address

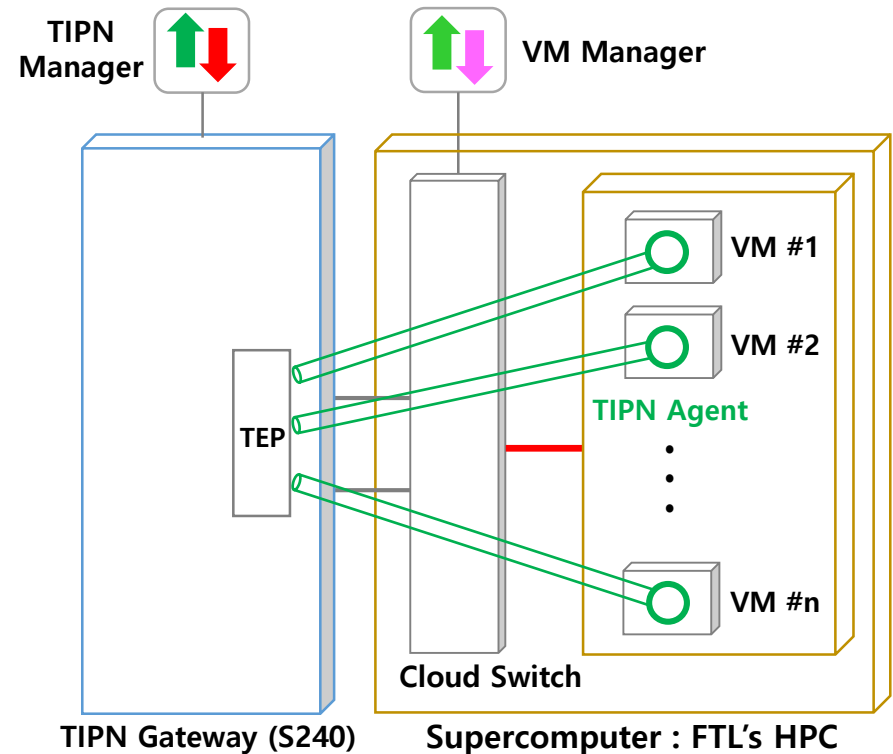


# Supercomputing @Smart Device (3)



## TIPN Agent per VM

- TIPN Agent per VM
  - Authentication
    - Protocol : TLS
    - MFA (Multi-Factor Authentication)
    - Authentication Packet Encryption
- Network VPN Tunnel Management
  - TIPN Manager
    - Smart Devices
    - VM

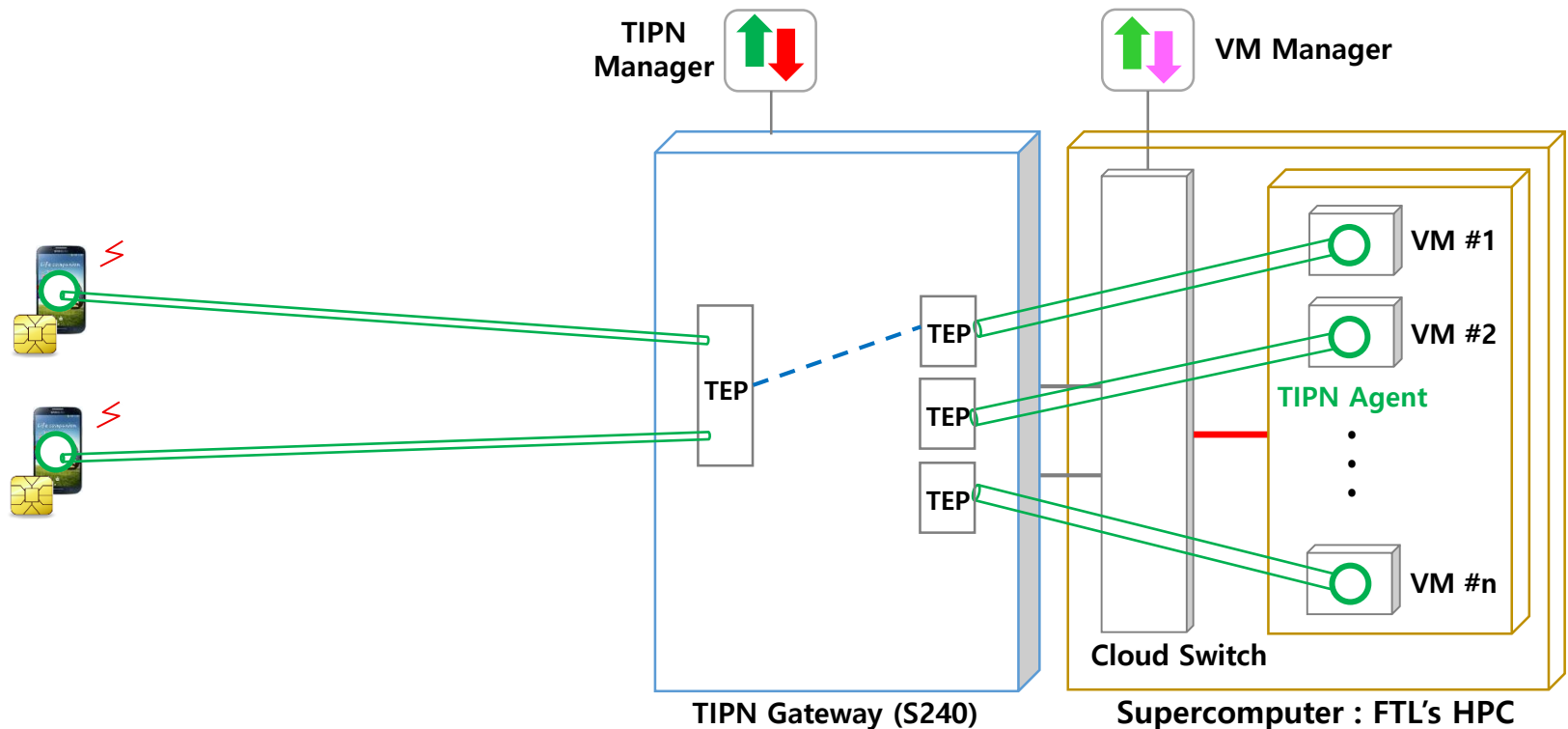


# Supercomputing @Smart Device (4)



## Internetworking between TEP(Smart Device) and TEP(VM)

- TIPN Manager
  - TEP(Smart Device) : Network VPN Tunnel per Smart Device
  - TEP(VM) : Network VPN Tunnel per VM
- Interworking between TEP(Smart Device) and TEP(VM)
  - Same Routing Domain Separation per TEP Group



# Thank you