How Router Technology Shapes Inter-Cloud Computing Service Architecture for The Future Internet

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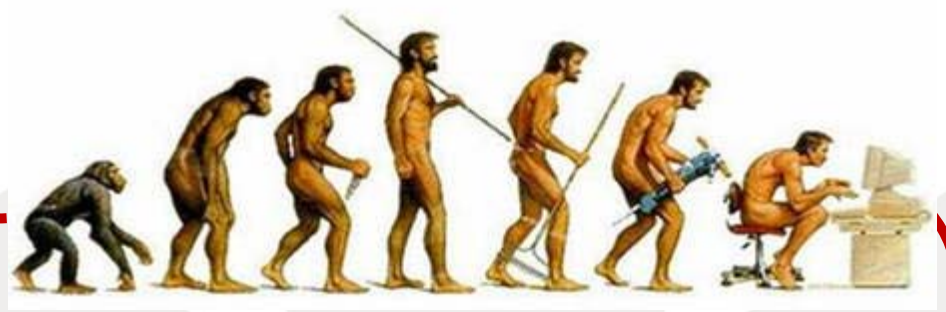
Outline

1. Future Internet Concept...
2. Evolution of Future Internet Architecture...
   (Inter Cloud Computing Perspective)
3. Industrial Point of View...
4. Router Development for Future internet...
5. Virtual Router...

1 Future Internet Concept...

Future Internet?

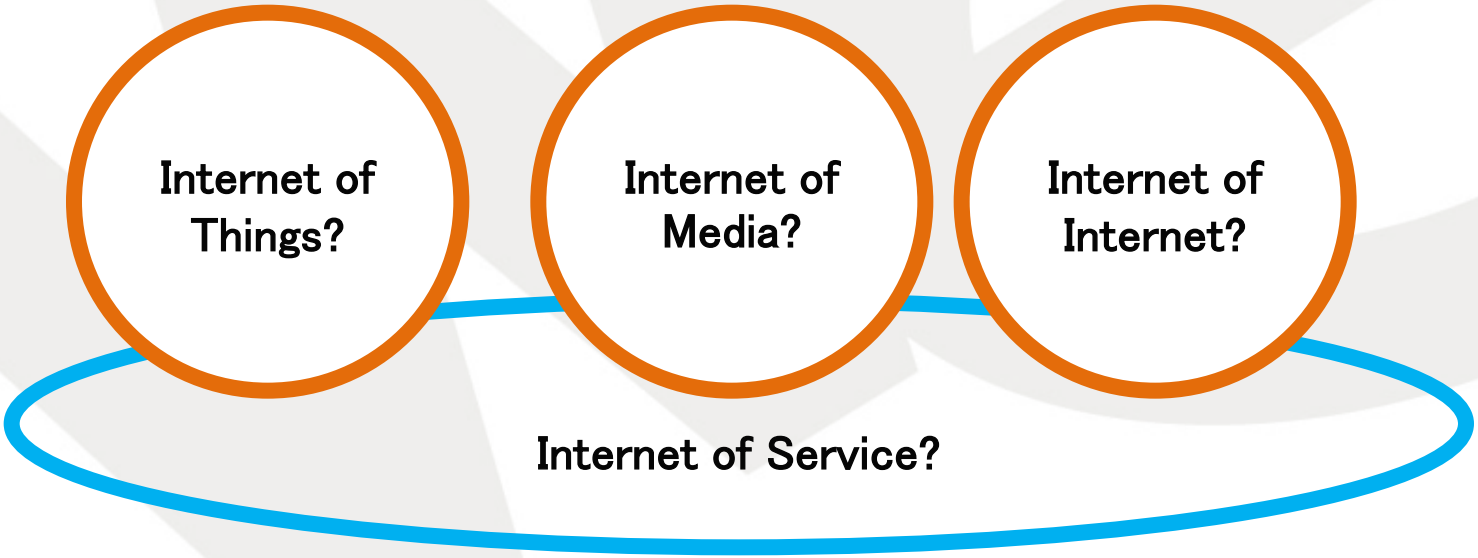


Too early to discuss?

What is its form?

STOP!

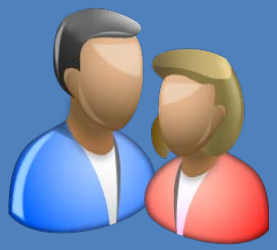
What Future Internet would be like???



The evolution of Internet Service Architecture

OLD Internet

Servers



User-end

Future Internet

Content processing & storage

Every Things

Content delivery platform

User-end

User as content provider

Massive Storage !

Content service provider (storage)

Scalable Framework !

Content delivery platform

Content service processing

High Performance Computing !

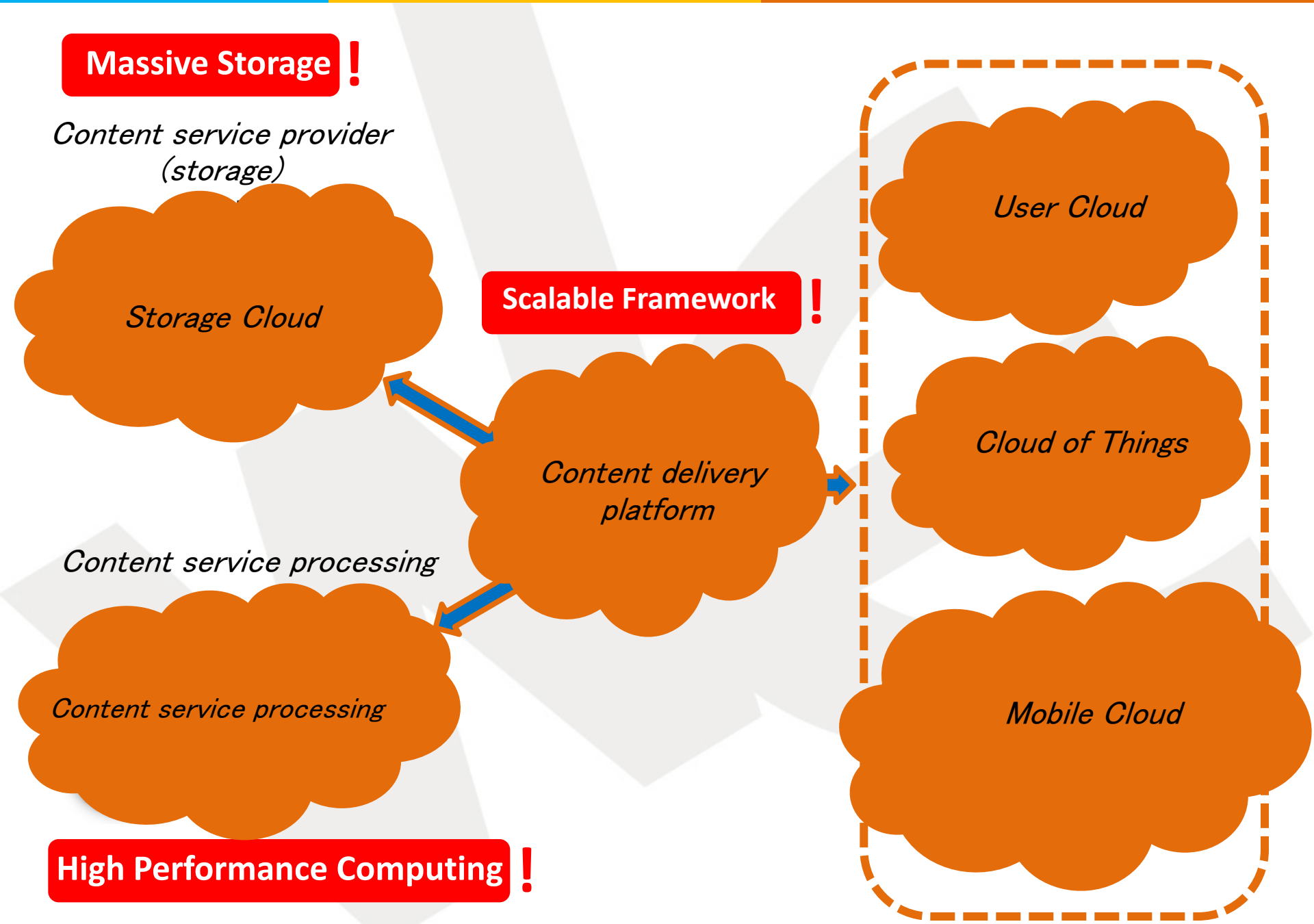
User-end

Every Things

User as content provider

What is Cloud Computing Roles
for this Architecture?

Yes! We can put this on the
CLOUD!


Massive Storage !
Content service provider (storage)
Storage Cloud
Scalable Framework !
Content delivery platform
Content service processing
Content service processing
High Performance Computing !
User Cloud
Cloud of Things
Mobile Cloud

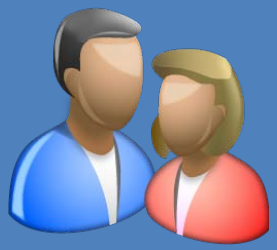
Inter-Cloud Computing = Future Internet?

Yes it could be!

2 Evolution of Future Internet Architecture... (Inter Cloud Computing Perspective)

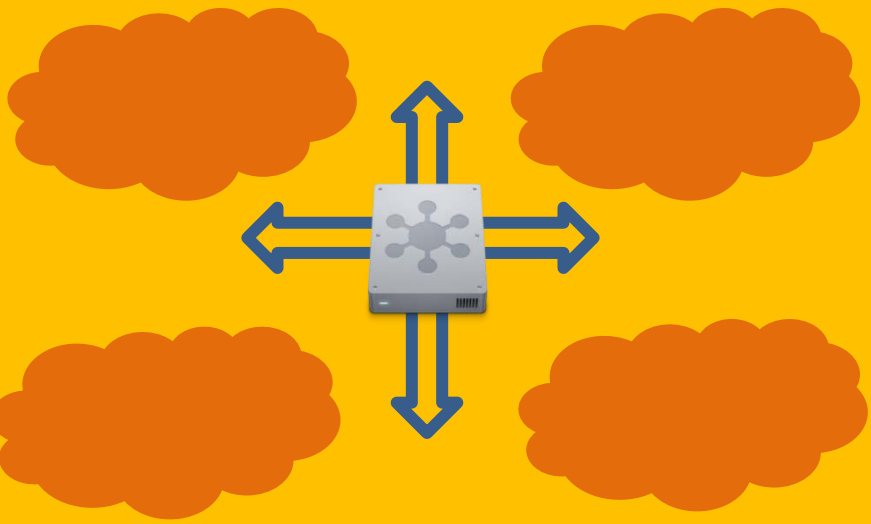
The evolution of Internet Service Architecture

OLD Internet



User-end

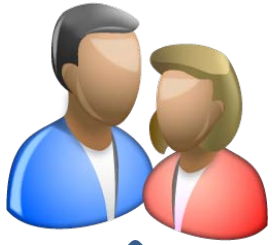
Future Internet



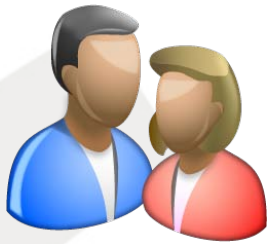
Could we use the same router technology for Inter-Cloud Computing?

WE HAVE TO SAY NO!

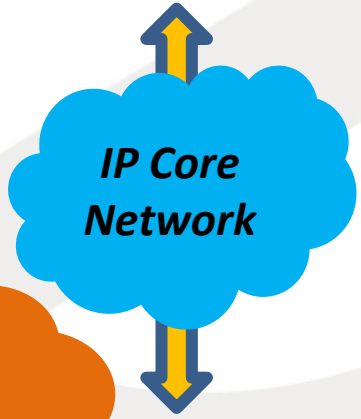
Virtual Architecture



Domain A



Cloud Controller



IP Core Network

Domain A

Virtual Network

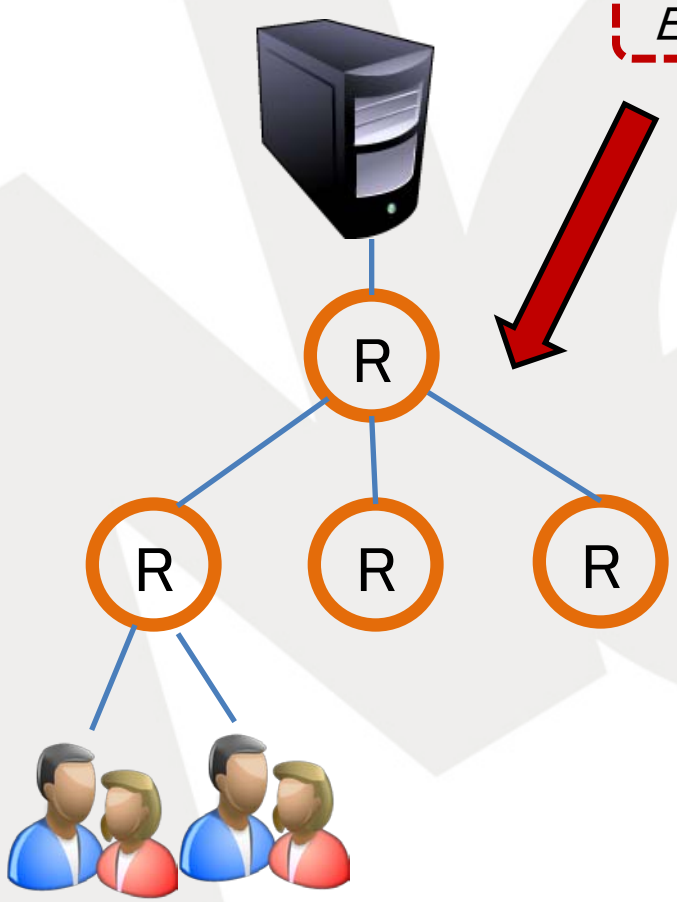
Domain B

Virtual Network

Can Hierarchical Network Supports Cloud Computing Architecture?

Moving up the traffic between Client-Server requires logical tree transition

Every hop adds the total latency



Can Hierarchical Network Supports Cloud Computing Architecture?

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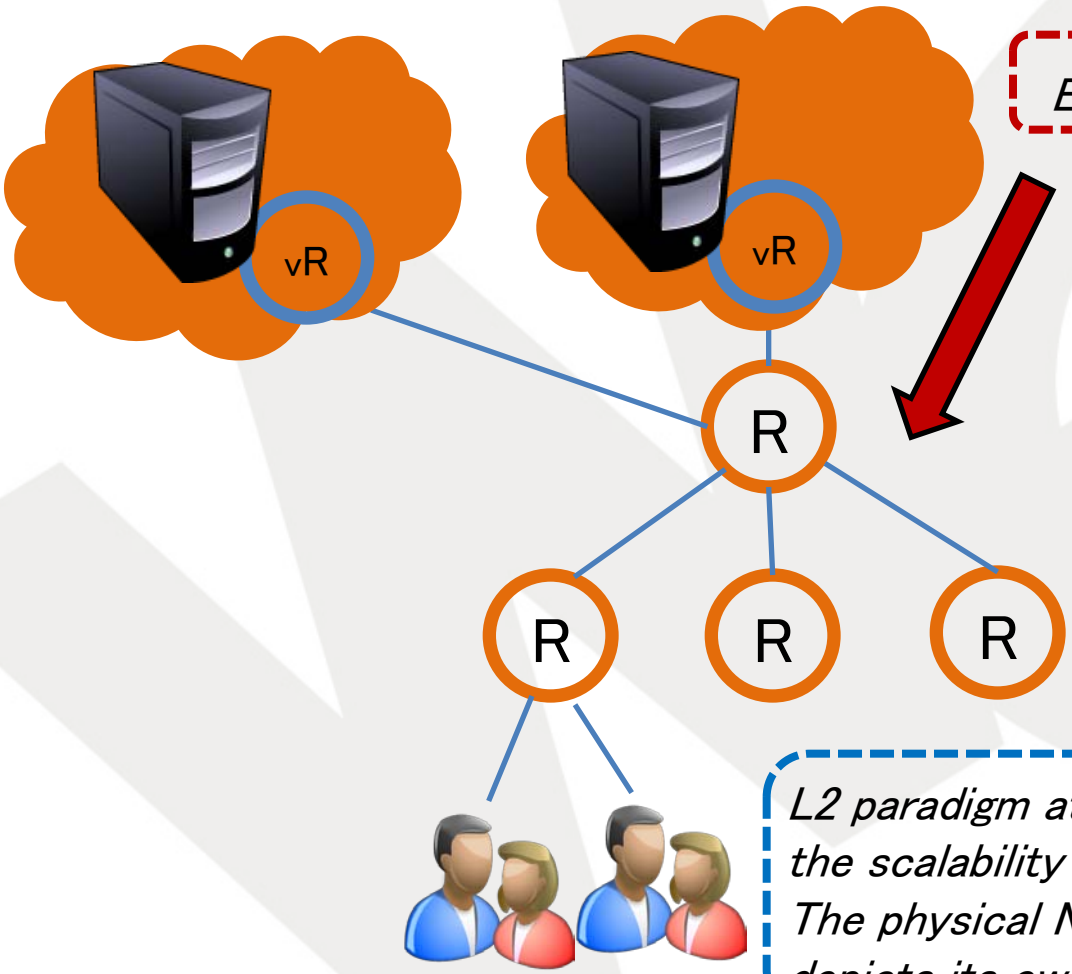
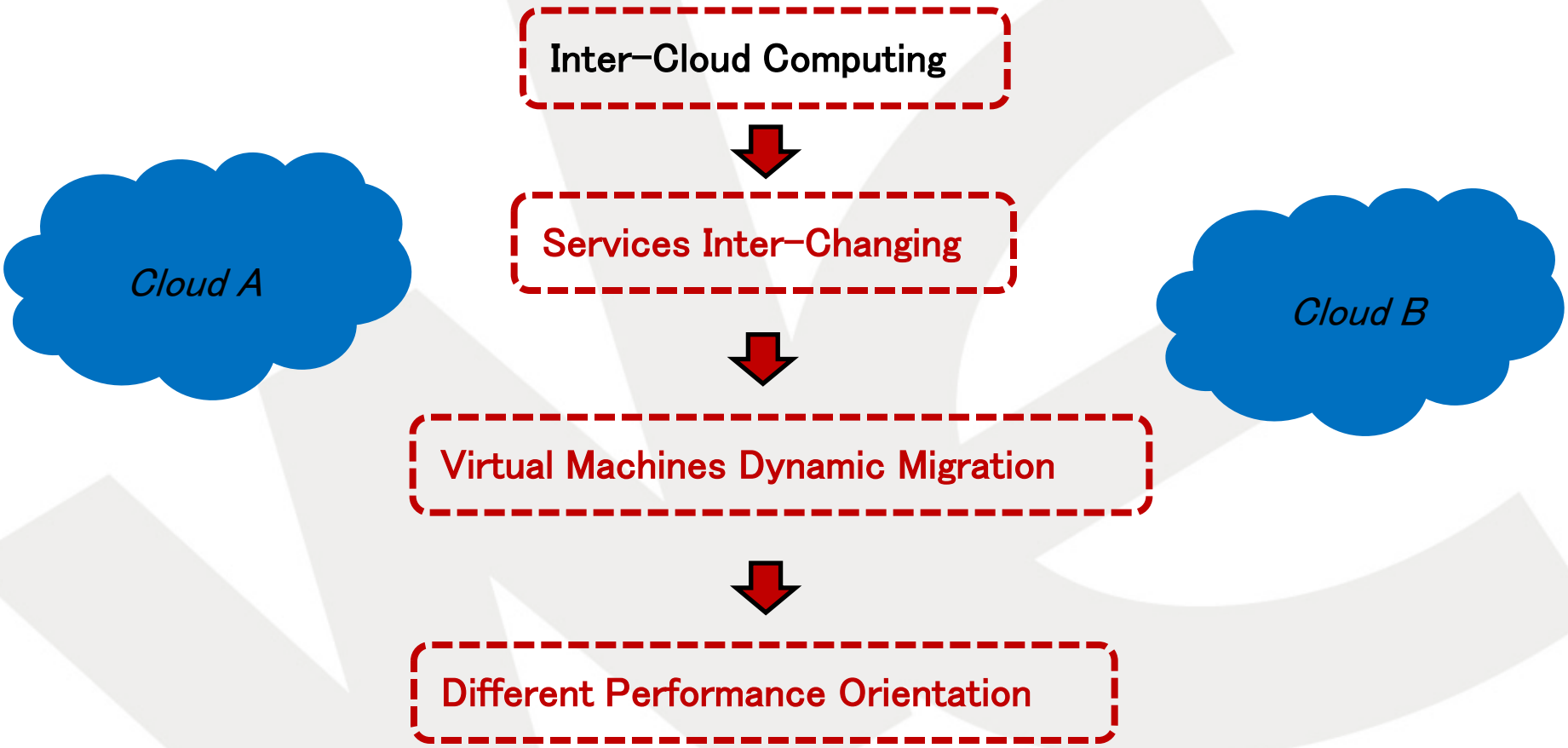


Every hop adds the total latency

L2 paradigm at Inter-Cloud : Virtual LAN: extends the scalability of network.
The physical Networks look Hierarchical but virtual depicts its own topology



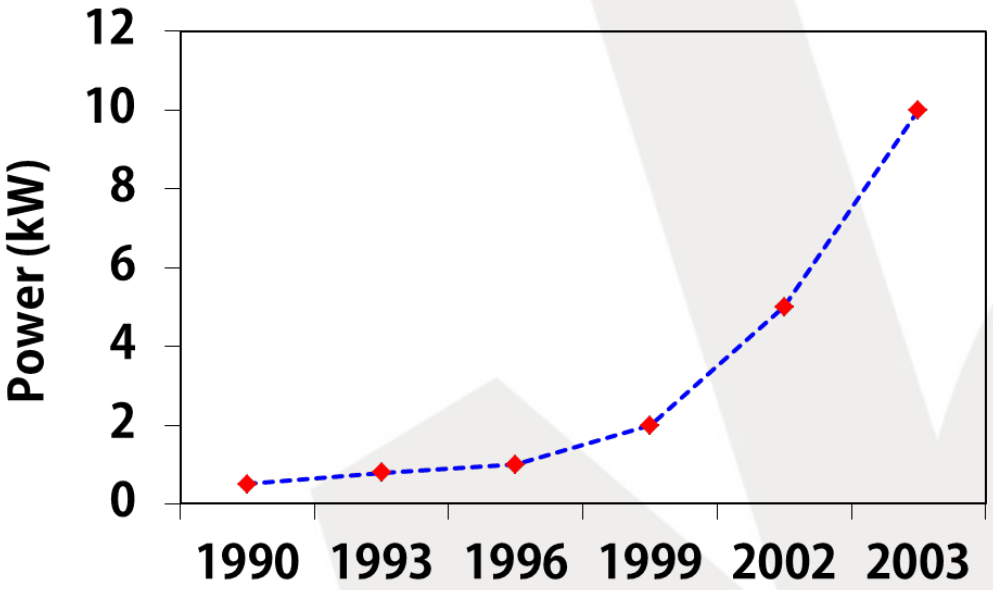
- *The link Availability becomes new performance indicator*
- *Systems need policies implementation enabling intelligent routing*

3 Industrial Point of View...

Some vision for Industry in Implementing Router for Inter-Cloud Computing Service...

1. There is no real router product optimized for Inter Cloud Computing system, some providers offer router supporting cloud computing technology
2. Unified network management system (interaction between applications and networks)
3. Virtualization layer support
4. Energy efficiency and operational cost

Routers' Energy Consumption is a Big Deal?



Source: Stanford EE

Power Consumption Trend prior to Cloud Computing Generation

An Emerging Concern for Power Consumption and thermal solution in Inter Cloud Computing Era

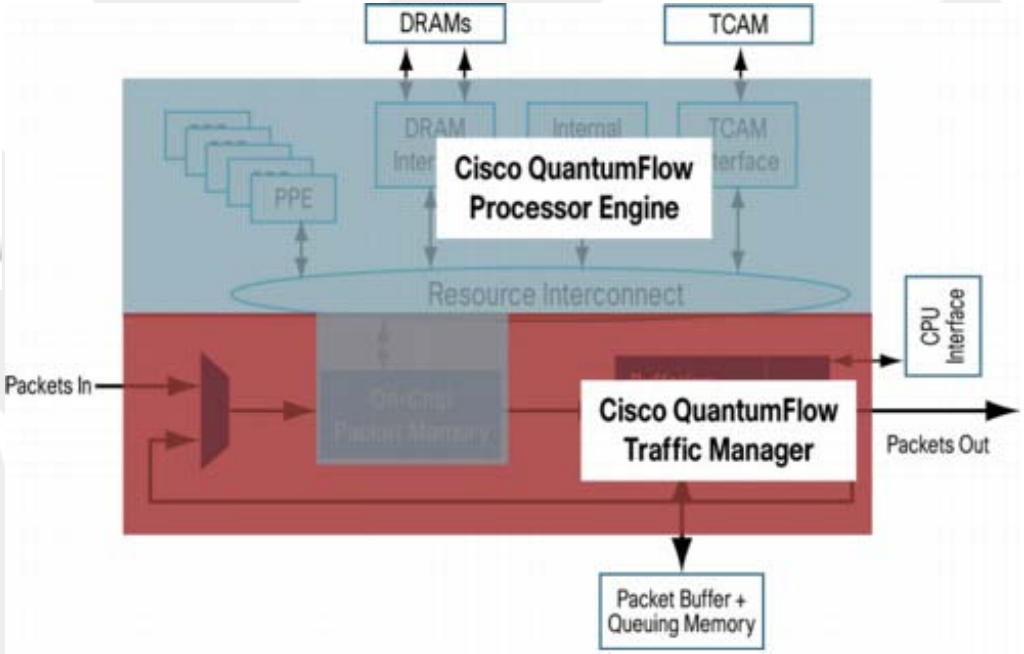
Working on Protocol or Device?

Router Providers 'Trend

Cisco Carrier Routing Systems (CRS)

Increasing performance routing

Powered by
Cisco QuantumFlow Processor Engine Module



- Support more than 100Gbps bandwidth
- Using high speed interface to program the processor and databases
- Uses external reduced-latency memory: TCAM (ternary content addressable memory)

Router Providers 'Trend

Different Vision from Juniper!

Juniper: Cisco CRS-3 Performance 'Unrealistic in Practice'

By Chad Berndtson, CRN

March 09, 2010 6:17 PM ET

Cisco (NSDQ:CSCO) is positioning its new CRS-3 Carrier Routing System in the highest end of the service provider router market, but said Tuesday that as bandwidth and other networking concerns increase, the opportunities for more traditional solution providers to profit with the system will grow.

Meanwhile, however, its closest competitor in the space moved quickly to dismiss the CRS-3's market viability.

"We agree with Cisco that the Internet and networks themselves require fundamental change, but Juniper takes a different, open-standards approach that better benefits service provider economics and end user experiences. That's why we've been delivering 100GB-capable systems since 2007," said Mike Marcellin, Juniper's vice president of marketing, infrastructure products group and Junos Ready Software, in a statement e-mailed to ChannelWeb.

Announced Tuesday, Cisco's CRS-3 family offers what Cisco claims is 12 times the traffic capacity as the nearest competing system, boasting 322 Terabits-per-second performance. The "12-times-the-nearest-competitor" statement, thought to be directed at Juniper, is misleading, Marcellin suggested.

"The claim of 12 times the traffic capacity of the nearest competing system is based on a theoretical maximum of 72 interconnected CRS-3 chassis in order to achieve the 322Tbps total capacity -- this

RECENT ARTICLES

Cisco's Financial Analyst Day: 10 Thought-Provoking Takeaways

Cisco CEO John Chambers and other members of Cisco's executive team took the stage to discuss and defend the company's strategy during Cisco's annual Financial Analyst Day in San Jose. Here were some of the key messages from Cisco on how it will chart a growth course for its fiscal 2012 and beyond.

15 Scenes From Carousel Industries' Customer Soiree

Fast-growing VAR 500 power Carousel Industries brought more than 100 customers and major vendor and distributor partners to an appreciation event at Boston's New England Aquarium. CRN was there, too; here's a look at the festivities.

15 WAN Optimization Players VARs Should Know

With WAN optimization and acceleration having moved from niche technology play to full on practice for many solution providers, the vendors they partner with become increasingly more important. Here are 15 WAN optimization players, established and emerging, to keep an eye on.

More Slide Shows

Users can be amazed by Sovereignty of CRS, but Juniper said it is Unrealistic!

A market competition strategy?

Or

A clue for future internet development?

Juniper takes a different, open-standards approach that better benefits service provider economics and end user experiences

Important Question:
Why do Juniper concern about Open Standards?

Methodology of Service Exchanging have to embodied on Service Level Agreement (SLA) point of view

Becomes new definition and paradigm of QoS

New definition and paradigm of QoS

Current QoS Parameters:
- *Delay*
- *Jitter*
- *Utilization*
- *Throughput*
- *Etc…*

→ *A network Minded Parameters*

Possible QoS parameters for Inter-Cloud Computing
- *Flow Completion Time*
- *VM migration speed*
- *Service Availability*
- *Network Failure…*
- *Etc.*

→ *A user Minded Parameters*

The case of Cisco vs Juniper sets two different directions for Industries to take their action for router technology improvement...

Using traditional way to develop router technology increasing classic QoS parameter; Close the development from the possible involvement from open standard.

Or

Working in totally new protocol, developing new router technology, let open standard that benefits the users and provider enrich the router technology for the future internet achievement

But still a remaining question...

How far we can use the existing router technology?

The 4 reasons why we cannot rely on the existing commercial Router Technology

IN THE TERM OF PERFORMANCE

1. *Network Traffic Characteristic has Changed...*
   Not only data exchange but task (computing) exchange

2. *Users Expectation has Changed...*
   Who Cares About Bandwidth, Delay, Throughput, Jitter?
   Users want the flow FAST!

3. *Upgrading the backbone*
   High speed backbone need extra cost!

4. *New protocol adaptation...*
   No TCP anymore but XCP, RCP, xRCP?

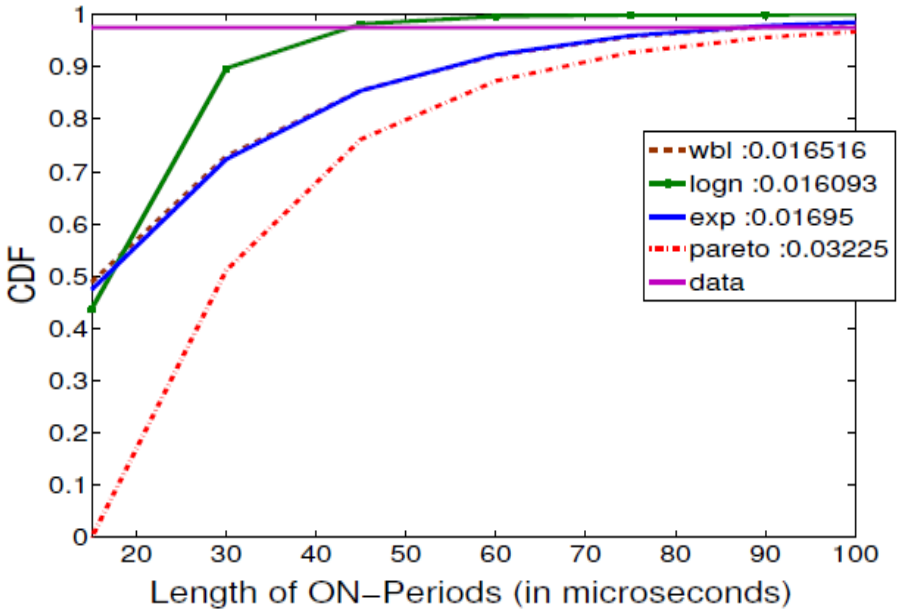
The 4 reasons why we cannot rely on the existing commercial Router Technology

SOME FACTS!

1

Network Traffic Characteristic has Changed...

Not only data exchange but task (computing) exchange



Surprising CDF model of Cloud Traffic!!!

Experiment of Cloud Network traffic vs Current Network Traffic Analytical Models

[1] Benson et al (University of Wisconsin Madison & Microsoft Research)

The 4 reasons why we cannot rely on the existing commercial Router Technology

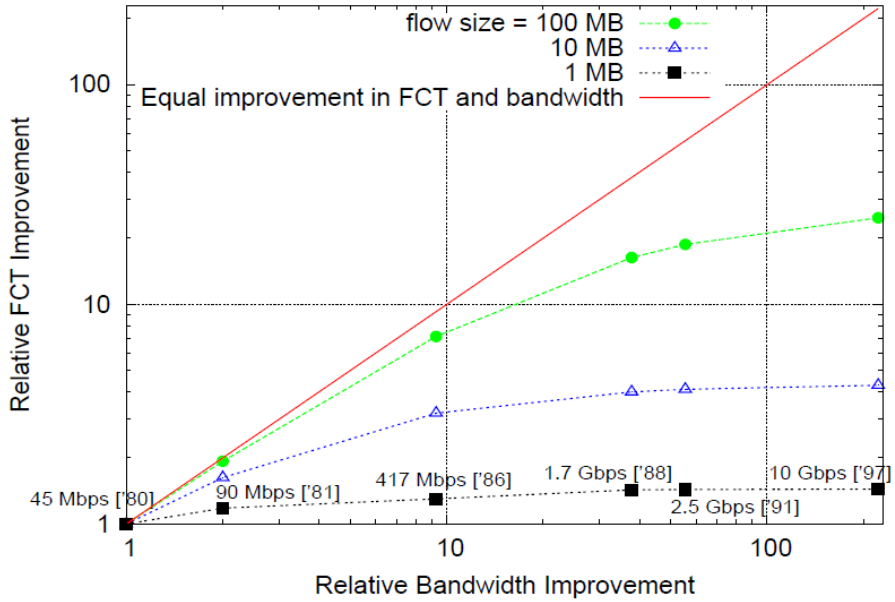
SOME FACTS!

2

Users Expectation has Changed...

Who Cares About Bandwidth, Delay, Throughput, Jitter?

Users only want it FAST!



Users always want to pay more
To buy faster bandwidth!
To get satisfied by better QoS!

But it doesn't help!
(FCT: Flow Completion Time)

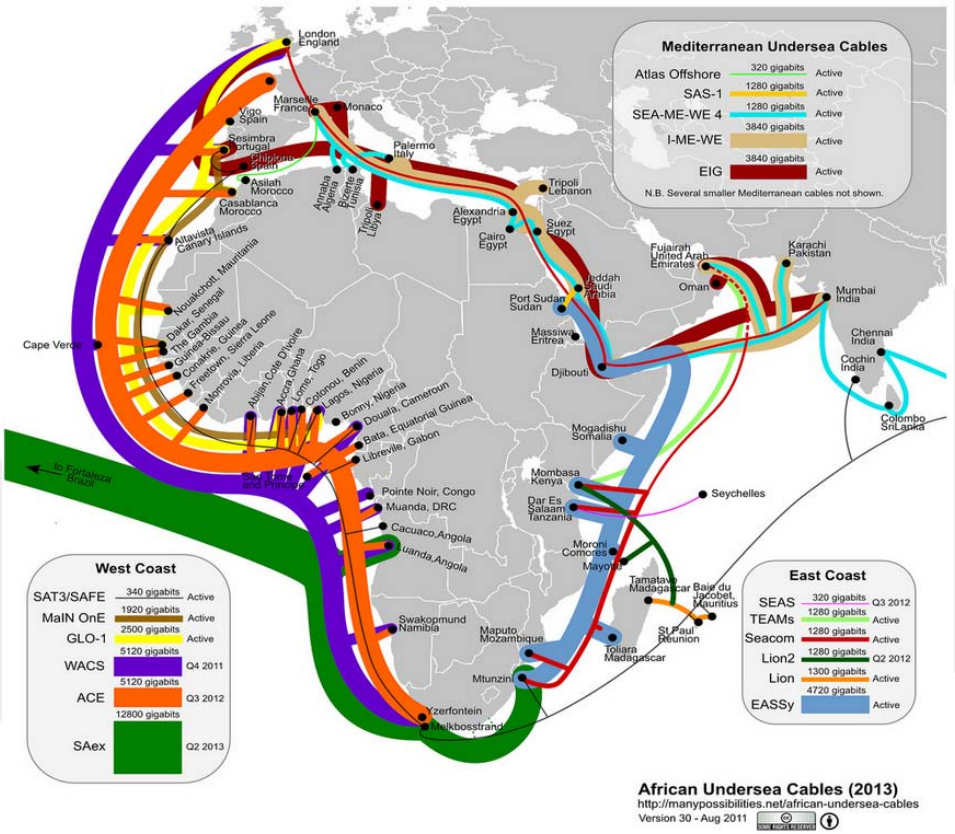
The 4 reasons why we cannot rely on the existing commercial Router Technology

SOME FACTS!

3

Backbone will be useless...

High speed backbone need extra cost!



Terabytes per Second

Investment!

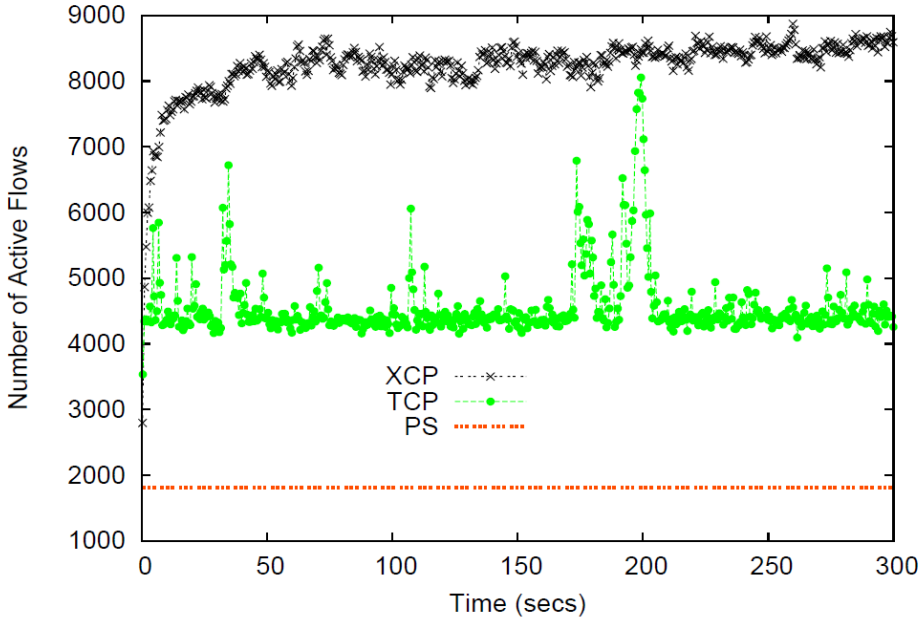
The 4 reasons why we cannot rely on the existing commercial Router Technology

4

New protocol adaptation...

No TCP anymore but XCP, RCP, xRCP?

SOME FACTS!



Source: Stanford Clean State Research

Hundred Papers and Researches
Has prove that :

TCP has no bright future!
(XCP: eXplicit Control Protocol
PS: Processor Sharing
xRCP: Extendable Rate Control

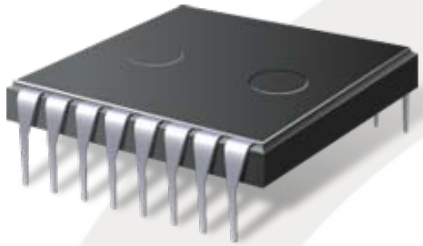
TCP Slow Start is an awful idea!
TCP was designed when L1 was very poor...
Routers are design to behave in accommodating TCP mechanism....

4 Efforts to Improve Router Technology...

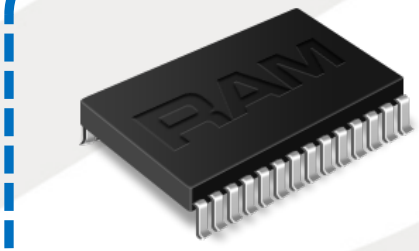
How router works?

Two main components
Determining Router Performance

Processing Unit



Buffer/Memory



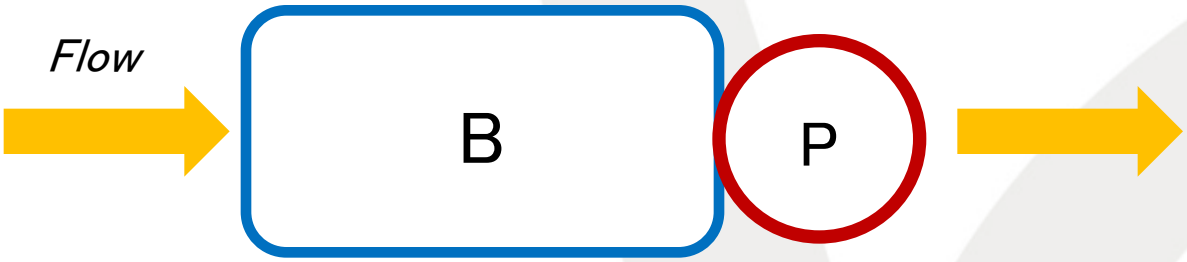
Queued Packets

Flow

B

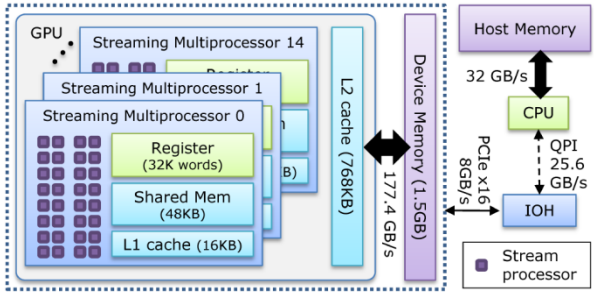
P

How to increase router performance?

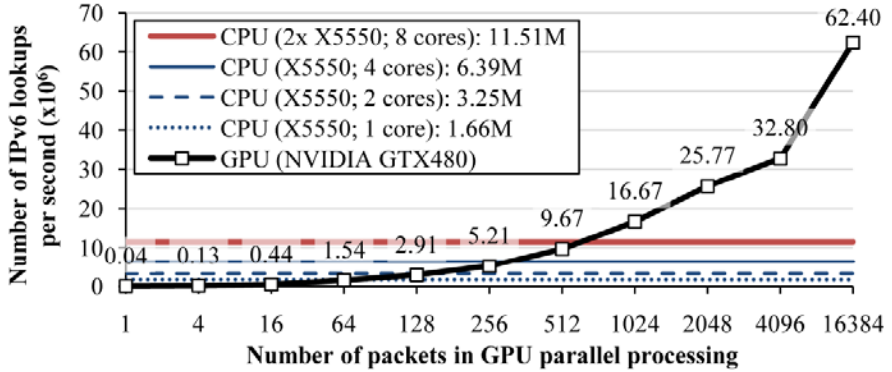


Using Powerful Processing Unit?

Research from KAIST: using Graphic Processing Unit (GPU) as router processor



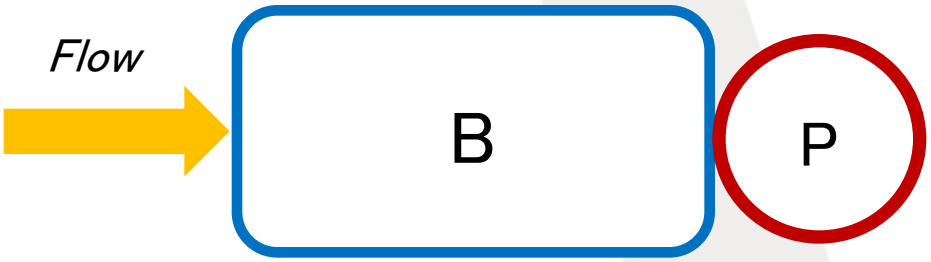
NVIDIA GTX480



Yes lets built a router using GPU!

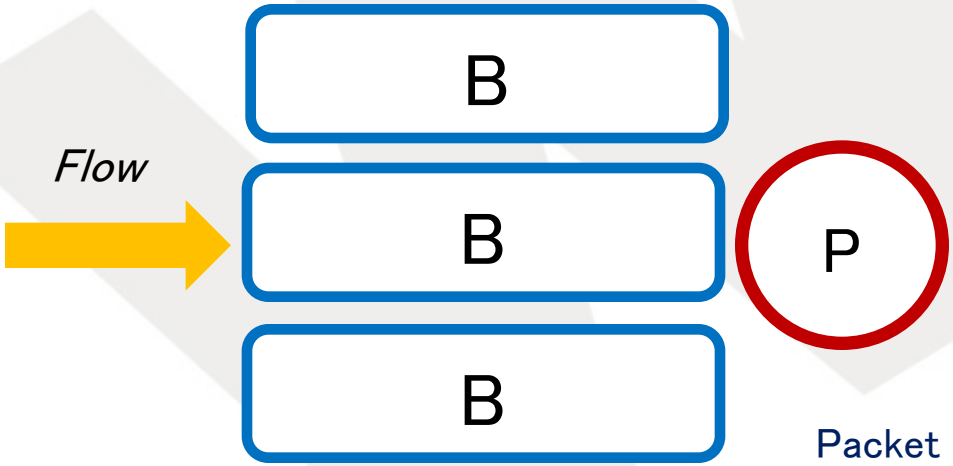
Means we need US$7000 per unit cost!

How to increase router performance?

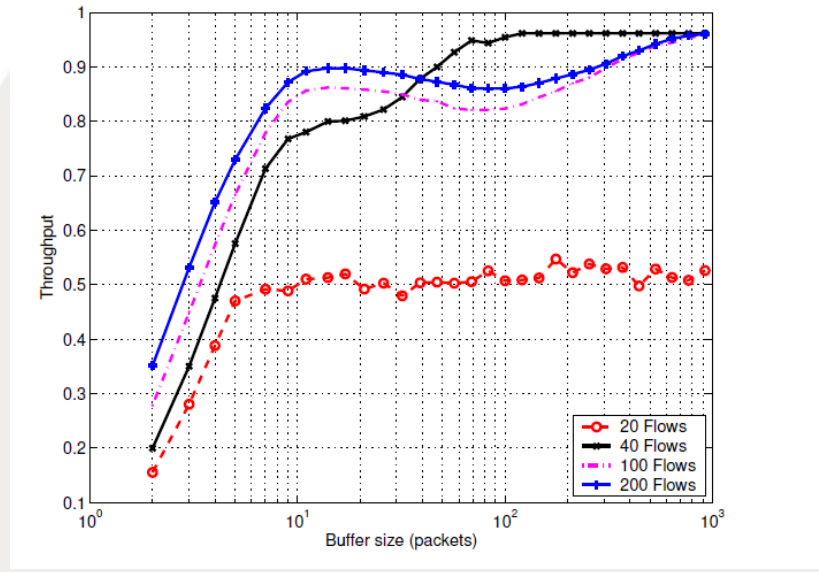


Increase buffer performance?

If we add more buffer capacity, will the system could be better?



Apply scheduling mechanisms



Source: Nandita Dukipatti (Stanford)

Packet Loss will always occur!

Extend Buffer does not solve the problem!

4 Router Development for Future internet...

Recalling the reasons...

Two approaches has to be accomplished!

1. Working on the Protocol Development
2. Working on the Hardware Development

the Protocol

Forget the TCP!

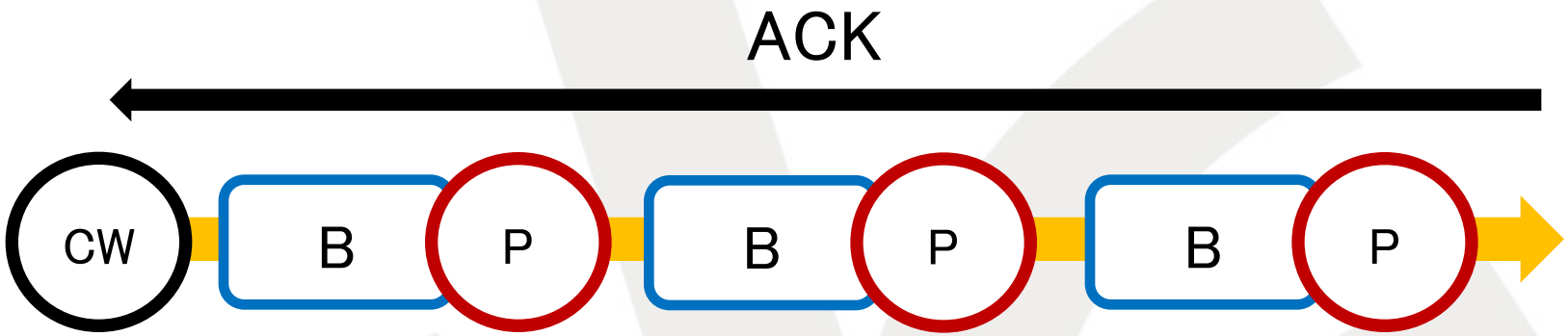
Cooperative UDP?

Designing the Router with semantic capability

Designing the Router that can talk each other

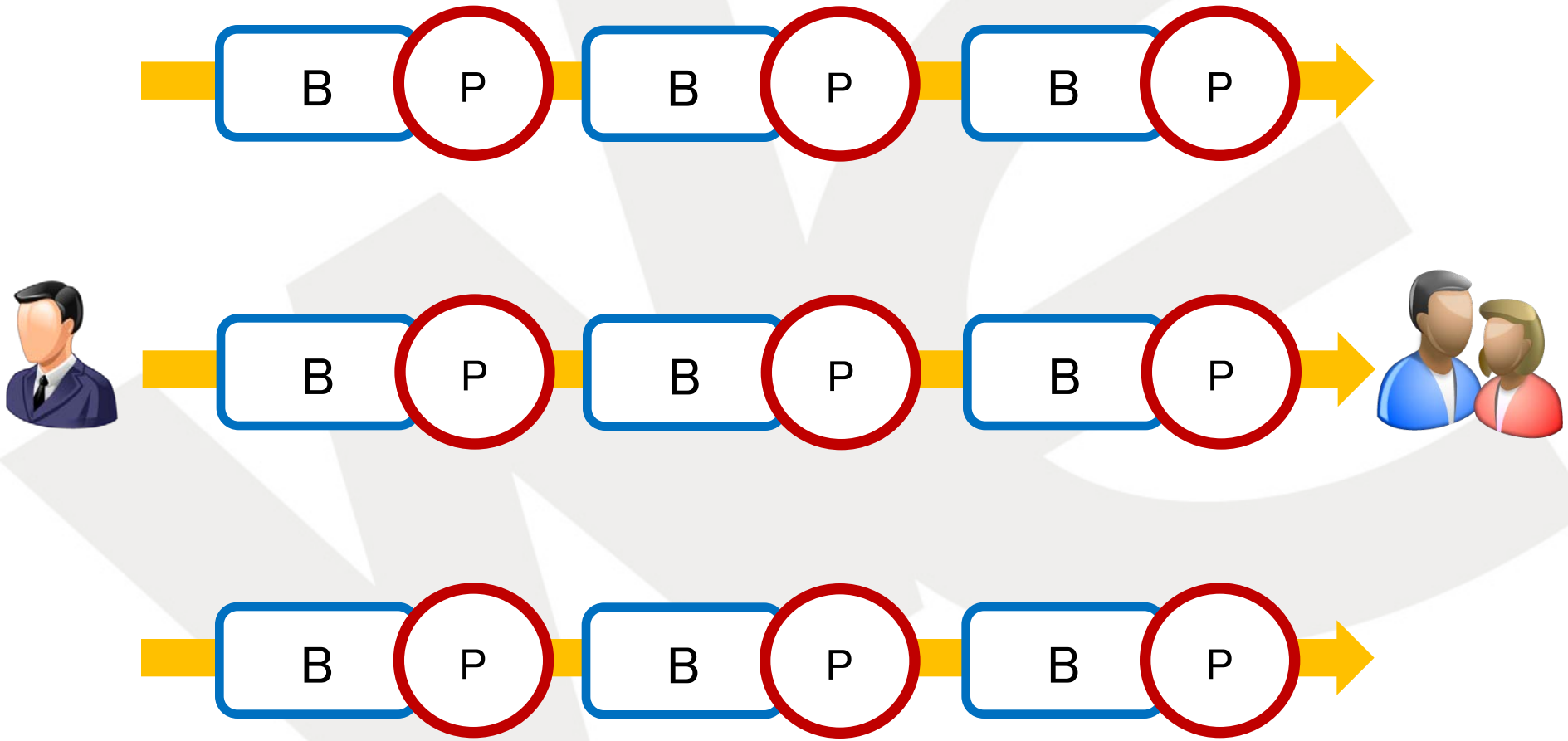
Open extremely wide research area...

the Concept of TCP



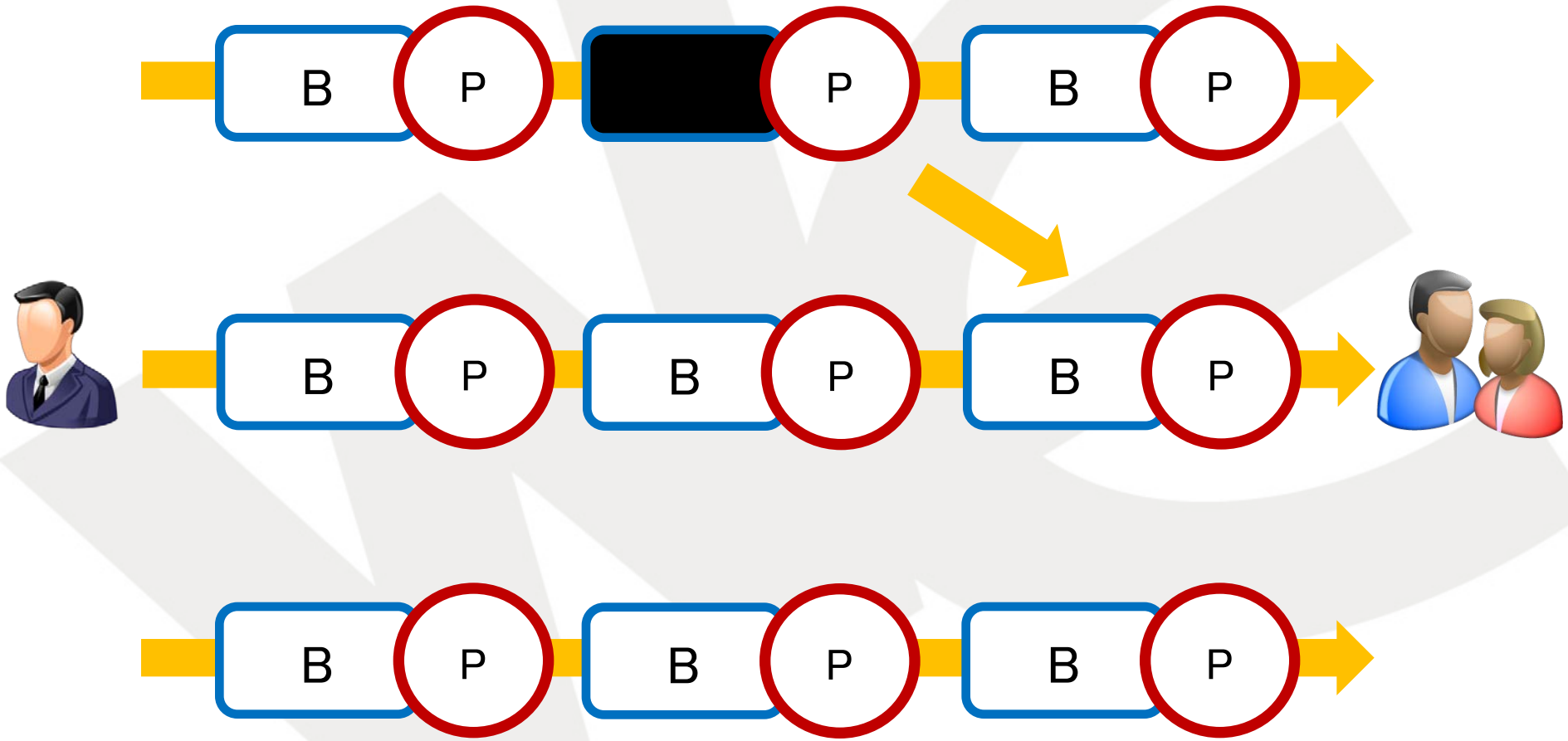
Single Flow!

the Concept of Semantic Router

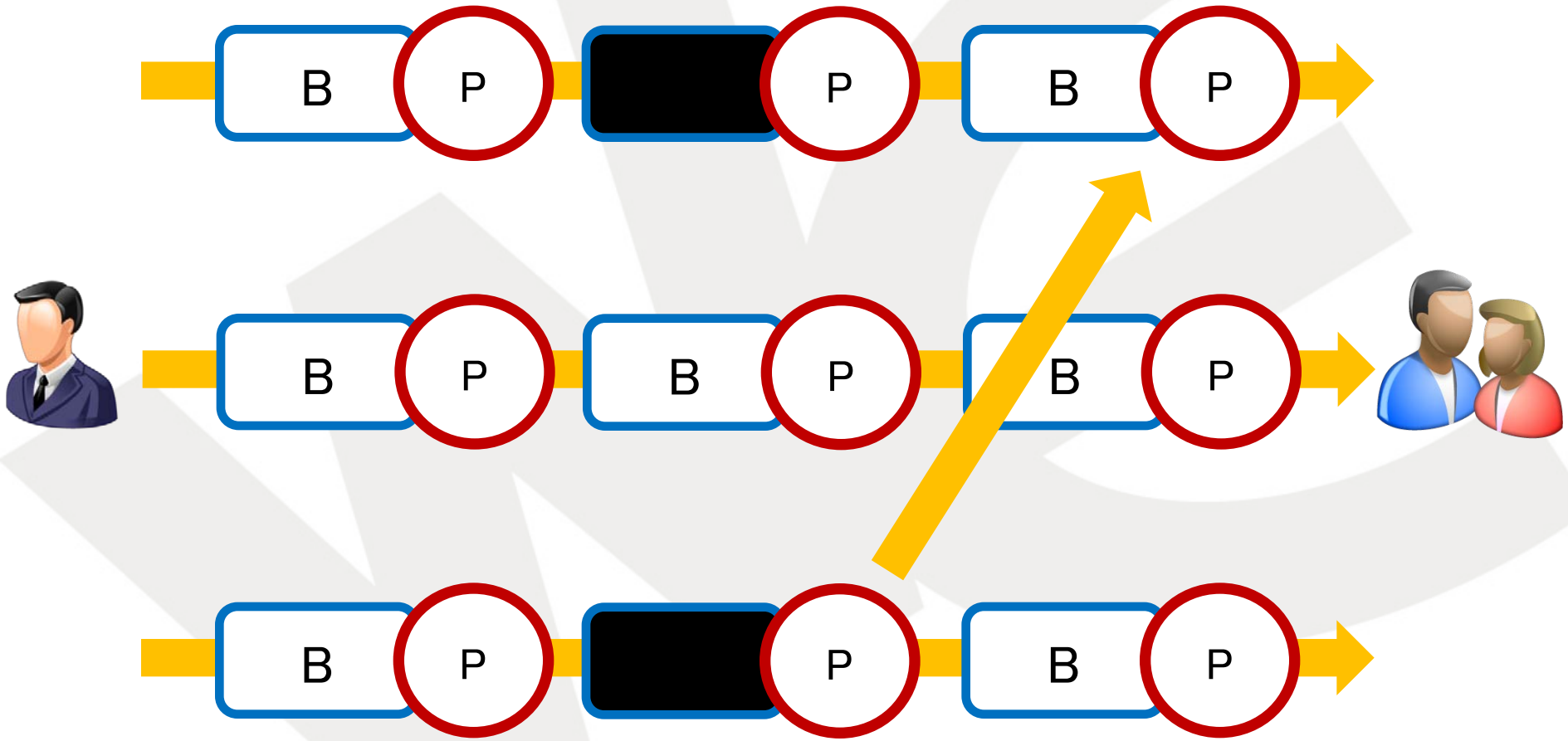


Distributed Flows!

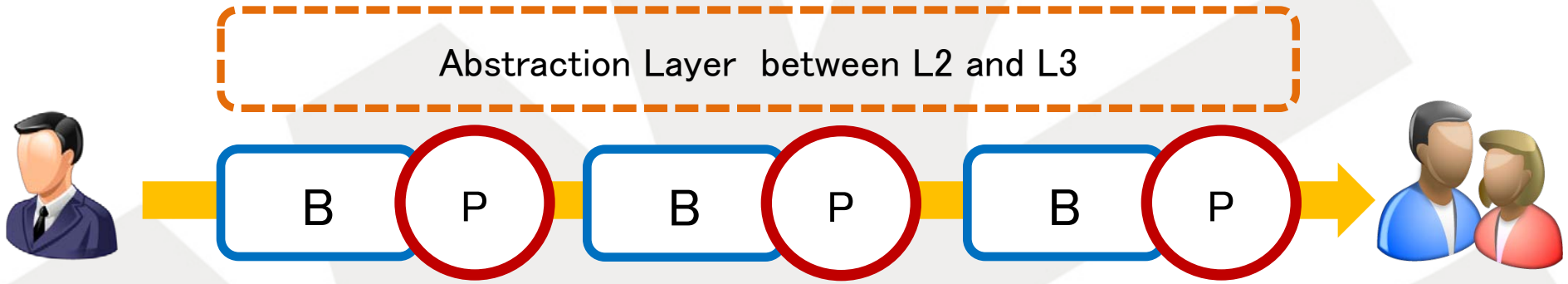
the Concept of Semantic Router



the Concept of Semantic Router



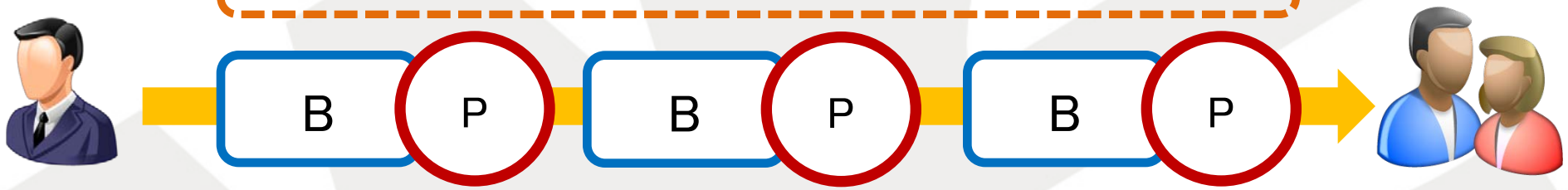
the Concept of Semantic Router



the Concept of Semantic Router

Congestion Control Algorithm, Management Module, etc

Abstraction Layer between L2 and L3



Enabling Self Configuring Mechanism

the Concept of Semantic Router

Services

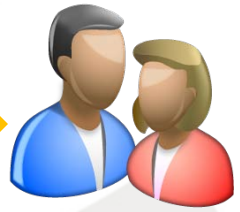
Services

Services

Congestion Control Algorithm, Management Module, etc

Abstraction Layer between L2 and L3

B P B P B P



Enabling Self Configuring Mechanism

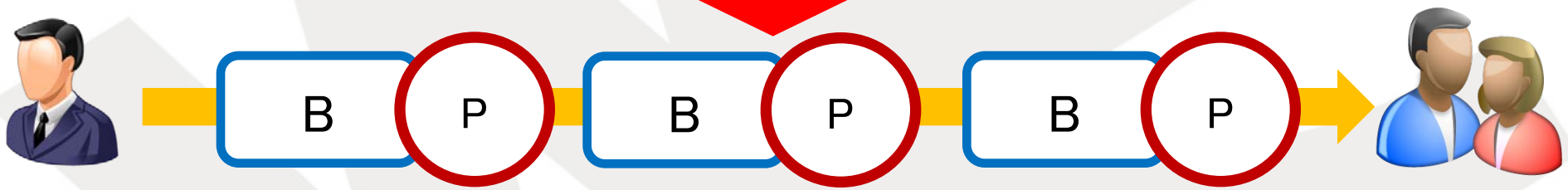
the Concept of Semantic Router

Services

Services

Services

Interaction Between Router and Services



A Preliminary Research on Approach to Semantic Router Technology @ WNEC Lab.

Using NetFPGA Platform

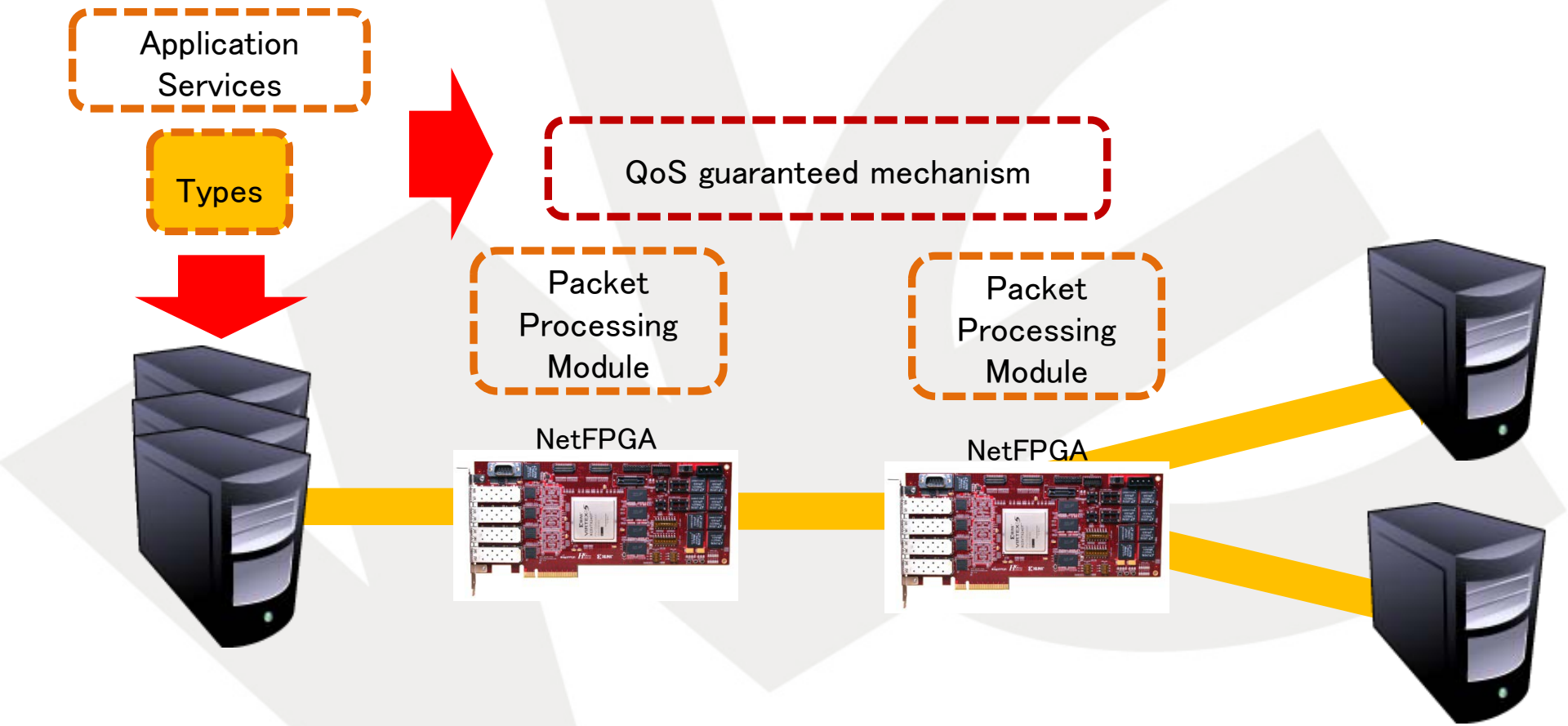
(An open platform developed by Stanford University, to design customizable network devices and to conduct experimental design for high speed network)

- *FPGA Logic , Xilinx Virtex-II Pro 50*
- *4 x 1G Ethernet ports*
- *400 MHz DDR2 DRAM*
- *PCI Slot*

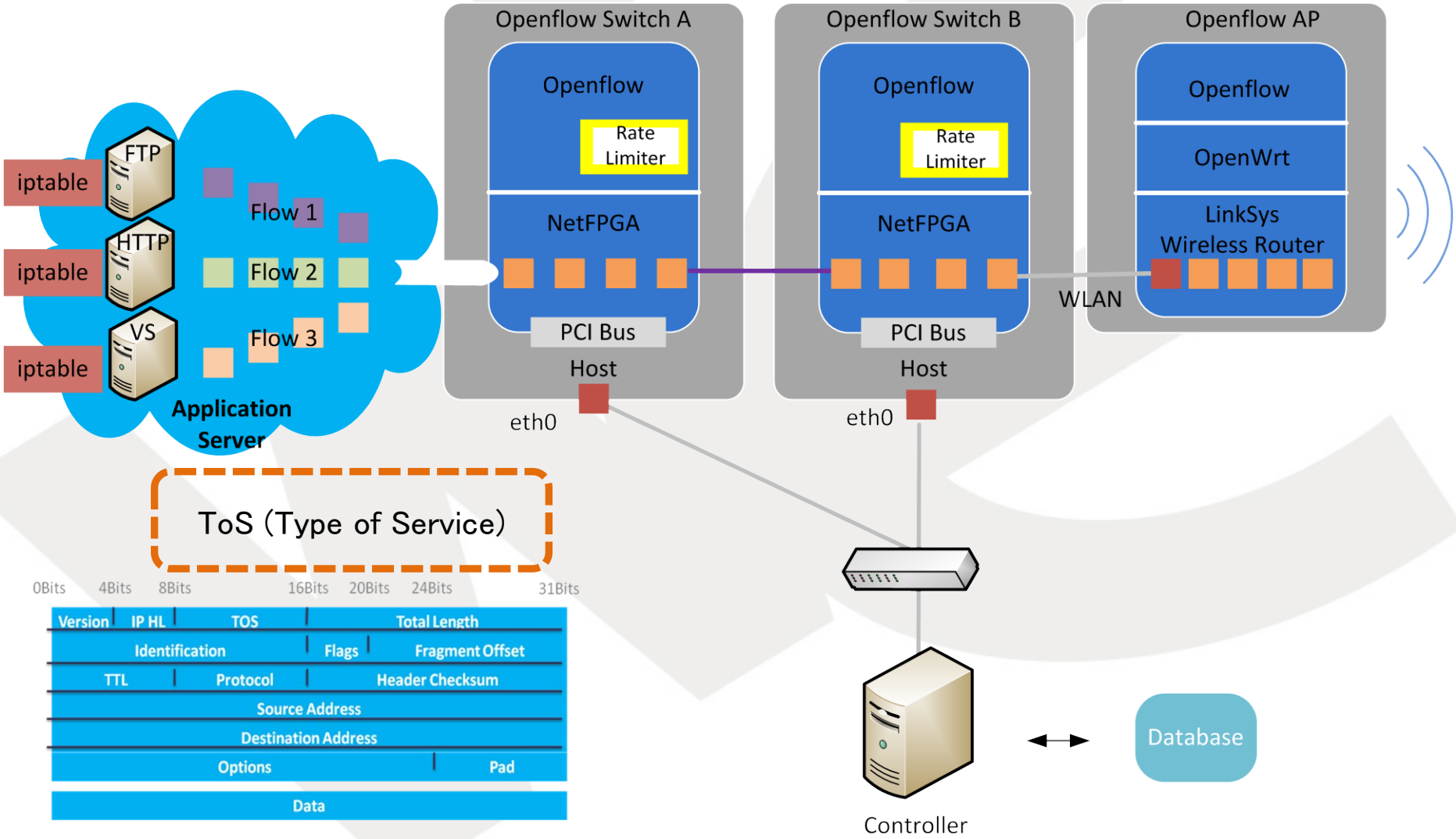
With NetFPGA we are enabled to design service oriented router technology to study the interaction between service and network layer

Current research approach (using NetFPGA Platform)

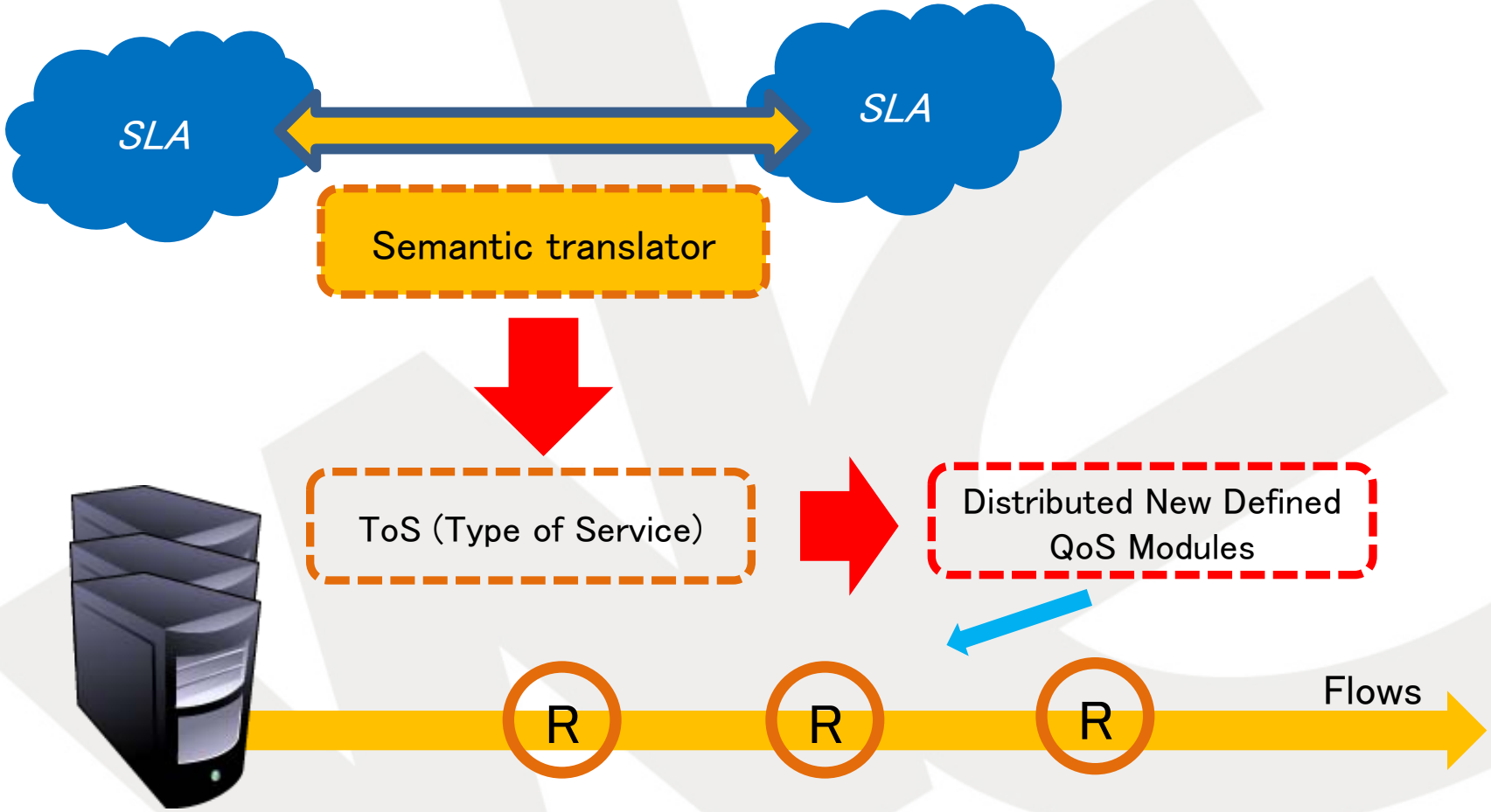
Creating Network Test Bed, let the router react based on the type off applications



Current research approach (using NetFPGA Platform)



ToS (Type of Service)


SLA
SLA
Semantic translator
ToS (Type of Service)
Distributed New Defined
QoS Modules
R
R
R
Flows

Recalling the reasons...

Two approaches has to be accomplished!

1. Working on the Protocol Development
2. Working on the Hardware Development

Some emerging questions

- What is the optimal buffer size for a Router?
- For the Future Router?
- We need to increase or decrease the buffer size?

1

A Traditional Router buffer requires:

$$B = C \times T$$

Buffer Size *Link Capacity* *RTT*

If we have 160Gbps link, with RTT: 250msec, means the router needs 5Gbytes of Buffer

2

Small Buffer Rule:

$$B = C \times T \times \frac{1}{\sqrt{N}}$$

Number of TCP flows

Using the same link, with small buffer rule we need 5000 IP packets for buffer size

3

Tiny Buffer Rule

$$B = O(\log W)$$

Congestion window size

Need 20–50 IP packets / 30–75 kilobytes of memory

Unfortunately...

! Decreasing Buffer Size will cause instability to Network Performance

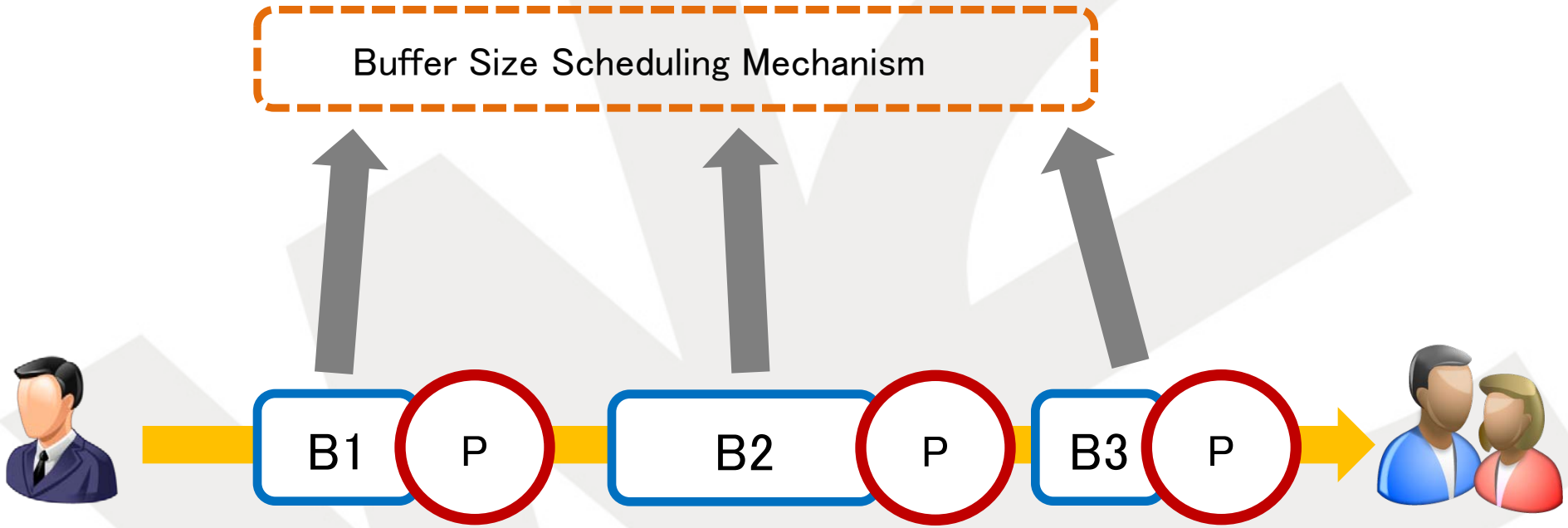
But...

! Increasing the buffer will cause significant performance Degradation on the network

?

Determining Buffer Requirement: Solve the Problem?

Can we make the size of the Buffer changed dynamically?



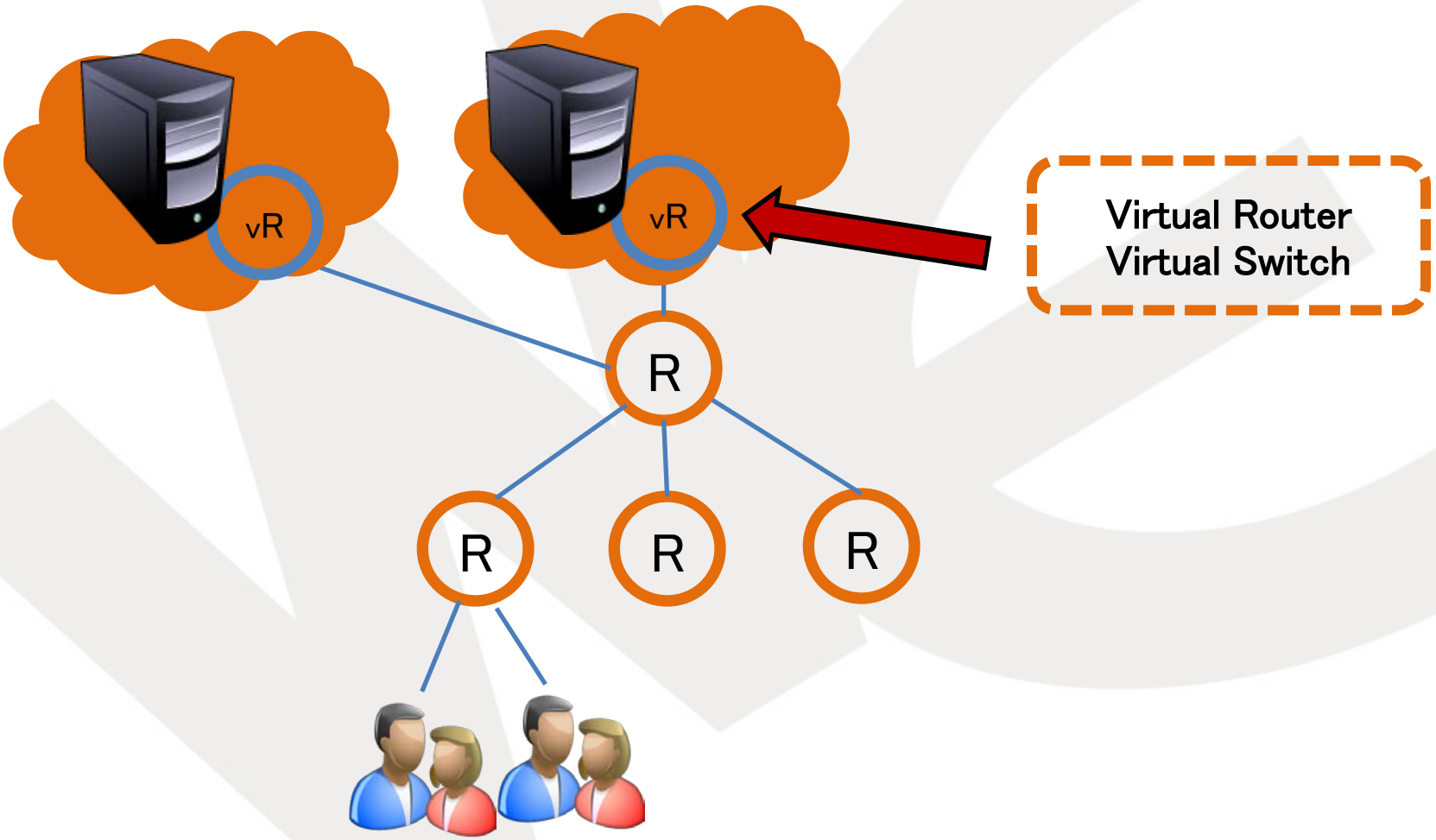
- Using this design, the optimal flow of traffic will be achieved…
- With the study of network topology, the network designer can allocate

Most appropriate router with particular buffer size…

5 Virtual Router...

When Physical Computing Goes to Virtual Layer...

Could networking Devices also designed at the same consideration?



Existing Virtual Router Products

Developing router on virtual network layer, works with existing Virtual Machine Infrastructure.
Available in market as commercial product…

Creating new segment of industrial product…

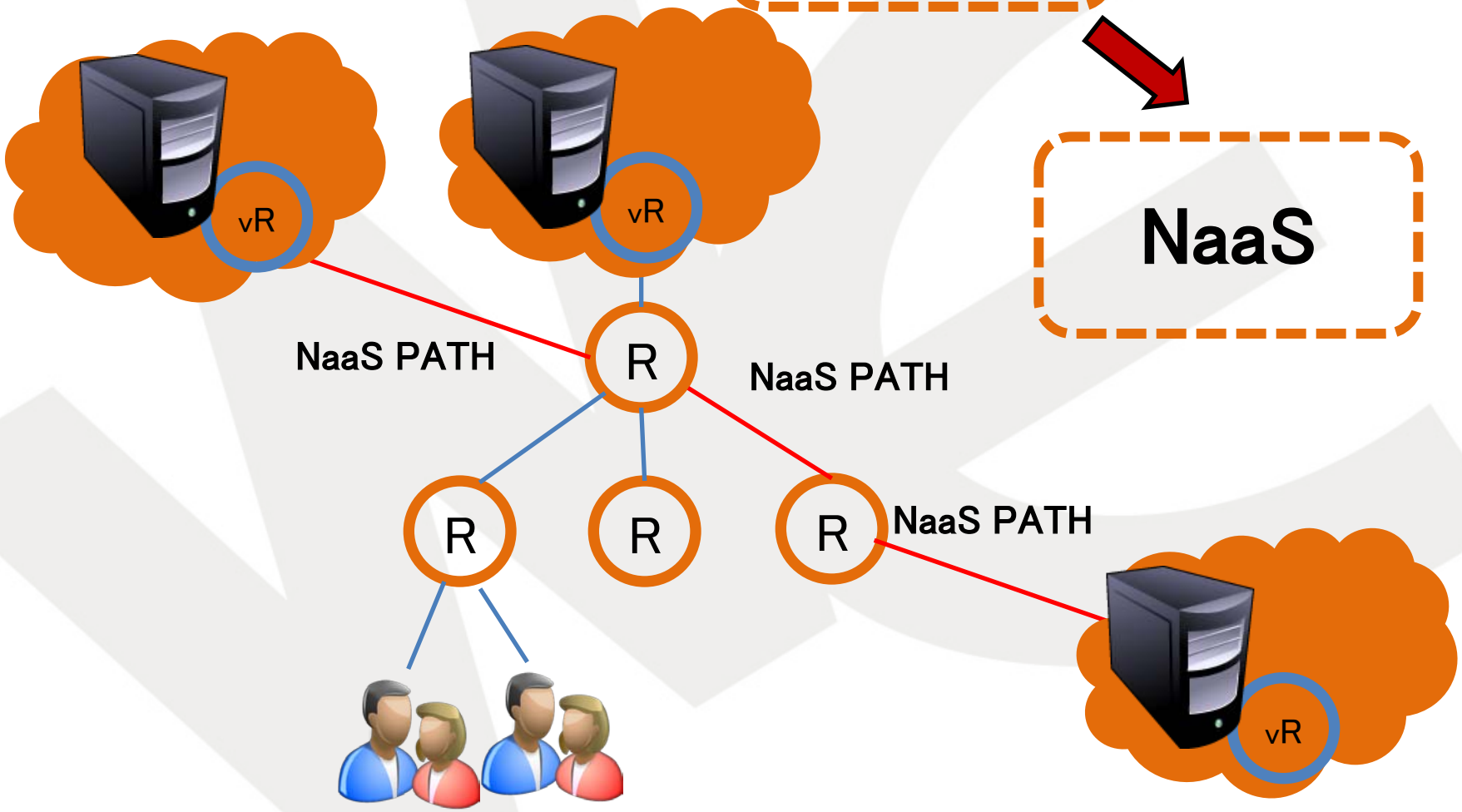
But what is it mean for Inter-Cloud Computing System Defining the service?

Virtual Router...

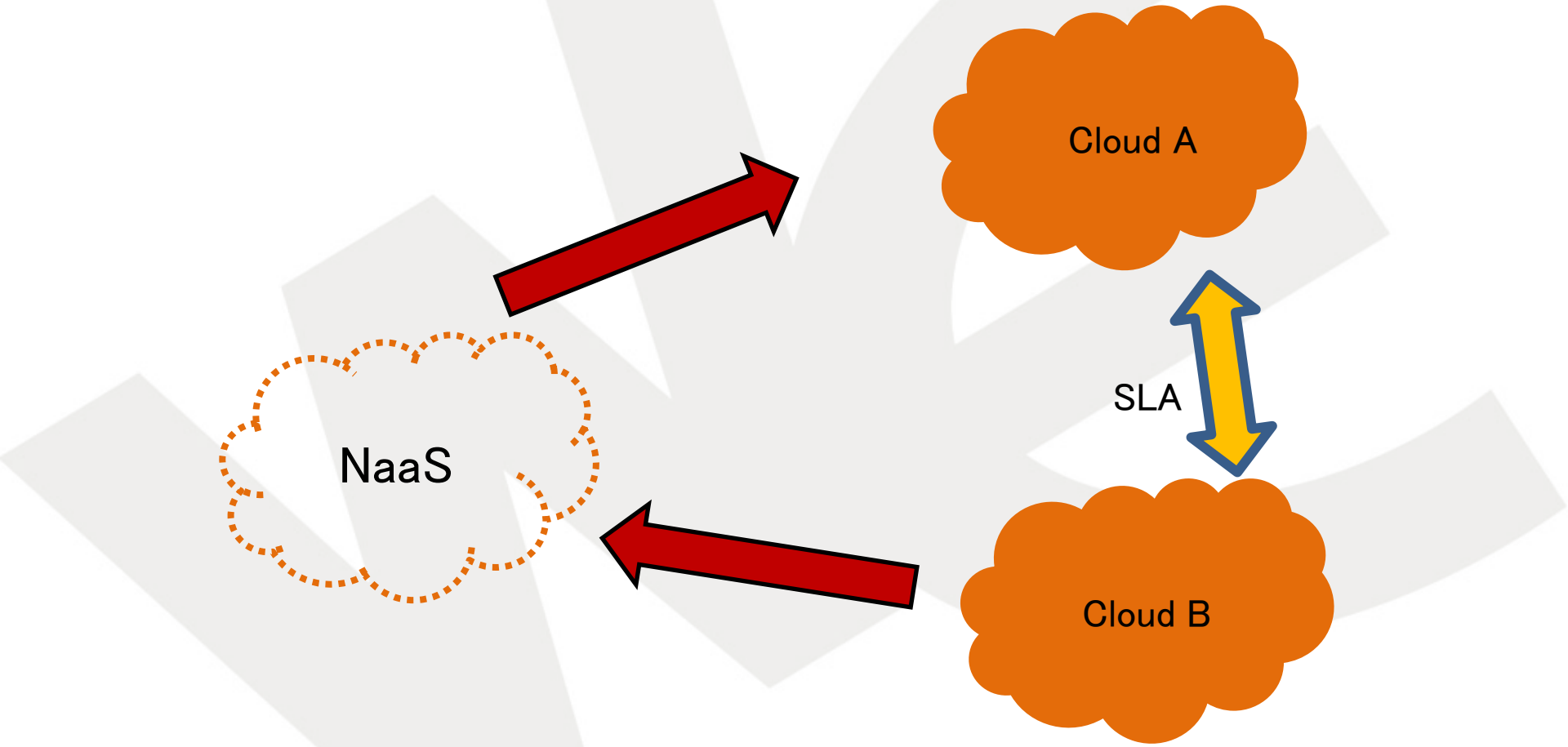
It means “Scalable Router”

Virtual Network Devices can be used as a Service

NaaS



NaaS Illustration



Cloud A uses NaaS from another cloud to fulfill Cloud B SLA requirements

Conclusions

- Inter Cloud computing is an arguably and a possible model for future internet.
- Industrial point of view in defining Future Router is yet far from the markets 'need.
- The hardware design of future router is constrained by the internet protocol design.
- Designing new Internet protocol giving the alternative for TCP, has become a priority task. Moreover, Future internet defines a new paradigm and definition of QoS parameters.
- The study of Semantic router technology is important to determine the direction of future internet technology evolution.
- Determining size of buffer could be dynamically influenced by the behaviors of network traffic .
- Virtual Network devices creates a new segment for commercial product, as well as defining new service paradigm such as NaaS.

Thank You!

Q & A

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