3G Mobile Core-network Evolution for IP based Environment

April 8, 2004

Makoto Furukawa
IP Core Network Development Dept.
NTT DoCoMo, Inc.

Overview

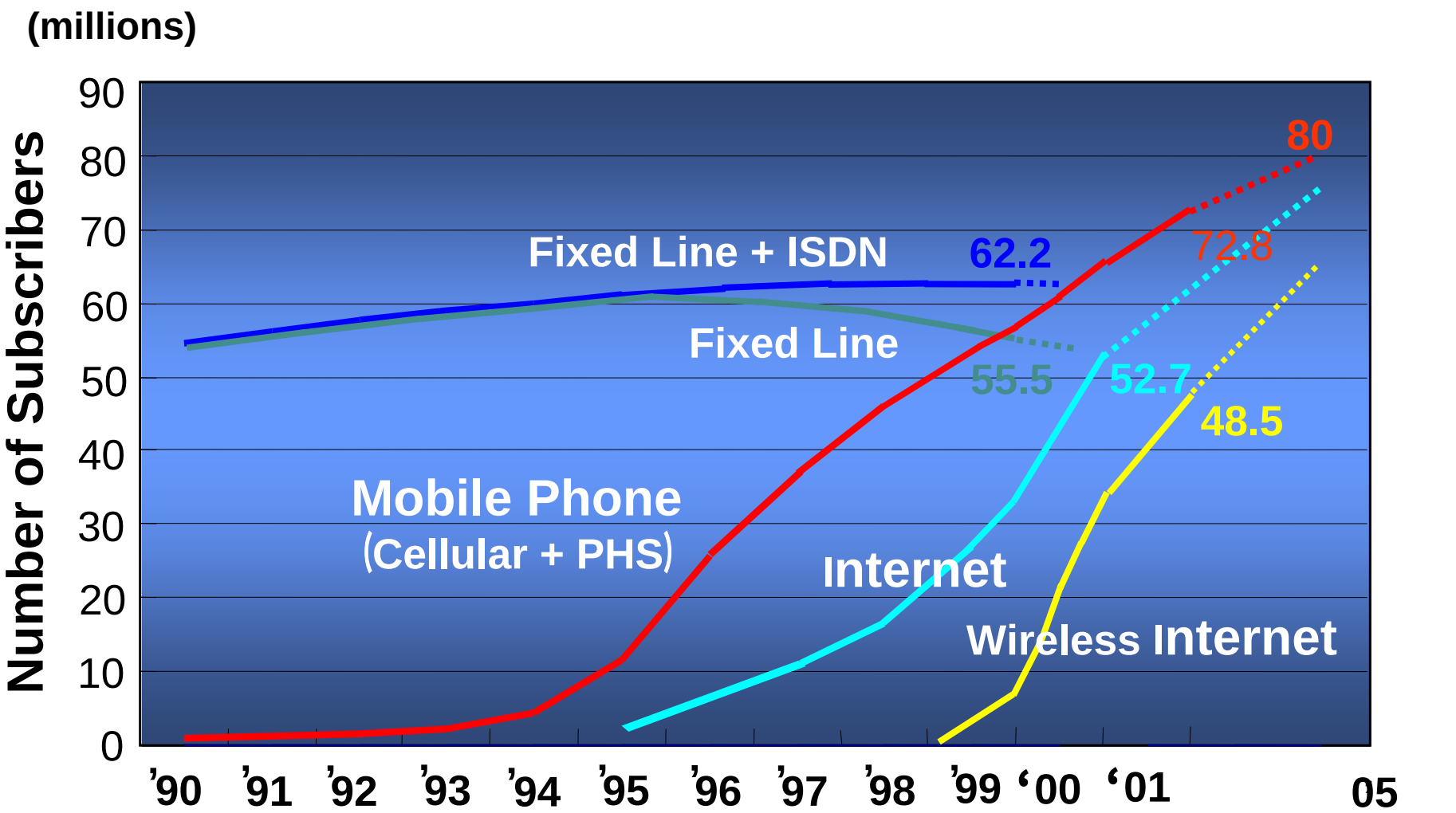
- Evolution from a CS&PS integrated ATM-based Network to an independent IP-based PS Network

[Contents]

1. Introduction to DoCoMo's 3G Network
2. Need for an Independent PS domain Evolution
3. Method for Independent PS Network Evolution
4. Future Issues

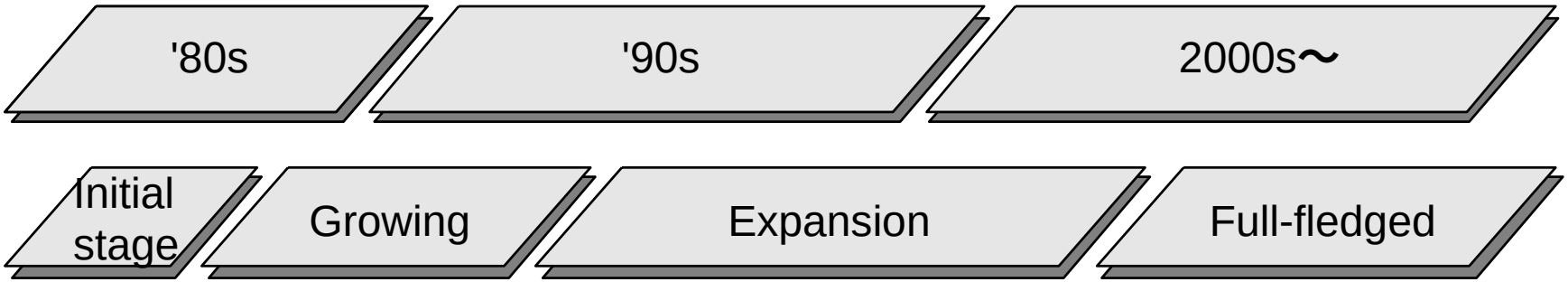
1. Introduction to DoCoMo's 3G Network

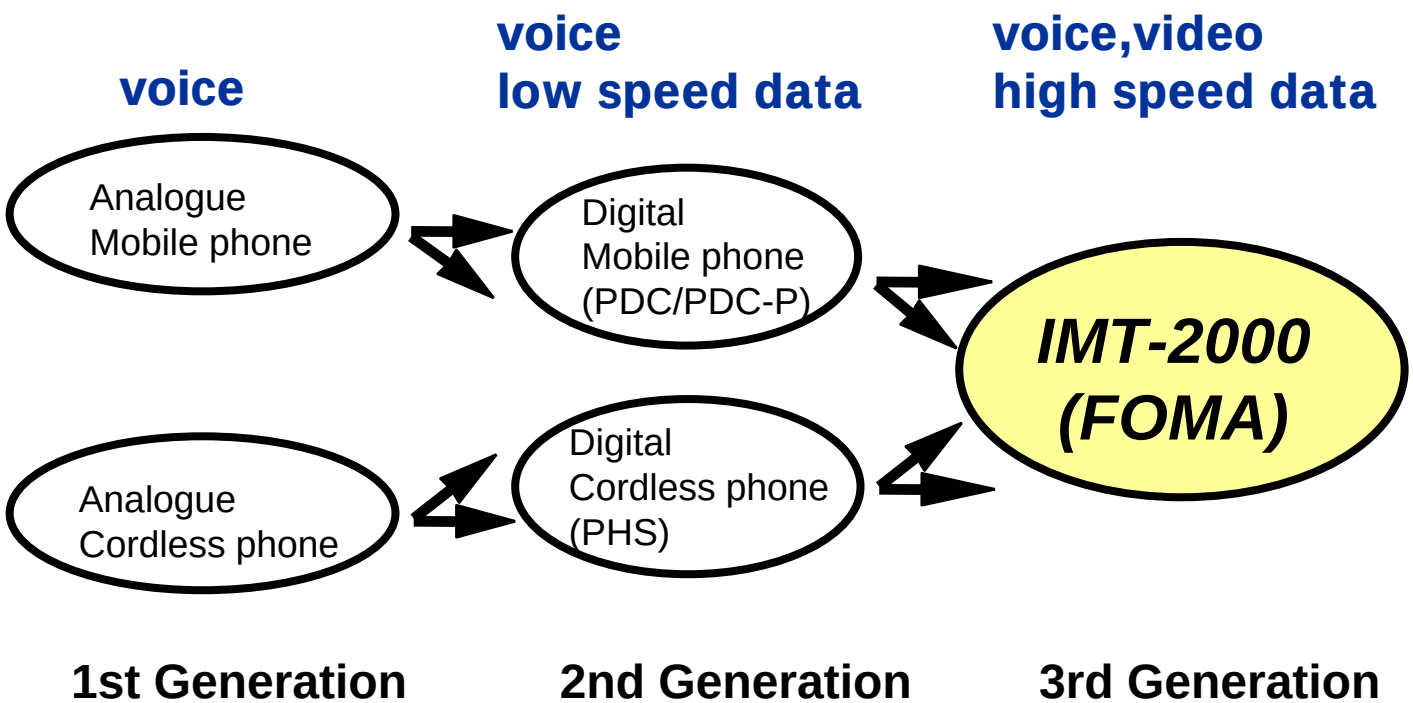
The Telecom Market in Japan



The projected values are calculated based on information and assumptions available today. However, there is no guarantee that the actual results would fall in line with the projected figures, given the inherit uncertainties in projections, as well as possible fluctuations due to future business performances and changes in internal/external circumstances, etc.

Development of Cellular Phone



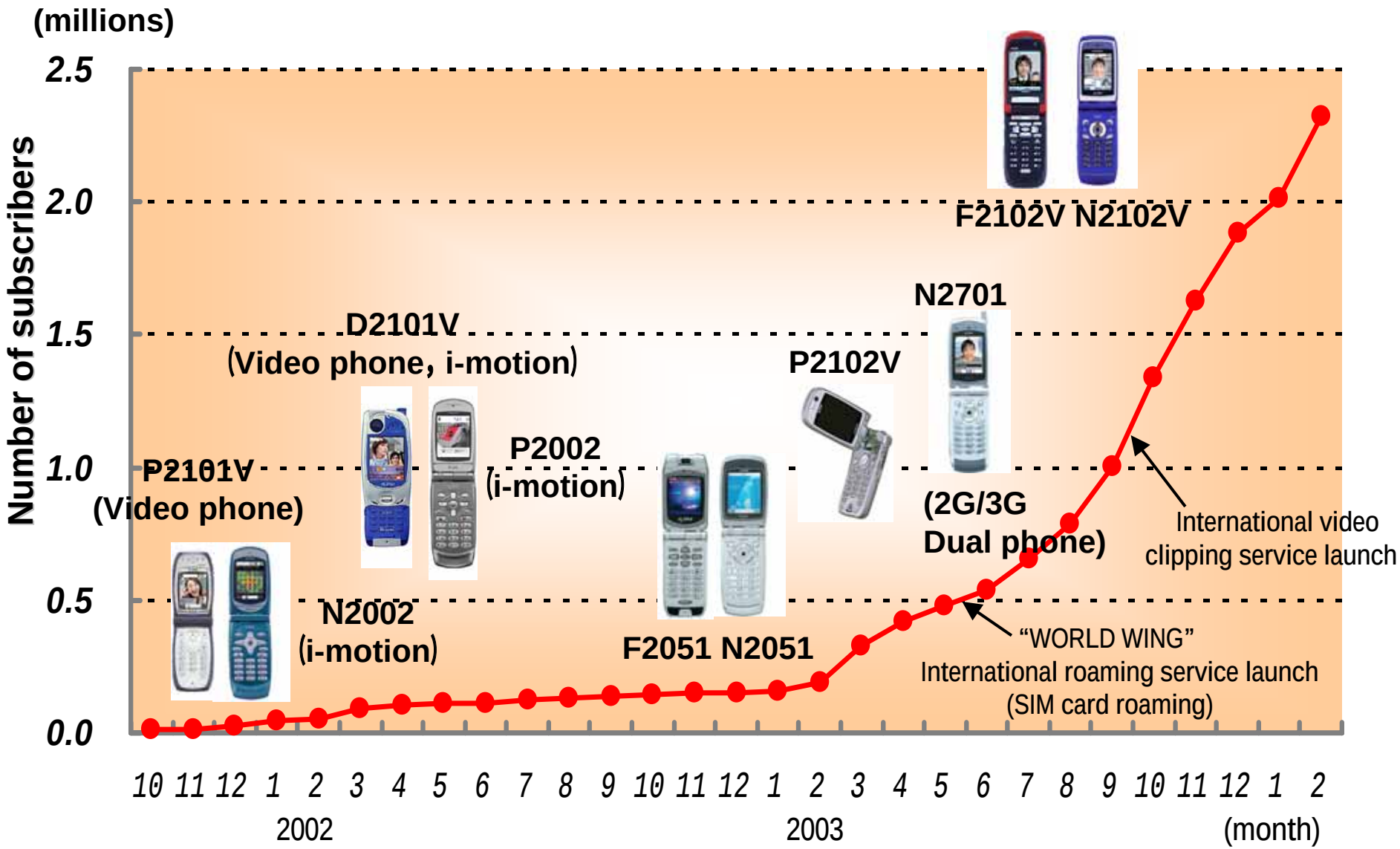


FOMA: Freedom Of Mobile multimedia Access

DoCoMo's 3G Service Climate

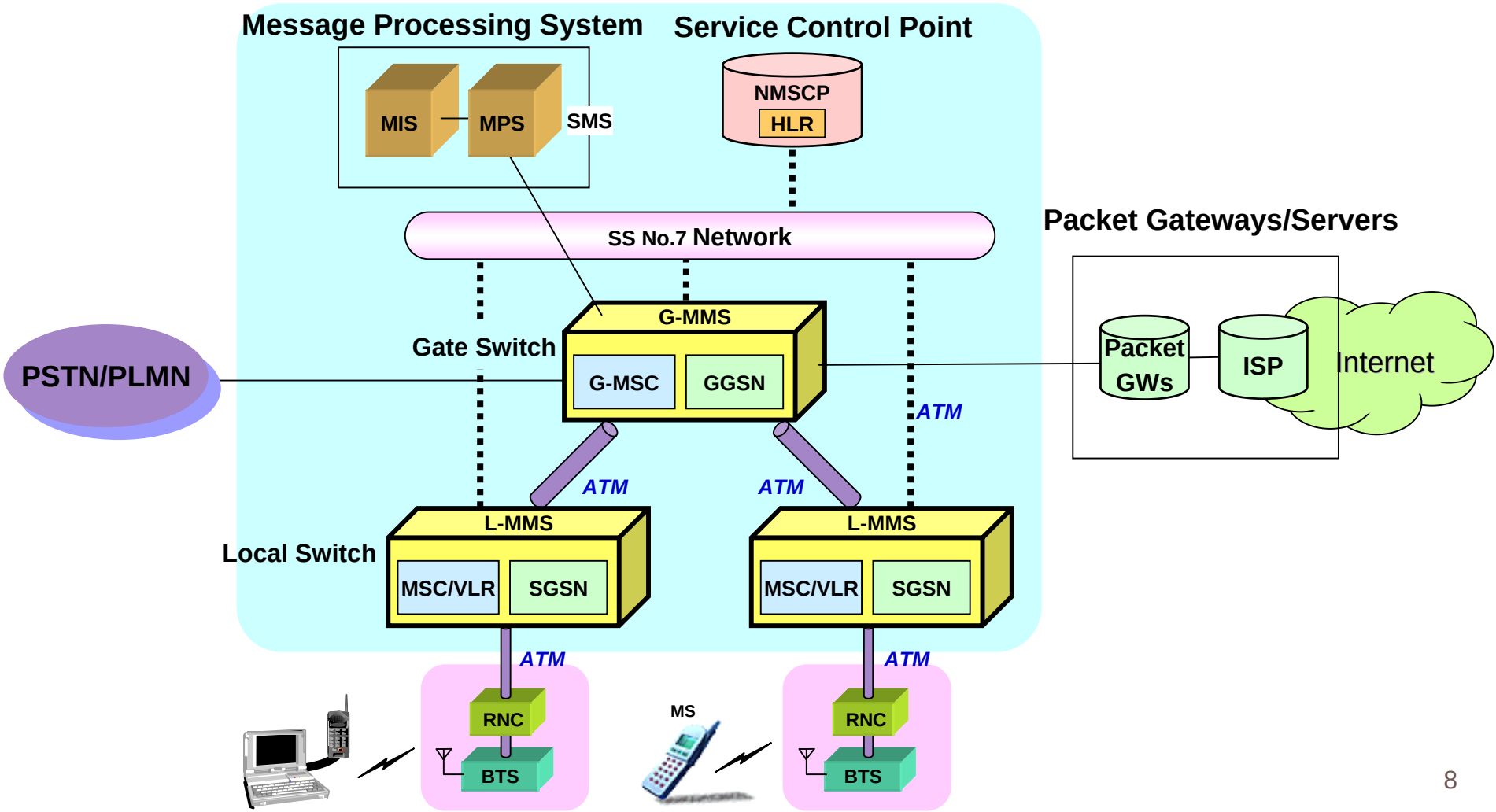
- Service launch: October, 2001
- Service area: Throughout Japan
- Service features:
  - High speed packet data communications
    - Packet transmission at up to 384kbps(downlink)/64kbps(uplink)
    - Video clipping mail, text mail, web browsing (e.g. i-mode)
  - Visual communications: Video phone
  - Multiple Access: Providing voice communications and packet transmission simultaneously
- Subscriber population: 2,321,300 as of Feb.2004

Number of 3G Subscribers



DoCoMo's Network Structure for 3G

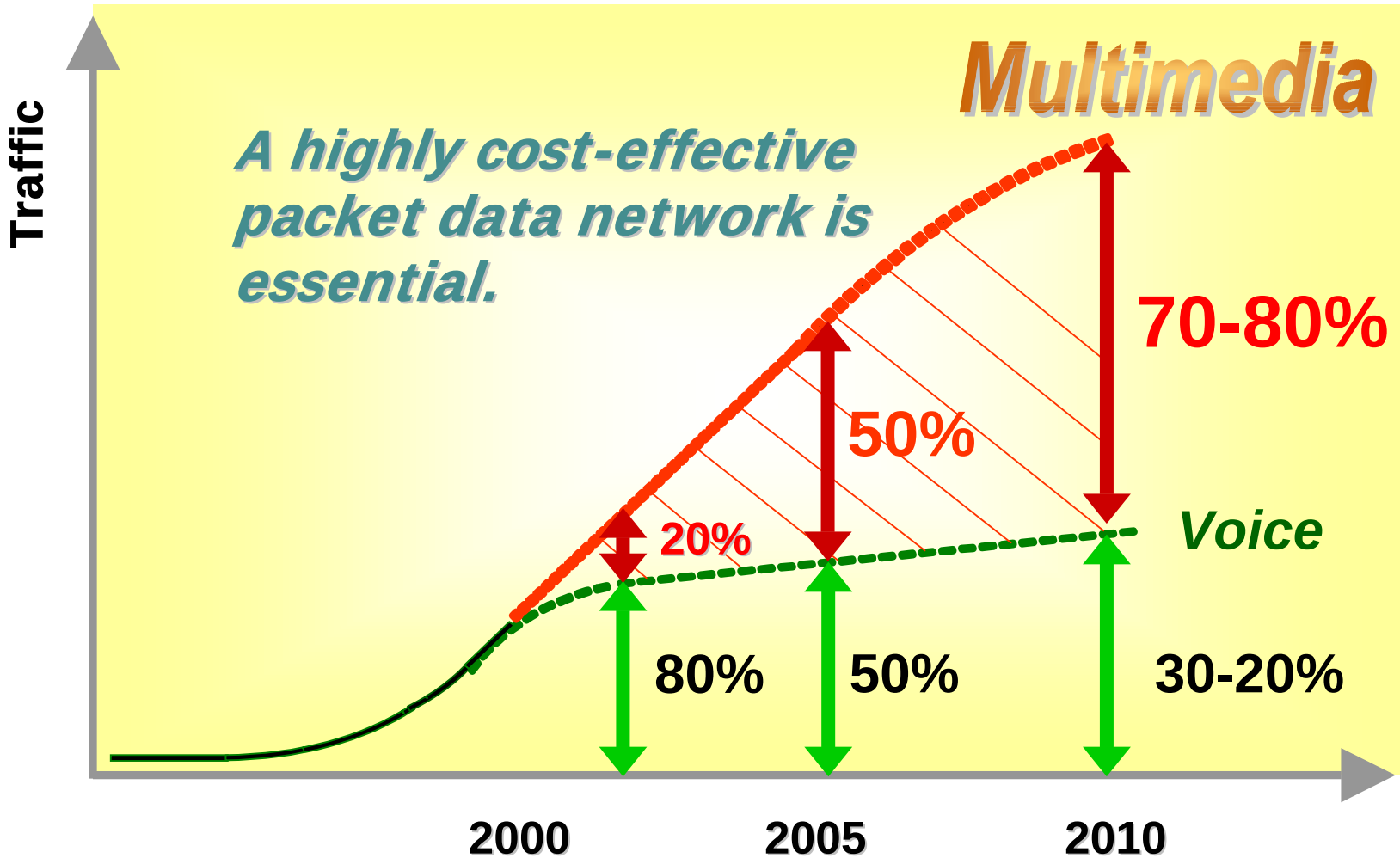
- Circuit Switching network and Packet Switching network are integrated into one ATM switching network.



2. Need for an independent PS domain evolution

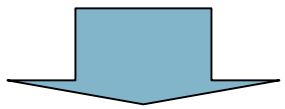
Challenges in Traffic Growth

Traffic Growth (*voice vs. multimedia*)



Need for an independent PS domain evolution

- **Background and new requirements**
  - Cost reduction for packet infrastructure is especially important due to future increases in packet data traffic

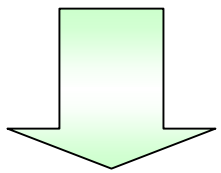


(1) Reduction of Node Cost

(2) Reduction of Transmission Cost

Reduction of Node Cost

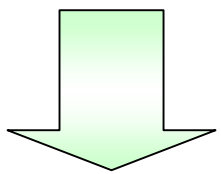
- Legacy carrier switching nodes are not mainframe servers but made only for operator use.
- Their market is small hence their introduction and development are expensive.



Realization of PS infrastructure with mainframe servers is needed.
Carrier grade software platform should be improved to realize the carrier requirements.

Reduction of Transmission Cost

- As the 3G network has been developed to meet increasing needs for high-speed data communication,it must be able to process much higher traffic than the 2G network.
- Extending ATM based Network for higher traffic is expensive.



Transmission via an IP backbone Network is more cost effective than via an ATM based Network.

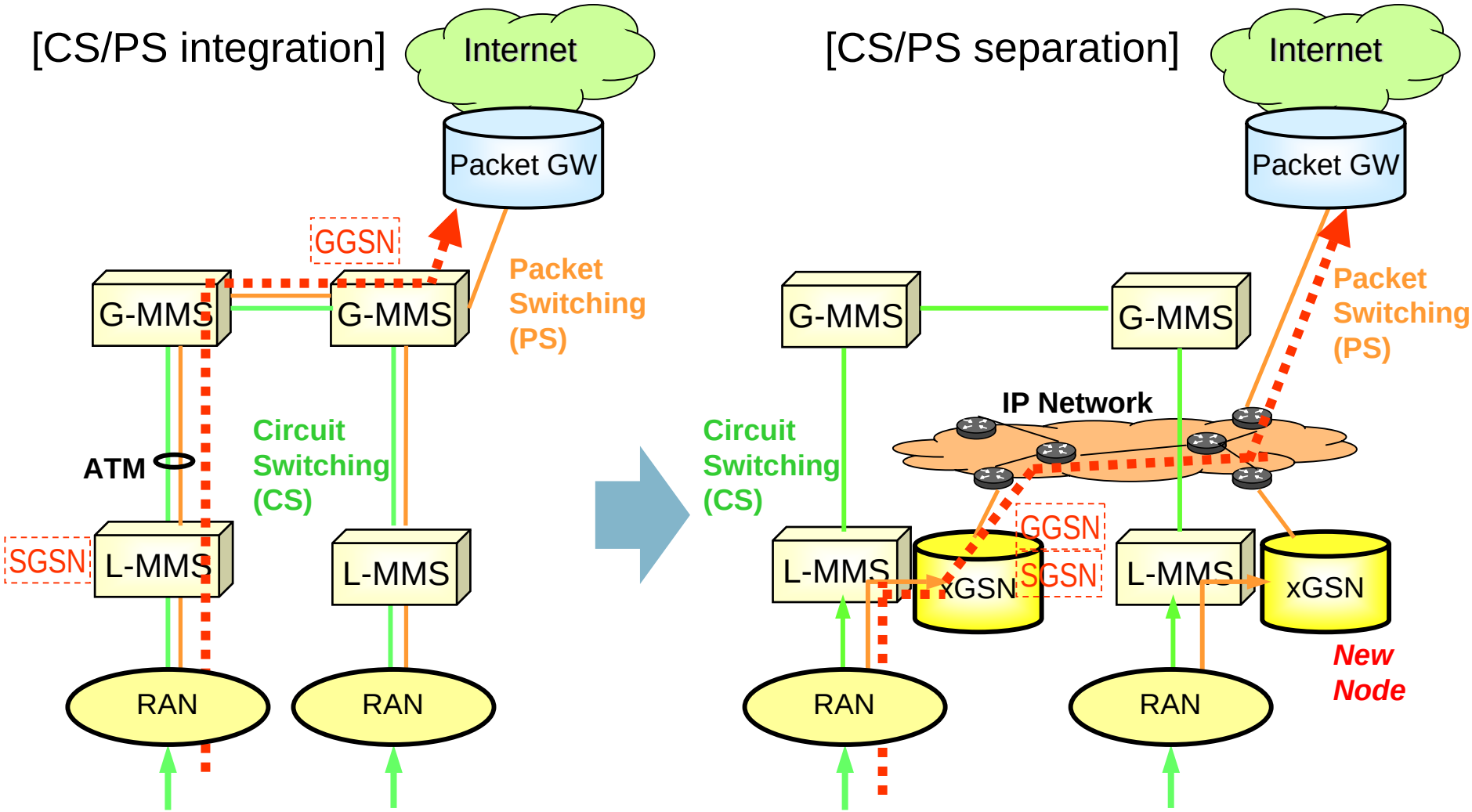
Cost reduction achieved using IP technologies

- **Applying IP backbone Network to PS Network**

[Node cost]
Separating PS Network from CS ATM based Network and building PS Nodes using mainframe servers.

[Transmission cost]
Processing huge PS traffic efficiently by replacing ATM based Network with IP based Network.

CS/PS Separated Network



xGSN: Serving/Gateway GPRS Support Node

x

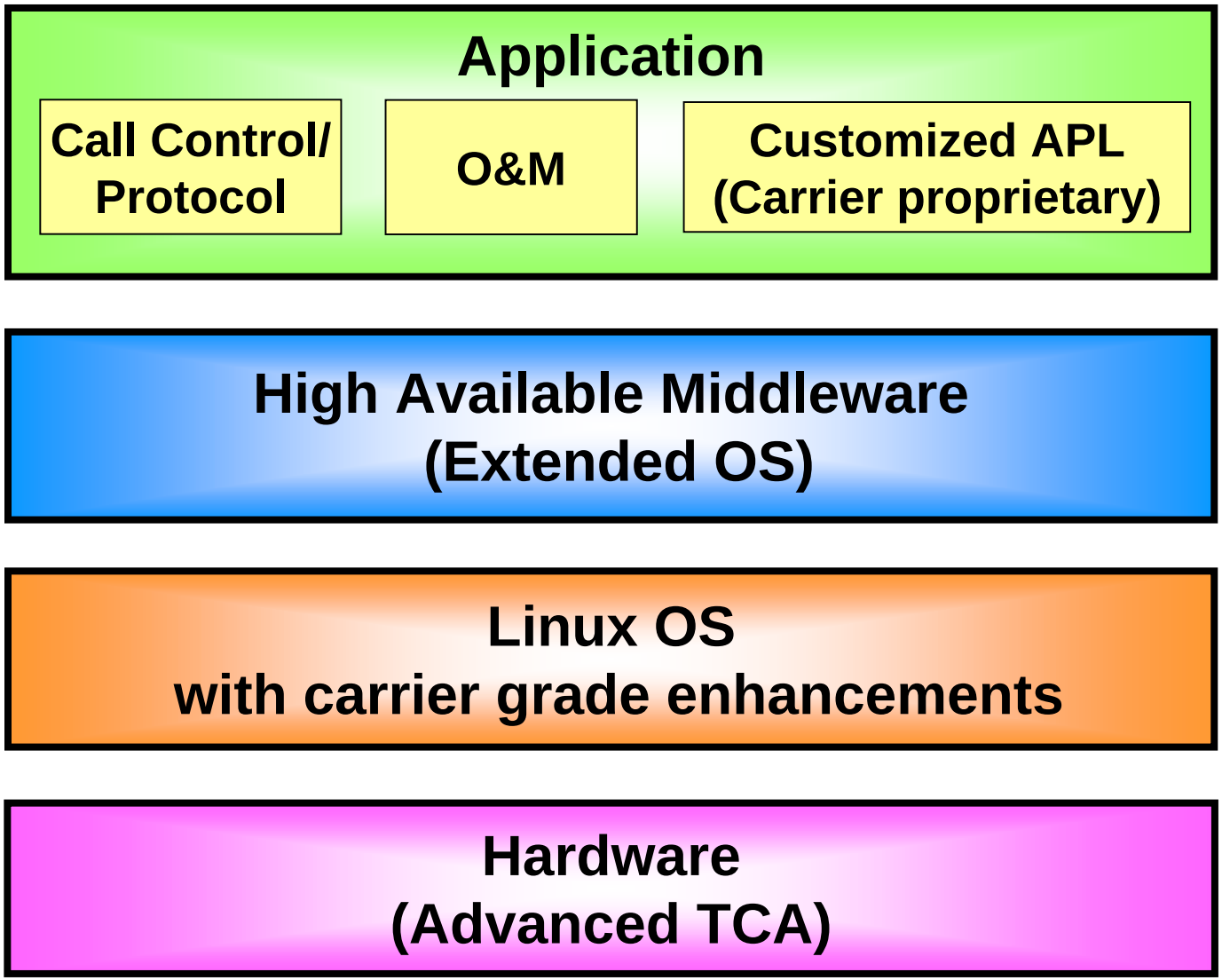
3. Method for independent PS Network evolution

3-1. Realization of PS Nodes using mainframe servers

Carrier Nodes Requirements

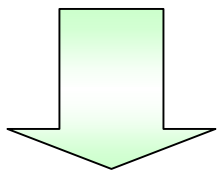
- For Mass Subscribers
  - Large Capacity
  - Large Scalability
- For a Public Communication
  - High Reliability
- To Guarantee Call Processing under an Overload
  - Real-time Processing
- For a Customer Satisfaction
  - Service Continuity

Carrier-grade Server Software Structure



ATCA solution

- In the past mainframe servers for consumer use were prevalent and their capacities were insufficient to be used by operators.
- Recently mainframe servers have evolved rapidly and are now available for operator use.



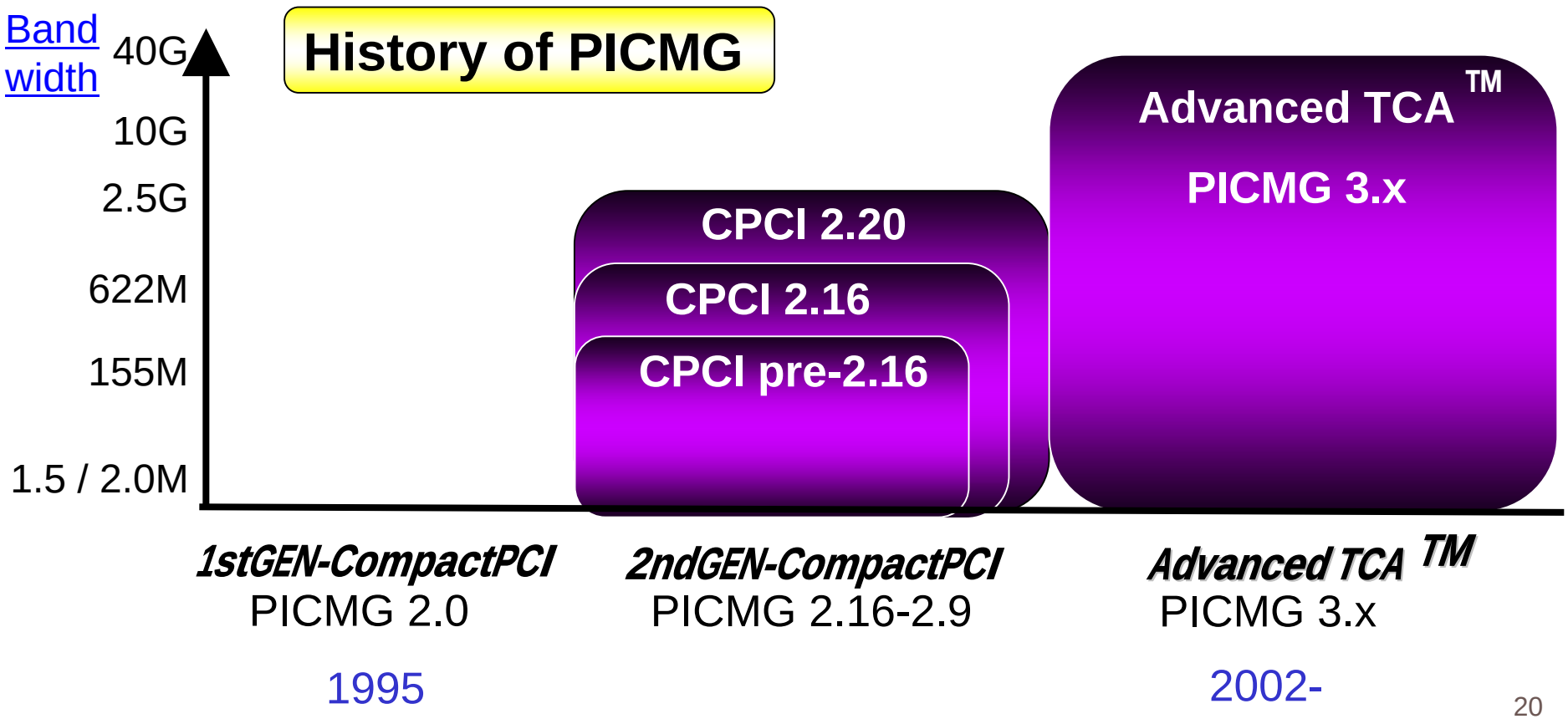
ATCA Server(Based on PICMG ver3.x) is a good solution.

・PICMG＝PCI Industrial Computer Manufactures Group

--- Standardization Group for PCI-based boards and related products

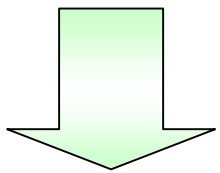
Merits of ATCA solution

- Higher Throughput
- Faster Processing
- Multi-Vendor implementation possible



Realization of PS Nodes using mainframe servers

- Legacy carrier switching nodes have high reliability but there are some functions which are not so essential for PS Nodes.



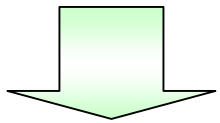
To replace legacy carrier switching nodes with mainframe servers,
we considered the need for each function of legacy carrier switching nodes.

Carrier-grade Features

- System non-working time
- System resume scheme
- Hardware fail-safe structure
- Program live upgrade
- Plug-in(Non-stopping partial program replacement)
- Remote firmware download
- Test call
- Congestion call control
- Performance (Reset proceeding time, Acticve Processor change over time, etc.)

Criteria for a Carrier-grade Server

- Some criteria for a carrier-grade server are shown below(HA Middleware and OS issues).



[System resume]

A server must have the resume escalation logics(ph1,2,3) as a legacy carrier switching node.

[Fail-safe structure]

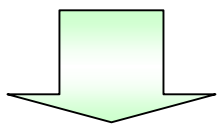
A server must not go out of service when a single device failure occurs.

[Non-stopping partial program replacement]

A server must continue processing its calls during partial renewal of its programs.

Common Carrier-grade Platform

- Once we specify the carrier-grade function in HA Middleware and OS,
  they should be applicable to future server based nodes.

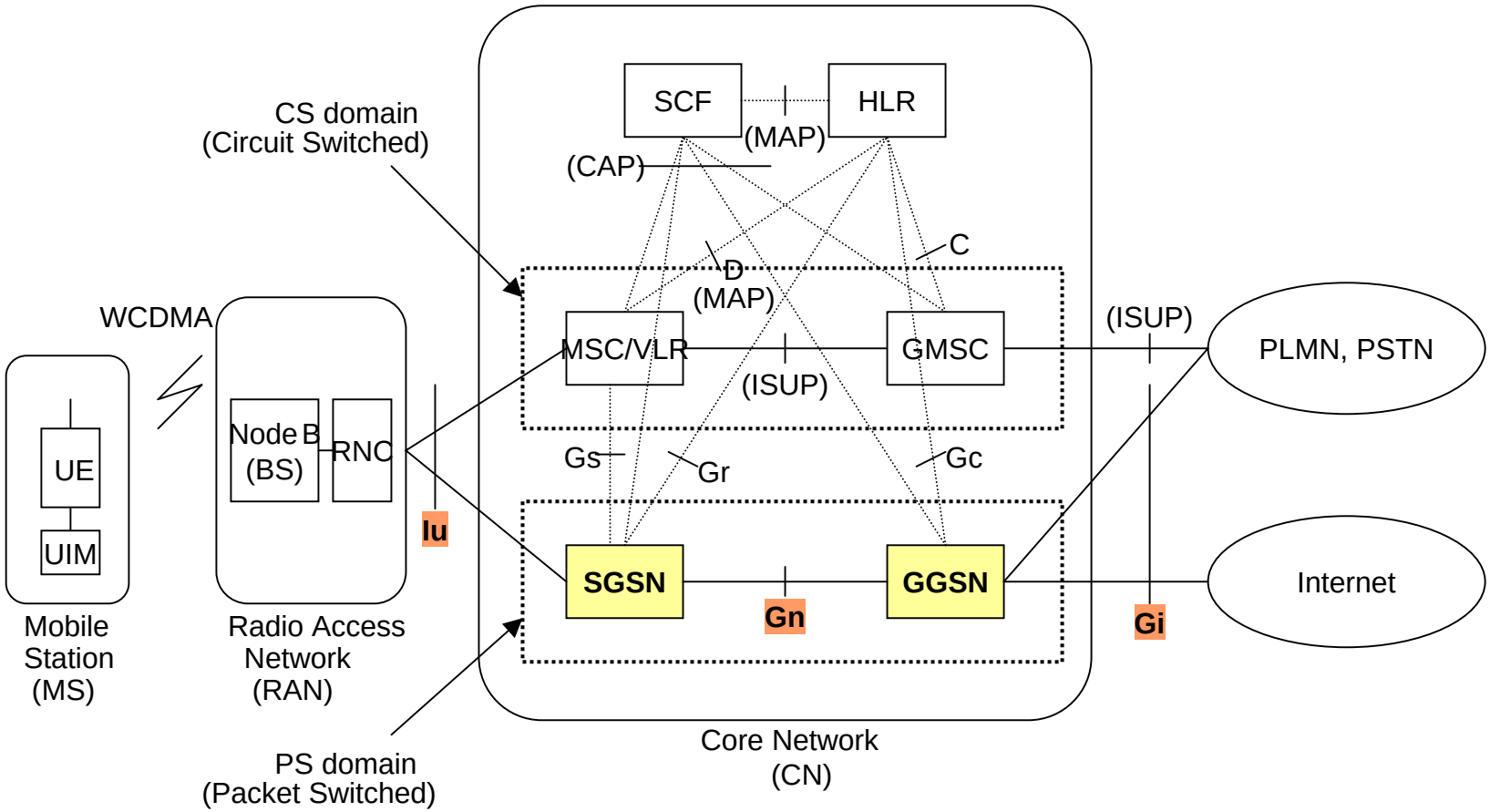


HA Middleware/Carrier-grade Linux

Standardization
Reusability
Portability

3-2. xGSN I/F models

3GPP Architecture Model



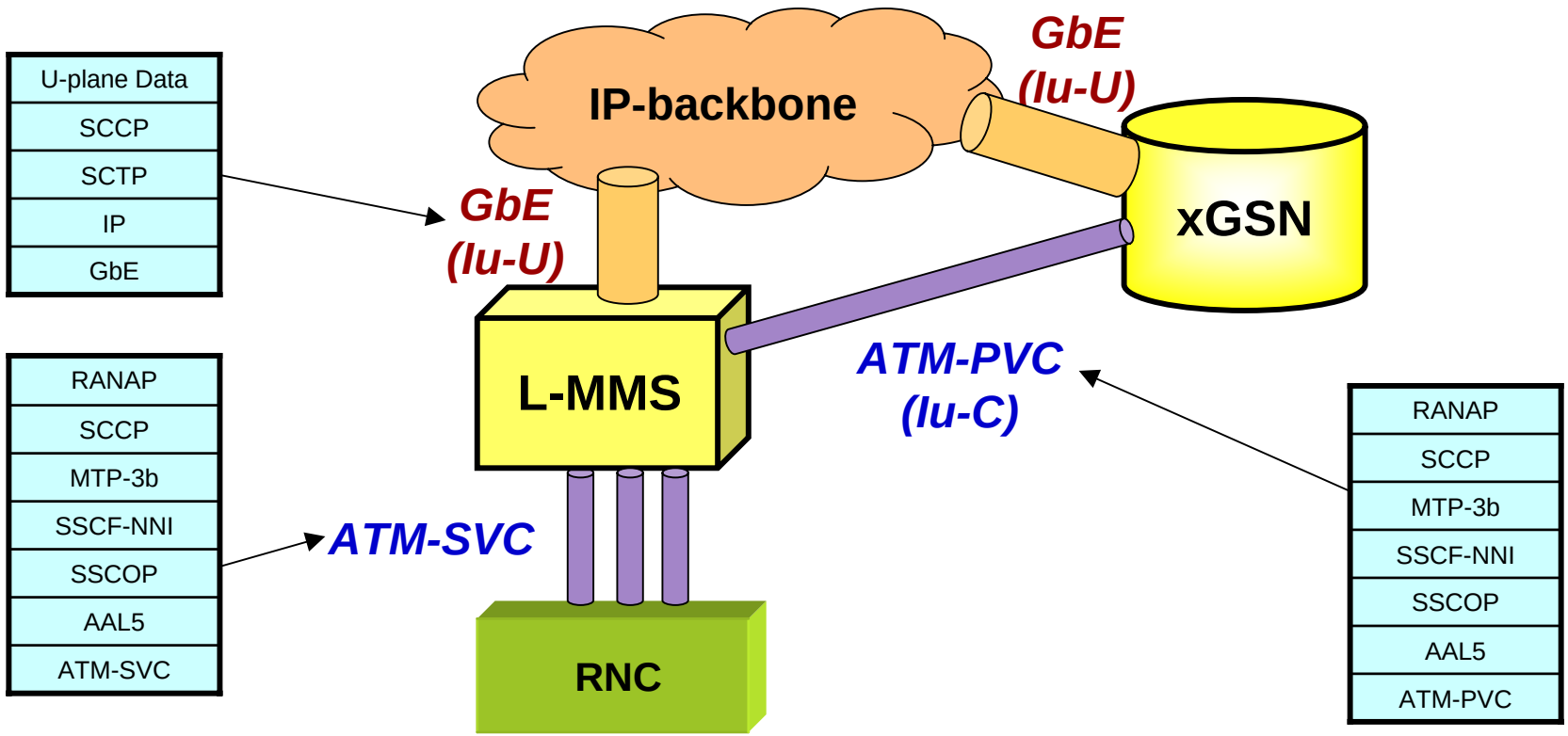
RNC: Radio Network Controller
BS: Base Station
UE: User Equipment
UIM: User Identity Module

MSC: Mobile-services Switching Center
GMSC: Gateway MSC
SGSN: Serving GPRS Support Node
GGSN: Gateway GPRS Support Node
VLR: Visitor Location Register

SCF: Service Control Function
HLR: Home Location Register
PLMN: Public Land Mobile Network
PSTN: Public Switched Telephone Network

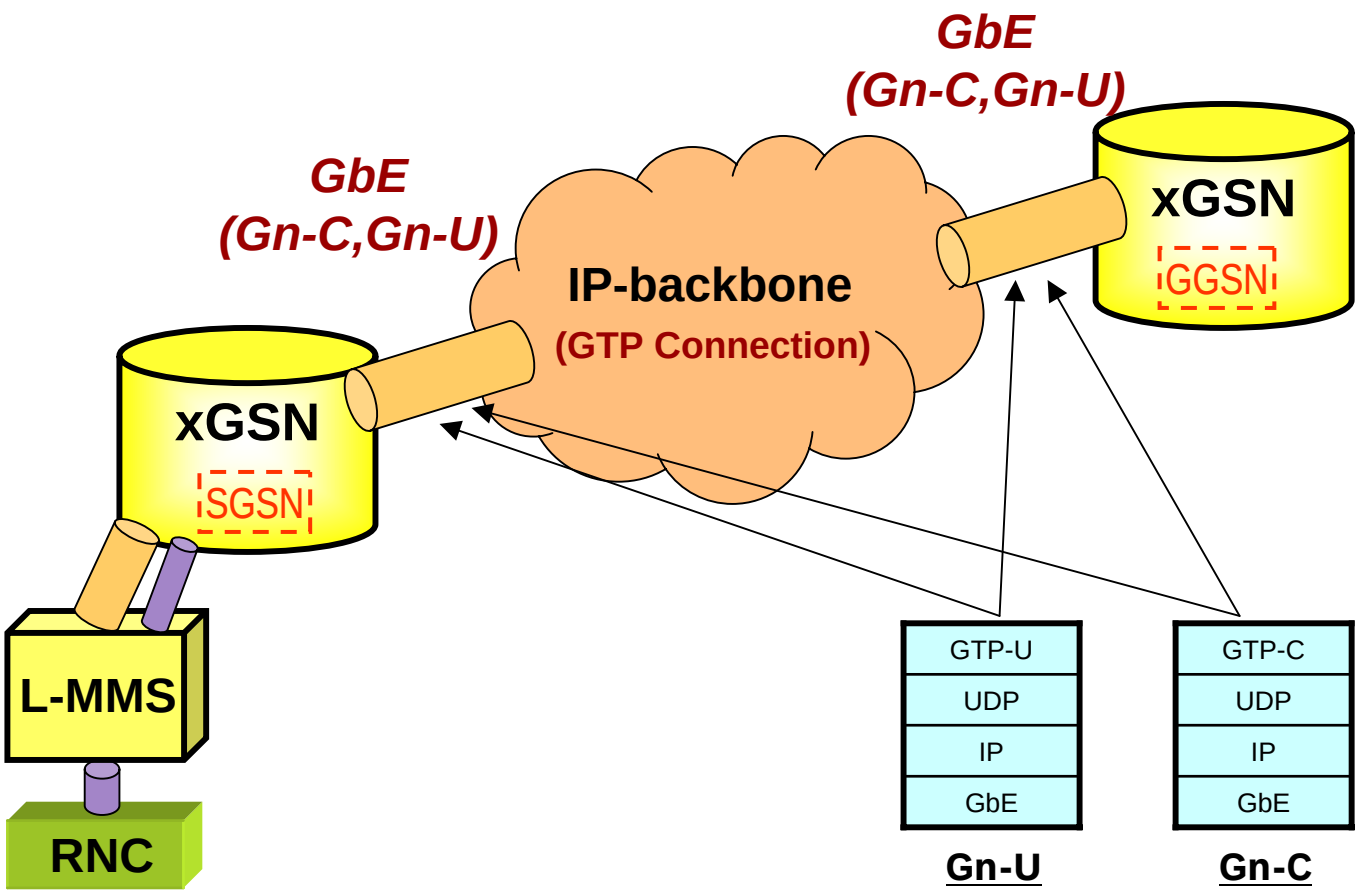
(1)Physical Iu I/F(RNC-xGSN)

- **Iu-C (C-Plane),Iu-U (U-Plane)**
  - To reduce the impact on RNCs, LMMS retains physical Iu I/F with RNC (pre-existent within DoCoMo's NW).
  - xGSN has Iu-C I/F(ATM-PVC) with LMMS via ATM-PVC.
  - xGSN has Iu-U I/F with LMMS via IP backbone network.



(2) Physical Gn I/F

- **Gn-C (C-Plane) ,Gn-U(U-Plane)**
  - xGSN has Gn-C,U I/F with other xGSNs via IP backbone Network.
  - Gn-C,U data(GTP,user data packets e.t.c.) is transmitted over IP,so transmission via IP backbone Network is much more efficient than via ATM based Network.



3-3. VPN Models from ATM based NW to IP based NW

Policy for Applying L2VPN/L3VPN to IP backbone Network

- **Some criteria for whether to apply L2VPN or L3VPN to the IP backbone Network are shown below.**

(a)n:m Connection or 1:1(or a few) Connection?
-> If I/F has few connections between nodes it is appropriate to apply L2VPNs.
-> If I/F has many (n:m) connections the number of VPNs needed is less if L3VPNs are applied.

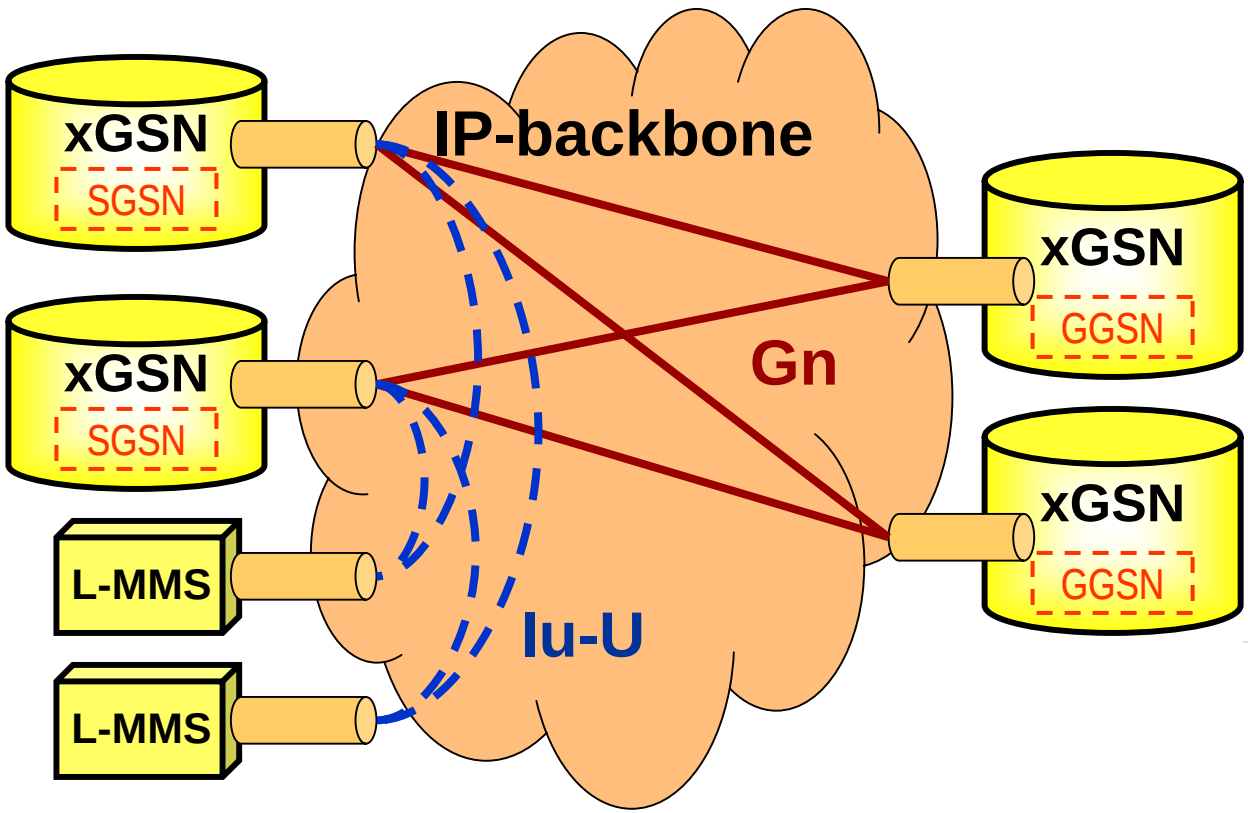
(b)Connection already exists before migration?
-> If a connection already exists before migration,it will be easy to apply L2VPN because of the impact on the node/client(ISPe.t.c.) is smaller than L3VPN.

(1)Iu-U,Gn I/F

- **We apply “Layer 3 VPN” to Iu-U,Gn I/F.**

[Reason]

- Gn I/F has n：m(xGSNs : xGSNs) connection.
- The number of VPNs can be smaller by building Iu-U and Gn I/F on the same L3VPN.

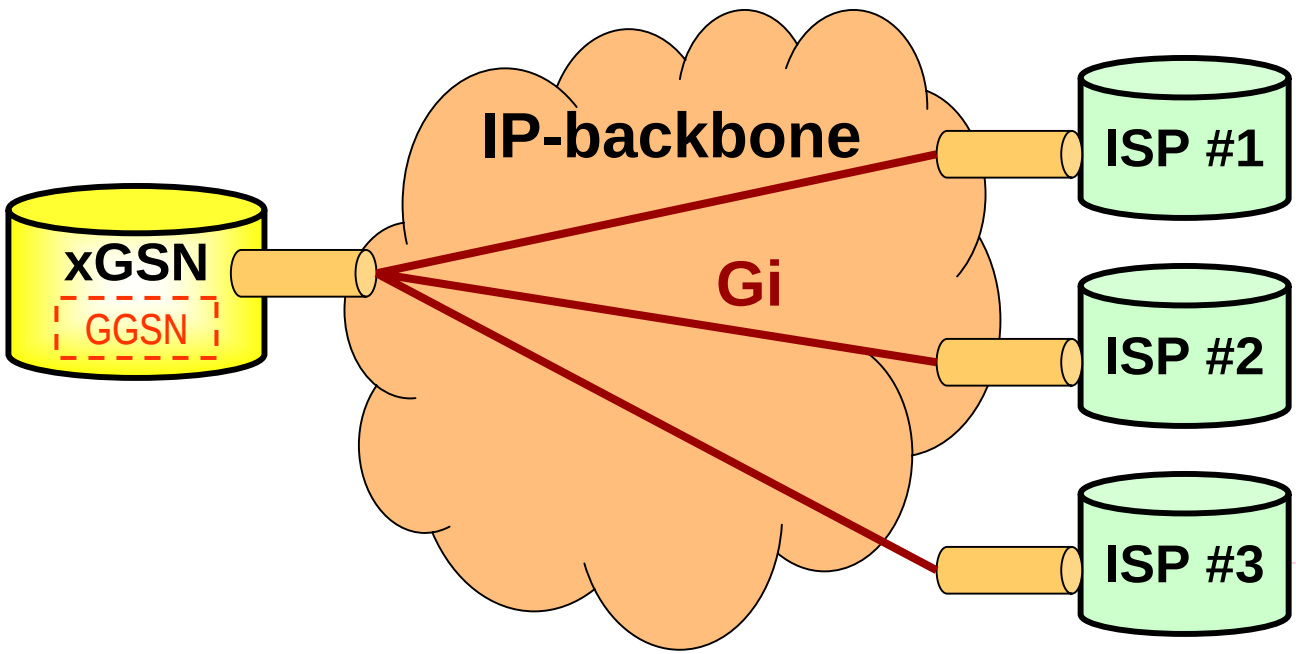


(2)Gi I/F

- **We apply “Layer 2 VPN” to Gi I/F.**

[Reason]

- Gi I/F has 1:1(xGSN : ISP) connection.
- To reduce impact on ISPs already connected to G-MMS.



4. Future Issues

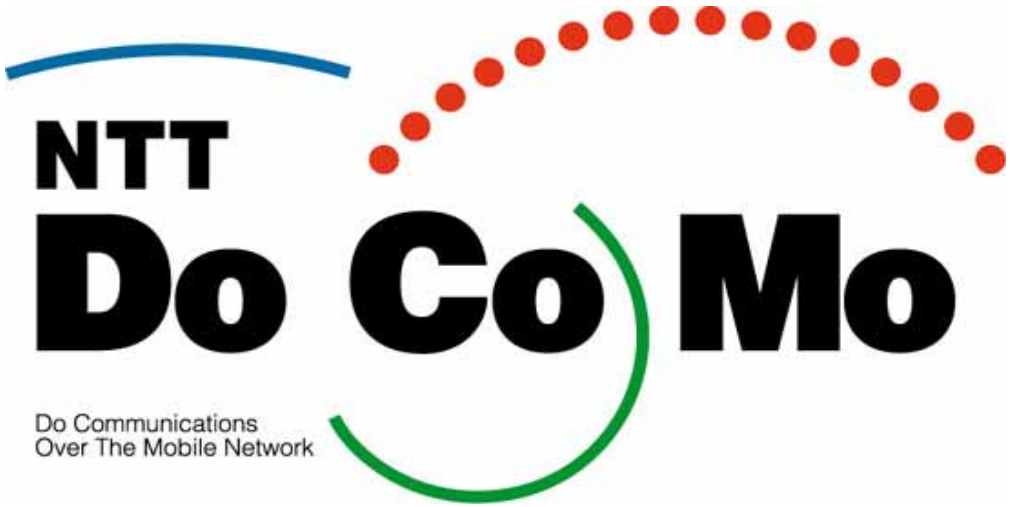
Future Issues

- Common Carrier-grade Platform (Middleware/OS)
  - hardware vendor free
  - common CG functions
  - portable

- Legacy Nodes Migration
  - for full IP network environment
  - server based solution

Summary

- Cost reduction for packet infrastructure is especially important due to future increases in packet data traffic.
- Mainframe servers are cost effective as next carrier grade nodes. Carrier-grade software platform (OS, HA middleware) needs to be enhanced to realize the carrier requirements.
- Improving the portability of carrier-grade software platform is necessary.
- A migration from ATM based network to IP based network is possible.


NTT
Do Co Mo
Do Communications
Over The Mobile Network