"Open Network" Regulatory Framework for Third Generation Public Mobile Radio Services in Hong Kong

Discussion Paper for Industry Workshop

To be held on 5 January 2001

Background

On 3 October 2000, the Telecommunications Authority (TA) issued the second consultation paper (entitled "Licensing Framework for Third Generation Mobile Services - Analysis of Comments Received, Preliminary Conclusions and Further Industry Consultation") in the industry consultation exercise on the licensing framework for third-generation (3G) public mobile services. In the consultation paper, the TA proposed a "hybrid" approach for the selection of licensees for the operation of 3G services, including the elements of "pre-qualification", spectrum auction and "open network" requirement.

2. The "open network" requirement aims to meet the Government's policy objective of introducing more competition at the content and service application level. In particular, such an arrangement will greatly benefit the development of innovative, small and medium sized application houses and service providers in Hong Kong. It would also allow room for all incumbent 2G operators to take part in the 3G business even if they lose out in the licence bidding process for 3G network operation.

3. Responses to the second consultation paper generally called for more clarity in the "open network" regulatory framework and how the "open network" requirement should be defined and enforced. In this discussion paper, the TA would like to give more details of his proposals, which will form the basis for discussion at the industry workshop to be held on 5 January 2001. Taking into consideration the discussions at the workshop, the TA would then finalise the "open network" regulatory framework for the 3G services.

"Open Network" Requirement

4. In TA's proposed 3G licensing framework in the second consultation paper, the licensees, as the mobile network operators (MNOs), will be required to open up their 3G networks to 3G service providers, including resellers and "mobile virtual network operators" (MVNOs)[1]. The "open network" requirement allows the MNOs themselves to be service providers at the same time. As content and service applications are expected to be the major revenue sources in 3G business, the MNOs may retain a certain amount of network capacity for their own use or use by their affiliated companies for service provision. However, the MNOs will be required to open a minimum amount of network capacity to non-affiliated service providers (NSPs) which include all non-affiliated resellers, MVNOs and content providers which lease capacity from the 3G networks to sell their services directly to their own end customers. In the

[1] A more precise definition of MVNO is given in Annex 1.

second consultation paper, the preliminary view of the TA on the percentage of network capacity to be open to such NSPs was in the range of 30% to 50%. The TA considers that the proposed percentage would strike a balance as to render a meaningful “open network” requirement and meanwhile not to discourage the MNO's investment incentives. The TA will review the need to continue specifying such a percentage after five years from the date of award of the 3G licences.

5. Some of the responses from industry preferred that the “open network” requirement should be left completely to commercial negotiations. However, the TA shares the concern of other respondents that without a mandatory “open network” requirement and some basic ground rules backed up by an enforcement mechanism as a last resort, the “open network” requirement might not be implemented, or just implemented in a perfunctory manner, or it would take too long for the commercial negotiations to be completed. Thus, the TA considers that a mandatory "open network" requirement is essential in the proposed 3G licensing regime, albeit only as a reserved mechanism to be activated when commercial forces do not produce the desirable policy outcome.

"Open Network" Regulatory Framework

Preference for Commercial Agreements

6. In fulfilling the policy objective of an “open network” requirement to facilitate the availability of a wide range of innovative content and other 3G services in Hong Kong, the TA is mindful that market forces should be the most desirable means to regulate the behaviour of the market players. However, the TA is also mindful that market forces work best when there is little or no constraint to the supply of the demanded goods or services. In the case of the supply of 3G network capacity, because of the limitations in the supply of the available spectrum, only four networks could be licensed in the near future. As 3G is still very much in its infancy, it is difficult to conclude at this stage whether four licences would bring about sufficient competition in the supply of network capacity to ensure the “open network” policy objective is met by pure market forces.

7. The current thinking of the TA is that he would first leave it to the market to work out commercially the “open network” requirements. He would monitor the market to see if the policy objectives have been largely accomplished. However, if commercial arrangements could not been reached between the parties within a reasonable period of time, it would be in the public interest for the TA to intervene to facilitate the efficient and effective interconnection between the 3G network operators and the NSPs. The proposed regulatory framework under which the TA would exercise his power is described in the following paragraphs.

Definition of Network Capacity and Percentage of "Open Network"

8. The "open network" requirement is not intended to compel MNOs to leave network capacity idling, waiting for the demand from NSPs. An MNO will only be obliged to fully equip network capacity to handle efficiently, and on a non-discriminatory basis as compared with traffic of the MNO or its affiliated service providers, traffic to and from customers of the NSPs to meet the requirements under the contracts between the MNO and NSPs. However MNOs must be prepared to supply higher capacity under existing

contracts and enter into new agreements upon request, so long as the “Actual NSP Traffic Occupancy Percentage” is less than the “Open Network Percentage”.

9. The terms "Actual NSP Traffic Occupancy Percentage" and "Open Network Percentage" require precise definitions. The TA's proposed high level definitions of these two terms are as follows:-

- *Actual NSP Traffic Occupancy Percentage* – the ratio, expressed as a percentage, of the sum of actual NSP busy hour traffic volumes to the “short-term busy hour traffic capacity”. The “short-term busy hour traffic capacity” is defined as the potential capacity of the network that could be made available within a reasonably short period of time, say, one month. For example, this might involve adding channel cards or other simple expansions of capacity but not additional entire base stations or additional sites; and

- *Open Network Percentage* – the traffic occupancy threshold defining the “open network” requirement – a single figure yet to be specified by TA but nominally 30% to 50%.

10. Once the Actual NSP Traffic Occupancy Percentage reaches or exceeds the Open Network Percentage, the MNO has already met the “open network” obligation, and is no longer obliged to supply additional capacity to NSPs upon demand nor is it required to entertain new NSP agreements. However, the MNO may choose to supply additional capacity to NSPs beyond the target percentage of the “open network” requirement, based on its own commercial decisions.

11. When an MNO expands the capacity of its network so that the Actual NSP Traffic Occupancy Percentage falls below the Open Network Percentage, its obligation to supply to NSPs will be calculated in accordance with the new expanded capacity.

12. To enable the TA to readily respond to requests for intervention by NSPs that have been refused new agreements or additional capacity for their existing agreements by MNOs, each MNO will have an obligation to calculate and report the Actual NSP Traffic Occupancy Percentage of its network to the TA on a monthly basis. The MNOs should also report any contractual commitments for the provision of additional capacity in the near future so that the TA could take this into account when deciding whether the Open Network Percentage has been met or not, if the measured Actual NSP Traffic Occupancy Percentage at that time still falls short of the obligation.

13. The enforcement of the “open network” requirement will entail evaluation of the short-term traffic capacity. Measurement of 3G network capacity with a mix of services of different, and likely asymmetric, data rates of both circuit and packet switched data is a complex task. Therefore establishing an exact level of network capacity available to an NSP on a 3G network is not likely to be a simple task. Practical verification of the “open network” requirement would need further definition on what constitutes “short-term traffic capacity” in terms that can be unambiguously enforced. Paragraphs 19-28 of this discussion paper present a precise definition of these terms and a possible method of deriving the values from information available within 3G networks, and seeks input from industry on some aspects related to practical implementation.

Non-discriminatory Treatment

14. The traffic of the customers of NSPs must be handled by an MNO on a non-discriminatory basis compared with traffic of the customers of the MNO itself or its affiliated resellers or MVNOs. When the total traffic level generated by all subscribers exceeds the capacity of the network and results in service degradation, such degradation will affect the quality of service of the affiliated and non-affiliated service providers, as well as that of the MNO itself, in a non-discriminatory manner. In such cases the MNO will probably have to expand the network capacity in affected areas to meet the quality requirements demanded in the commercial NSP contracts. As mentioned in paragraph 11 above, when an MNO expands the capacity of its network and the Actual NSP Traffic Occupancy Percentage becomes less than the Open Network Percentage, its obligation to supply to NSPs will subsequently be increased to the defined percentage of the expanded capacity.

Wholesale Price of Usage Offered by MNOs to MVNOs

15. The wholesale price of usage applied in the contracts between the MNOs and NSPs should be established in the first instance by commercial negotiations among the parties. The TA will only intervene when such negotiations fail and the TA is requested to make a determination under the interconnection provisions of the Telecommunications Ordinance. The intervention of the TA will be for the supply of capacity up to the Open Network Percentage stipulated under the “open network” requirement. Supply of capacity beyond this percentage will be based purely on commercial arrangement and regulated by competition in the market for the supply of such capacity.

16. As proposed in the second consultation paper, in making such a determination, the TA would consider economic principles based on both the "retail minus' and "cost plus" approaches. The "retail minus" approach would be based on the retail price of the services provided by the MNO or its affiliated service providers in the market minus the cost of providing the services by the MNO or its affiliated service provider. The "cost plus" approach would be based on the relevant long run average incremental cost in operating the network and providing the conveyance service including an appropriate cost of capital commensurate with the risk of investment in a 3G network. In an undistorted market the TA would consider favourably the “retail minus” approach as it reflects more closely normal commercial behaviour.

Commitments of NSPs

17. MVNOs are expected to enter into contracts with the MNOs. Under the contracts, the MNOs will be committed to supplying, while the MVNOs will be committed to taking up, a defined amount of network capacity. The definition of network capacity will be elaborated upon in the subsequent paragraphs of this discussion paper. In view of the different scales of possible MVNO implementation as illustrated in Annex 1, the terms and conditions will be expected to be different for MVNOs of different scale. The TA would expect that a full MVNO be required to make more serious commitments in its contract with the MNOs including, for example, a longer contractual period, compared with those committed to by other smaller scale MVNOs. Smaller scale resellers or content providers would normally lease capacity from the MNOs with shorter term

commitments or at wholesale tariffs which would reflect the costs and the risks involved in the investment of a 3G network.

18. With the exception of a pure content provider or simple reseller who does not operate any telecommunications facilities in offering its services, service providers operating telecommunications facilities including a full scale MVNO will need to take out a Public Non-exclusive Telecommunications Service (PNETS) licence from the TA for the provision of a public telecommunications services. Service providers including resellers who do not operate any telecommunications facilities in offering public telecommunications services will be regulated under class licences to be issued when the new section 8(1)(aa) under the Telecommunications Ordinance is brought into operation.

Measurement of Actual NSP Traffic Occupancy Percentage

Scope of the Measurement

19. Any definition of measurement method must account for the fluctuation in demand from day to day and place to place. Clearly the time and locations of the measurement will greatly affect the percentage determined. This will be especially so when special events occur. In the interests of keeping the regulatory regime both simple and fair to all parties, the TA proposes that the measured Actual NSP Traffic Occupancy Percentage be an average established over:

- *The Measurement Area* – a specified geographic area of the network (which may not be contiguous). The Measurement Area will be specified at the time of licence award; and

- *The Measurement Time* – the weekly time consistent busy hours within the reporting period (which may be different for different cells). The weekly time consistent busy hour is likely to fluctuate and will be determined by the MNO for each reporting period.

20. The size of each geographic area within the Measurement Area needs to be small enough to prevent any high occupancy in part of the area being obscured by excess capacity elsewhere within the area. The TA has considered that the following five possible approaches to define these areas and is interested in receiving comment from industry on the various approaches:

- Entire 3G network;
- Area served by specific network elements, such as Radio Network Controller (RNC);
- Designated geographic boundary, typically encompassing major Central Business District (CBD) areas;
- Busiest 1% of Location Areas (LA), where LAs are areas within which paging and location updates are performed; and
- Busiest 1% of cells in the 3G network.

21. The approaches outlined above will have increasing demands on the ability of network management systems to relate positional information with calls. Hence, one factor in determining the most appropriate approach to defining the Measurement

Area is the ability of the network management systems to associate Call Detail Records (CDR) with geographic areas.

22. It is also quite possible that the services offered by a NSP may lead the NSP to have somewhat different busy areas in respect of the usage of the network of the MNO. This could lead to high local traffic occupancy compared to the average across the designated network area for measurement. Since the purpose of the "open network" requirement is to encourage genuine open access across the network, the geographic areas should not be limited to small areas of anticipated high NSP traffic occupancy.

23. It is recognised that the definitions of Measurement Area and Measurement Time have practical implications for all concerned and consequences for accuracy and validity for the measurement process. The industry is welcome to suggest alternative schemes for Measurement Area and Measurement Time.

Overview of the Measurement Method

24. The method proposed to determine the Actual NSP Traffic Occupancy Percentage depends upon measures of the actual NSP and MNO occupancy, coupled with measures based upon the network loading as reported at cell level. Since 3G networks may be limited in either uplink or downlink directions, estimates of both Actual NSP Traffic Occupancy Percentages will be formed for both uplink and downlink directions. The higher of these traffic occupancies will be used in assessing if the network is open, by comparison with the Open Network Percentage specified by the TA.

25. The following definitions apply for the purposes of calculation:

Term	**Definition**
Measurement Area	The gross area within which traffic and load characteristics is assessed. In practical terms the Measurement Area is the area bounded by a discrete number of 3G Node B.
Measurement Time	The weekly time-consistent busy hours within the reporting interval.
Loading Limit	the Maximum Uplink Rise Above Thermal for stable normal network operation
Occupancy	The user data volume that is physically supported by the network as determined by the CDRs within the Measurement Area and the Measurement Time.
Available Capacity	The total short-term network capacity that can reasonably be provisioned within a period of one month. It is expressed in terms of user data volume and is determined for the Measurement Area and the Measurement Time.
Load Multiplier	A scaling factor derived from the measured network load and maximum network operating point to estimate the Available Capacity on the basis of the measured Occupancy

26. Determination of the Actual NSP Traffic Occupancy Percentage requires calculation of the actual NSP Occupancy and the Available Capacity. The proposed measurement method involves the following steps:

- Establish the Loading Limit;
- Determine the actual NSP Occupancy within the Measurement Area and Measurement Time;
- Determine the total Occupancy within the Measurement Area and Measurement Time;
- Determine the average uplink loading by averaging the uplink loading values corresponding to the measured Rise Above Thermal values for each cell in the Measurement Area over the Measurement Time;
- Calculate the Load Multiplier by dividing the Loading Limit by the average uplink loading;
- Calculate the Uplink available capacity using the Load Multiplier and the Total Occupancy;
- Determine an estimate of downlink available capacity by multiplying the Uplink Available Capacity by the ratio of Total Downlink Occupancy to Total Uplink Occupancy;
- Determine the Uplink Actual NSP Traffic Occupancy Percentage by calculating the ratio of the Uplink actual NSP occupancy to the Uplink Available Capacity; and
- Determine the Downlink Actual NSP Traffic Occupancy Percentage by calculating the ratio of the Downlink actual NSP occupancy to the Downlink Available Capacity.

27. Annex 2 contains background information on the relationship between measured uplink Rise Above Thermal as measured at a cell and the uplink loading at that cell.

Detailed Measurement Method

28. The following provide detailed description of the methods for measuring the various parameters for the calculation of Actual NSP Traffic Occupancy Percentage:-

Establish the Loading Limit: This limit will be agreed between the parties and will be subject to review from time to time. It should be noted that this is a soft limit. Choosing an appropriate operating point on the load curve will entail engineering judgement based upon experience of practical network operation, and the impact of service mix. Methods for tuning this value can be established after general acceptance of the principal.

Determine the actual NSP Occupancy within the Measurement Area and Measurement Time: This is performed by aggregating the user data volume reported in CDRs as being supported during the Measurement Area and Measurement Time for both uplink and downlink directions.

Determine the total Occupancy within the Measurement Area and Measurement Time: This is calculated in the same manner as the Actual NSP Occupancy, but includes all network traffic (i.e. traffic associated with the MNO, affiliated service providers as well as NSP traffic)

Determine the average uplink loading by averaging the uplink loading values corresponding to the Rise Above Thermal values reported by each cell in the Measurement Area over the Measurement Time[2].

Calculate the Load Multiplier by dividing the Loading Limit by the average uplink loading, i.e. Load Multiplier = Loading Limit / average uplink loading.

Calculate the Uplink Available Capacity using the Load Multiplier and the Total Occupancy using the formula

Uplink Available Capacity = Uplink Total Occupancy * Load Multiplier

Determine an estimate of Downlink Available Capacity by multiplying the Uplink Available Capacity by the ratio of Downlink Total Occupancy with Uplink Total Occupancy[3], i.e.

Downlink Available Capacity =

$$\text{Uplink Available Capacity} * \frac{\text{Downlink Total Occupancy}}{\text{Uplink Total Occupancy}}$$

Determine the Uplink Actual NSP Traffic Occupancy Percentage by calculating the ratio of the actual NSP occupancy to the Available Capacity, i.e.

Uplink Actual NSP Traffic Occupancy Percentage

$$= \frac{\text{Uplink Actual NSP Occupancy}}{\text{Uplink Available Capacity}} \times 100\%$$

Determine the Downlink Actual NSP Traffic Occupancy Percentage by calculating the ratio of the actual NSP Occupancy to the Available Capacity, i.e.

Downlink Actual NSP Traffic Occupancy Percentage

$$= \frac{\text{Downlink Actual NSP Occupancy}}{\text{Downlink Available Capacity}} \times 100\%$$

Determine the Actual NSP Traffic Occupancy Percentage as the maximum of the Actual NSP Traffic Occupancy for uplink and downlink directions.

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[2] Initially it is anticipated that this averaging should consider all cells within the Measurement Area (macro, micro and pico) but it is recognised that this point may need further clarification.

[3] This assumes that the uplink and downlink capacities of a carrier are equal. In practice the uplink and downlink capacities will differ and depend upon the network design, the traffic mix to be supported and the propagation environment. However, the general approach is considered to be appropriate for the purposes of determination of 'open networks' and may be adopted albeit with a more appropriate scaling parameter determined in the experience of practical network operation.

Annex 1 – Levels of MVNO Implementation

Overview of MVNO Types

According to the definition put forward in the Oftel (UK) Inquiry of June 1999 into what an MVNO could offer customers, "A Mobile Virtual Network Operator (MVNO) is an organisation that offers mobile subscription and call services to customers but does not have an allocation of spectrum. It would therefore pay Mobile Network Operators (MNOs) for the use of the mobile networks."

2. The interpretation of this and the (non–radio) infrastructure to support the operation can be quite broad, but to differentiate it from the historic Service Provider the prime issues would seem to be:

- Ownership and control of the brand that the customer sees;
- Ownership of the SIM cards in the mobile handsets such that the name of the MVNO appears on the handset rather than that of the host MNO;
- A bulk capacity agreement for long term host network access, rather than a discount on the retail price purchased on a when needed basis.

Other issues include the degree to which the MVNO is able to route both incoming and outgoing traffic, and support Value Added Services on their own infrastructure.

UMTS R99 Network Architecture

3. GSM standards have been developed to add packet switched traffic to the network; this is known as the General Packet Radio Service (GPRS). The addition of GPRS to GSM networks (sometimes known as 2.5G) provides the essential infrastructure for its ensuing upgrade to 3G, namely a packet based network infrastructure capable of supporting IP (Internet Protocol) traffic. The essential elements of a GPRS core network are the Serving and Gateway GPRS Support Nodes (SGSN and GGSN) which may be likened to the MSC and Gateway MSC of the conventional GSM circuit switched network.

4. The initial release of the 3G UMTS network standard, known as Release '99 or R99 effectively replaces the radio access interface to an existing GSM/GPRS network with a new air interface based on Wideband–CDMA technology (WCDMA). Thus R99 may be regarded essentially as providing the same functionality in service terms as GSM/GPRS; although clearly it is capable of supporting these services at higher bit rates.

5. Therefore, the basic Core Network (CN) to which the UMTS Terrestrial Radio Access Networks (UTRAN) may be connected, will be a GSM core network as extended for GPRS by an IP based overlay network. The SGSN and GGSN interact over a set of new interfaces, in particular the Gb interface between the BSS and the SGSN, the Gs interface between the SGSN and the MSC and the Iu interface between the Radio Network Controller (RNC) and the SGSN. In essence, voice traffic (circuit switched) is effectively handled by a second generation GSM MSC/GMSC network and the newer packet based high speed data services by their packet based counterparts the SGSN/GGSN.

6. The Iu interface connects UTRAN to the core network (CN). Iu is an open interface that divides the system into the radio specific UTRAN and CN which handles switching, routing and service control. The Iu can have two different instances, which are Iu CS (Iu Circuit Switched) for connecting UTRAN to the circuit switched (CS) CN, and Iu PS (Iu packet Switched) for connecting UTRAN to the packet switched (PS) CN.

MVNO Definition

7. The term Mobile Virtual Network Operator (MVNO) does not imply a precise network architecture nor a commitment to a particular set of standard system components. Rather there exists a range of options for sharing more or less of the infrastructure between the MNO and the MVNO.

8. Any mobile network will typically comprise the elements:

- Basic switching and data network – MSC/VLR/GMSC and SGSN/GGSN;
- Subscriber registers, value added services – HLR, WAP Gateway, Voicemail, etc;
- Business support systems – customer care / administration, billing, call centre;
- Application and content servers.

9. The relationship between these elements is shown in Figure 1.

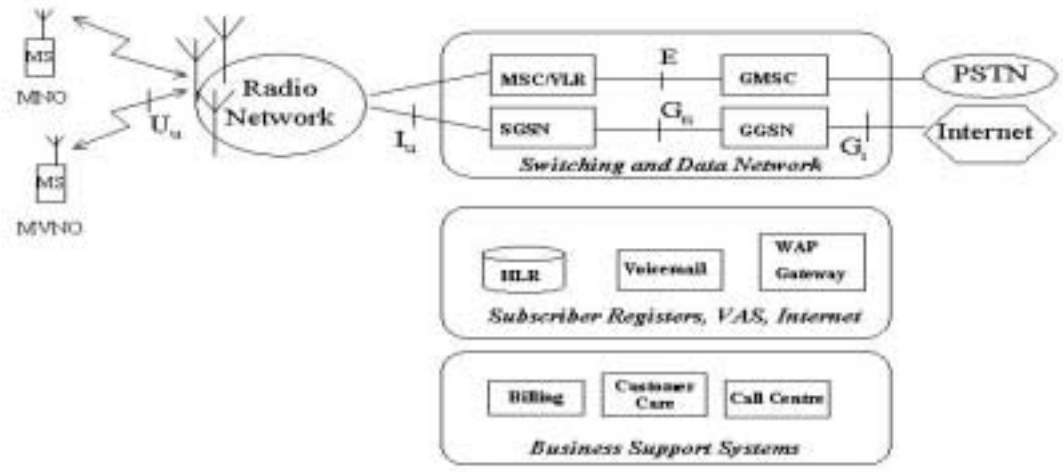

Figure 1 3G System Components

10. For a minimal implementation a MVNO may outsource the majority of its operation on to the host MNO and simply receive the billing information (for mobile originated calls) pertinent to its customers from the host MNO. At the other extreme,

customers of an MVNO would share access to the radio interface (U_u) and the MVNO would interconnect to the MSC (E interface) and SGSN (G_n interface), duplicating the remaining network functions and customising them for their particular service offerings.

11. Three examples of MVNO implementation follow. These are categorised rather arbitrarily to aid understanding, there is no reason why any potential MVNO should be limited to these precise options.

Service Provider

12. In some circumstances Service Providers have been described as MVNOs. In this scenario the MVNO uses the maximum of the host MNO's infrastructure but has full ownership of the customer base using a partition on the HLR belonging to the host MNO. The MVNO handles the billing of its customer base using Call Detail Records forwarded by the host MNO. The SIM card is typically configured to reflect the Service Provider's brand. The Service Provider in this example has no control over routing and hence the MVNO could not collect or save revenue associated with terminating calls or optimising routing.

13. It provides a very low cost, very low risk approach to the market but the MVNO has no control over the service offerings, no access to the routing of traffic and little opportunity to differentiate its services.

Enhanced Service Provider

14. In this scenario the MVNO again uses a large part of the host MNO's infrastructure and has full ownership of the customer base using either an independent Home Location Register (HLR) or a partition on the HLR of the host MNO. However the major difference is that in this scenario, the MVNO is able to route Internet traffic and this enables the potential for differentiating its services. In this example the MVNO still shares the Mobile Network Code (MNC) of the host MNO, which means that the MVNO's subscribers are captive to the MNO's network. The SIM card is configured to reflect the service provider's brand. The MVNO handles its own billing of the customer base and the It provides a low cost, low risk approach to the MVNO market. An outline architecture is shown in Figure 2.

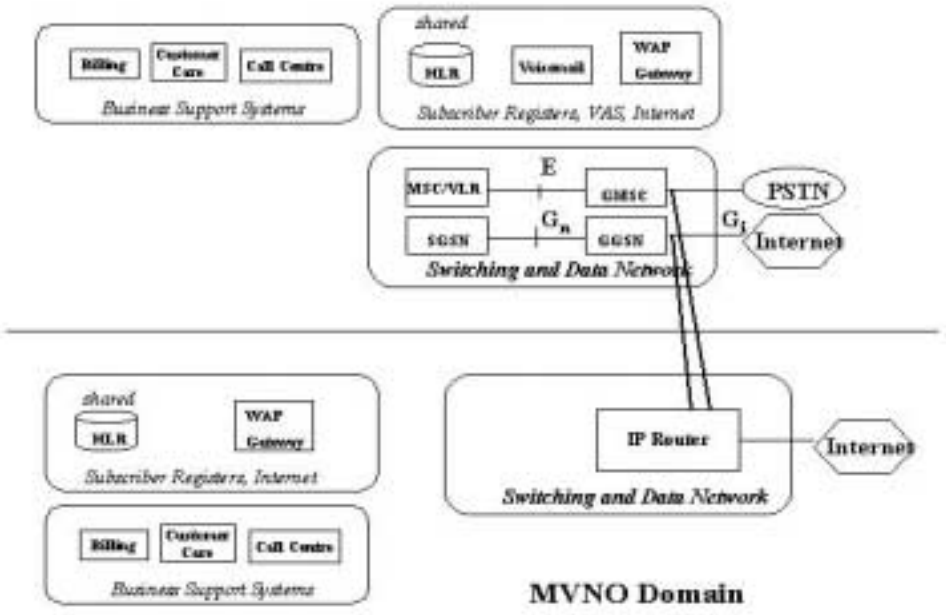

Figure 2 Enhanced Service Provider Scenario

15. The MVNO interconnects to the MNO at the air interface (U_u) and at the PSTN and Internet interfaces (points of reference) of the host MNO to provide access to the MVNO routers if the MVNO provides its own mobile ISP function; this gives the MVNO routing control of data, but not voice, calls. The Enhanced Service Provider in this example has control over incoming data services from the Internet but not circuit switched voice which terminates on the host MNO GMSC.

16. The approach offers a low risk entry to the MVNO but a high dependence on the MNO. There are no interconnection or roaming agreements to establish and it allows the MVNO to concentrate on IP based services such as mobile multi–media.

Full MVNO

17. This category describes an operator that wishes to provide mobile telephony services to a similar degree as an MNO but does not have an allocation of spectrum. The Full MVNO would replicate a large part of the host MNO's infrastructure, have its own MNC and would likely provide mobile ISP infrastructure, customer care and subscriber administration systems. As indicated in Figure 3 the Full MVNO would thus have:

- Control of the subscriber's SIM card;
- HLR / EIR / AUC;

- GMSC for providing interconnect;
- GGSN;
- Billing system;
- Mobile ISP infrastructure / WAP Gateway;
- Customer care and subscriber administration systems.

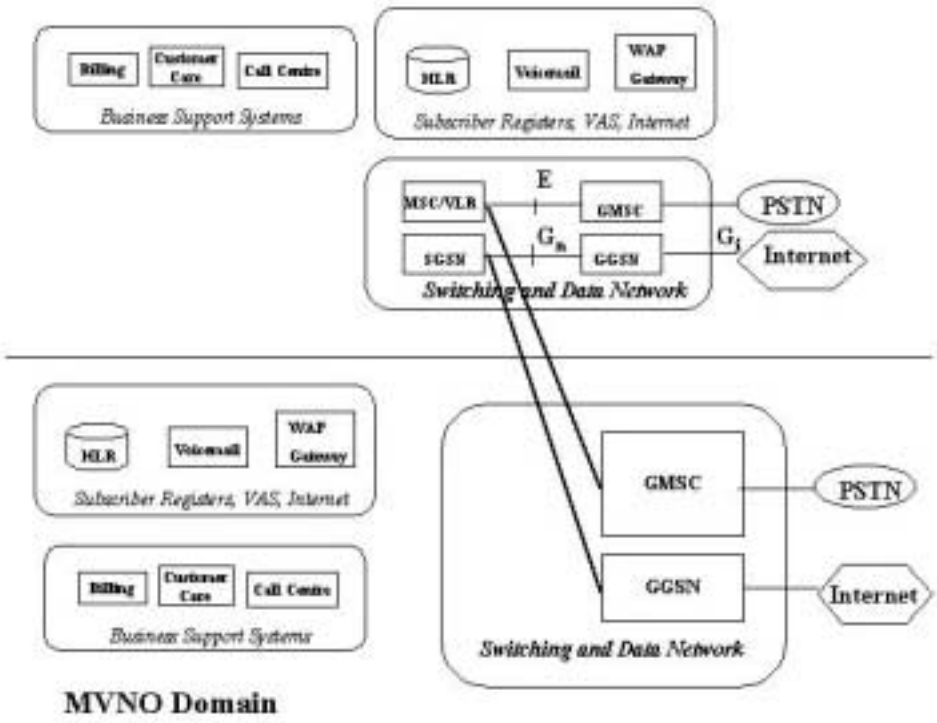

Figure 3 Full MVNO Scenario

18. Interconnect to the host MNO is at the Air Interface (U_u), E (GSM) and G_n (GPRS) interfaces and to other networks from its own GMSC (PSTN / ISDN) and GGSN (Internet).

19. The benefits of the Full MVNO approach include: maximum independence from the host MNO; own interconnect agreements; an independent Mobile Network Code (MNC), giving the option to switch readily to another MNO without major impact on its customers or operations; and the option to interconnect to more than one MNO. A Full MVNO which terminates incoming PSTN / ISDN and Internet traffic has control over both incoming and outgoing routing. The penalties are higher costs, both capital and running; complex telecommunications integration activities requiring skilled personnel.

Summary

20. This annex has examined MVNOs within the context of Third Generation Mobile Services, specifically the UMTS R99 Architecture proposed by the 3GPP Standards body. In network terms R99 is equivalent to the GSM system as enhanced for the packet data service GPRS wherein a packet based switching and transmission network is provided as an overlay to the existing circuit switched network. The simplest conceptual approach to an MVNO is to liken it to roaming within the present GSM (voice) network. The necessary signalling protocols for this are well proven. These protocols have been extended for the GPRS service (and by implication therefore to UMTS R99). Early demonstrations of GPRS roaming have been completed by at least one leading manufacturer.

21. At a highest level an MVNO may be viewed as an organisation that offers mobile subscription and call services to customers but does not have an allocation of spectrum, rather it relies on hosting its service on a licensed Mobile Network Operator. Provided this can be realised technically, MVNOs are primarily about ownership and control of the brand that the customers sees. Nor is there any precise network architecture or set of network components implied by the term MVNO, rather there are issues and levels of implementation and control to be addressed. Two key dimensions of this level of implementation are whether or not the MVNO has its own Mobile Network Code (MNC) and the degree to which it switches and routes both incoming and outgoing traffic.

Annex 2 – Estimating Available Capacity in 3G Networks

Estimating the Traffic Occupancy Percentage requires determination of a method that can be used to determine the network potential to carry additional traffic. Performing this task with a complex mix of 3G traffic is likely to be problematic, if at all possible.

2. One simple method which calculates the degree of cell loading may be appropriate if used in conjunction with aggregation of the traffic supported on the network. This method is based on loading curves and is explained in the following.

Loading Curves

3. Loading curves can be theoretically determined for both uplink and downlink directions. These factors can be used to make an estimate of the average capacity of a CDMA cell without the complexity of performing system level simulations. These loading curves exhibit a so-called 'pole response' which depicts an essential element of interference limited systems, *i.e.* that more load requires more power from the existing connections which adds more load. Figure 4 shows the uplink Rise above Thermal versus load curve.

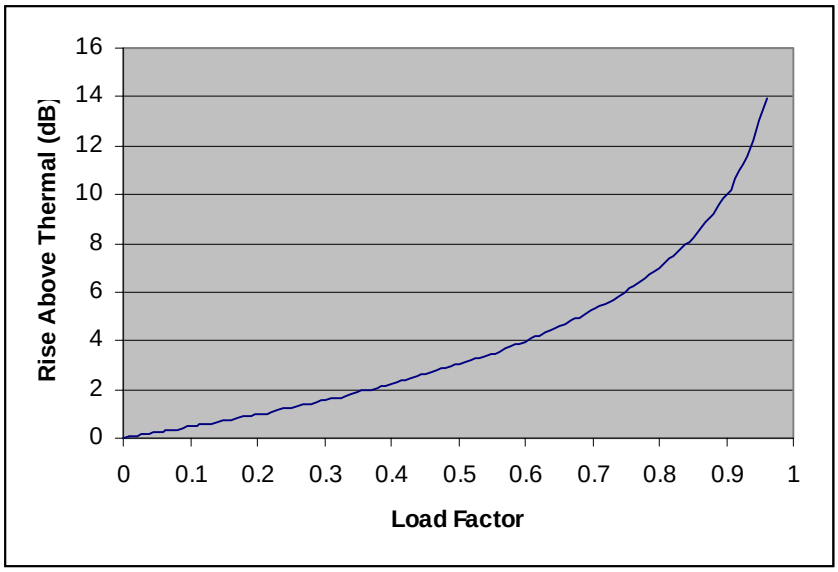

Figure 4: Generic (Uplink) Load Curve

4. Expressions based upon loading factors are commonly used in network dimensioning. Similar responses exist in both uplink and downlink loading curves. To maintain network stability, networks are normally designed to operate below the 'knee' of the curve, and a maximum average load factor consistent with system stability is estimated to correspond to a load factor of 0.75 (or a Rise Above Thermal of 6dB). Whilst loads will for short periods increase above the target operational load factor target, typical operation would ensure that average load factors are maintained within target loading. Typically, networks might be dimensioned based upon a load factor of between 0.25 (for some rural cells) to 0.5 (for urban cells).

Note: Appropriate operating points for loading are based upon engineering judgement, and some small scale simulations. In reality, no-one yet knows how 3G networks will respond in a real environment. Since traffic demand is unlikely to reach high load factors for some time, operators are likely to learn about their network response to load and will be able to select appropriate operating points for their networks from experience.

Uplink Load

5. The uplink loading can be reasonably characterised by the effective noise increase measured at the cell receiver, the so called, Rise above Thermal (RAT). Note that different services will have different impacts on this noise rise, since different services have different bearer parameters. However, the RAT compactly measures the aggregate of all the different interference components arriving at a cell (from sessions connected to that cell and other uplink connections causing extra-cellular interference) and provides a clear indication of the ability of that cell to be able to support additional uplink load.

6. Potential problems with this approach are:

- Wideband power based measurement of the received uplink interference may include interference contributions from adjacent frequencies. Over-estimating this interference would result in measured RAT values that are higher than the actual cell load;
- The value of cell load would not distinguish between different services that may be supported by different operators; and
- The parameters are measured at the cell and would need to be provided by the operator; independent verification may be difficult.

Downlink Load

7. Determining a downlink load factor is analogous to determining the uplink load factor – however, the parameters are slightly different. A key issue in practice is that matching the impact of the downlink load factor to the equivalent noise rise is less satisfactory since the noise rise depends upon the interference and propagation effects relevant to the mobile terminal location. Whilst this could be measured at a given location, any practical application will need to demonstrate applicability across the cell.

8. Another method to estimate down link load factor is to express the transmit power used as a fraction of the maximum cell transmit power. A problem with this approach is that this approach does not give a clear measure of the proximity to the pole capacity. Hence in a small cell a given value of fractional maximum power may correspond to operating closer to the pole capacity than in a larger cell.

9. Potential solutions to overcome these problems are to either agree representative measurement locations and propagation environments to estimate the downlink interference level to estimate downlink noise rise parameters; or determine relationship between fractional transmit power and cell capacity – possibly for different cell types. In either case, the parameters are measured at the cell and would need to be provided by the operator; independent verification may be difficult.