Complus Systems

Traffic Analysis & Network Structure Taiwan Case Study

Complus Systems

Transmission Network Structure

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Transmission Network Structure

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Transmission Network Structure

General

- This document contains:
  - **Analysis of the potential services to be transported by a transmission network.**
  - **Traffic Dimensioning rules per service type.**
  - **SDH Network topology**.

Transmission Network Structure

General

- The analysed operator will provide, as Carrier's Carrier, to second fixed Operators the trunk capacity for:
  - National Services
  - International Services
- The services Carried by the transmission network will be:
  - Voice services for business (private PABX) and residential (phones) customers
  - ATM/IP for Data & Internet Services for business (big companies, banks, multimedia providers…etc) and educational (university campus, research departments…etc) customers
  - Internet Services for residential users (Dial-Up)
  - Leased lines services (data and voice) for business customers (big companies, mobile operators, VPN)
  - Leased lines for Video Contribution (TV operators)

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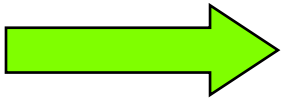

- General
- Voice Services Network
- ATM Data Services Network
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- Video Services Network
- Leased Lines Services Network
- SDH Network
- Global View

Transmission Network Structure

Voice Services Network

- **Traffic dimensioning parameters:**
  - **Total Population (Source: Government of Taiwan)**
    - 21.88 Million inhabitants in Taiwan (1998).
    - Forecasted 22.49 Million inhabitants in Taiwan (1999).
    - Forecasted 23.10 Million inhabitants in Taiwan (2000).
    - Forecasted 23.71 Million inhabitants in Taiwan (2001).
    - Forecasted 24.32 Million inhabitants in Taiwan (2002).
  - **Total Subscribers-Main Lines (Source: Government of Taiwan)**
    - 11.74 Million subscribers in Taiwan (1998).
    - Forecasted 12.69 Million subscribers in Taiwan (1999).
    - Forecasted 13.72 Million subscribers in Taiwan (2000).
    - Forecasted 14.83 Million subscribers in Taiwan (2001).
    - Forecasted 16.03 Million subscribers in Taiwan (2002).

Transmission Network Structure

Voice Services Network

- **Traffic dimensioning parameters:**
  - **Calculated Penetration (percentage of subscribers / number of inhabitants)**
    - 53.66% (1998) penetration ((Subscribers/inhabitants)*100) of telephone lines for CHT (Major Taiwan PTT Operator)
    - 57.48% (1999) penetration ((Subscribers/inhabitants)*100) of telephone lines forecasted for CHT and other incumbent fixed operators.
    - 61.58% (2000) penetration ((Subscribers/inhabitants)*100) of telephone lines forecasted for CHT and other incumbent fixed operators.
    - 65.96% (2001) penetration ((Subscribers/inhabitants)*100) of telephone lines forecasted for CHT and other incumbent fixed operators.
    - 70.66% (2002) penetration ((Subscribers/inhabitants)*100) of telephone lines forecasted for CHT and other incumbent fixed operators.

Transmission Network Structure

Voice Services Network

- **Traffic Loading Target for the New Operator**

  - **Loading per station calculated in four phases (1999, 2000, 2001 & 2002):**
    - 10% of Forecasted subscribers (Penetration) for 1999
    - 20% of Forecasted subscribers (Penetration) for 2000
    - 30% of Forecasted subscribers (Penetration) for 2001
    - 40% of Forecasted subscribers (Penetration) for 2002

  - The portion of this telephone lines (Target) acquired by the New Operator (10%-1999, 20%-2000, 30%-2001, 30%-2002) are subdivided in (according to data of similar countries, e.g. Singapore):
    - 80% are residential and small business
    - 19% are business E1 access lines
    - 1% are business E1 ATM access lines

  - All customers are directly (or via suitable access network) connected to the relevant Local Switching exchanges.

  - Assumed Traffic concentration (customers to 64 Kbps bandwidth) according to CHT parameters:
    - Residential customer's concentrated with an average Erlang factor 0,07
    - Business customer's, concentrated with an average Erlang factor 0,2 (PABX users)

Transmission Network Structure

Voice Services Network

- **Traffic Distribution for the New Operator**

  - Residential Traffic distribution:
    - 1% of the traffic stays local on the same local exchange
    - 13% of the traffic goes international
    - 63% of the traffic is directed towards the incumbent operators Exchanges
    - 23% of the traffic is directed to other Local Switching Exchanges of the New Operator.

  - Business Traffic distribution:
    - 2% of the traffic stays local on the same local exchange
    - 14% of the traffic goes international
    - 43% of the traffic is directed towards the incumbent operators Exchanges
    - 41% of the traffic is directed to other Local Switching Exchanges of the New Operator.

Transmission Network Structure

Voice Services Network

- **Traffic loading calculation formulas:**
  - Total **loading** per **local Exchange** is **defined according to the population inside the local Exchange Area** and the following formulas:
  - **Residential Subscribers:**
    - Number of subscribers (64KBPS) =
      - (STATION_POPULATION) X (1000) X (PENETRATION_PERCENTAGE_YEAR) X (TARGET_PERCENTAGE_YEAR)
        - Where YEAR can be:
          - 1999 - PHASE 1
          - 2000 - PHASE 2
          - 2001 - PHASE 3
          - 2002 - PHASE 4
    - 2MBPS (E1) EQUIVALENT =
      - ((64KBPS(K) SUBSCRIBERS) X (1000)/30) X (80%) X (RESIDENTIAL_ERLANG_FACTOR)
  - National traffic matrices (end-to-end) computed distributing the traffic from one Local Switching Exchange to all other Local Switching Exchanges according to their loading size (Kruithof Method).
  - Business Traffic distribution (Inside same Local Exchange, Between Local Exchanges of the New Operator, to the incumbent operators, to International gateways) according to the Percentages previously defined.

Transmission Network Structure

Voice Services Network

- **Traffic estimates parameters:**
  - **Business Subscribers:**
    - 64KBPS =
      - (STATION_POPULATION) X (1000) X (PENETRATION_PERCENTAGE_YEAR) X (TARGET_PERCENTAGE_YEAR)
        - Where YEAR can be equal to:
          - 1999 - PHASE 1
          - 2000 - PHASE 2
          - 2001 - PHASE 3
          - 2002 - PHASE 4
    - 2MBPS (E1) EQUIVALENT =
      - ((64KBPS(K) SUBSCRIBERS) X (1000)/30) X (19%) X (BUSINESS_ERLANG_FACTOR)
  - National traffic matrices (end-to-end) computed distributing the traffic from one Local Switching Exchange to all other Local Switching Exchanges according to their loading size (Kruithof Method).
  - Business Traffic distribution (Inside same Local Exchange, Between Local Exchanges of the new operator, to the incumbent operators, to International gateways) according to the Percentages previously defined.

Transmission Network Structure

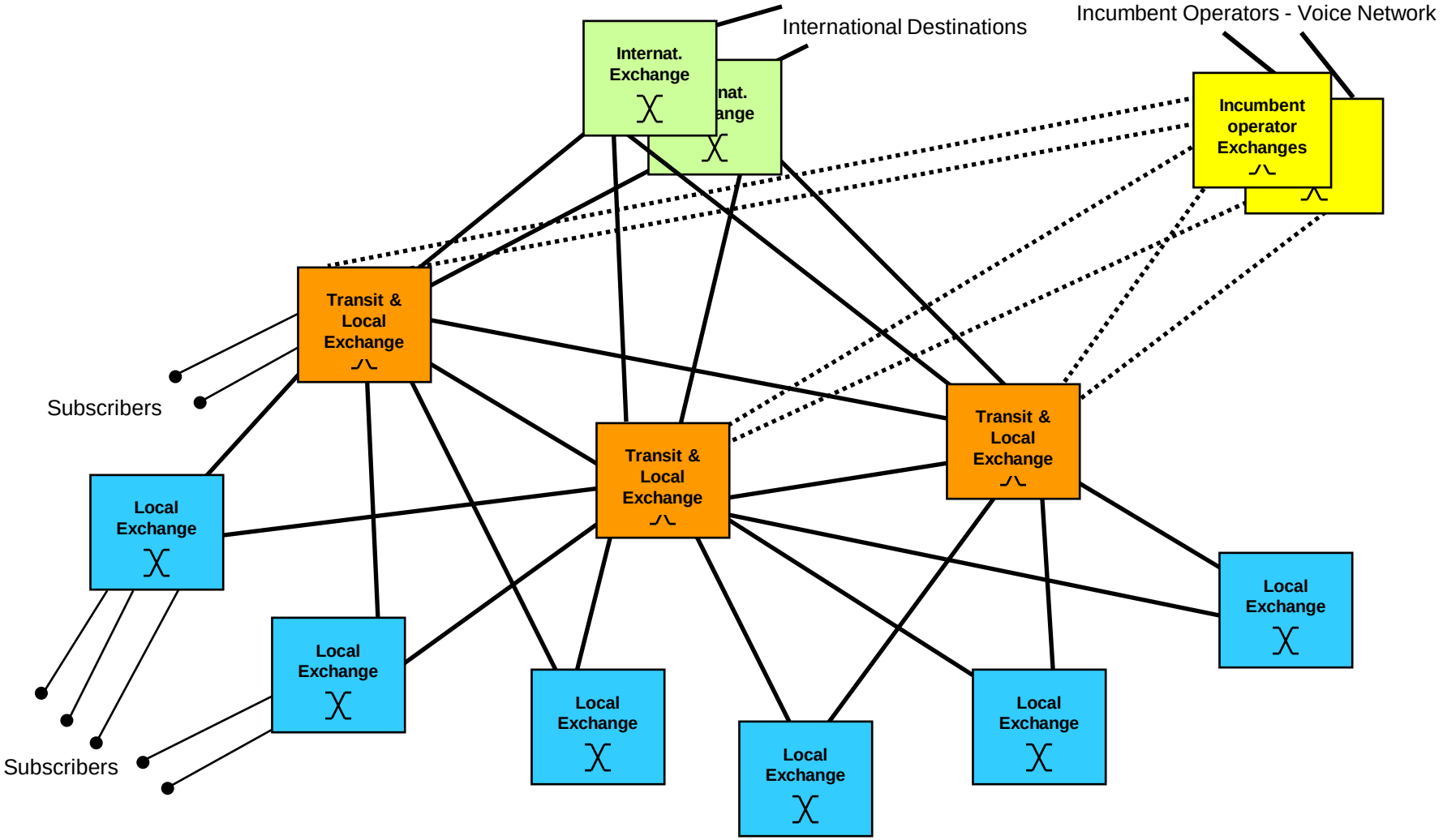
Voice Services Network

- **Switching Points**
  - 46 Sites with Local Switching Exchanges:
  - 9 Sites with Transit Exchanges (with Local Switching functions too)
  - 2 International Switching Exchanges
- **Interconnections**
  - 2 Sites on the Backbone for interconnecting the incumbent operators.
  - Every Local Switching Exchange is interconnected to two Tandem Exchanges (traffic sharing)
  - Every Tandem Exchange is interconnected to the two International Exchanges (Traffic sharing)
  - Every Tandem Exchange is interconnected to two exchanges of the incumbent operators (Traffic sharing)
  - Customers (both residential and business) are directly connected to the nearest Local Switching Exchange of the New Operator

Transmission Network Structure

Voice Network Structure

Schematic view of the Voice Network



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ATM Data Services Network

- **Traffic estimates**
  - Users distributed on all local ATM Edges.
  - Total ATM traffic per local ATM Edge area defined according to the number of subscribers in the area
  - All traffic originated by the subscribers of a local area is sent directly to other ATM Edges of the same area or through ATM Cores (distributed along the Backbone network) to ATM Edges of other areas. Furthermore a percentage of the subscribers (as defined in the next pages) is sent to two nodes for International and Inter-Operator routing
  - Number of E1 access lines (Subscribers to ATM Edges) equal to the number of subscribers .
  - Required bandwidth (MBPS) per Transmission Network obtained by multiplying the number of subscribers by 0.1 (Erlang "C" for packed data switching subscribers)
  - No Penetration data available for ATM/IP traffic at this stage in Taiwan (the service is not yet available).

Transmission Network Structure

ATM Data Services Network

- **TARGET FOR THE NEW OPERATOR**

  - Four phases (1999, 2000, 2001 & 2002):
    - 1% of 10% of Forecasted Business subscribers (Penetration) for 1999
    - 1% of 20% of Forecasted Business subscribers (Penetration) for 2000
    - 1% of 30% of Forecasted Business subscribers (Penetration) for 2001
    - 1% of 40% of Forecasted Business subscribers (Penetration) for 2002

  - All customers directly (or via suitable access network) connected directly to ATM Edge Nodes (this functionality can be integrated directly inside SDH transmission equipment), which will be part of the Transmission network.

  - ATM Traffic concentration (Business customers collected with E1 bandwidth)
    - Business customer's, concentrated with a Erlang "C" factor 0,1 (MBPS Equivalent)

  - Business Traffic distribution:
    - 2% of the traffic stays local on the same local ATM Edge
    - 14% of the traffic goes international
    - 43% of the traffic is directed towards Incumbent and other Fixed operators ATM Networks
    - 41% of the traffic is directed to other Local ATM Edges

Transmission Network Structure

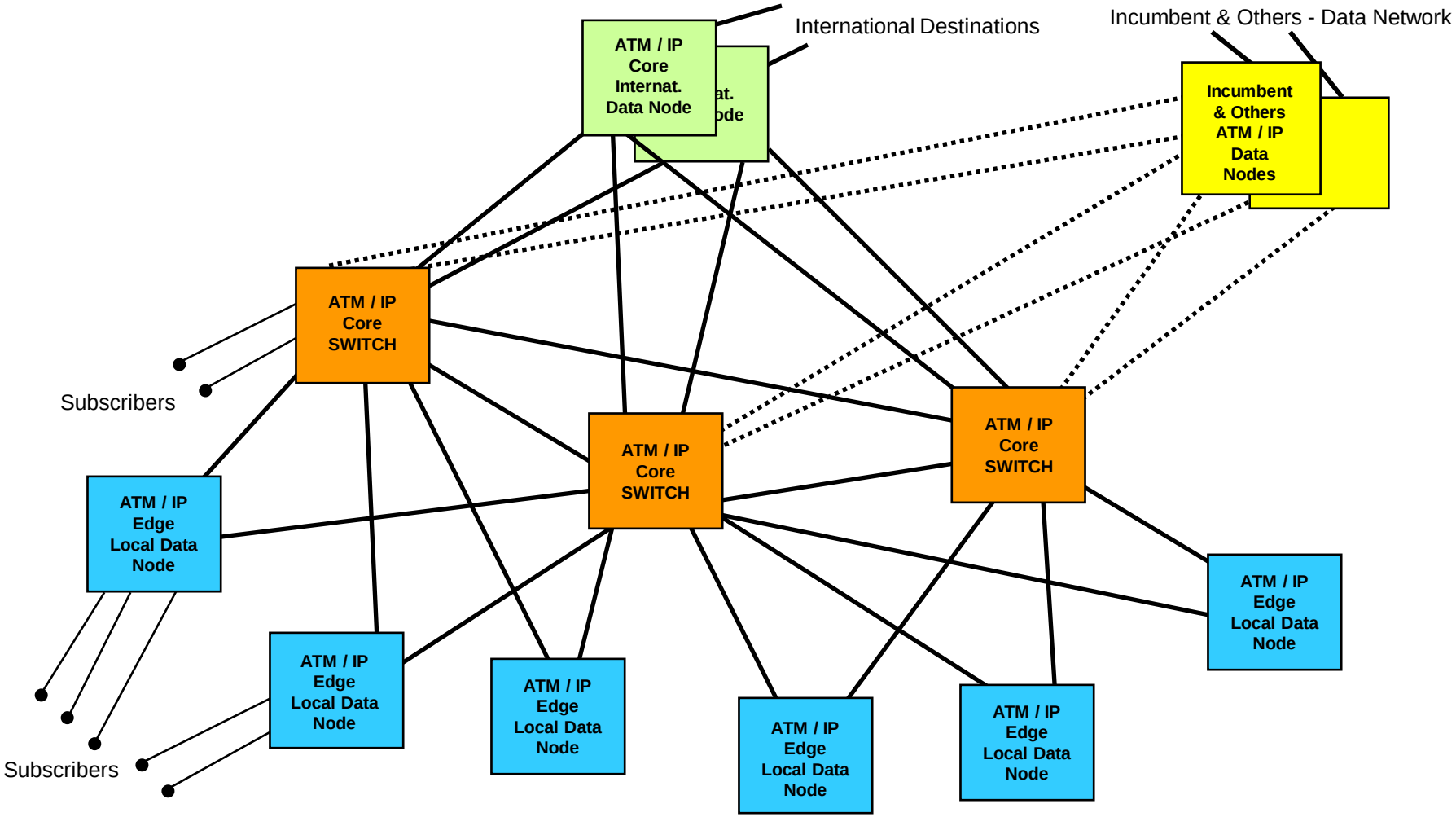
ATM Data Services Network

- **Data Switching Points**
  - 46 Sites with Local ATM Edge Switching Nodes:
  - 9 Sites with ATM Core Transit Nodes (with Local ATM Data Switching functions too).
  - 2 International ATM Data Switching Core Nodes.
- **Interconnections**
  - 2 Sites on the Backbone for interconnecting Incumbent and other new fixed operators, ATM Switching data nodes.
  - Every Local ATM Edge Data Switching Node is interconnected to two Transit ATM Core data nodes (traffic sharing).
  - Every Transit ATM Data Node is interconnected to the two International ATM Data Nodes (Traffic sharing).
  - Every ATM Transit Data Node is interconnected to two Incumbent and other new operators, ATM Switching Data Nodes (Traffic sharing).
  - Business Customers are directly connected to the nearest ATM Edge Local Data Switching Node.

Transmission Network Structure

ATM Data Network Structure

Schematic view of the Data Network



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Internet Access Services Network

- **Traffic estimates parameters:**
  - **Population (Source: Government of Taiwan)**
    - 21.88 Million inhabitants in Taiwan (1998).
    - Forecasted 22.49 Million inhabitants in Taiwan (1999).
    - Forecasted 23.10 Million inhabitants in Taiwan (2000).
    - Forecasted 23.71 Million inhabitants in Taiwan (2001).
    - Forecasted 24.32 Million inhabitants in Taiwan (2002).
  - **Subscribers-Main Lines (Source: FIND/I.T. Promotion Division, III, 1999)**
    - 3.01 Million subscribers in Taiwan (1998).
    - Forecasted 4.05 Million subscribers in Taiwan (1999).
    - Forecasted 5.46 Million subscribers in Taiwan (2000).
    - Forecasted 7.36 Million subscribers in Taiwan (2001).
    - Forecasted 9.92 Million subscribers in Taiwan (2002).

Transmission Network Structure

Internet Access Services Network

- **Traffic estimates parameters:**
  - **Penetration**
    - 13.63% (1998) penetration ((Internet Subscribers/inhabitants)*100) of telephone lines for the Incumbent and other ISPs.
    - 18.37% (1999) penetration ((Internet Subscribers/inhabitants)*100) of telephone lines forecasted for the Incumbent / ISPs and other new fixed operators.
    - 24.54% (2000) penetration ((Internet Subscribers/inhabitants)*100) of telephone lines forecasted for the Incumbent / ISPs and other new fixed operators.
    - 32.77% (2001) penetration ((Internet Subscribers/inhabitants)*100) of telephone lines forecasted for the Incumbent / ISPs and other new fixed operators.
    - 43.75% (2002) penetration ((Internet Subscribers/inhabitants)*100) of telephone lines forecasted for the Incumbent / ISPs and other new fixed operators.
    - The portion of this telephone lines (Target) acquired (40%-1999, 50%-2000, 60%-2001, 70%-2002) are residential users (business users are considered part of data services)

Transmission Network Structure

Internet Access Services Network

- **Traffic estimates parameters:**
  - Users distributed on all local exchanges according to the number of voice subscribers (PSTN/ISDN)
  - Total Internet traffic per local exchange area defined according to the number of subscribers in the area
  - All traffic originated by the subscribers is sent to a central site for national and international routing
  - Number of access lines (Local Switch to IAD) obtained by multiplying the number of subscribers by 0.07 (PSTN Access Concentration Factor)
  - Required bandwidth per IAD (Internet Access Device) obtained by multiplying the number of subscribers per 1.33 (Global conversion factor subscribers to peak bit-rate)
  - E1s equivalent for transmission nodes connected to IADs obtained by dividing the required total bandwidth of IAD output (MBPS) by 2MBPS.

Transmission Network Structure

Internet Access Services Network

- **TARGET FOR THE NEW OPERATOR**
  - Four phases (1999, 2000, 2001 & 2002):
    - 10% of Forecasted subscribers (Penetration) for 1999
    - 20% of Forecasted subscribers (Penetration) for 2000
    - 30% of Forecasted subscribers (Penetration) for 2001
    - 40% of Forecasted subscribers (Penetration) for 2002
  - All customers directly connected to the relevant Local Switching exchange, which will be NOT part of THE New Operator network.
  - Access to Internet Access Device (IAD) is via voice switching exchanges (Dial-up connection). Each IAD is collocated with the Local voice switching exchanges.
  - Traffic concentration
    - Concentration factor (Switching to IAD) calculated as 0.07 (calculated according to parameters for Asia Pacific Area and formulas as reported in document of Cambridge Strategic Management Group) resulting by the formula:
    - ((days/year usage x minutes/day per session x seconds/minute) / (seconds/year)) x (peak conversion factor)
    - Global conversion factor (IAD to Trasmission Node) calculated as 1.33 (calculated according to parameters for Asia Pacific Area and formulas as reported in document of Cambridge Strategic Management Group) resulting by the formula:
    - ((days/year usage X minutes/day per session X seconds/minute X Average KBPS) / (seconds/year)) X (peak conversion factor)

Transmission Network Structure

Internet Access Services Network

- **TARGET FOR THE NEW OPERATOR**
  - Traffic distribution:
    - 90% of the traffic towards international sites
    - 10 % of the traffic towards national sites

- **Computation of Concentration factor for switching lines input (From Local switch to IAD):**

Parameters (ASIA Pacific Area):

Average KBPS	days/year usage	Minutes/day per session	Seconds/minute	Seconds/year	Data Link Utilization	Peak conversion factor
20	200	25	60	3.15E+07	70%	7.00

Concentration Factor Formula:

((“days/year usage” * “minutes/day per session” * “seconds/minute”) / / (“seconds/year”)) * (“peak conversion factor”) = 0.07

Formula Explanation:

All the seconds of usage in one year are calculated to reach the average concentration factor allowed for Internet Subscriber accesses (E1 ports from switching to IAD). Then the calculated coefficient is multiplied by the Peak Conversion factor to take into account the Peak accesses amount during a year.

- **Computation of "Global conversion factor subscribers to peak bit-rate" for IAD Aggregate output:**

Parameters (Asia Pacific Area):

Average KBPS	days/year usage	Minutes/day per session	Seconds/minute	Seconds/year	Data Link Utilization	Peak conversion factor
20	200	25	60	3.15E+07	70%	7.00

Global conversion factor subscribers to peak bit-rate Formula:

(("days/year usage" * "minutes/day per session" * "seconds/minute" * * "Average KBPS")) / ("seconds/year")) * ("peak conversion factor") = 1.33

Formula Explanation:

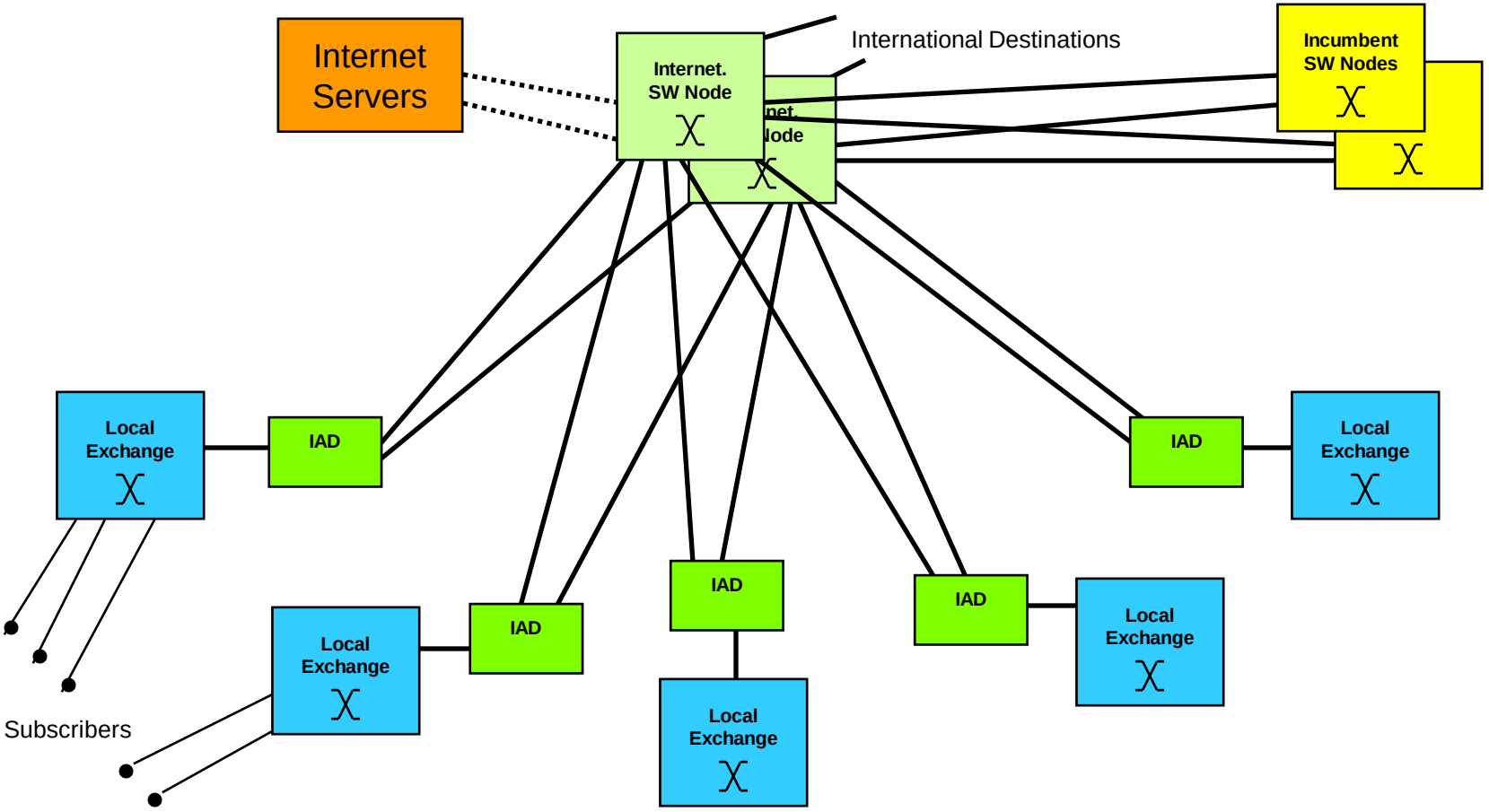
Once the quantity of accesses to IAD is obtained via the applied erlang factor, it is necessary to know the bit-rate necessary at the output of IAD or in other words which is for all the subscribers the amount of average bit-rate used during all the seconds in a year. That is obtained multiplying all the seconds of usage in a year by the average speed rate (KBPS) foreseen for ASIA Pacific Countries (20). Then the result needs, even in this case, to be multiplied by the Peak Conversion Factor in order to take into account the peak speed-rate of the accesses during a year.

Transmission Network Structure

Internet Access Services Network

- **Internet Access and Switching Points**
  - 55 Access Nodes:
  - 2 Switching Nodes (router), also as international gateway
  - 1 Service node for access authorisation and accounting purposes
  - Interconnection with the Incumbent switching Nodes at Switching Nodes level
- **Interconnections**
  - Every Access Node is interconnected to the two switching Nodes (traffic sharing)
  - Every Switching Node is interconnected to International Nodes
  - Every Switching Node is interconnected to the Incumbent Data Nodes
  - Internet Access Nodes provide integrated modems for dial up access and Frame Relay connections to the Switching Nodes

Schematic view of the Internet Network



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Video Services Network

- **TARGET FOR THE NEW OPERATOR**

  - Video services are related to the contribution part of the video network
    - From video-cameras to studio (in Taipei)
    - From studio to studio

  - Access in the 6 main cities in Taiwan is:
    - via radio links to access sites for mobile video-cameras;
    - vie direct connection for studios

  - Traffic concentration
    - No traffic concentration

  - Traffic distribution:
    - All traffic is national
    - a value of 6 STM-1 systems are left available on the ring to provide for variable DS3 point-to-point connections between the seven main cities. DS3 connections are between codec systems.

Transmission Network Structure

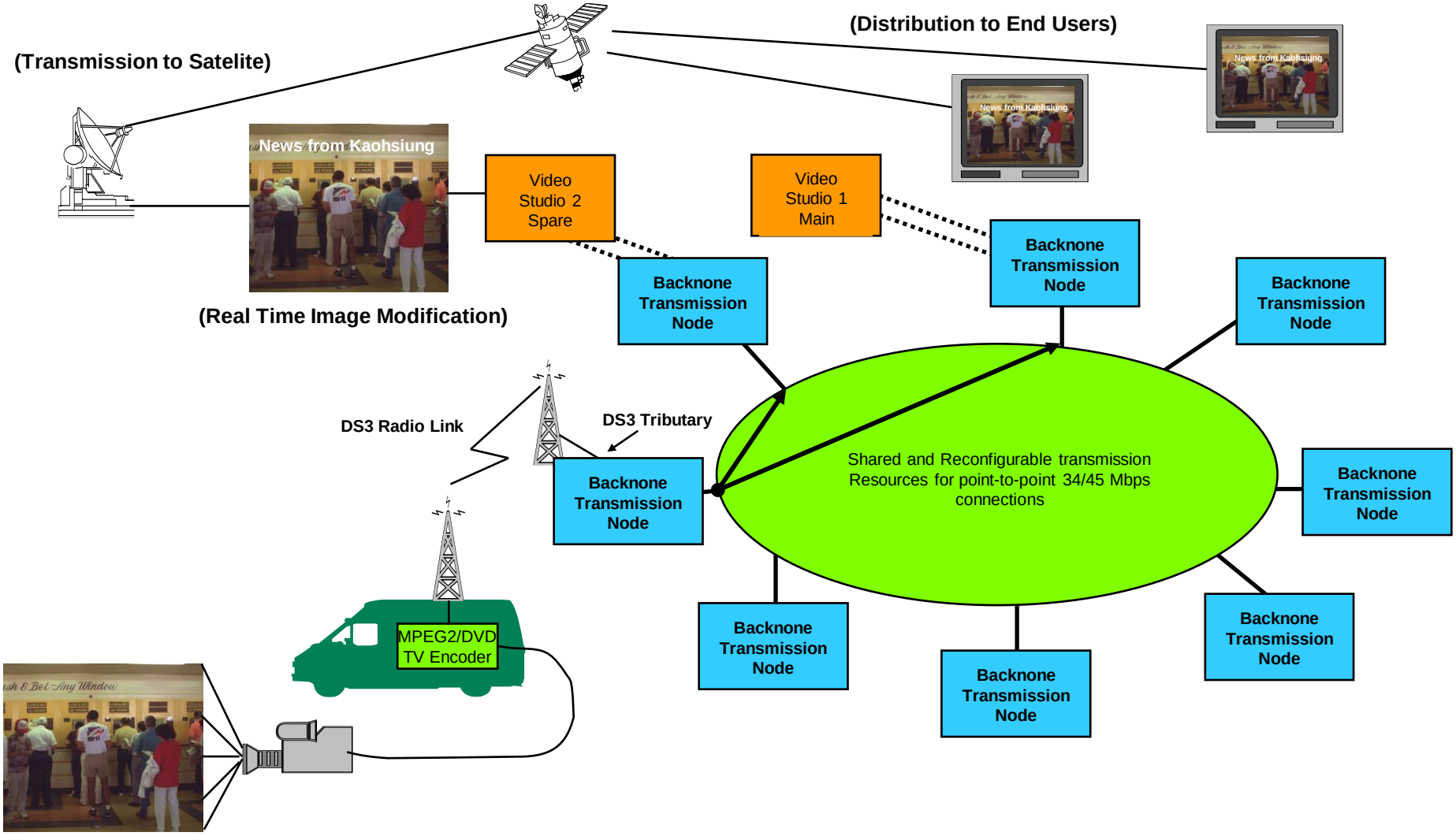
Video Services Network

- **Video Access Points**
- Video Point of Presence (PoP's)
  - 7 Video PoP's on the seven backbone transmission nodes:
- **Interconnections**
  - Every Video PoP has a number of antennas to serve DS3s radio links connecting remote mobile video-cameras via compressed (MPEG2/DVB) video codecs
  - Every Video PoP has Broadcast connection to two TV studios for protection purpose.

Transmission Network Structure

Video Services Network Structure

Schematic view of the Video Services Network



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Leased Lines Services Network

- **TARGET FOR NEW OPERATOR**

  - Four phases (1999, 2000, 2001 & 2002):
    - 12% of New Operator, Switching Forecasted subscribers for 1999 (All E1s Interfaces).
    - 12% of New Operator, Switching Forecasted subscribers for 2000 (All E1s Interfaces).
    - 12% of New Operator, Switching Forecasted subscribers for 2001 (All E1s Interfaces).
    - 12% of New Operator, Switching Forecasted subscribers for 2002 (All E1s Interfaces).

  - All customers directly connected to the relevant Local Transmission nodes.

  - Traffic concentration.
    - No Concentration

  - Traffic distribution.
    - 2% of the traffic stays local on the same local Transmission node.
    - 14% of the traffic goes international.
    - 43% of the traffic is directed towards the Incumbent and other new operators Transmission nodes.
    - 41% of the traffic is directed to other new operator Local Transmission nodes.

Transmission Network Structure

Leased Lines Services Network

- **Traffic estimates parameters:**
  - Total number of leased lines per Transmission node according to the number of E1s and/or STM-1 channels required by Large Business Customers.
  - 2 % of Leased Lines with E1 Ports
  - 10% of Leased Lines with STM-1 ports
  - National traffic matrices computed distributing the traffic from one Local Transmission Node to all the others, according to their loading size (Kruithof Method).

Transmission Network Structure

Leased Lines Services Network

- **Access Nodes**
  - 46 Local Transmission Nodes:
  - 9 Backbone Transmission Nodes.
  - 2 International Transmission Nodes.
  - 2 Interconnection with the Incumbent and others new operators via the Backbone.
- **Interconnections**
  - Every Local Transmission Node is interconnected to two Backbone Nodes (traffic sharing).
  - Every Backbone Node is interconnected to the two International Nodes (Traffic sharing).
  - Every Backbone Node is interconnected to the two Incumbent and other new operators Nodes (Traffic sharing).
  - Leased Lines Customers are directly connected to the nearest Local Transmission Node of the new operator.

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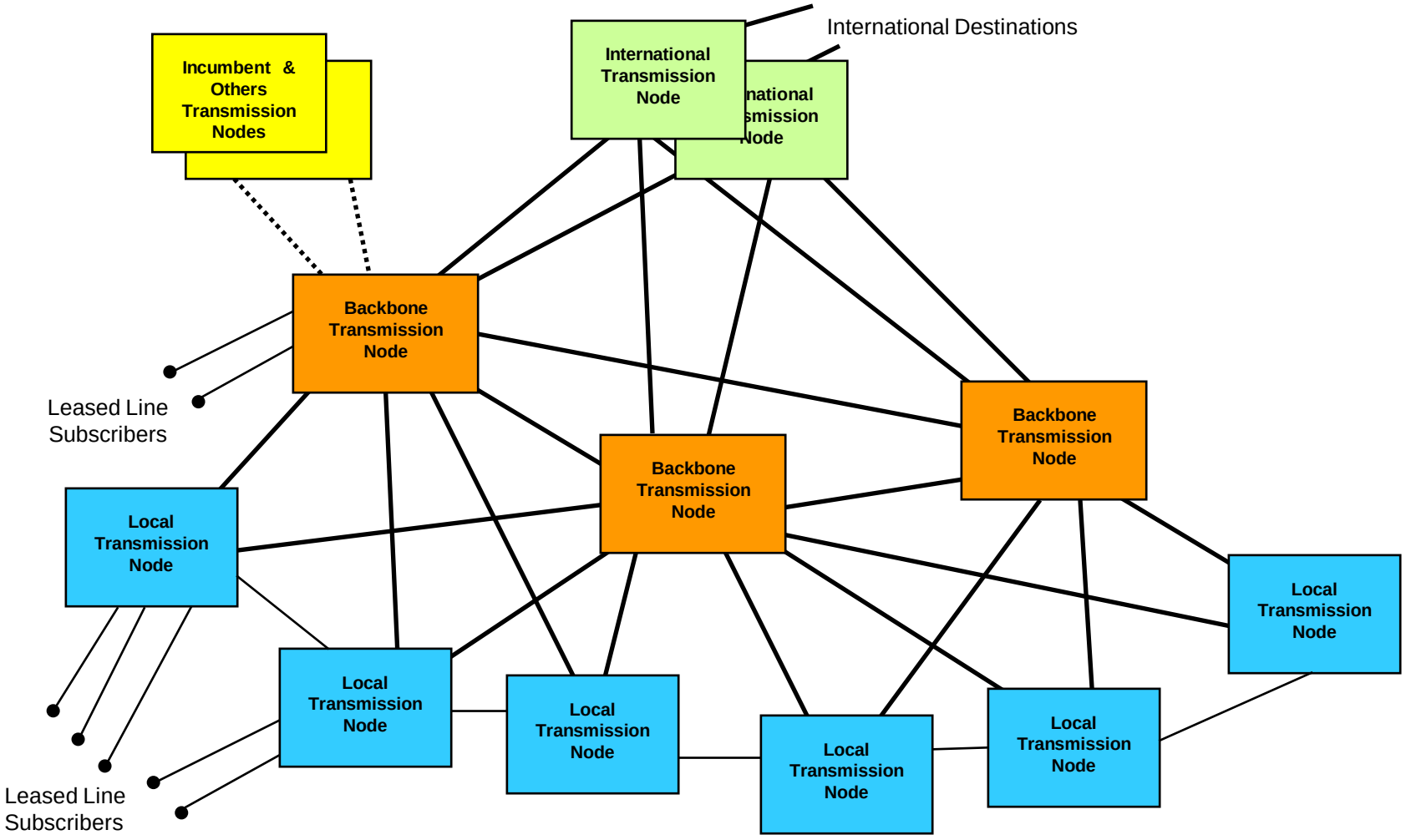
Leased Lines Network Structure

Schematic view of the Leased Lines Network



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General

- SDH Network will provide transport infrastructure for all the core networks defined for the different services that this New fixed Operator will transport on its transmission network.
- T1 interfaces are not required for the SDH equipment in that:
  - all business customers requiring T1 connections to the Switching exchange will then be converted (at voice channel level) to E1 inter-exchange connections by the switching exchange itself or via suitable external T1/E1 converters.
  - ATM Data equipment connections will be carried over E1 links.
  - Video signals will be carried over DS3 links.
  - Leased lines will be carried as E1 links and STM-1.
- SDH equipment will provide for all protection/restoration mechanisms required

- **Protection/Restoration**
  - Network Protection and restoration strategies are as follow :
    - traffic between stations inside a single ring are path protected via the SNCP (Sub-Network-Connection-Protection Mechanism) as defined in relevant ITU-T recommendations.
    - traffic between station located in different rings will be path protected by Drop & Continue mechanism as defined in relevant ITU-T recommendations
  - Equipment protection will be provided
    - duplicated common parts (Clock Interfaces and Power Supplies)
    - tributary card protection will be applied (1+1; N+1)

Transmission Network Structure

SDH Network

- **Access Nodes**
  - 46 Local SDH Transmission Nodes:
  - 7 Backbone SDH Transmission Nodes
  - 2 International SDH Transmission Nodes (in the Backbone)
- **Interconnections**
  - 8 Local rings structure provide for SDH connections between local sites and backbone sites (two backbone sites per ring)
  - 1 backbone ring interconnecting all backbone sites will provide for interconnections between local sites belonging to different local rings
  - Backbone sites will act as gateways between rings, the existence of two gateways per local ring will allow for a more resilient network structure with Drop & Continue functionality

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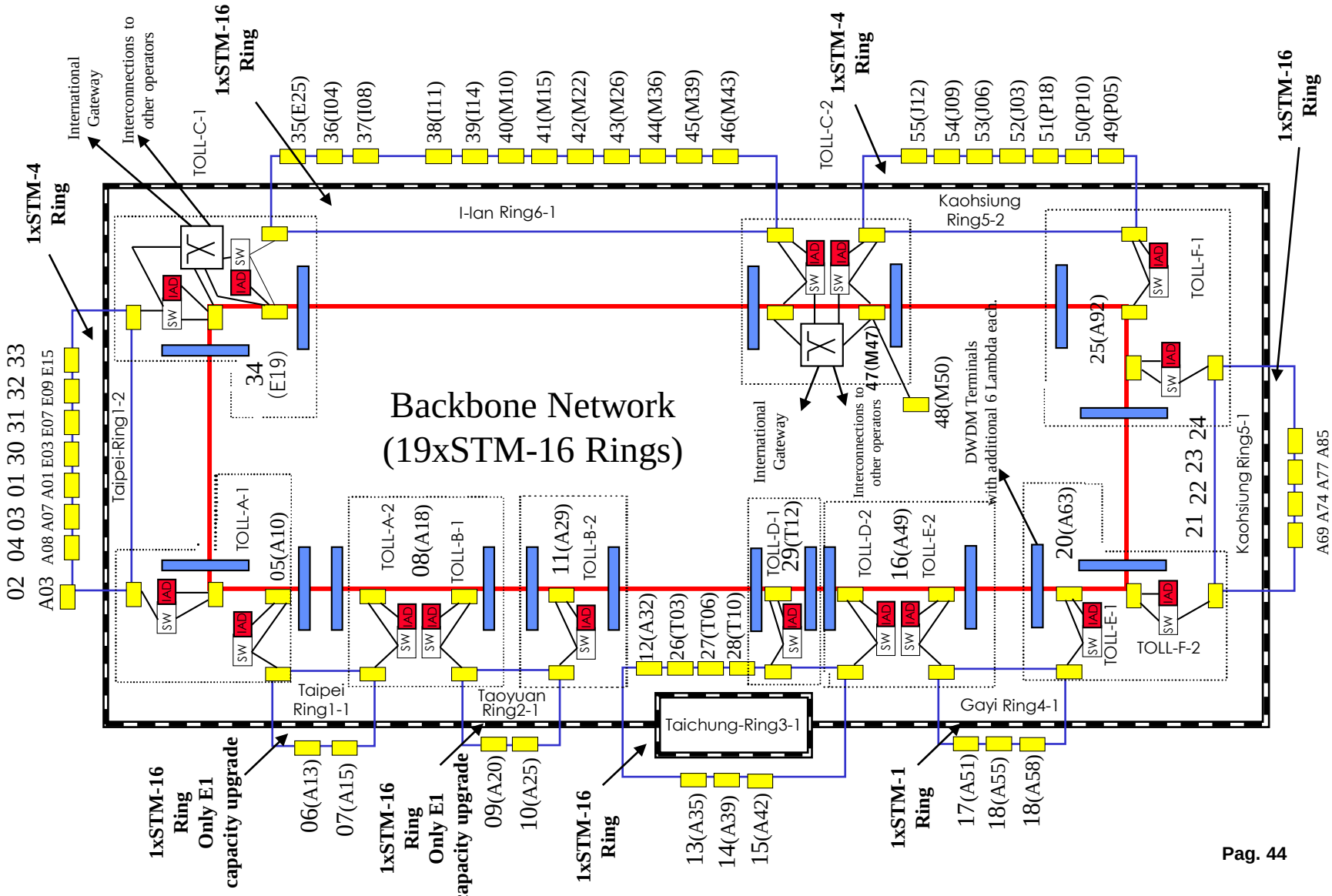
SDH Network Structure for Voice & Internet Traffic (example)

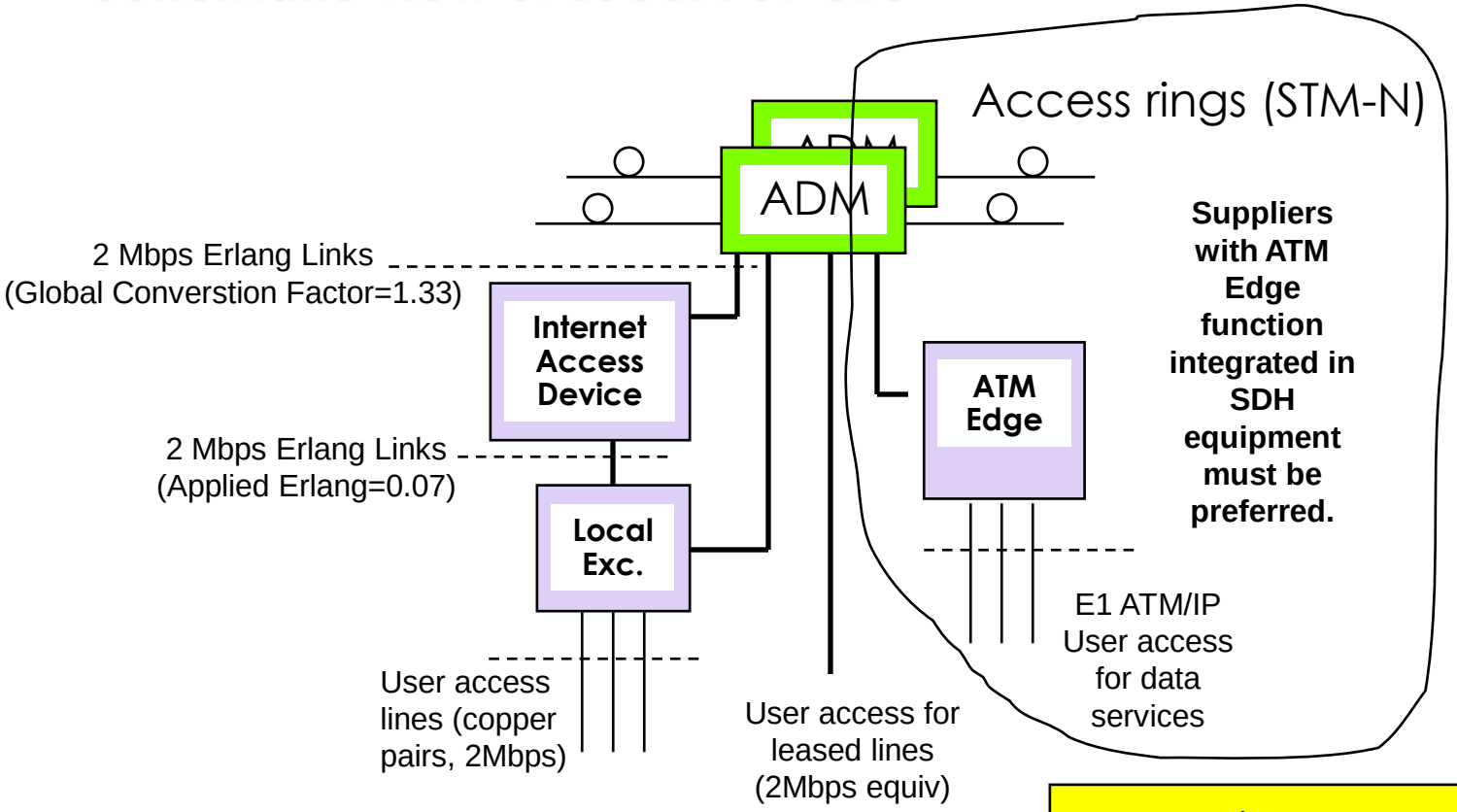


PHASE 4 Backbone and Region network structure for Switching and Internet traffic transmission

Transmission Network Structure

Global view

Schematic view of Local PoP Site



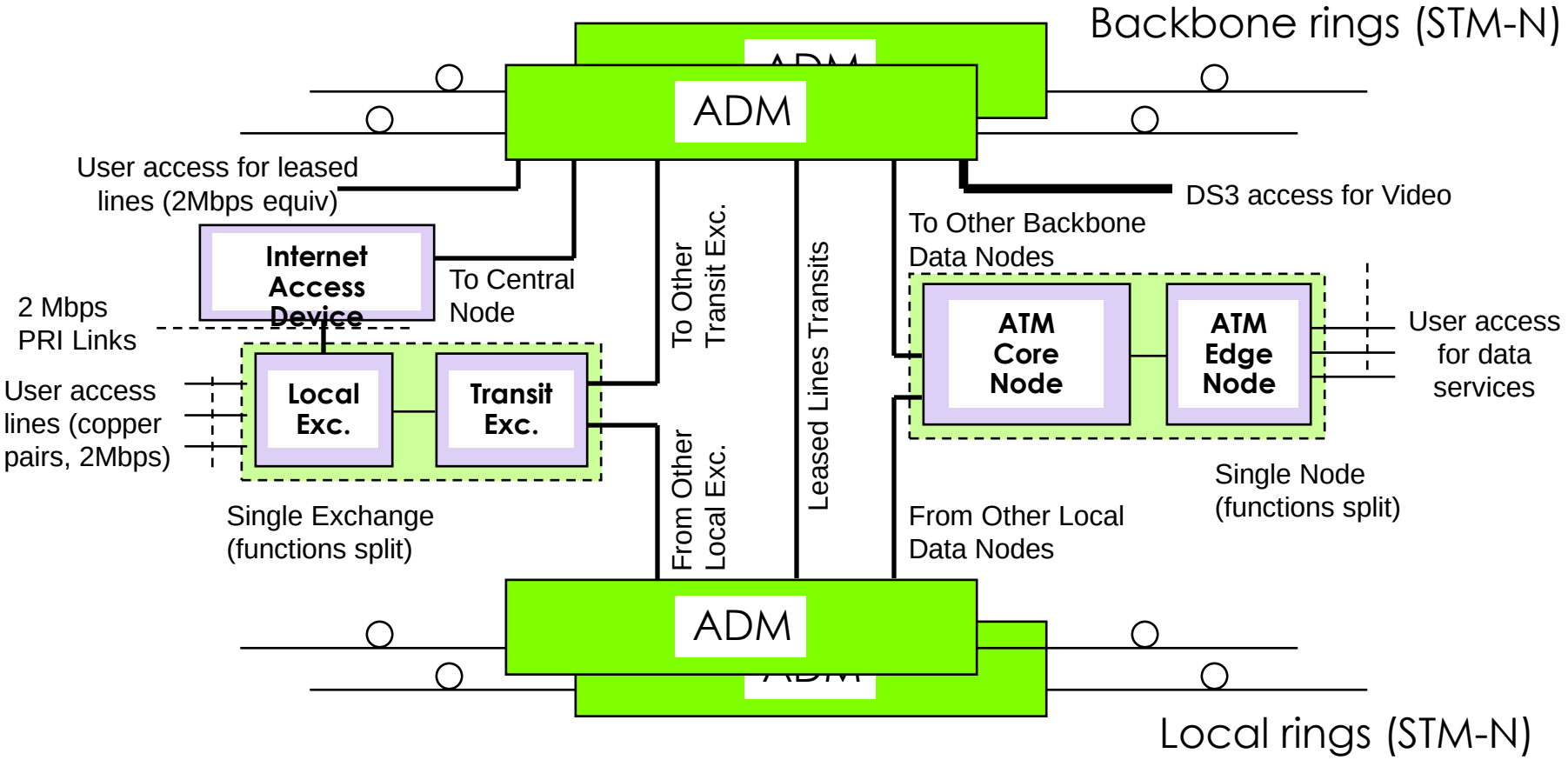
E1:
DS3

For protection purposes, traffic is split on two equipment per site attached to two different Access Rings.

Transmission Network Structure

Global view

Schematic view of Backbone PoP Site



E1: ——

DS3 ——

For protection purposes, traffic is split on two equipment per site attached to two different Access Rings.

Schematic view of the Backbone Central Site