Electronics & Telecommunication Research Institute

Measurement-based Resource Control and Management for Future Internet

2008. 8. 25

Future Internet Summer Camp 2008

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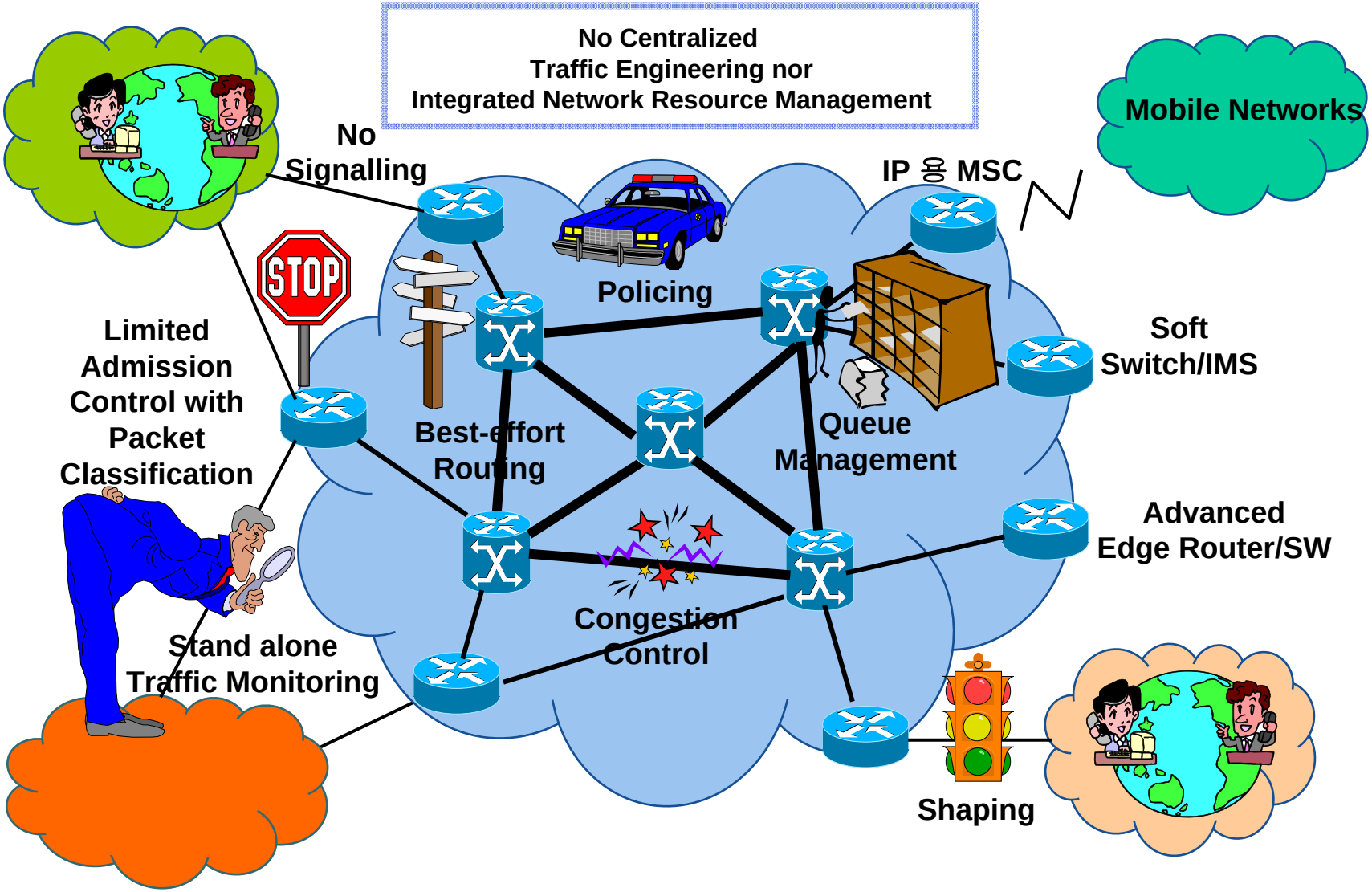
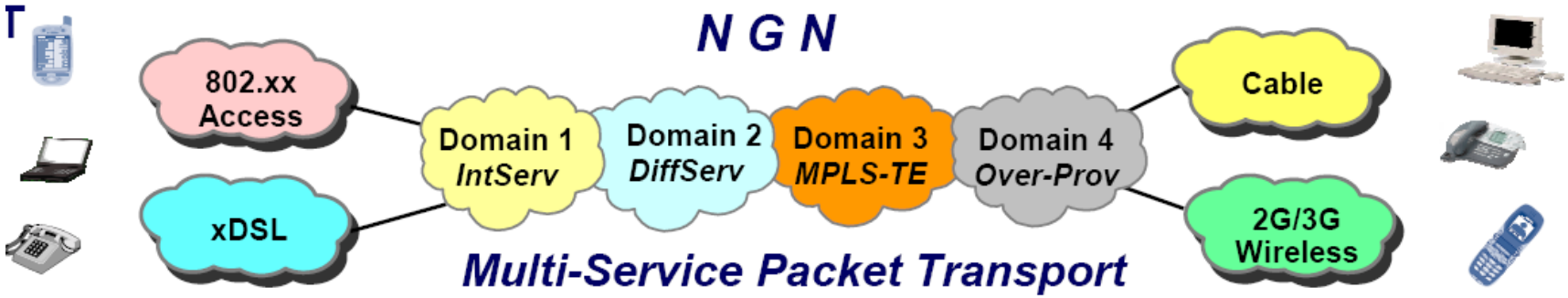
Topics

- Resource Control and Management Overview
- Traffic Measurement: state-of-the-art
- Binding Traffic Measurement and Resource Control & Management
- Various Approaches: From NGN to Future Internet

Resource Management in the Internet



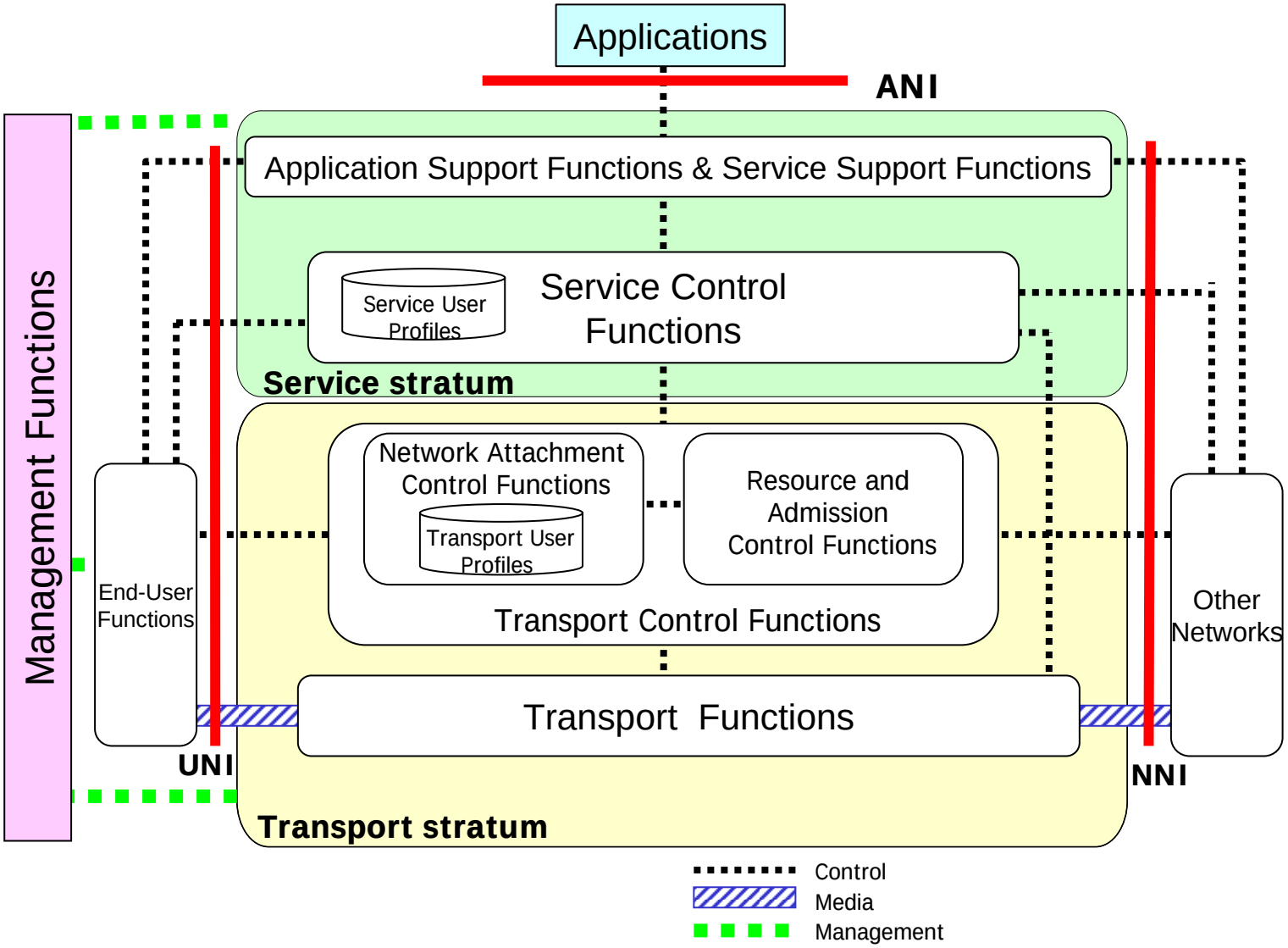
Complexity of NGN/BcN QoS



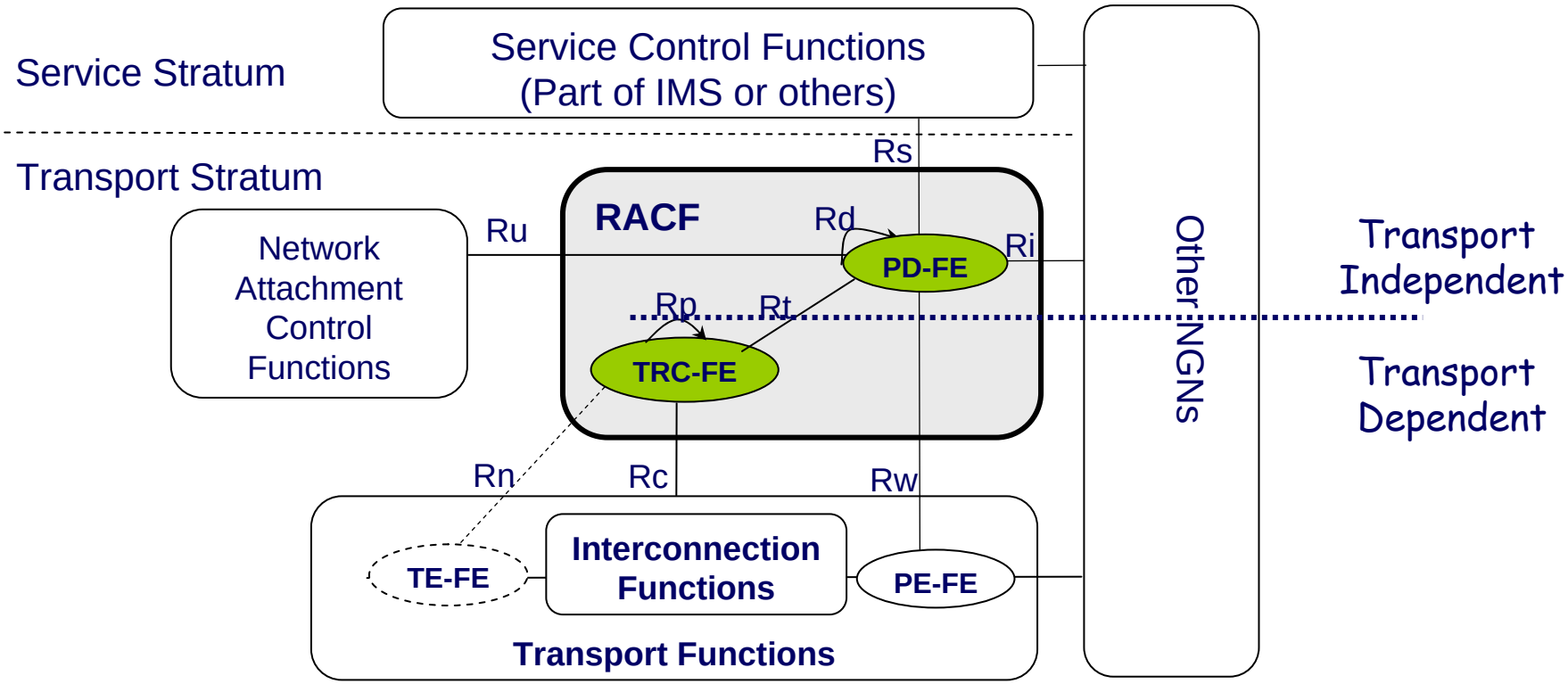
- User-perceived QoS is end-to-end (cf. E.800)
- NGN QoS is complex
  - NGN applications have *diverse* performance needs
  - IP is *not* designed for *consistent* application performance
  - *Diversity* in an end-to-end path is common
    - Different levels of QoS support in *endpoints*
    - Varying types of QoS support in the *transport*
    - Multiple *provider domains*

Source: ITU-T Workshop, Kobe-April-2006

ITU-T NGN Architectural Framework



ITU-T RACF Architecture



- Policy Decision Function
  - Service facing, transport independent
- Transport Resource Control Function
  - Service independent, transport dependent, network-segment specific
- Policy Enforcement Function
  - Part of border transport elements

- Augments native transport QoS support
  - Preempting transport congestion at the service control layer
  - Protecting on-going premium traffic
- Is applicable to all network controlled applications
  - VoIP, IPTV, etc.

Key Roles of RACF & Major Functions

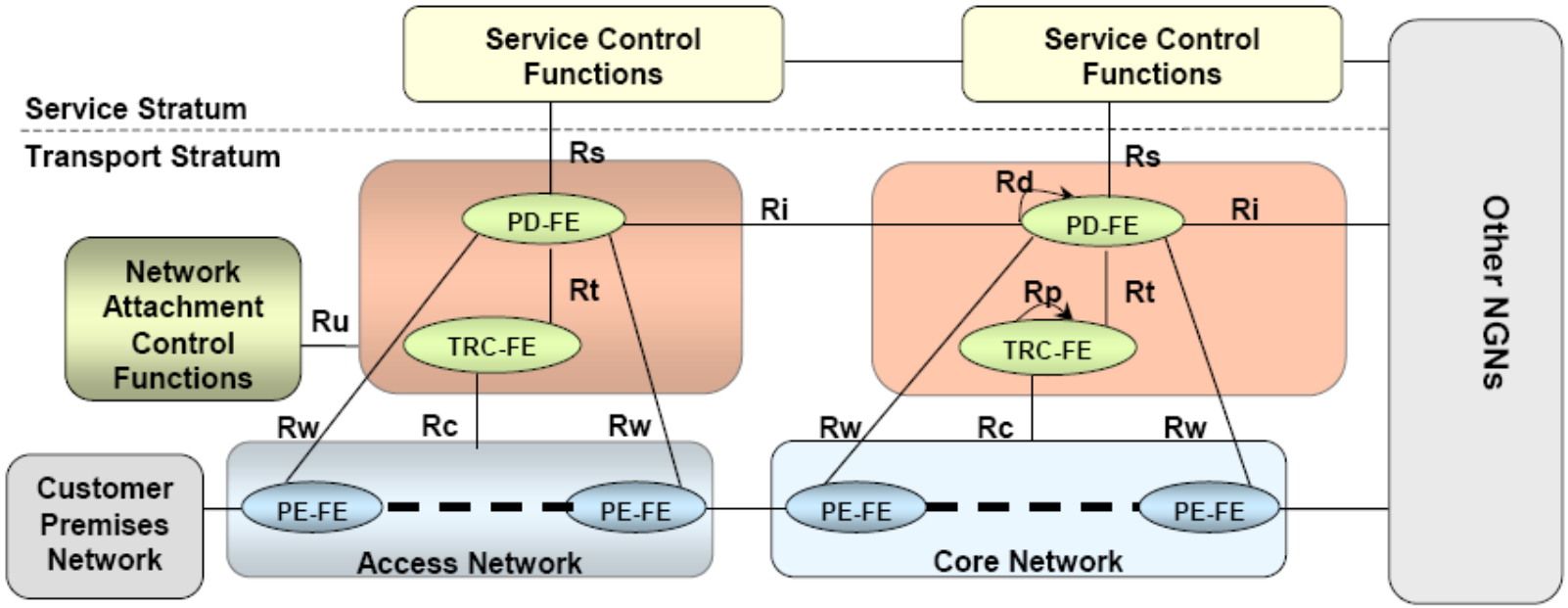
RACF supports

- *Relative* and *absolute* QoS, including *priority*
- Endpoints of varied QoS control capabilities
- *Push* and *pull* models for policy installation
- Multiple transaction models for resource requests
- Various resource management methods based on *accounting*, *measurement* and *reservation*
- *Existing* and *emerging* transport QoS mechanisms

RACF Major Functions

- Policy Decision Function
  - Makes the overall admission decision based on policy and resource availability (including path and enforcement point selection)
  - Applies resource controls to the transport for bandwidth allocation, packet marking, gating, NAPT, etc.
- Transport Resource Control Function
  - Tracks transport resource usage and network topology
  - Resource-based admission control
  - *Applies L2 resource Applies L2 resource controls to the transport*
- Policy Enforcement Function
  - Enforces controls applied by PDF

A Configuration Example



The PE-FE can reside in the

- Gateway GPRS Support Node
- Packet Data Serving Node
- Session Border Controller
- Cable Modem Termination System
- Access Node
- Border Gateway

RACF enables incrementally-deployable end-to-end QoS solutions through per-domain control and inter-domain communication

Traffic Measurement: state-of-the-art

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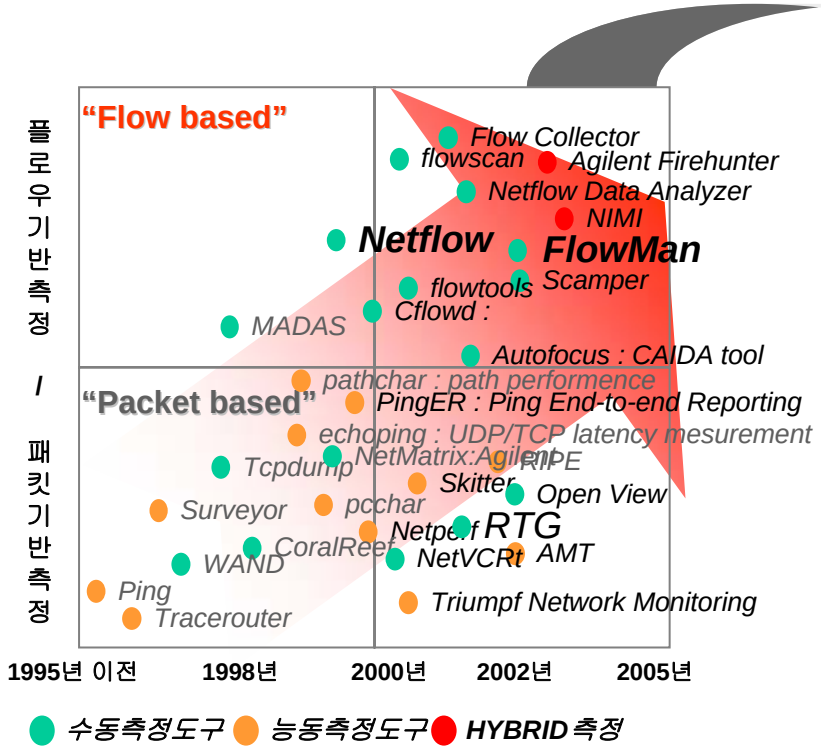
- **트래픽 측정기술의 고도화 방향**
  - ✓ 패킷 기반 측정 → 플로우 기반 측정 (+ 실시간 기반의 응용서비스별 컨텐츠 분류)

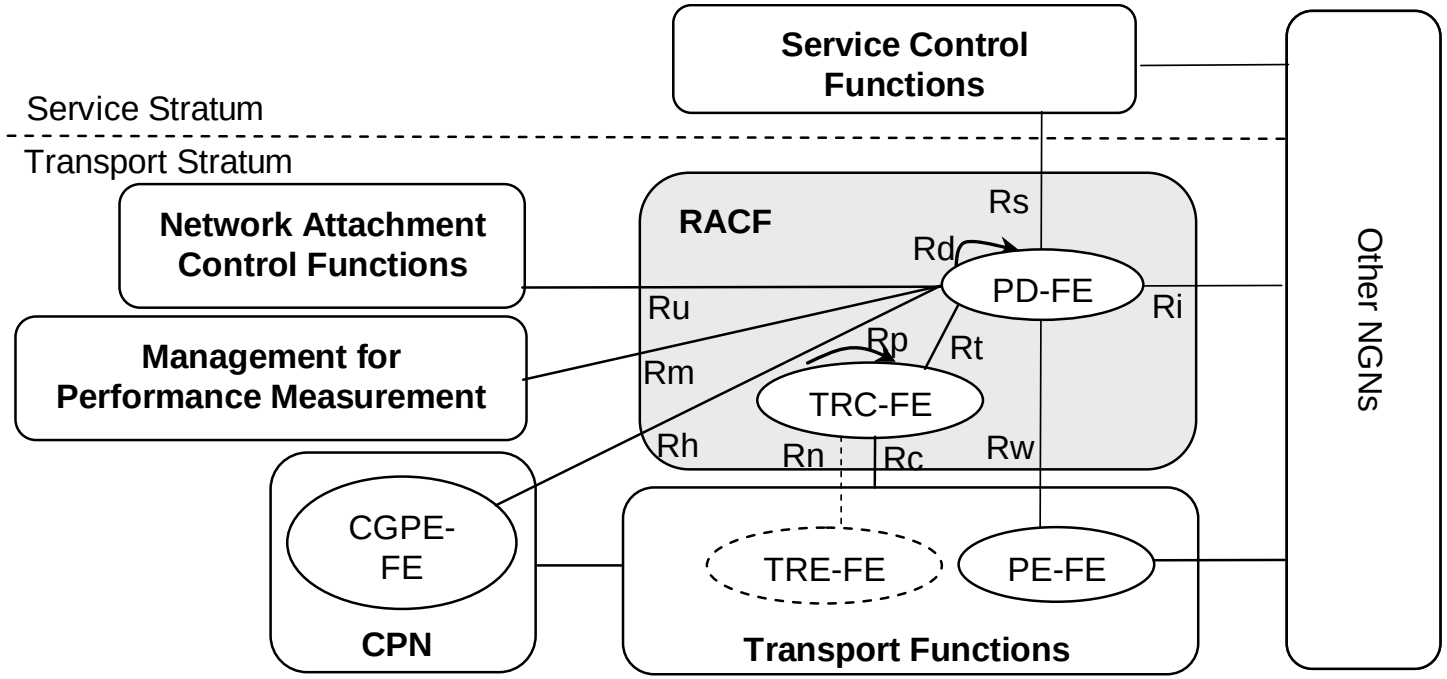
플로우 측정의 확장성, 실시간성, 최소비용 방향으로 고도화



Measurement Methods	Measurement device Type	Scalability	Cost	Real-Time	Metrics
Packet-based	Embedded in Network Element	Low	Low	Yes	IPLR, Packet, Byte count per interface
	S/W Probe in User Terminal	Low	High	Yes	Packet, Byte, other terminal specific metrics (e.g., MOS, etc.)
	Dedicated Standalone Measurement device	High	Medium	No	IPTD, IPDV, IPLR, Packet, Byte count per interface
Flow-based	Embedded in Network Element	Low	Low	Yes	IPTD, IPDV, IPLR per flow
	S/W Probe in User Terminal	Low	High	Yes	IPTD, IPDV, IPLR per flow
	Dedicated Standalone Measurement device	High	Medium	Yes	IPTD, IPDV, IPLR per flow
Content-based	Embedded in Network Element	Low	Low	Yes	IPTD, IPDV, IPLR per flow and applications
	Dedicated Standalone Measurement device	High	High	Yes	IPTD, IPDV, IPLR per flow and applications
OAM-based	OAM based	High	Low	Yes	IPTD, IPDV, IPLR per path

Binding TM and Resource Control & Management

- Bandwidth only based admission control results in coarse level quality control
- Need tightly coupled coordination between TM and RC&M
- First attempt in the standardization activity: ITU-T SG13/Q.4



Approach 1: Link-based Resource Management

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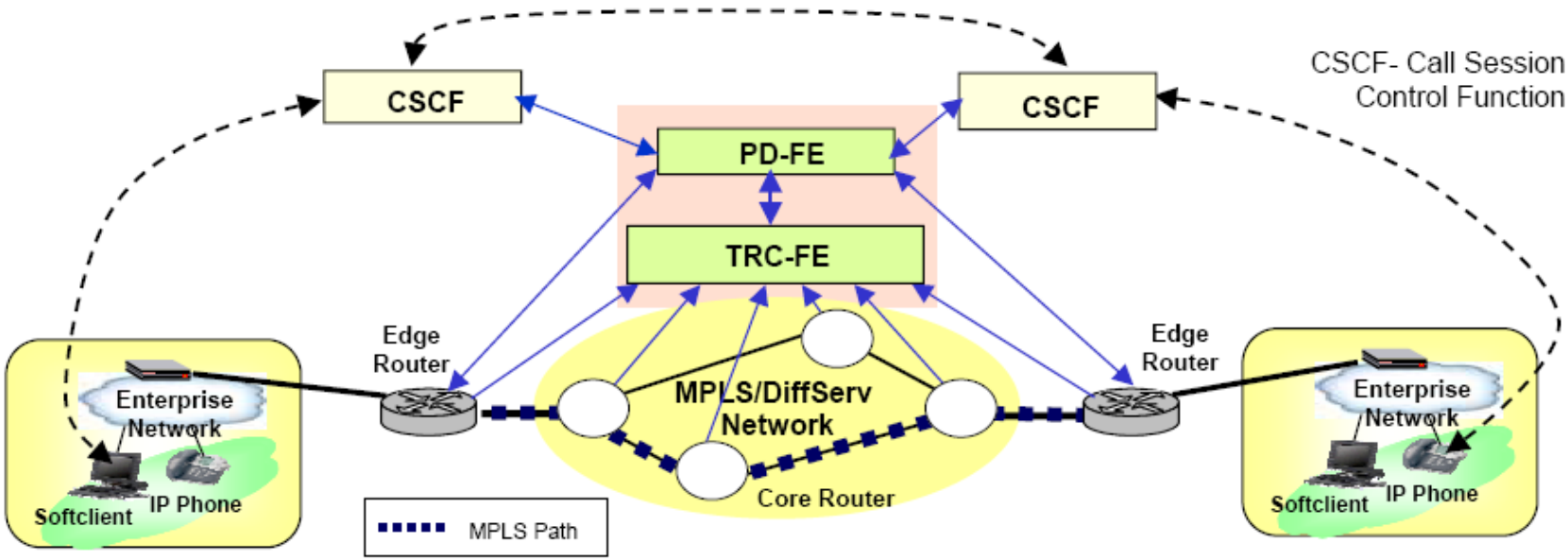
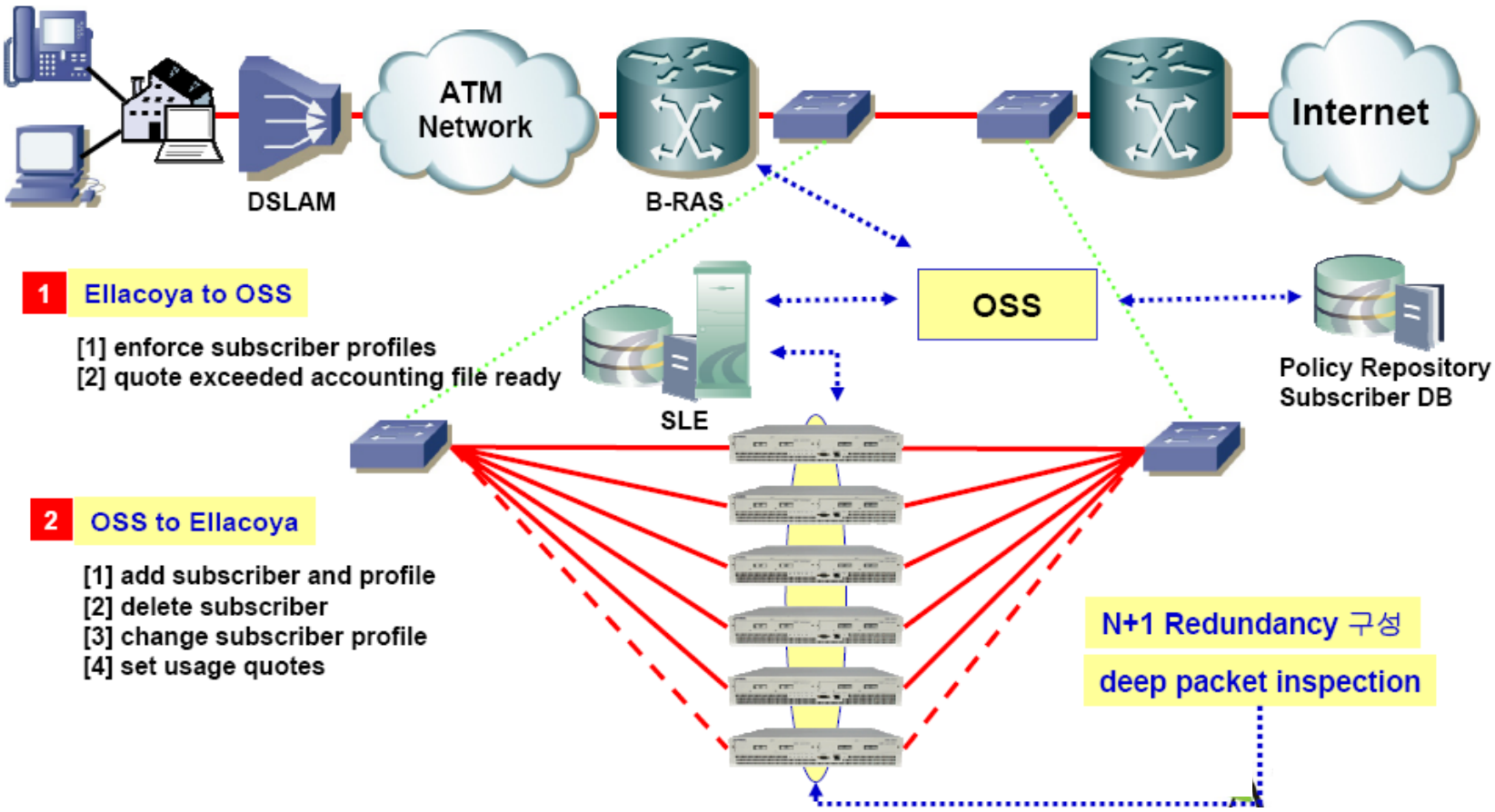


- LSPs are set up a priori for routing traffic of a specific application
- DiffServ is used for effecting desired treatment of traffic
- RACF
  - ✓ Measures link utilization per service class periodically
  - ✓ Formulates blocking policy upon link congestion for affected paths
  - ✓ Makes admission decision per policy
  - ✓ Configures edge routers for the admitted traffic

Approach 2: Ellacoya's BT Business Case



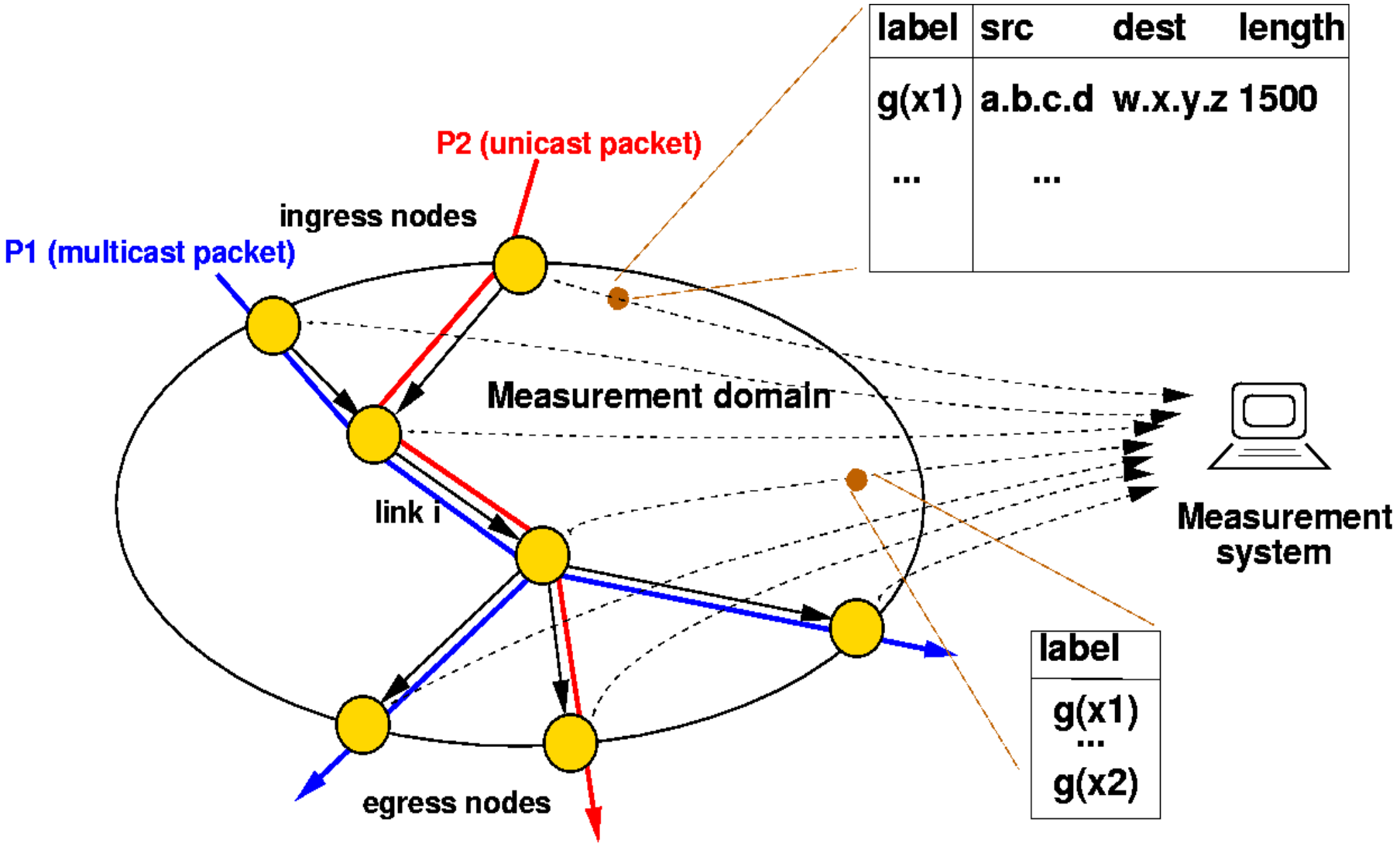
Approach 2: Various Service Models

Basic Speed	256 Kbps	256 Kbps	128 Kbps	512 Kbps
Basic allowance (volume)	10 GB	10 GB	10 GB	10 GB
Boost Speed	N/A	N/A	N/A	1 MB
Boost allowance (volume)	0 GB	0 GB	0 GB	1 GB
Action on Basic allowance exceeded	2 MB Game service suspended	Only Email and access to top-up pages allowed	Web traffic Rate-limit to 128K	Rate Limit 64K except for traffic to affiliated news sites
Time exclusions	None	None	None	None
Traffic exclusions	Traffic to affiliated gaming servers boosted to 2MB	Email traffic doesn't count towards volume allowance	Web traffic boosted to 1MB	Traffic to affiliated news sites free
Basic volume cap	20 GB	10 GB	20 GB	25 GB
Boost volume cap	N/A	N/A	N/A	10 Hrs
Boost time cap	N/A	N/A	N/A	N/A
Volume top-up unit size	1 GB	1 GB	0.5 GB	0.5 GB
Time top-up unit size	N/A	N/A	N/A	N/A

Approach 3: Cisco's Quantum Flow Processor

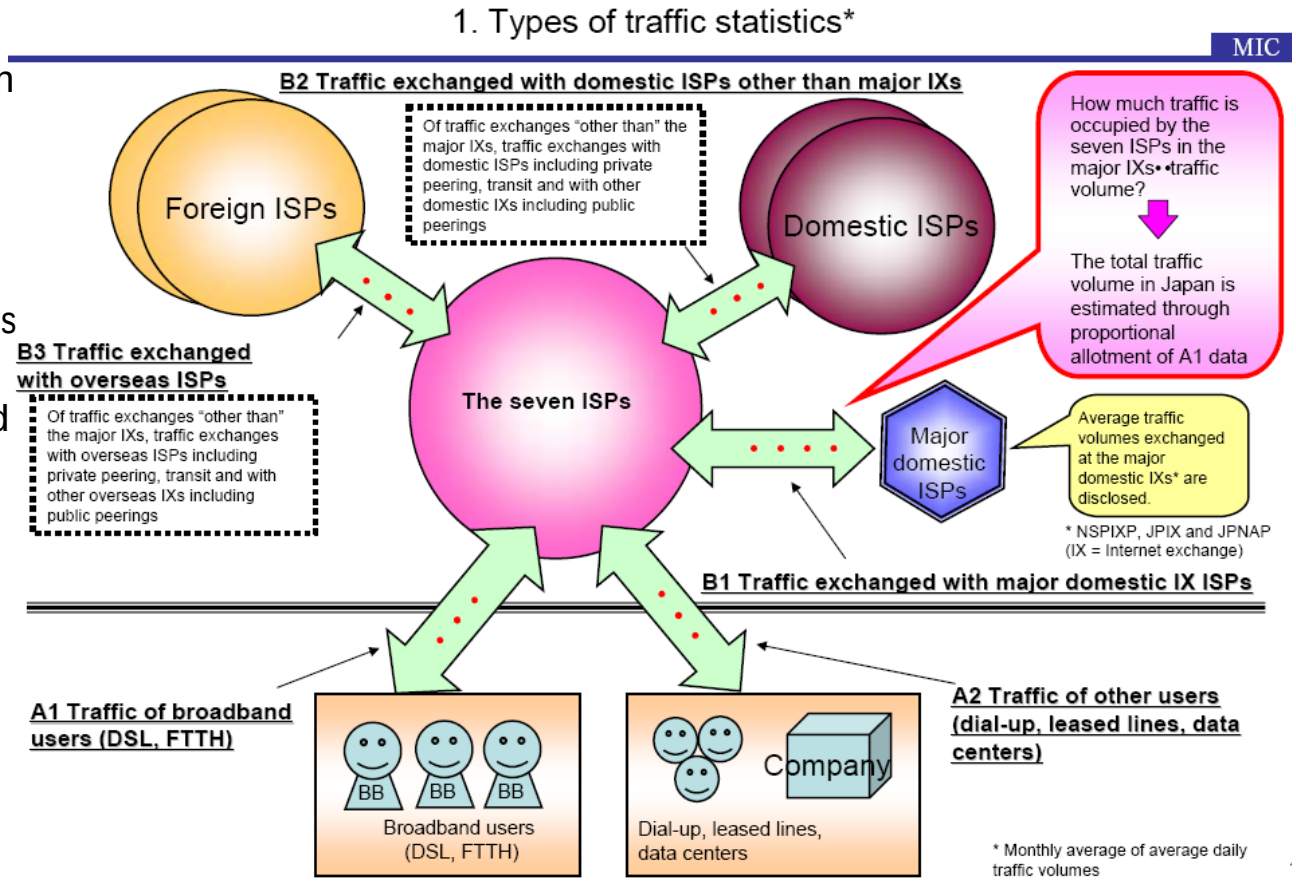
- 40 Tensilica cores and 1.3 billion transistor ASIC
- Aims to perform flow processing not packet processing in a wire speed
- Target is an edge device and flagship product is ASR1000 (Aggregation Service Router)
- Spent $250 ($100 for Quantum) million and 5 years for Development
- Handle 20Gbps DPI, firewall, IPsec, and SBC functionality
- Try to squeeze over dozen boxes for such functions into a one small form factor box

Approach 4: Trajectory Sampling



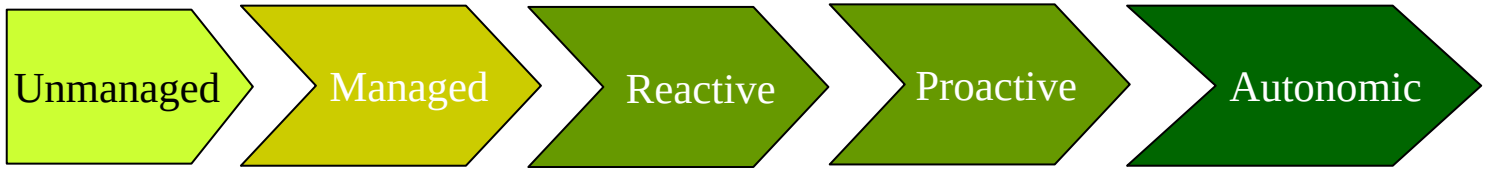
Approach 5: WIDE

- WIDE(Widely Integrated Distributed Environment)
  - Japan's Internet Research Consortium
  - Has been 20 years
  - Hundreds organizations and around 600 researchers and engineers participating
  - Funded mostly by SPs and vendors
  - Major facilities managed by WIDE
    - International links, IXes, Root Name servers, etc.



Issues of the Current Approaches & Challenges for the Future Internet?

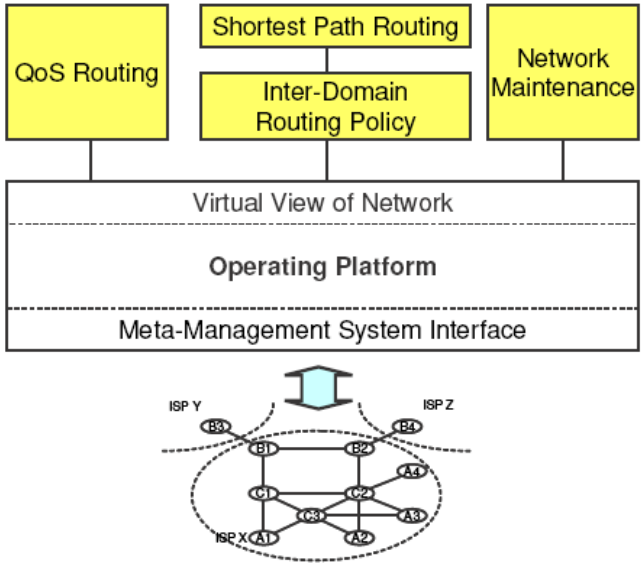
- Most measurement-based Resource control approaches are point solutions to specific problems
- Mainly because of lack of support from the network (e.g., most current routers and switches do not have such capabilities)
- Less granular and accurate measurement at network level, especially at the high-speed environment
- Management of the Future Internet will require customer centric and service oriented autonomic solutions

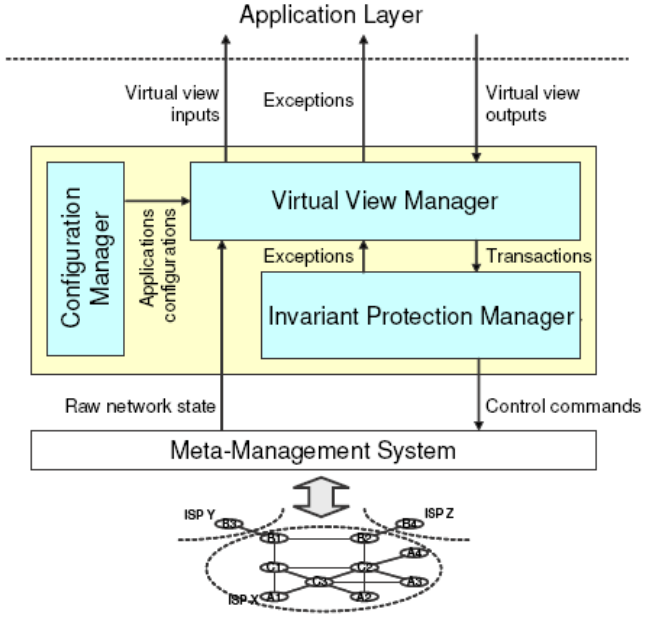


- Challenges for the Future Internet is how to support such requirements at the network architecture level
- Especially when virtualization becomes norm in the Future Internet, measurement-based resource control and management will be essential component

Approach 6: FIND Maestro

- **Maestro: An Architecture for Network Control Management**
  - Operationally independent, self bootstrapping management plane
  - A single, simple management interface for all data plane protocols
  - High-level, goal-directed specification of network properties and policies





Approach 7: FIND Hashing Infra for ME&MO

- A Network-Wide Hashing Infrastructure for Measurement and Monitoring
  - What types of measurement and monitoring tasks have effective solutions based on hashing?
  - What types of hashing data structures are most efficient for these tasks?
  - What would be the best form for the underlying hardware and architecture for a general-purpose network hashing infrastructure?
  - How can this infrastructure be made to universal among network devices, and what power would this give for network-level monitoring tasks?
  - What type of language, control structures, and hashing primitives should users have to leverage this type of architecture most effectively?
  - Objective:
    - Provide intrinsic capability of self-measurement and self-monitoring
    - Provide simple, flexible, cost-effective hash-based management infrastructure

Thank you for your attention

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