Technical & Operational Aspects of Interconnection

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Introduction

- My background
  - 25 years in telecommunications in a wide variety of roles
  - 10 years spent on interconnect from the beginning of competition in Australia
  - Worked for new carriers, incumbent carriers, and government regulators over the last ten years

Questions

- Please ask questions at any time
  - If I have not explained something properly, then it needs to be clarified before we go any further
  - My knowledge of China is limited; if the material does not match the Chinese context, then let me know so that I can adapt it
- Questions by email after the workshop

Interconnection Objectives

- There is no simple answer for interconnection
- It depends on where you start and where you want to finish
  - Level of national infrastructure
  - National capacity
  - Development aspirations

Interconnection Techniques

- No single solution – a toolbox of techniques to be applied appropriately
- Every regulatory requirement has a primary and a secondary effect
  - Efforts to encourage long-distance operators will have the effect of discouraging local access operators

Interconnection Conundrum

- Retail transactions are asymmetrical – the customer pays the carrier
- Interconnection transactions are symmetrical – each carrier pays to terminate its calls but is paid for calls that it terminates
- In an open market it may be difficult to distinguish the carriers from the customers

Interconnection in Context

- Simple Resale
  - Product unaltered
- Value Added Resale
  - Product altered
- Interconnection of Services
  - Products linked to others
- Access to Infrastructure
  - New products created

Simple Resale

- Carrier (network operator) sells access services and/or calls to service provider
- Service provider sells those services to end-customer
- Service provider bills and supports end-customer
- Allows service provider to offer a complete range of services to compete against carriers

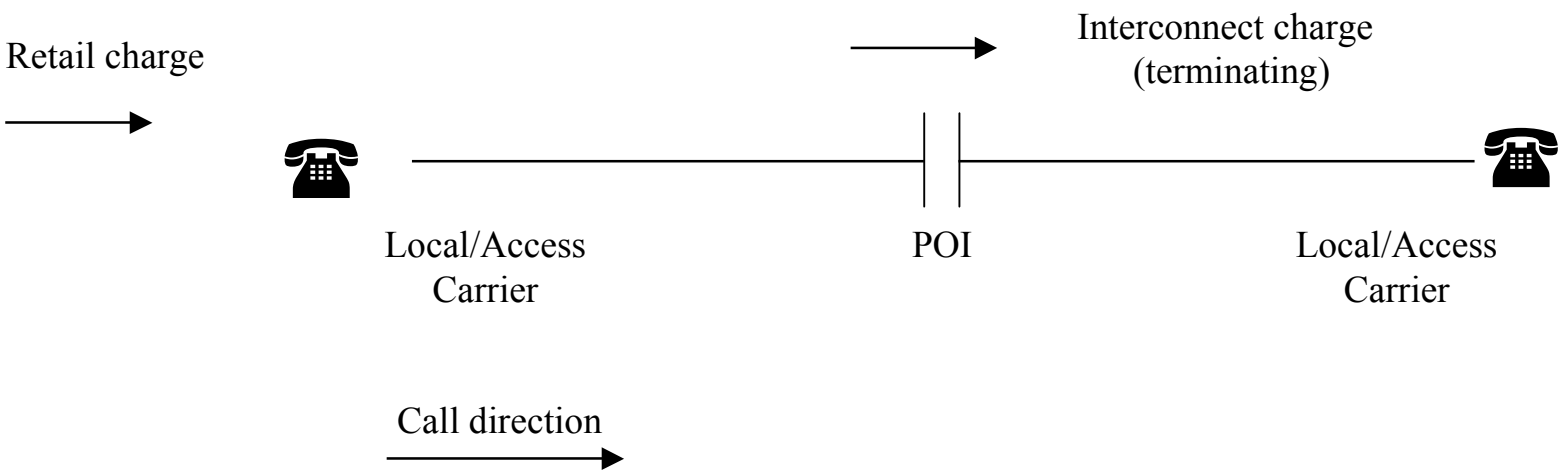
Value Added Resale

- Carrier sells product to service provider
- Service provider transforms those products into different products
- Service provider sells those new products to end-customers
- A service provider could purchase transmission services and combine them with switches or routers to create calls

Reasons for Interconnection

- To enable calls between networks
  - Long established practice
  - The reason for the creation of the ITU
  - Not entirely devoid of competition issues
- To enable competition between services
  - Intended to provide for the rapid introduction competitive services, particularly long-distance
  - Principally a competition issue

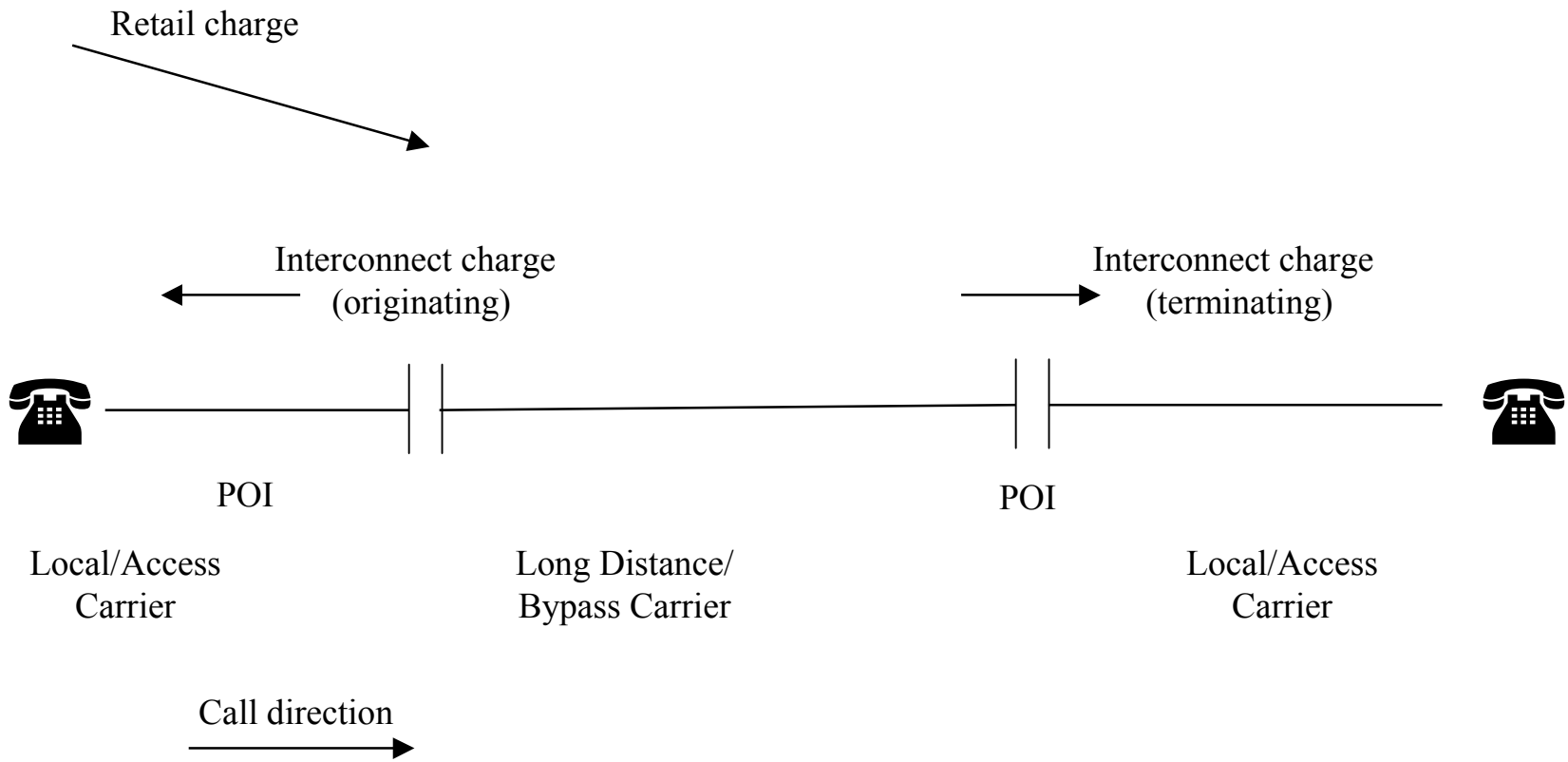
Simple Interconnection



Simple Interconnection

- Applicable to (in most cases):
  - Fixed to fixed local call
  - Fixed to mobile call
  - Mobile to fixed call
  - Mobile to mobile call
- Sometimes applicable to:
  - Fixed to fixed long-distance call

Bypass Interconnection



Bypass Interconnection

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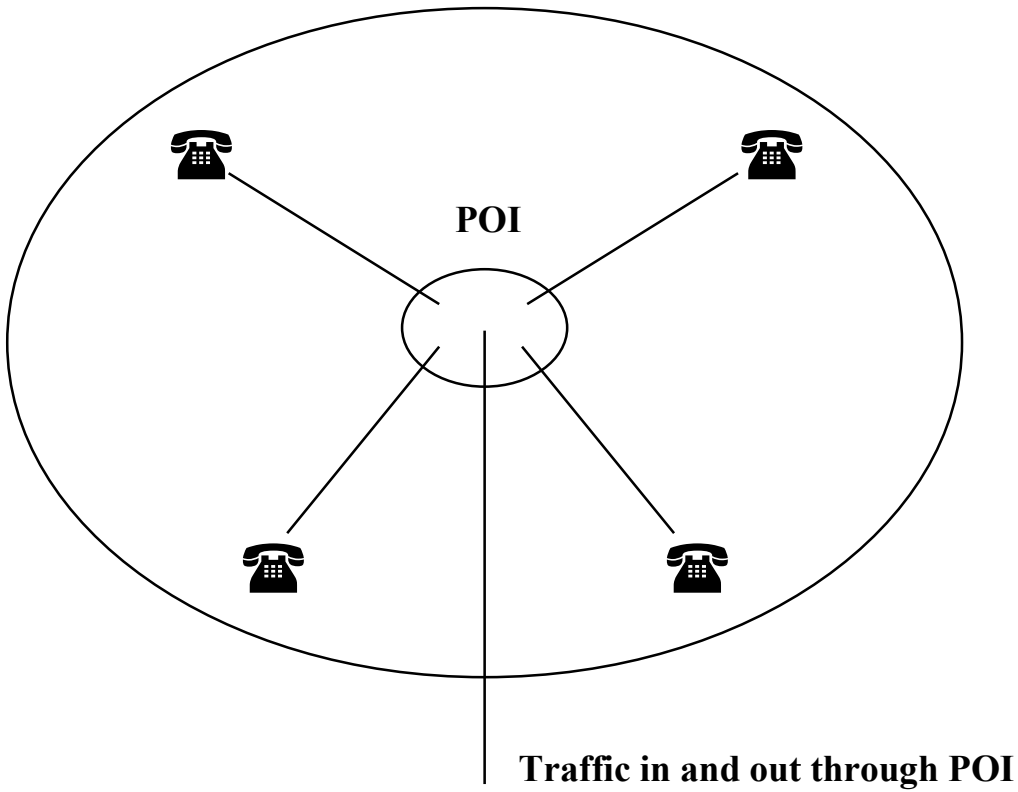
  - Mobile to fixed call

Call Collection Areas



Call Collection Areas

- Interconnection charges depend on nature of Call Collection Area
  - City
  - Urban
  - Rural
  - Remote
- Average of A$0.015 per minute
  - Varies with time of day and location

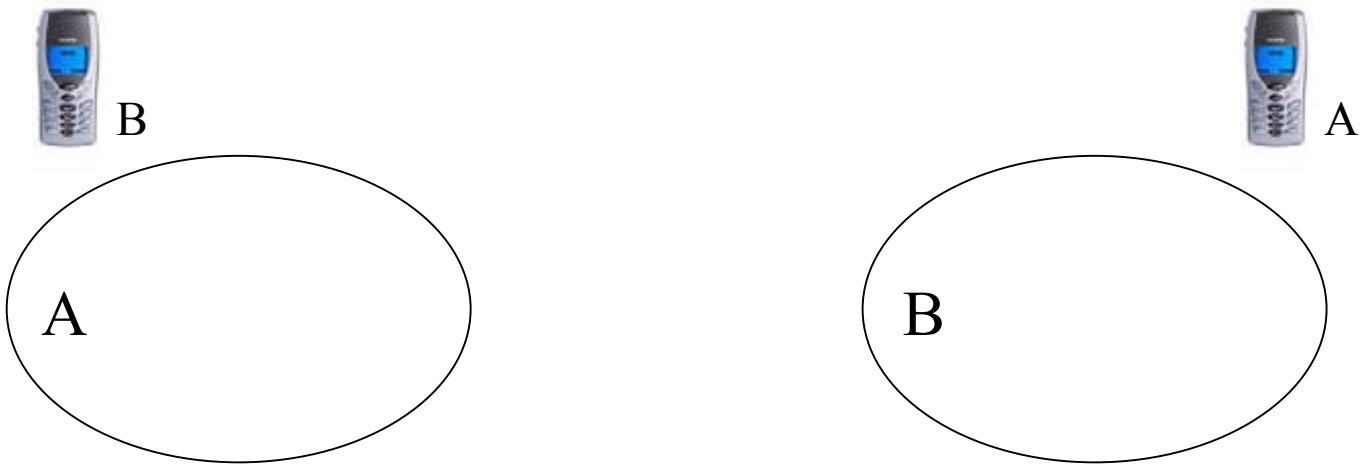
Call Collection Areas

- Australia has 66 Call Collection areas
  - Suits long-distance bypass traffic
- Further subdivision for local calls
  - Probably around 250 POIs connection to other Local Access Carriers
- POI may service a larger area: province or country

Mobile Roaming

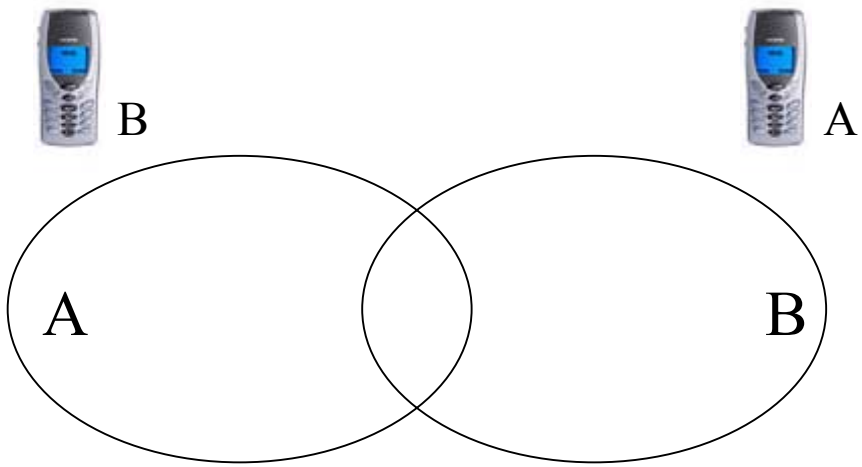
- A form of airtime resale
- Provides greater coverage for one or both carriers
- Competition issues depend on
  - No coverage overlap
  - Some coverage overlap
  - Complete coverage overlap

Mobile Roaming



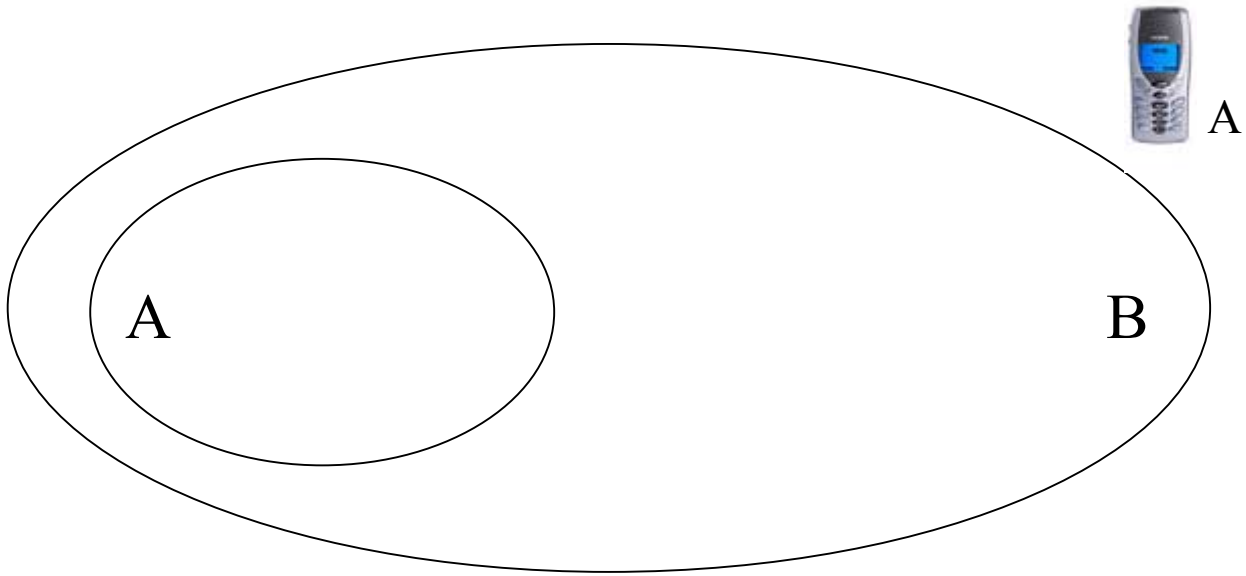
Geographically separate coverage areas.
Little competitive conflict between the tow carriers.
Roaming provides improvements in coverage for both carriers.

Mobile Roaming



Some overlap of coverage areas.
Some competition for customers, but mutual benefit from increased coverage areas.
Roaming may not operate within areas of common coverage.

Mobile Roaming



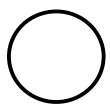
Complete overlap of coverage and direct competition for customers. Roaming may be unidirectional (customers of carrier A can roam onto the network of carrier B).

Mobile Roaming Charges

- Depends on the purpose and level of competition
- May be very low if there is mutual benefit for separate geographic regions
- May be very high if there is substantial extension to coverage for one carrier
- May be higher than retail charges

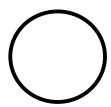
Transit Carriage – 1 Carrier

With



No interconnection

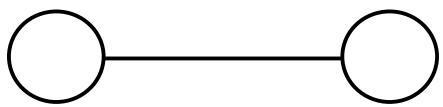
Without



No interconnection

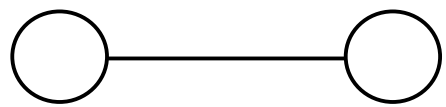
Transit Carriage – 2 Carriers

With



1 interconnection

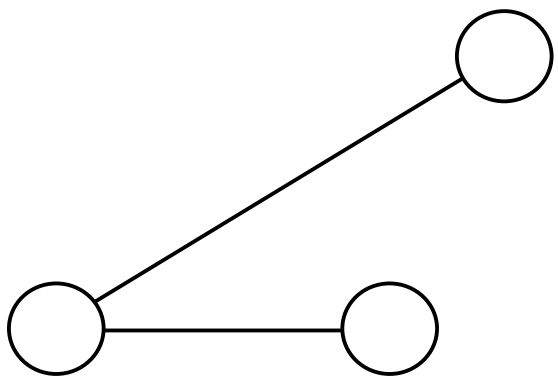
Without



1 interconnection

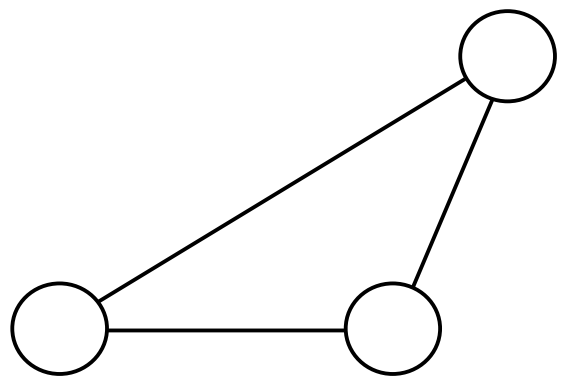
Transit Carriage – 3 Carriers

With



2 interconnections

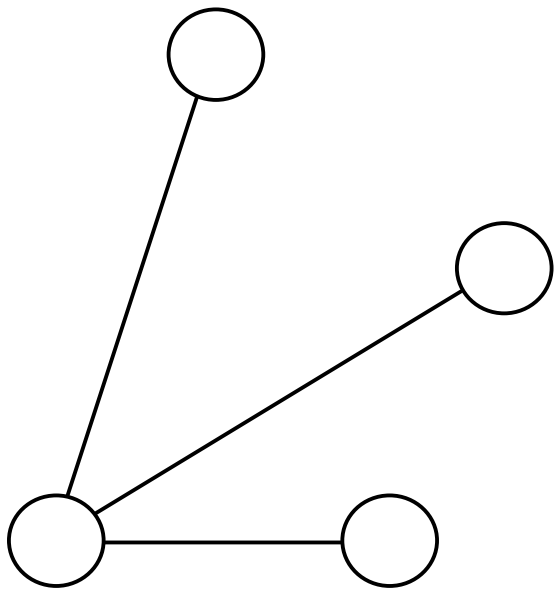
Without



3 interconnections

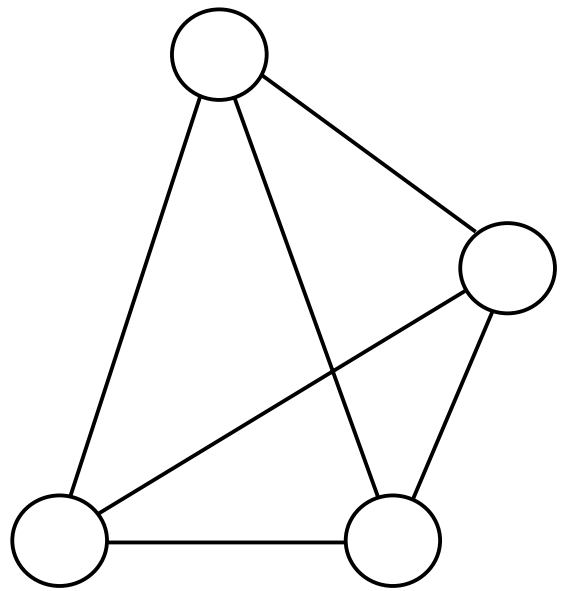
Transit Carriage – 4 Carriers

With



3 interconnections

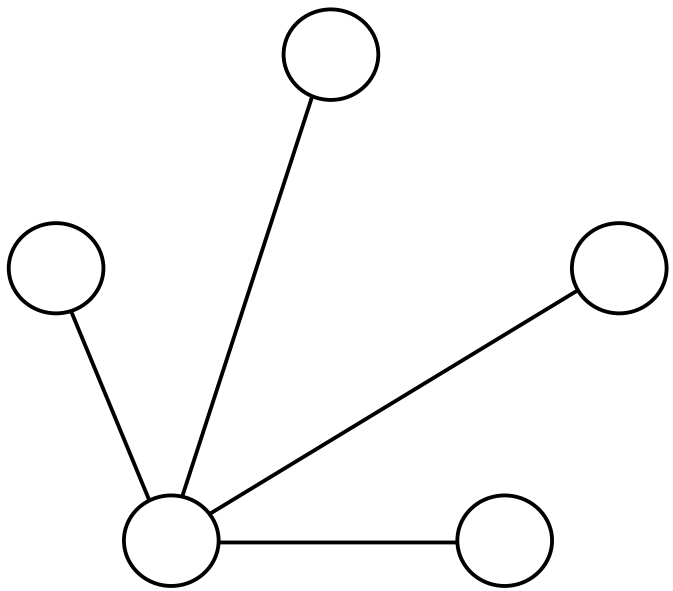
Without



6 interconnections

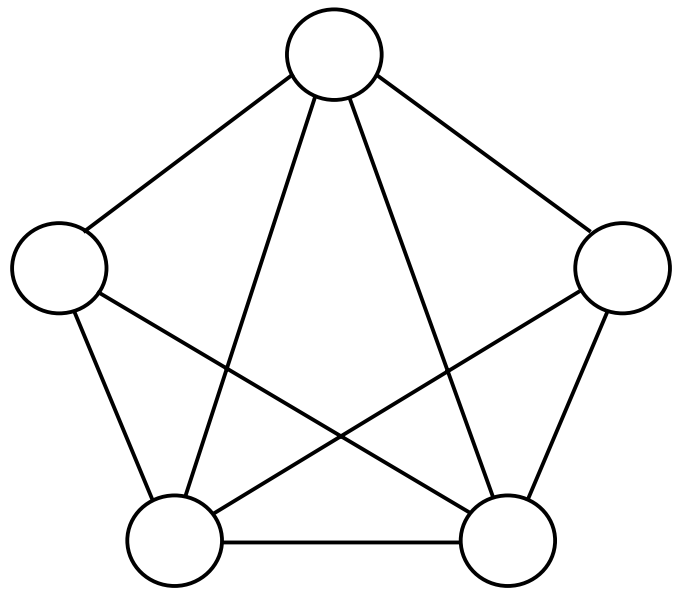
Transit Carriage – 5 Carriers

With



4 interconnections

Without



10 interconnections

Transit Carrier

- Needed to avoid delay and high cost of market entry – network efficiency
- Typically the incumbent carrier
- May need regulatory requirement
- May not be needed in the long-term and the market develops

New Entrant Delay and Complexity

- A new carrier entering a market with five existing carriers would need to establish a separate interconnection arrangement with each of those carriers, even though the total traffic volume may be very small
- The alternative is to establish a single connection to an established transit carrier

New Entrant Delay and Complexity

- Direct connections between other carriers can be established later when they are economically justified
- Refusal by the incumbent carrier to provide transit services or demands for excessive interconnect charges may be intended to impede the operation of new carriers

Points of Interconnection

- An economic more than a technical issue
- There are technical limitations on interconnection, but there are numerous places in a network where interconnection can take place
  - Local exchanges
  - Trunk exchanges
  - International exchanges

Points of interconnection

- Number and location of POIs is a balance of fixed and variable costs
- The larger the number of POIs, the closer the interconnecting carrier can get to the call destination and the lower the per minute charge (variable cost)
- Each POI has a cost associated with its establishment and operation (fixed cost)

Points of Interconnection

- There is a trade-off between the cost of POIs and the amount of traffic carried
- A provider of local call services might want POIs at each local telephone exchange
- A provider of international service might want a POI at one point in the country or a limited number of high traffic points
- The optimal number and location of POIs may change as traffic volume increases

POI Technology

- In some jurisdictions it is simply a joint in a cable connecting the two networks
- In others it is a test/disconnection point in the building of one of the two carriers
- One party (the incumbent carrier) is usually in a better position to provide the interconnecting link

POI Technology

- Incumbent carrier generally sets standards
- Normally simple, stable technology because multiple vendors are involved
- Standard transmission links are used to interconnect carriers
  - Multiples of 2Mbit/s or 1.5 Mbit/s
  - Voice channel structure
  - STM may be used in future

POI Technology

- Modified and simplified CSS7 signalling is used to control the connection
  - TUP or preferably ISUP
  - Network protection modifications
    - Barring of no charge messages
    - Isolating control of network timers
  - Review of signalling system to identify all threats to network integrity

POI Technology

- Call records and performance statistics would be measured at the POI
- Call destinations would be monitored
  - The POI may be for limited range of destinations and types of call
  - Calls rejected according to dialled number

Future POIs

- Carriers, including incumbents, are increasingly using voice over IP within their networks
- Inefficient to convert to voice circuits in one network across the POI and back to packet in the other network
- Opportunity for conversion devices (not limited to POIs) between circuit and packet

Handover

- Near-end handover
  - Used for interconnection to mobile networks and for calls to special services (eg 1800)
  - Originating network does not know the destination of the call and delivers to the terminating network at the closest point
- Far-end handover
  - Call delivered as close as possible to the destination

Interconnect Billing Systems

- Depend on the complexity of the commercial arrangements
  - More focussed on costs than retail charges
- Generally simpler retail billing
  - May not provide retail level of call detail
- Records will be kept on both sides of the POI and there will have to be a reconciliation process

Bill and Keep

- Simplified approach to billing for certain types of interconnection
- No interconnect billing system – each carrier keeps its full retail revenue and carries the interconnected traffic for free
- Traffic must be reasonably symmetrical (not long-distance bypass)

Bill and Keep

- Induces strange behaviour
  - No carrier wants incoming traffic such as call centres and internet service providers as it generates no revenue
- Works with the interconnection of free local calls
- Useful in the short-term because it is simple to implement

Interconnect Billing

- Typical Parameters
  - Call count
    - May include unsuccessful calls (call attempts)
  - Call minutes
  - Call records
    - May be collected for analysis and fault finding purposes
  - Data volume in the future?

Interconnection Agreements

- Substantial long-term relationship
- Subject to regular review (possibly as a result of regulator intervention)
- Complex range of products and issues
- Not like most commercial agreements, the other party may be reluctant (particularly the incumbent carrier)

Carrier Relationships

- Regular (possibly continuous) need to negotiate extensions (new products/technologies) and reviews of agreements
- Regular contact for routine activities
- Need for regular review meetings to assess progress and improve processes (one to two months)
- Formal escalation process to handle disputes

Carrier Relationships

- Four major issues
  - Ordering and provisioning of services
  - Operations and maintenance issues
  - Billing and settlement issues
- May also include access to facilities

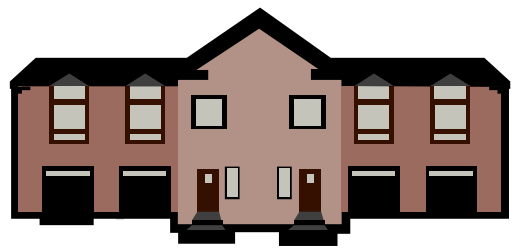
Local Loop Unbundling

- Copper pair between end-user and telephone exchange building
  - Direct access to twisted copper pair
    - Widest variety of services, but greatest technical complexity
  - Provision of managed services (principally DSL) by incumbent local access carrier
    - Less technical complexity, but less variety
  - Both

Local Loop Unbundling

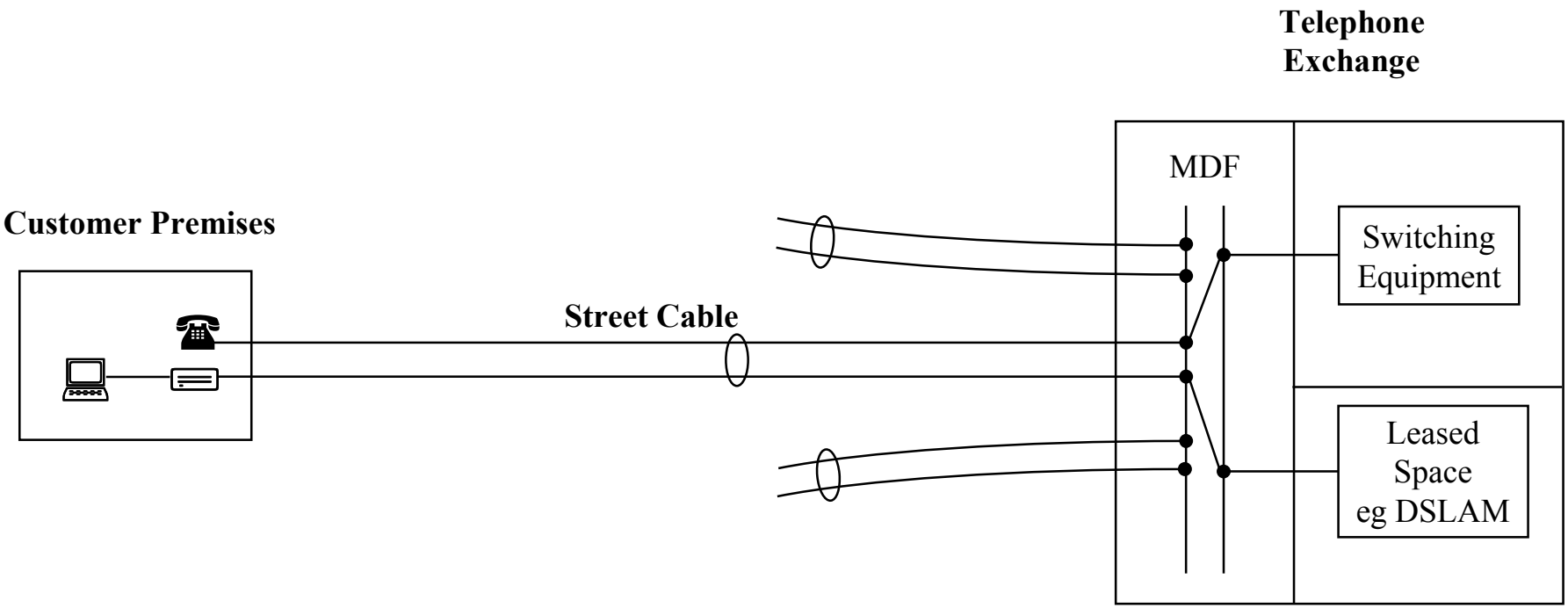
Customer Premises

Telephone Exchange Building



Street Cabling (Twisted Copper Pair)

DSL Configurations



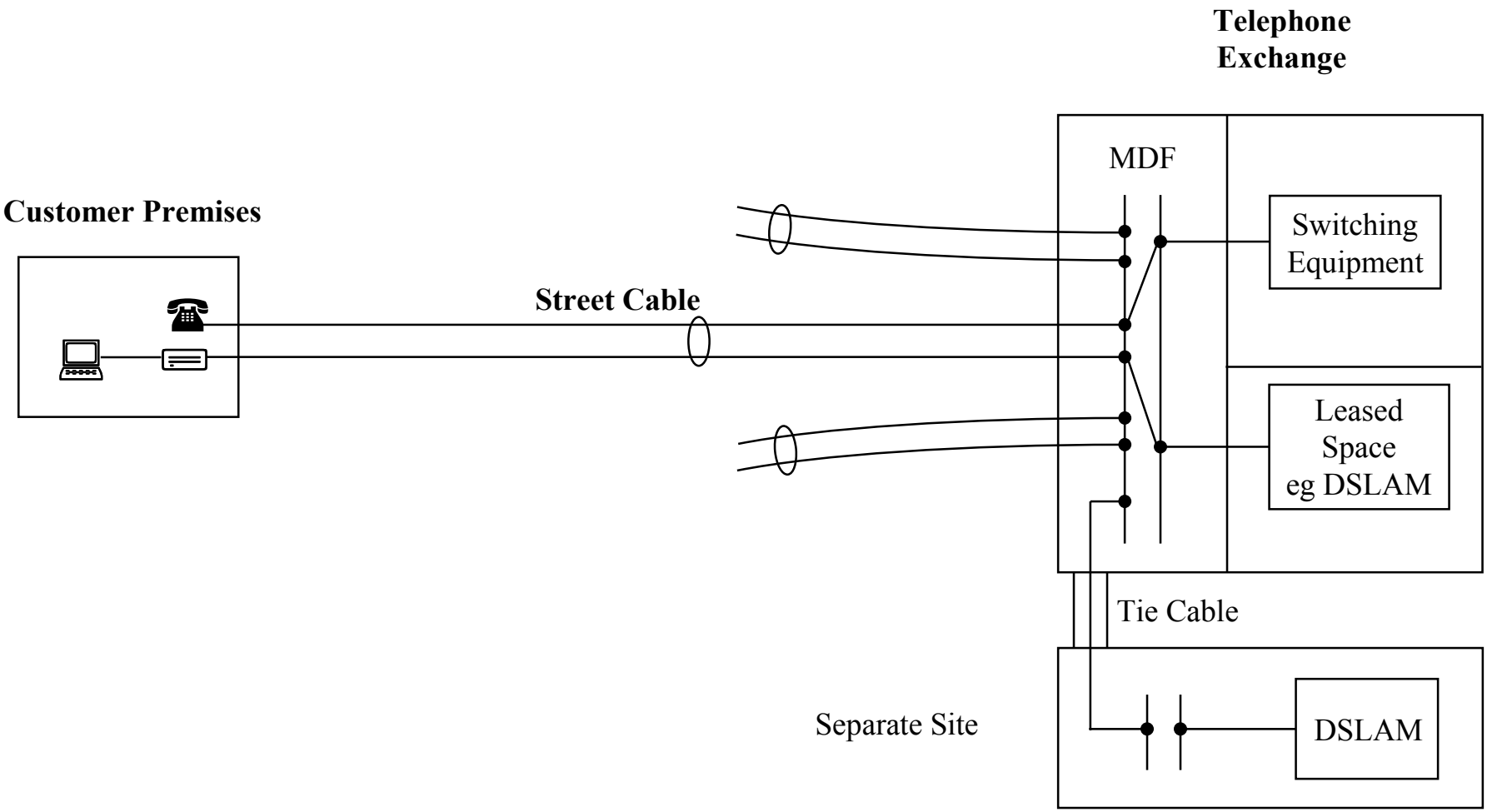
Local Loop Issues

- Cost determination
  - May be greater than retail
- Shared use
  - Difficult co-ordination, but lower cost
- Life-line telecommunications
  - Limits use of voice over internet
  - Need to retain standard telephone service

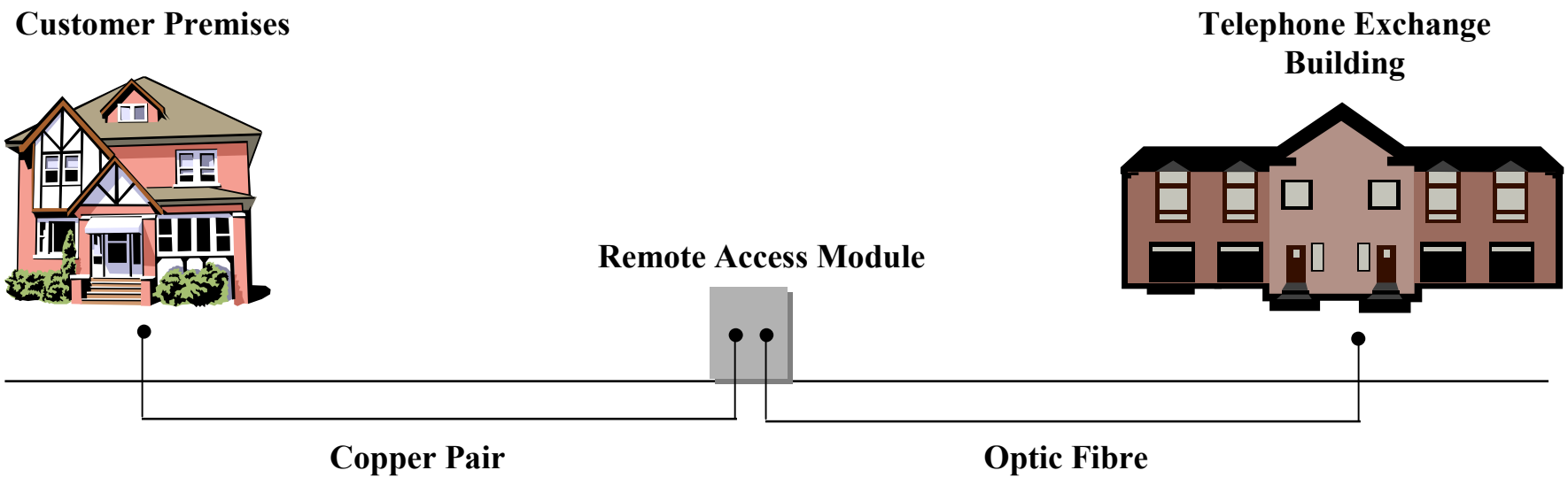
Local Loop Structure

  - Modern equipment requires less space and buildings can accommodate other carrier's equipment
- Access seeker equipment may be housed on the premises of the access provider
- Tie cable between access seeker and access provider
  - To internal or external equipment space

DSL Configurations



Changing CAN Technology



Changing CAN Technology

- Increasing use of optic fibre in Customer Access Network (CAN)
  - Optic fibre to the curb, copper pair to the house
- Existing copper cable may be retained and the optic fibre used for expansion
  - Continuous copper still available but may be interference problems between services

Changing CAN Technology

- Need for greater number of DSLAMs
  - One per cable rather than one per exchange
- Larger number of customers needed to justify cost
  - Market of 500 per cable compared with 20,000 per exchange
- Shorter copper pair and faster service
  - 52 Mbit/s

Infrastructure Sharing

- Numerous opportunities
- Mobile sites
- Mobile towers
  - May require larger tower and create operational issues
  - Need to disable lower antennae to service higher antennae

Infrastructure Sharing

- Mobile networks
  - (mobile roaming)
- Spectrum sharing
  - Shared mobile network
- Trenches or ducts
- Building space

Mobiles

- Two distinct configurations of mobile service
- City Licence (North America, Hong Kong)
  - Similar to wireless local loop
  - Local number; local charging
- Regional Licence (Europe, Australia)
  - Regional/national number; national charging

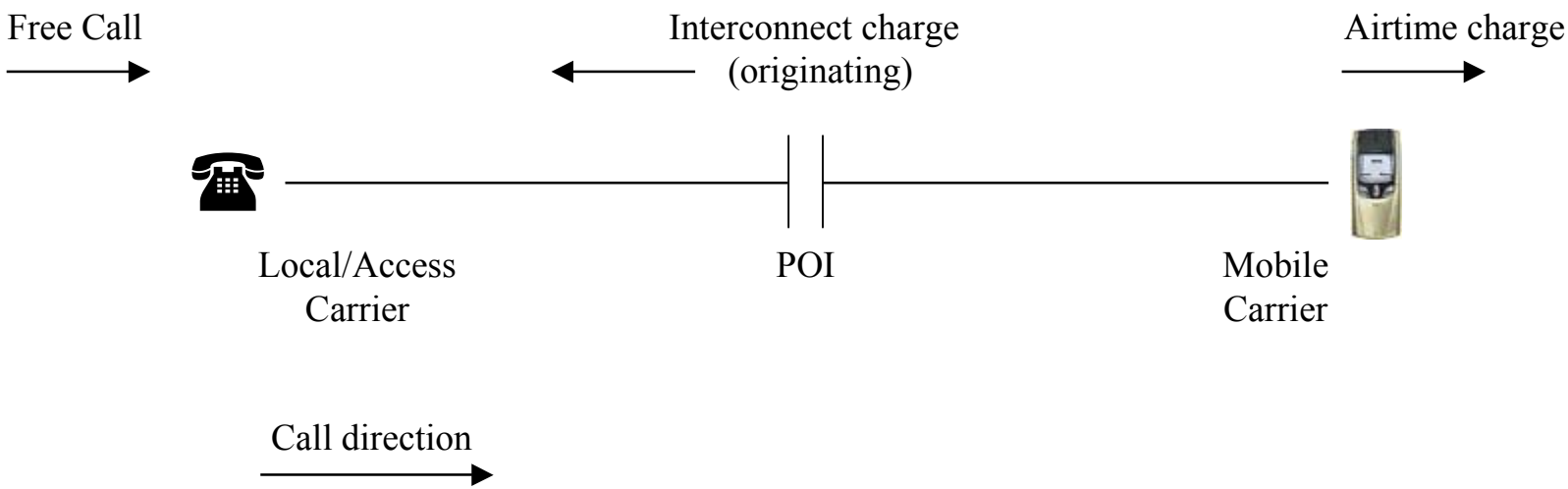
Mobiles – City Licence

- Mobile number indistinguishable from local number
  - (216) 457 3158
  - (216) 543 7429
  - Not widely published
- Fixed network caller pays normal local or long-distance charges

Mobiles – City Licence

- Mobile user pays similar long-distance and international charges to fixed network, plus
- Mobile user pays airtime charge for both incoming and outgoing calls
- Roaming to other locations sometimes requires prior arrangement and incurs roaming charges

Fixed to Mobile Interconnection



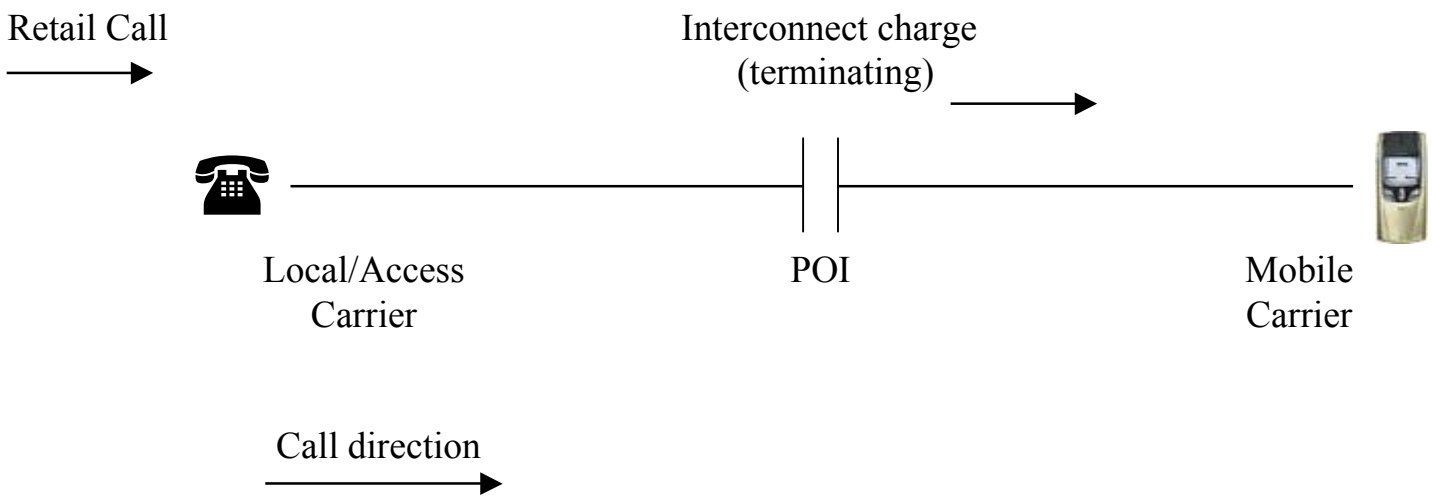
Mobiles – Regional Licence

- Mobile distinctly different to fixed number
  - 0413 880 220
  - (03) 9288 5008
  - Widely published
- Fixed network caller pays single timed charge independent of distance (or two tier charge based on distance in some places)

Mobiles – Regional Licence

- National charging system
  - Most have one rate for calls to and from (and between) mobiles
  - Some carriers in large countries have distance rates
- No unbundling of long-distance component for calls from mobiles
- Roaming is automatic throughout the network

Fixed to Mobile Interconnection



Mobiles Interconnection

- Mobile networks tend to be highly centralized and less distributed than fixed networks
- Typically one or more switches in a large population centre with extensive transmission to base stations in the surrounding area
- Interconnection is highly centralized

Mobiles Interconnection

- Interconnection rates of about 30% of retail are typical in Australia
- Comparison is difficult because of the complex retail tariffing
  - Retail charges vary by a factor of 4:1
  - Retail charges include a component for mobile handset subsidy

Mobiles Interconnection

- Terminating carrier provides the long-distance component, but more than 80% of traffic is switched locally

Equal Access - Preselection

- Automatic selection of long-distance operator without extra dialled digits
- Normal number dialled (local, national or international format)
- Selected types of calls are automatically routed to a selected long-distance carrier
- Mostly used by small/single line customers
- Can be overridden by dial code

Equal Access - Dial Code

- Long-distance carrier is selected for each call using additional dialled digits before national or international number
- Code can be dialled before any number the user chooses (including inappropriate numbers)
  - Sometimes the code will be ignored – emergency number
  - Sometimes the call will fail – local calls and carrier specific numbers

Equal Access – Dial Code

- Managed by customers
- No records kept by carriers
- Used by large customers with PBX least cost routing systems
- Less convenient for small customers who forget to dial additional digits or do not understand when to do so

Equal Access - Issues

- Industry agreement required on technical and administrative operation
- All carrier networks must operate the same way
- Difficult for niche carriers that handle particular types of call and do not want all preselectable calls
  - International traffic to specific locations

Equal Access - Issues

- Which calls should be be preselected
  - National long distance
  - International
  - Mobile (more later)
- Multiple baskets
  - Independent selection of carrier for each class of call
  - Number of baskets, combination of call types

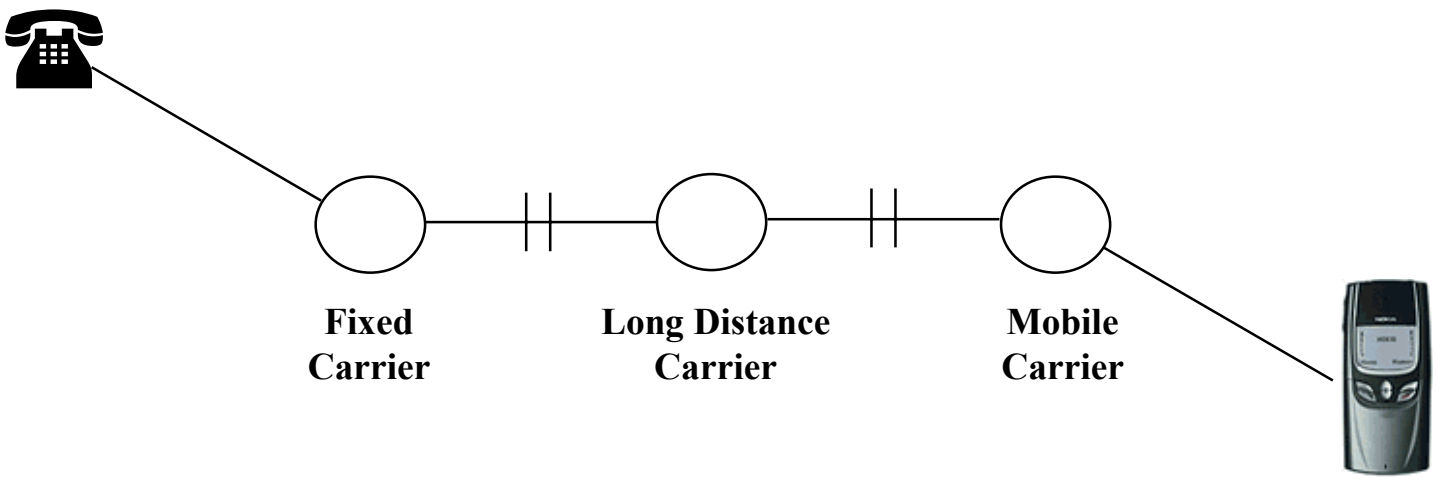
Equal Access - Issues

- Major issues are administrative rather than technical
- Initial arrangements
  - Ballot
  - Default
- Authoritative record of preselection
- Slamming

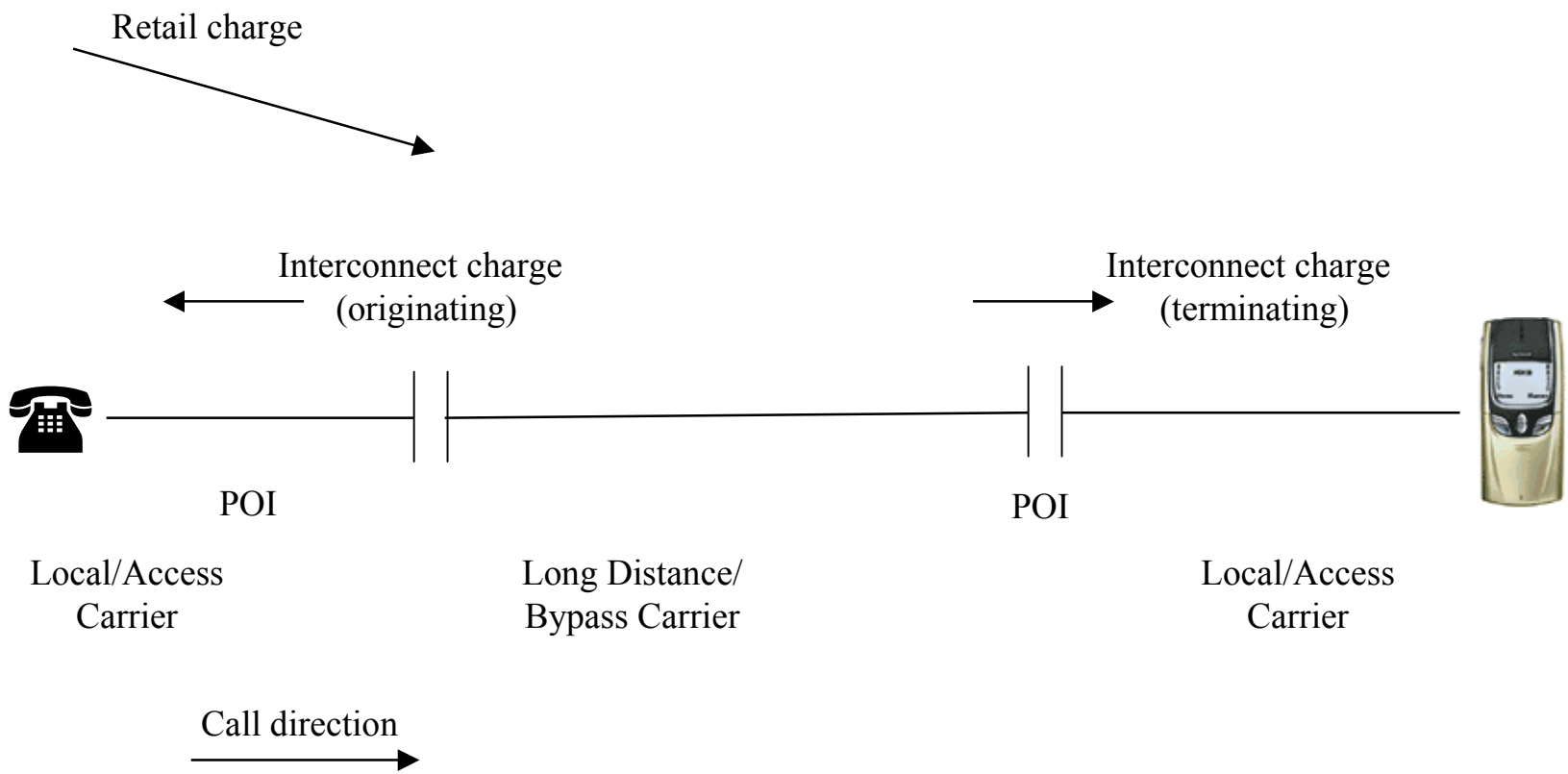
Mobiles Preselection

- Fixed to mobile preselection
  - Opens fixed to mobile charges to increased competition
  - Fixed to mobiles traffic rivals long-distance revenue
  - Call passes straight through the bypass carrier and on to terminating mobile carrier, with the bypass carrier contributing nothing to the carriage of the call

Fixed to Mobile Preselection



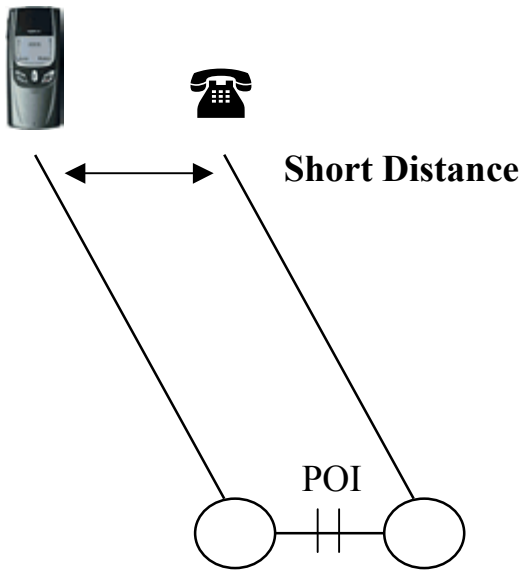
Fixed to Mobile Preselection

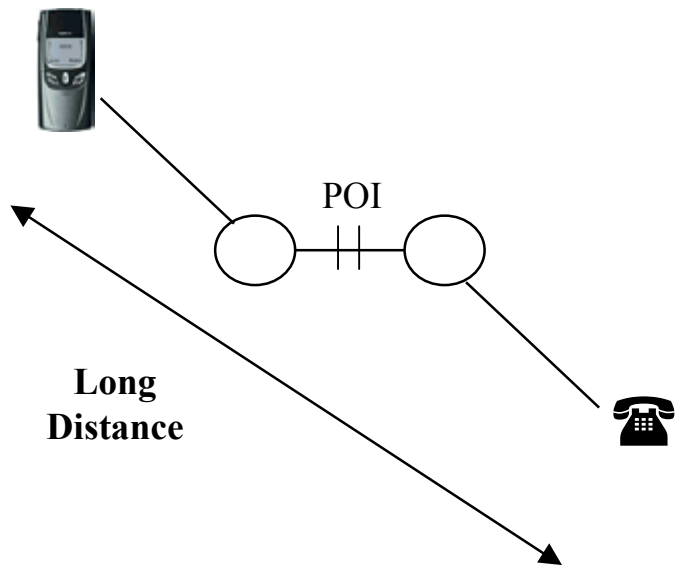


Mobiles Preselection

- Mobile to fixed preselection
  - Difficult to implement
  - Generally no preselection on mobile networks
  - No concept of a distinct long-distance call within the mobile coverage area (would work with international calls)
  - Same charges for short and long-distances

Mobile to Fixed Preselection





Quality of Service

- Major performance issues for voice telephony is congestion
- Digital networks ensure that most performance requirements are maintained across interconnect boundary
- Need for national standard for transmission level and a national number plan

Quality of Service

- The carrier providing the traffic is responsible for ensuring that there are sufficient circuits to terminate the traffic that it expects to send to that other carrier
- The carrier originating the traffic determines it s own fate through forecasting and paying for sufficient circuits

Issues - ISP Traffic

- Very long held calls from Local Access Carrier to Internet Service Provider
- Little or no traffic in the opposite direction
- Free or fixed price local calls
- Very large flow of revenue to ISP
  - Cap termination charges (fixed price)
  - Reverse interconnection charge

Issues - ISP Traffic

- Dial up traffic may diminish with increasing use of DSL to provide permanent broadband connections
- South Korea currently has more than 50% permanent broadband internet connections