ETRI
Electronics and Telecommunications Research Institute

Flow based control for Future Internet

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- Motivation and current status of flow base network control
- Introduction on Flow State Aware technologies
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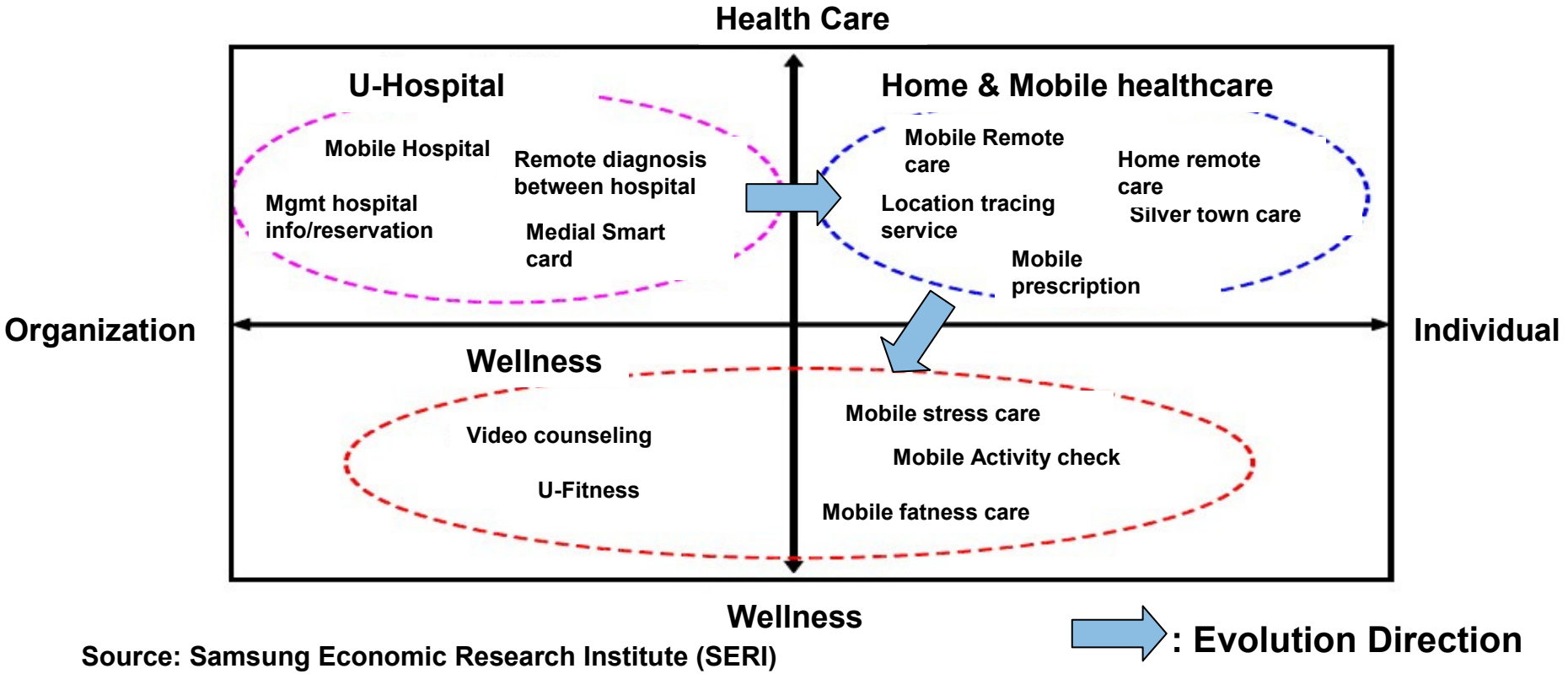
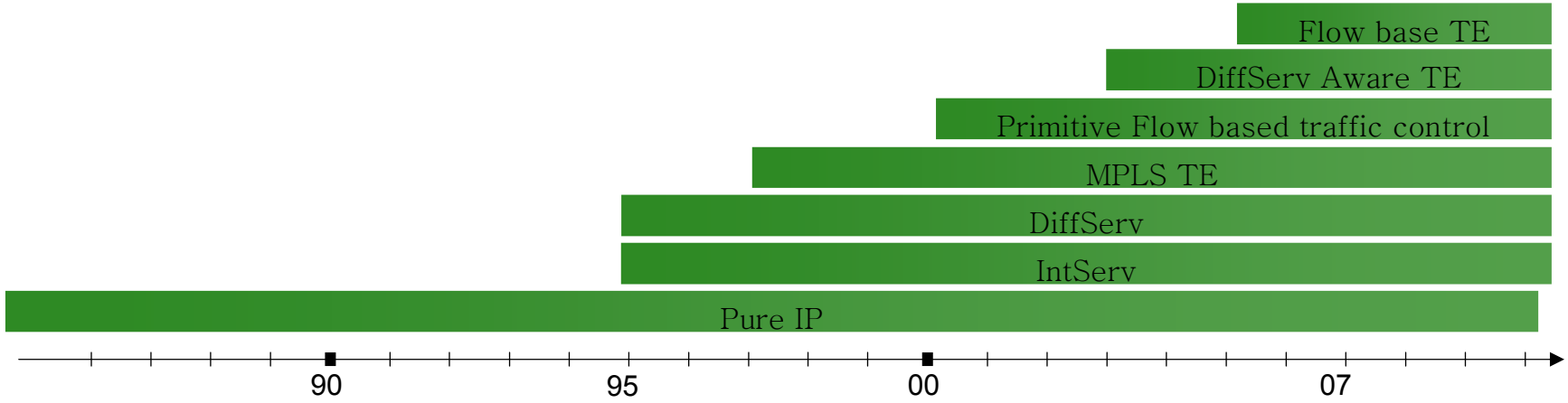
Future Internet services



Source: Samsung Economic Research Institute (SERI)

- Future Service Trend
  - ★ Limited customer -> general public
  - ★ Typical service -> personalized service
- ICT's requirement for the future services ?

Evolution of Internet QoS Control



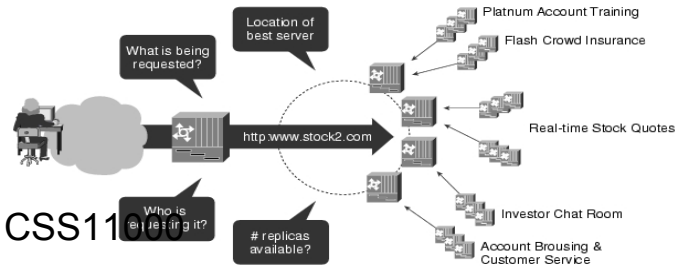
Technologies	Motivation	Real Implementation	Routing	Scheduling
Pure IP	Packet based network Distributed control	Intra domain routers	Destination Address (DA)	Single Queue
DiffServ	Class based differentiation Stateless	Scheduler, DSL forum	DA	Priority based scheduling
IntServ	End to end QoS	LSP setup, Access network	DA	Session Based
Primitive Flow based Control	Advance of NP	Edge Router	DA	Flow based queuing and scheduling
MPLS TE	Improve DA based forwarding	Core Network	LSP	Single Queue
DiffServ Aware TE	Class based control + TE	DiffServ + MPLS	LSP	Per class queue Priority base schedule
Flow based TE	Managed IP network	Flow based control + managed forwarding	Flow + aggregate flow	Flow base control in access Aggregate flow at the core

Flow base control product - chipset

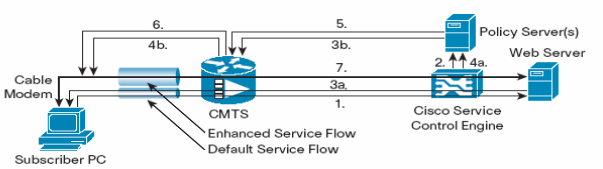
Companies/ product	Flow queue structure	Technology
Ezhip NP2	thousands of queues in multi-level hierarchies.	Advanced flow-based bandwidth control with WRED congestion avoidance, traffic metering, marking, and policing, and granular shaping and scheduling.
AMCC nPX5700	Up to 512K flows, Up to 64K virtual pipes, hierarchical scheduling	multiple levels of bandwidth provisioning and per-subscriber guarantees
Agere APP550TM	128k VCs or packet flows.	Class-based scheduling based on strict priority, weighted round robin (WRR), and deficit weighted round robin (DWRR). Performed as a standalone scheme or in conjunction with the rate shapers.
Motorola Q5	256k flows	per-flow scheduling with four levels of hierarchy
Sandburst QE-1000	Up to 2000 flow queue	The device supports DiffServ traffic management with up to 2,000 flows. The packet scheduler is tightly coupled to the switch fabric to ensure maximum system throughput
Vitesse IQ2200	500K flow queue	PaceMaker supports per-flow shaping and queuing with up to 256,000 flows.
Dune networks	??	Per-flow queuing service model with fine-grained scheduling and shaping
IDT 89TTM55x	1M flow queue	Queuing for each flow, using external memory. Configurable mapping of FLQs into aggregate flow queues. Two-level FLQ scheduling mode supports up to 128K or 256K virtual pipe or subscriber queues with up to 8 or 4 CoS priority queues each.

Implementation of Flow base control Technology

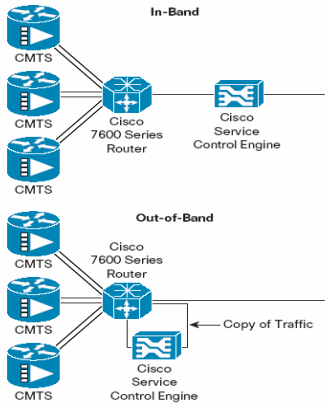
- Monitoring : Netflow
- Packet Inspection : Monitoring the suspicous traffic
- PacketCable : QoS control in the cable access
- Session Border Controller : VoIP session control
- Edge router : network policy enforcement
- Interworking : Interworking between two network. E.g., circuit and packet switching network.



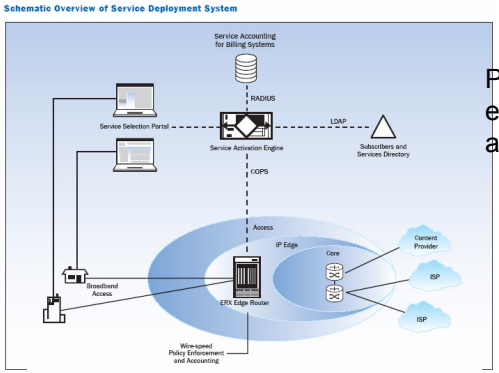
CSS 11000 control architecture



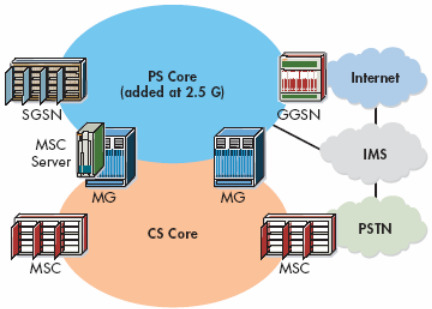
PCMM control architecture



Deep Packet Inspection



Policy enforcement at the edge

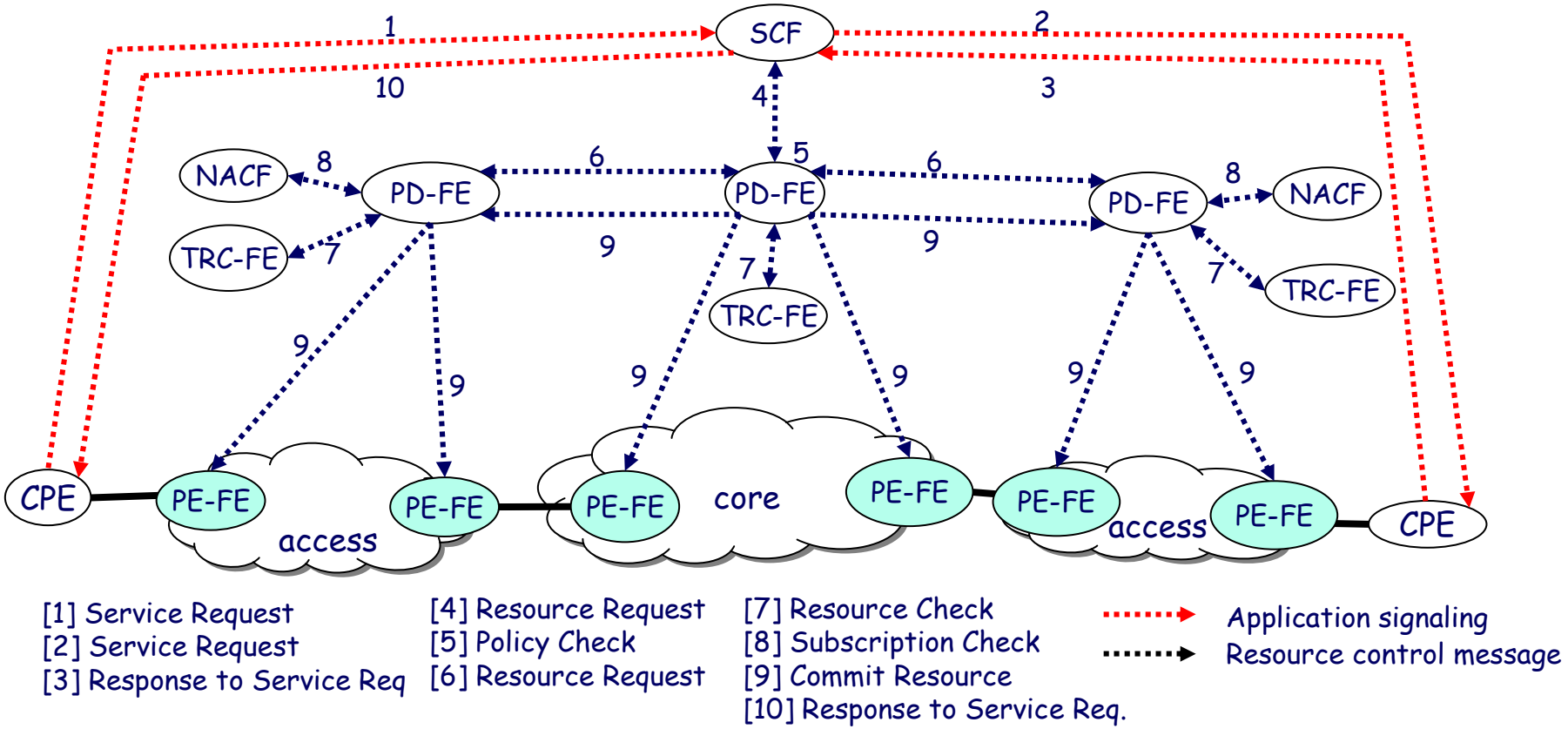


Media gateway

QoS control architecture

	Control Region	Transport technologies.	Static or Dynamic	Feature.
ITU-T RACF	core network, access network	Transport technology independent.	Dynamic	Call level control and the aggregate level traffic control QoS control for both the core and access network
ETSI RACS	Access network, edge of the core network	Transport technology independent	Dynamic	Call level control Access network and edge of the core network
MSF	Core network	DiffServ or the MPLS base core network.	Dynamic	Call level control and aggregate traffic control. Interoperability of multiple service and network providers.
PacketCable	Access network	Cable network	Dynamic + Static	Combine the call setup signaling and control of the cable transport access network.
DSL forum	Access network	DSL network	Static	Configuration based QoS control Differentiated service using DiffServ
3GPP	Access network	GSM network	Dynamic	IMS based session and service control

QoS control in ITU-T NGN



- Flow based control at the edge of the network

Problem in Edge only control

- DiffServ base control guarantees QoS only if the premium traffic load is very low (10%).
  - ★ Ref) I. Stoika and H. Zhang, "Providing guaranteed services without per flow management", in CM SIGCOMM, Sept, 1999, pp. 91-94
- As the size of Internet increase, the traffic uncertainty increases
- Cannot guarantee the low traffic load in the dynamic condition
- Edge node control cannot achieve the end-to-end QoS
- Flow State Aware (FSA) technology is proposed as a solution of flow base network control mechanism.

Quick Summary of FSA

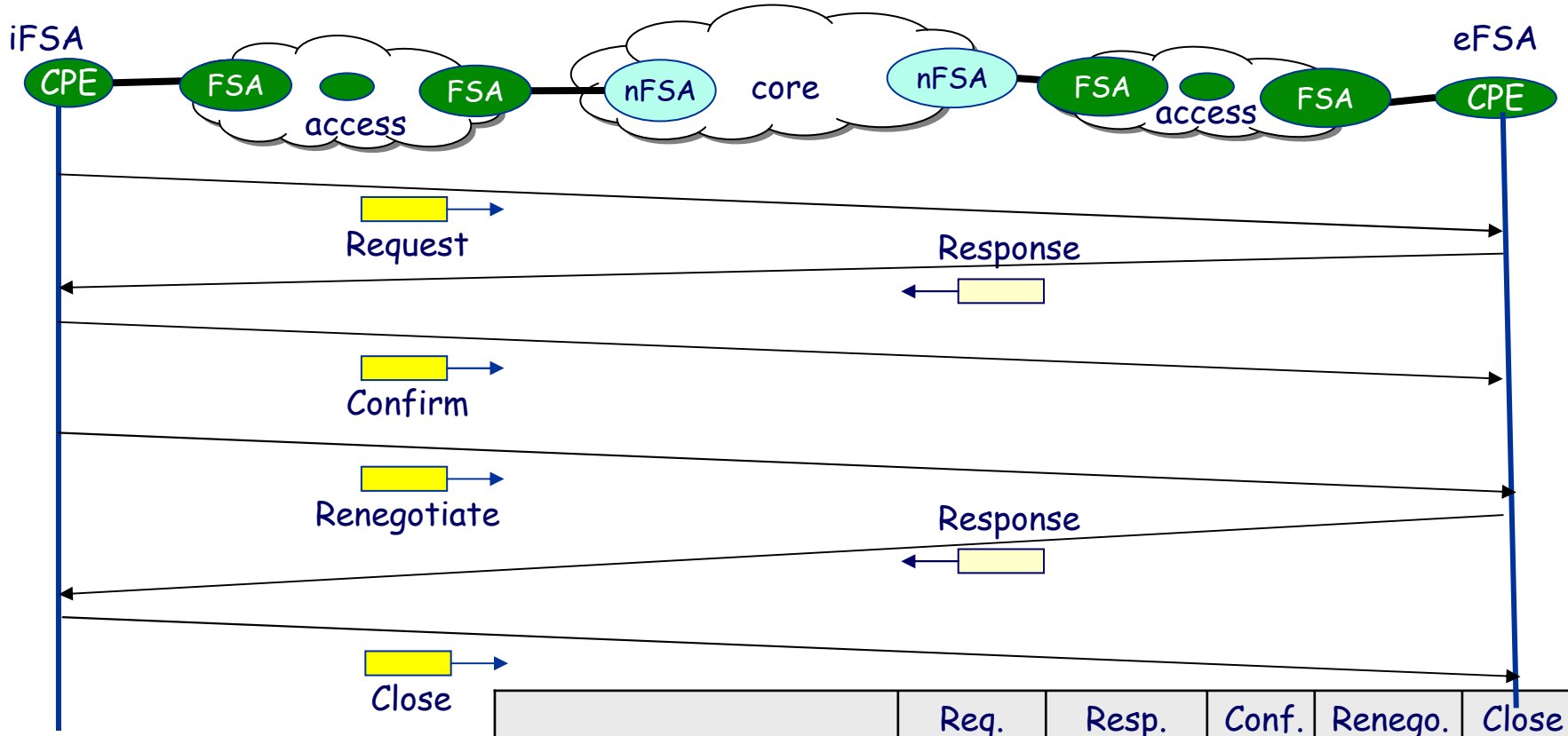
- FSA specify service type and requirement for flow base traffic control
- Signaling mechanism is defined based on in-band signaling, i.e., data packets carries the control information
- Define several Service Type based on typical example of Internet services
  - ★ Maximum Rate : MR
  - ★ Guaranteed Rate : GR
  - ★ Variable Rate : VR
  - ★ Available Rate : AR
- Being actively discussed in ITU-T NGN-GSI SG13 Q4
  - ★ Y.flowreq "Requirement on Flow State Aware technologies"
- Major Contributors
  - ★ BT, ETRI

Basic concept – Fixed Rate (FR) and Network Rate (NR)

- FR (Fixed Rate): when flow needs a fixed rate available duration of the flow
- NR (Network Rate): when flow sends buffered data using network available bandwidth.

- Service Type and FR/NR
  - ★ GR: FR
  - ★ MR: FR
  - ★ AR: NR – NR is set to the highest rate that the application can support
  - ★ VR: FR+ NR – FR specifies the minimum required rate

Basic Flow setup/release Signalling

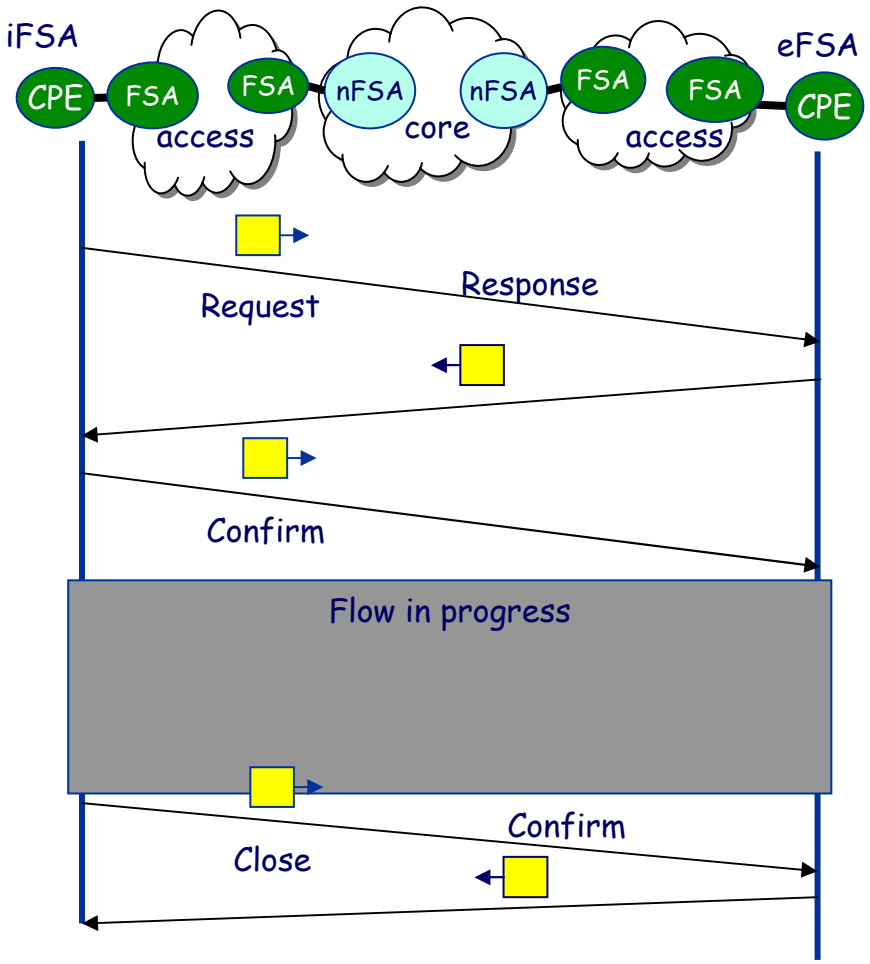


	Req.	Resp.	Conf.	Renego.	Close
MR (Maximum Rate)	o	optional			
GR (Guaranteed Rate)	o	o	o		o
AR (Available Rate)	o	o		o	
VR (Variable Rate)	o	o		o	

iFSA : Ingress FSA node
eFSA: egress FSA node
:FSA node
:Non FSA node

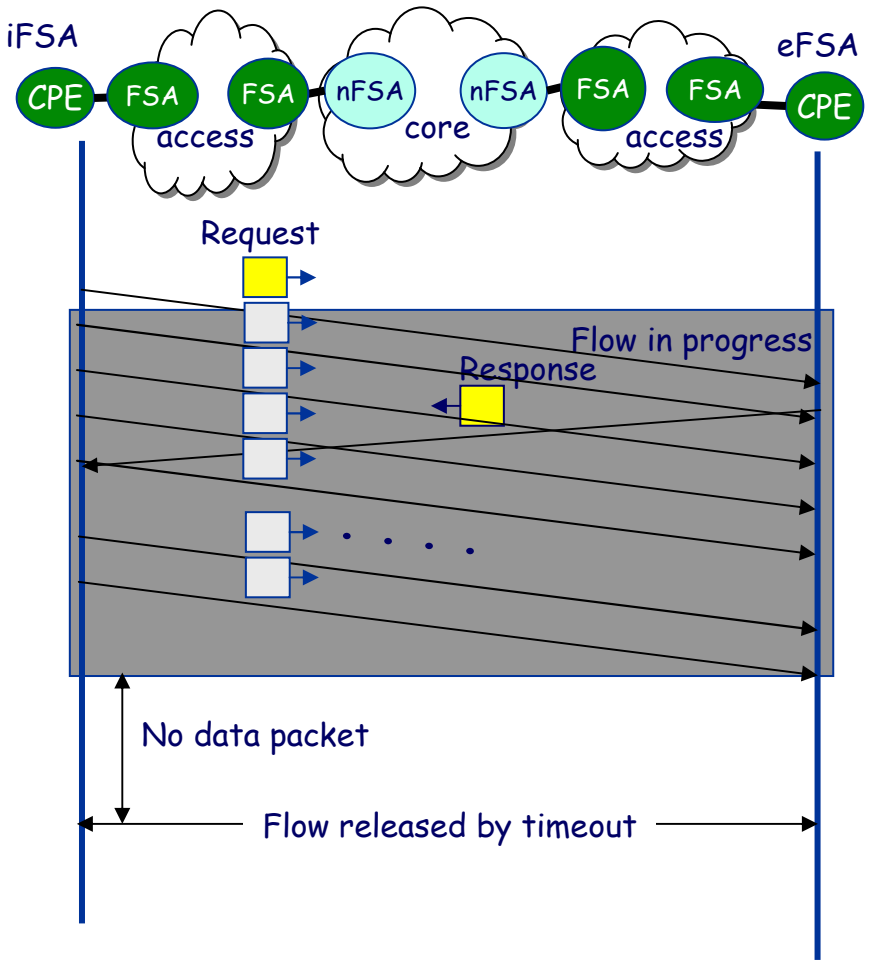
GR (Guaranteed Rate)

- Designed for applications requiring guaranteed bandwidth for the entire duration of the flow
- The network knows the exact QoS parameter and service time of the flow.
  - ★ Explicit service time management is require.
  - ★ Two additional message is required: “Confirm” for the start time and “Close” for the ending time
- Setup Procedure
  - ★ Before starting flow, iFSA sends request to eFSA with requested FR.
  - ★ eFSA sends a response back to the iFSA with the requested FR or a lower rate
  - ★ iFSA sends a confirm packet after receiving the response to tell all routers the final agreement.
- Release procedure
  - ★ iFSA sends additional close packets after short timeouts until a close confirm is received
  - ★ eFSA confirms the close to insure that there are no lost close packets.



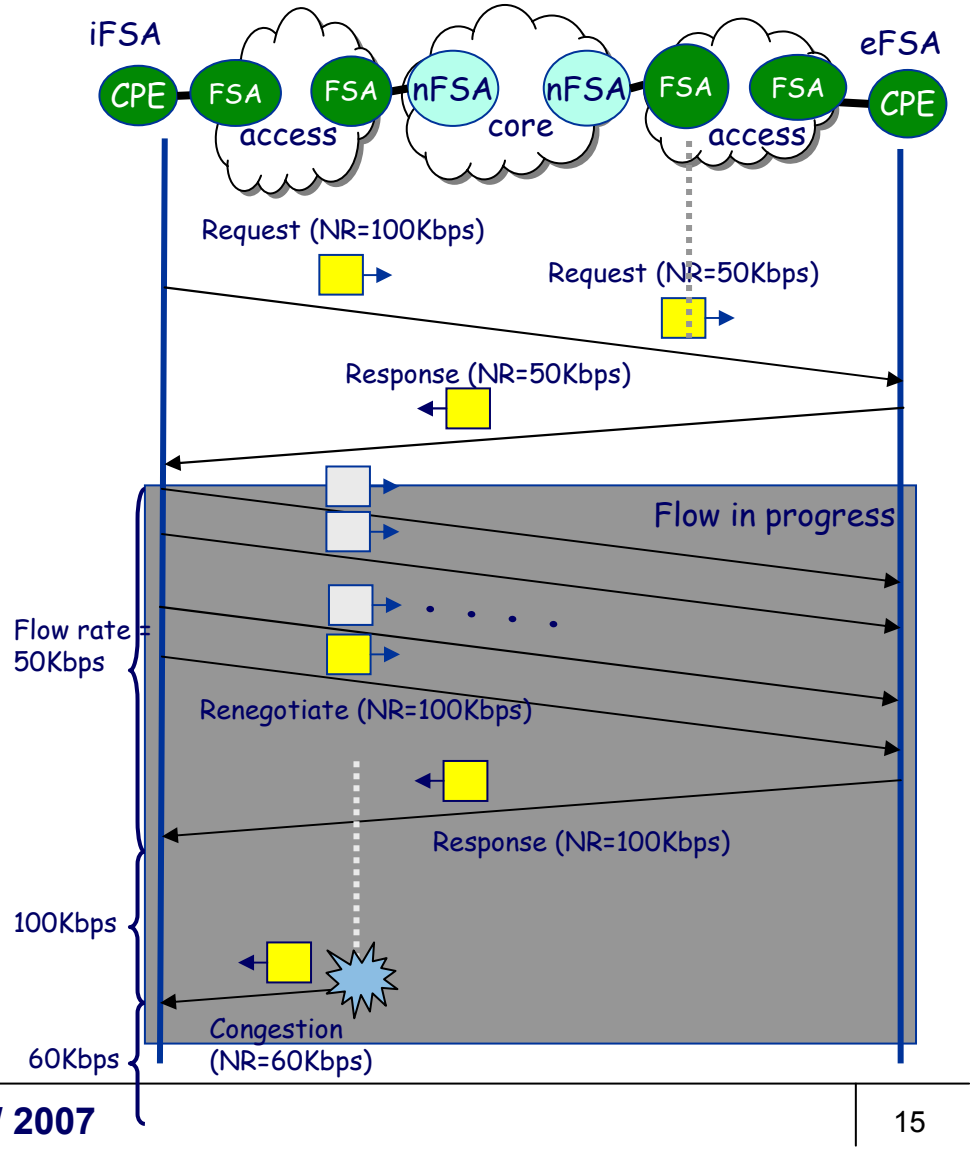
MR (Maximum Rate)

- Designed for video, voice, or other streaming media.
- The routers are accept MR based on statistical sum.
- Total traffic exceeds the trunk capacity can cause packet drop.
- Immediate transmission option: iFSA need not wait for a response and can send traffic at the requested FR immediately after the request.
  - ★ iFSA can transmit at any rate up to the specified FR in the request.
  - ★ Above this rate, packets may be discarded by the policer.
  - ★ The eFSA sends a response reflecting the rate received, or lower rate if desired.
- No confirmation is required at the setup time.
- Closed by timeout of the period of no data. No close is required.



AR (Available Rate)

- Typically used for data traffic flows It sets up a flow at the maximum rate the network can currently support.
- iFSA sends a renegotiate with the NR rate set to the maximum rate that the application or computer can support.
- Transit FSA node forwards the request and can reduce the requested NR to a rate they can support.
- eFSA sends a response to iFSA with a maximum rate it chooses to support.
- Once receiving the response, iFSA sends data at the rate less than the latest NR in the response.
- iFSA initiates and periodically repeats the request.
- FSA nodes along the path always updates the their NR with each periodic request/ response.
- Any FSA node sends a Congestion Notification to iFSA for reducing AR flow rate
- Same concept as ABR in ATM



VR (Variable Rate)

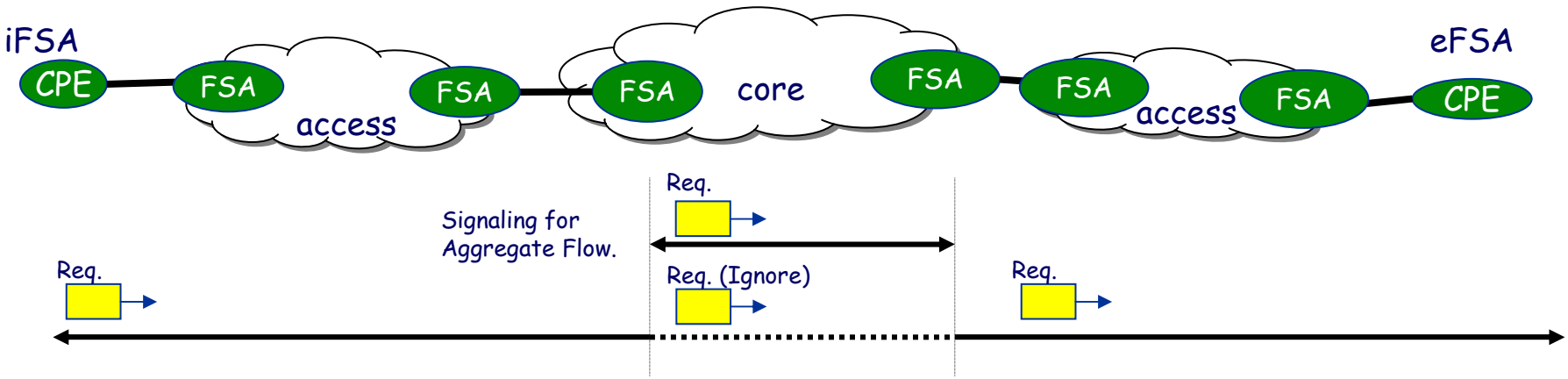
- Designed for obtaining a minimum response time for a transaction. For example, a stock trade may be required to be transacted or reported in some minimum time but faster is better.
- Combination of MR + AR
- iFSA sends two requests – for MR and AR
  - ★ The initial minimum rate request and response is treated like an MR request.
  - ★ Subsequent request after the initial signal is interpreted as a request for an AR one top of the previous MR request.
- The rate allowed for a VR service flow is NR plus FR.
- VR flows are expected to be treated like AR flows except for their minimum guaranteed capacity which shall be treated like MR.
- FR portion is a minimum required rate for the VR flow.
- No confirmation is required.

QoS parameters

- Delay priority
  - ★ Typically video and voice require lower delay variance than file transfer but there may be many other services with many different requirements.
- Preference priority:
  - ★ To indicate which flows should be admitted in case of network overload. In network overload state, flow with the lower preference priority can be rejected while the one with higher preference priority level still admitted.
- Packet Discard Priority:
  - ★ at least two values (discard first, discard last)
- Burst Tolerance
  - ★ If the transmission rate momentarily exceeds the agreed rate, it is typical in packet networks to include some tolerance for burst of packets.

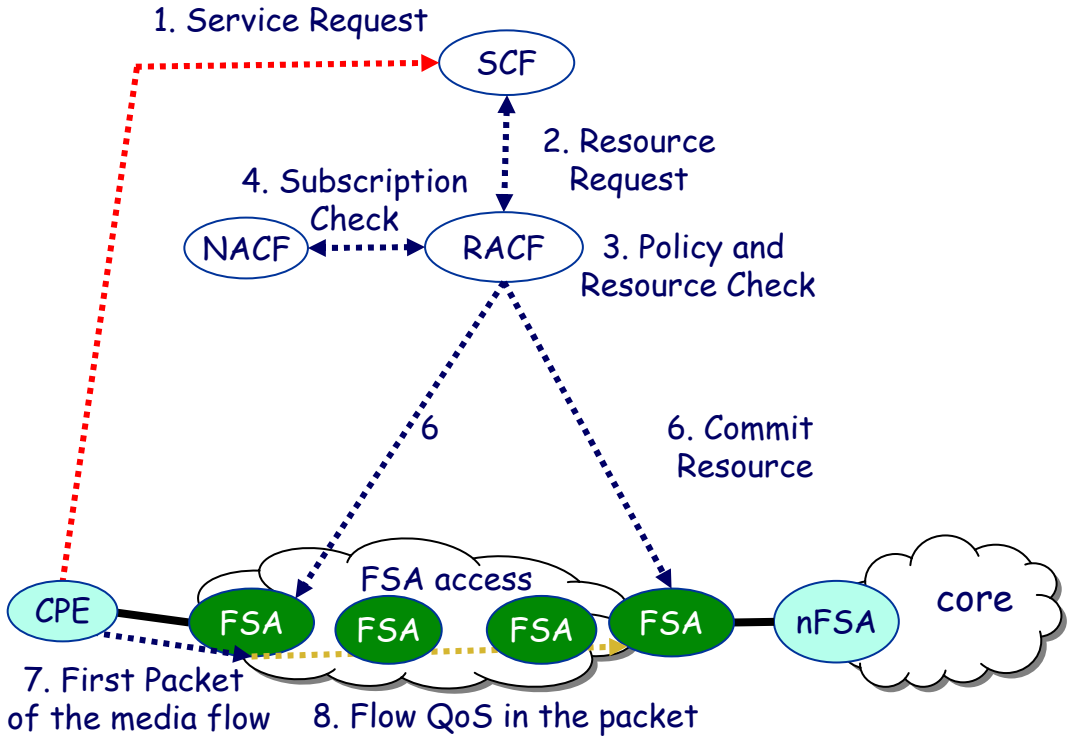
Other parameters

- Flow Identity :
  - ★ combination of parameters “source IP address”, “destination IP address”, “source and destination port numbers”, “protocol”, and “experimental/ Diffserv value” as a basis for a flow identity.
  - ★ Alternative method for carrying flow identity for aggregated flow is possible (e.g., MPLS LSP)
- Charging direction:
  - ★ In order to allow services where the flow is paid for by the receiver, a charging direction indication is needed.
- Ignore
  - ★ This indication enables aggregated signalling, such that the end-to-end signalling messages are hidden from (ignored by) the core nodes.



Simplified FSA

- Major overhead:
  - ★ Overhead of in-band signaling
  - ★ Requirement for FSA capable terminal
- Solution:
  - ★ Signaling overhead is distributed to the control plane (e.g., RACF).
  - ★ With the resource estimate of RACF, message overhead for response or confirm is not required.
  - ★ FSA functions starts from the edge node.
- Requirement:
  - ★ Hardware technology to implement automatic flow control when receiving the first packet
  - ★ Edge-to-edge QoS is configured dynamically

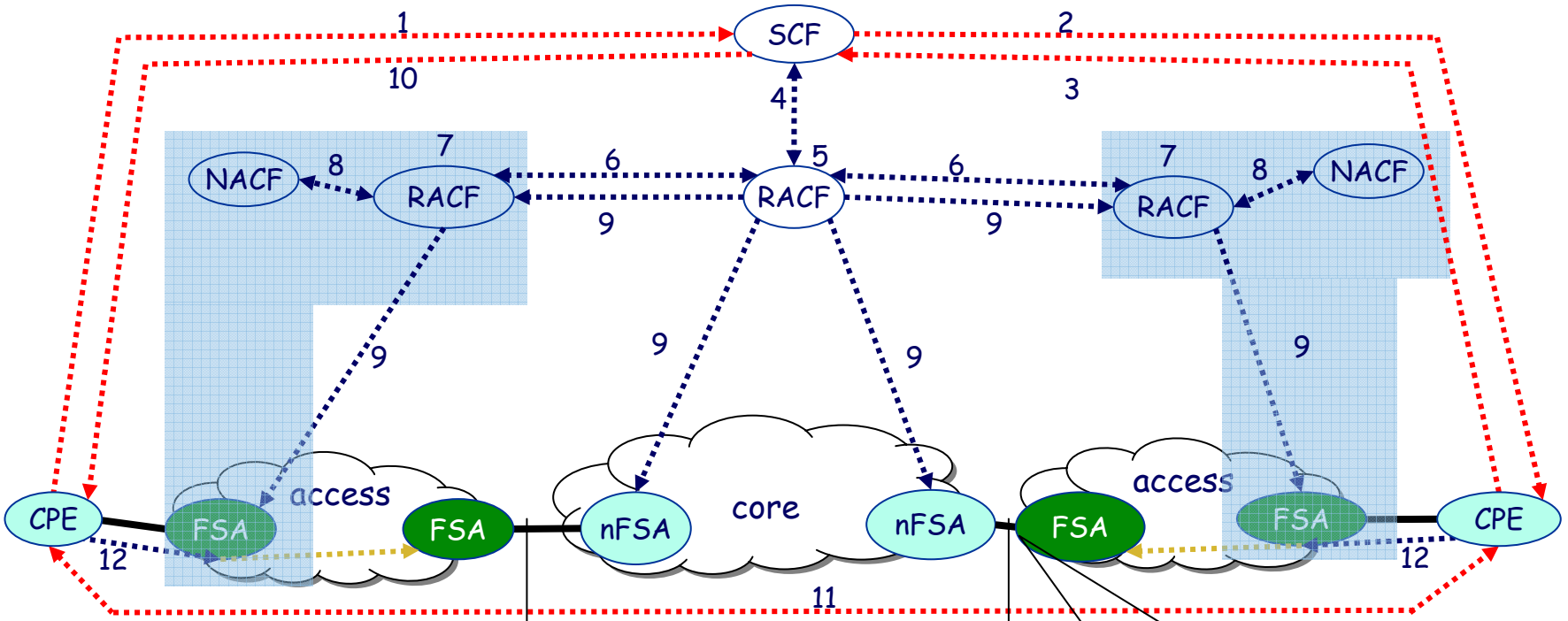


Acronyms
SCF: Service Control Function
NACF: Network Control Function
RACF: Resource and Admission Control
CPE: Customer Premise Equipment
(n)FSA: (non) FSA node

Potential e-2-e Solution

[1] Service Request
[2] Service Request
[3] Response to Service Req
[4] Resource Request
[5] Resource/Policy Check
[6] Resource Request
[7] Resource/Policy Check
[8] Subscription Check
[9] Policy push
[10] Response to Service Req.
[11] Confirm service request
[12] first packet

Application signaling
Resource control message
FSA signaling

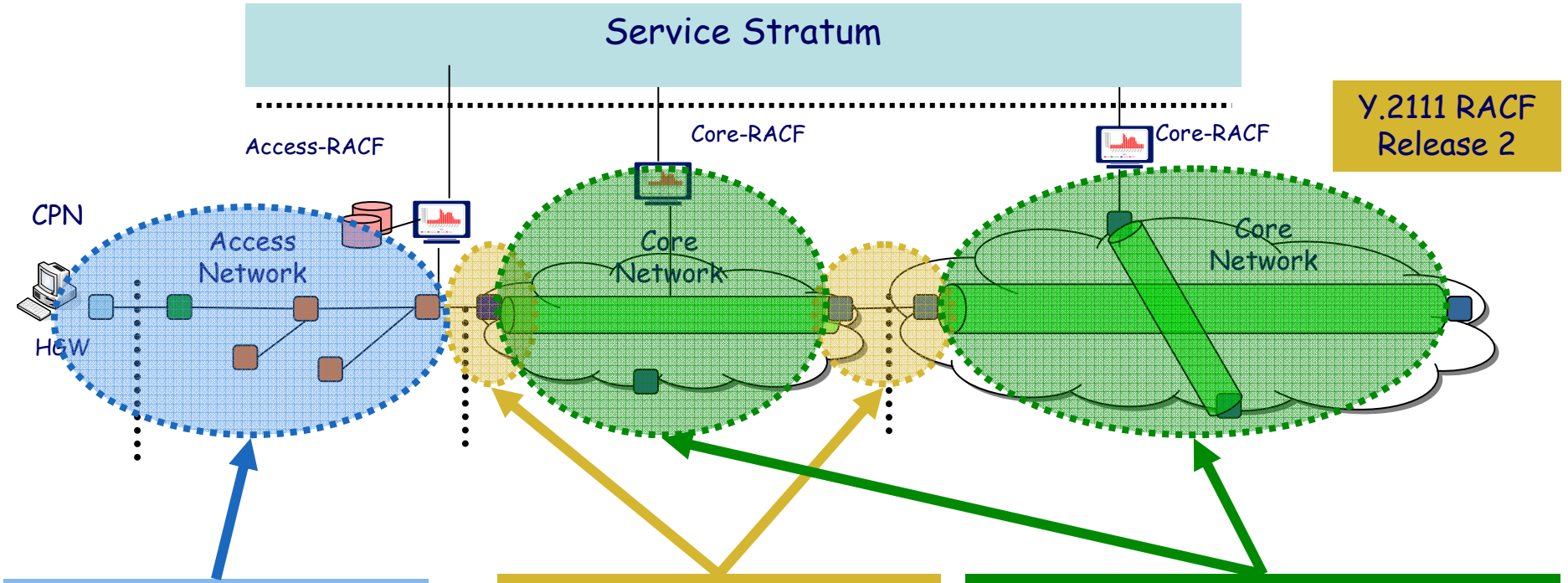


non FSA terminal
FSA based control in access
Simplify FSA signaling using RACF
PD-FE+TRC-FE+NACF in the FSA node
Termination/Proxy signaling mode
VLAN or Priority aggregation for Temp.

T-MPLS based aggregate FSA
Reliability and Monitoring
Selective call rejection
On demand LSP bandwidth control
Minimize call-by-call control

Policy base dynamic FTN setup
Signaling aggregation
Traffic aggregation/de-aggregation

Overview standard activity for flow base control



Summary

- Flow level control is desired for the personalized and converged future service
- FSA technologies defines the in-band control mechanism for flow based control.
- FSA defines 4 service types (GM, MR, VR, and AR)
- For end-to-end resource control, FSA technologies can play an important role to simplify the control mechanism.
- Overhead of the in-band signaling can be reduced by combining network resource control defined in ITU-T RACF
- Further effort is needed in following areas,
  - ★ Improving control scalability by traffic/signaling aggregation
  - ★ End-to-end and edge-to-edge performance monitoring
  - ★ Flow base seamless mobility support

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Thank You

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