



**CONSULTATION PAPER ISSUED BY
THE INFOCOMM MEDIA DEVELOPMENT AUTHORITY
ON
IMPLEMENTATION OF IP-BASED INTERCONNECTION IN SINGAPORE**

1 MARCH 2021

INTRODUCTION

1. On 20 February 2019, the Infocomm Media Development Authority (“**IMDA**”) issued a public consultation on the draft Code of Practice for Competition in the Provision of Telecommunication and Media services (“**Public Consultation**”). Subsequently, on 5 January 2021, IMDA issued an explanatory memorandum on its decisions on the Public Consultation (“**IMDA’s Decision**”).
2. In the Public Consultation, IMDA holistically reviewed the regulations and competition management for the Singapore info-communications media sector, with the aim of developing a harmonised competition code for the telecommunication and media markets. In addition, IMDA also reviewed developments in the telecommunication market to ensure that its policy frameworks continue to be relevant to the industry.
3. As IMDA noted in the Public Consultation, a significant development in the Singapore telecommunication market has been the deployment and widespread take-up of services on the Nationwide Broadband Network (“**NBN**”). This development has contributed to the migration of services and end-users from traditional copper and hybrid fibre-coaxial-based networks to Internet Protocol (“**IP**”)–based networks - for example, the transition from Time Division Multiplexing (“**TDM**”)–based voice services to IP-based voice services. The growing take-up of Over-the-Top (“**OTT**”) voice and messaging services that use IP-based networks has also further reduced reliance on and utilisation of traditional voice and messaging services, and fuelled the demand for data-centric services. In line with these developments, IMDA proposed in the Public Consultation a number of changes to the interconnection regime, particularly the following two proposals:
 - (a) To change the current interconnection charging regime for fixed-line call termination between operators from “Calling Party Pays” (“**CPP**”) to “Bill-and-Keep” (“**BAK**”), i.e. zero termination rate to the terminating operator; and
 - (b) To replace the existing interconnection regime from Signalling System No. 7 (“**SS7**”) to IP-based signalling.
4. Following the close of the Public Consultation, IMDA carefully reviewed respondents’ comments. In IMDA’s Decision, IMDA maintained its proposal to change the interconnection charging regime for fixed-line voice termination from CPP to BAK. IMDA noted that this change of the interconnection charging regime for fixed-line call termination to BAK would be in line with the current mobile interconnection charging regime, which is based on a zero mobile termination rate. This would allow for a harmonised interconnection charging framework for all domestic telephony services, which would be appropriate given that all these services would eventually be provided over IP-based networks. For the industry to effect the change to BAK, IMDA allowed a 3-year glide path.

5. In view of technology and market developments for fixed-line voice termination, IMDA also proposed to review the case for IP-based interconnection in the Public Consultation.
6. As highlighted in the Public Consultation, given the growing volume of IP-based and Voice over LTE (“**VoLTE**”) calls, IMDA would consider interconnection at the IP-level to be the new default going forward, replacing the existing SS7 signalling. From respondents’ submissions to the Public Consultation, IMDA noted that respondents were broadly supportive of the proposal to migrate to IP-based interconnection. One respondent agreed that IP-based interconnection would allow efficient exchange of voice traffic, while another respondent submitted that as traffic exchanges would be expected to converge towards a multi-service IP-network, IP-based interconnection should be the way forward for the industry.
7. IMDA agrees with the respondents and views that IP-based interconnection may bring about higher operational efficiency for voice traffic and improved voice call quality. In addition, IP-based interconnection may also result in cost savings and reduced complexity for operators in the steady state. With the eventual phasing out of technologies and equipment based on SS7 signalling, and the progressive transition of end-users to IP-based services, IMDA shares the respondent’s view that IP-based interconnection would be the way forward for the industry. As a long-term policy consideration, migrating the interconnection of all domestic networks in Singapore to IP-based ones would also serve to increase the overall efficiency of voice communication in Singapore.
8. On how IP-based interconnection should be implemented, one respondent opined that it would involve complex technical issues that would have commercial implications for the industry. Another respondent agreed that such a migration towards IP-based interconnection would be a major exercise, as significant amount of effort and resources, as well as implementation lead-time, would be required to replace existing switches and/or interconnect configurations, in addition to requiring co-ordinated efforts amongst all parties.
9. In IMDA’s Decision, IMDA agreed with the respondents that a separate in-depth consultation would be appropriate to review and address the industry’s technical, operational, and commercial concerns in implementing IP-based interconnection as the default in Singapore.
10. In this regard, IMDA hereby issues this consultation, inviting views and comments on IMDA’s proposals and preliminary views on the implementation of IP-based interconnection in Singapore.

IMPLEMENTATION PROPOSALS

11. IMDA's proposals are set out in the following sections:
- (a) Scope and technical requirements;
 - (b) Singapore Telecommunications Limited's ("Singtel") Reference Interconnection Offer ("RIO") for IP-based interconnection;
 - (c) Impact to number portability;
 - (d) Network security and Quality of Service; and
 - (e) Migration approach.

Scope and Technical Requirements

12. At the outset, IMDA would like to define the regulatory scope for the implementation of IP-based interconnection. IMDA recognises that under the current environment/landscape, a full end-to-end deployment of IP-based signalling protocol in the operator's network may not be feasible in the immediate to near term, especially in view of legacy network elements, and some international voice traffic terminating and/or transiting the operator's network which may still require SS7 signalling to establish the calls. Given the above context, IMDA proposes, at this time, to require only the establishment of IP-based signalling protocol at domestic Points-of-Interconnection ("POIs") across all operators' networks that are interconnected to provision voice services.
13. Based on the above defined scope, IMDA is of the preliminary view that all operators should follow a standardised set of technical requirements to implement IP-based interconnection at domestic POIs. IMDA notes that a lack of standardisation in technical requirements when implementing IP-based interconnection may give rise to various issues, including call quality problems; impeding the development of higher call quality; and possible higher costs for IP-based interconnection (to support multiple configurations such as transcoding between voice codec standards, etc.). With a standardised set of technical requirements deployed by all operators for IP-based interconnection, issues relating to the inter-operability of systems and hardware, which will have an adverse impact on the provision of voice services, may be avoided. IMDA believes that standardising the technical requirements for IP-based interconnection will lower the overall migration risk, and minimise any service disruption to end-users. Similar views have also been shared by overseas regulators, such as UK's Ofcom, which has conducted a public consultation on this matter¹. Nonetheless, IMDA understands that such standardisation may have an impact on operators who have deployed certain IP-based technical configurations in their networks and would prefer minimal changes, if any.

¹ Ofcom launched the consultation 'Future of interconnection and call termination' on 11 April 2019.

Question 1:

IMDA invites views and comments on whether operators should follow a standardised set of technical requirements to implement IP-based interconnection at domestic POIs across all operators' networks that are interconnected to provision voice services.

14. Based on the consultation responses, IMDA will determine an appropriate and relevant mode of IP-based interconnection for Singapore. IMDA would like to further propose that operators adopt the Session Initiation Protocol ("SIP") based on IETF² and 3GPP³ specifications at the POIs (the "Proposed SIP").
15. IMDA understands that the Proposed SIP, which is defined by IETF standards, also fulfils the specifications of 3GPP. As it is based on the use of the IP Multimedia Subsystem ("IMS") defined by 3GPP, the Proposed SIP is deemed appropriate for operator's networks that use an IMS. Further, the Proposed SIP is suitable for the growing proportion of VoLTE calls over mobile networks, which are based on SIP and IMS specified by 3GPP.
16. Notwithstanding IMDA's proposal for the Proposed SIP to pave the way for all domestic telephony services to be eventually provided over IP-based networks, IMDA notes that there are other SIP standards which are commonly deployed in other jurisdictions and can also be considered for Singapore. For example, based on the case studies⁴ by BEREC ("**BEREC's Case Studies**") on IP-based interconnection deployed in the European Union ("**EU**"), the fixed network operators analysed by BEREC had mostly deployed SIP (IETF and 3GPP), with some deploying SIP (IETF) or SIP-I⁵ (ITU-T). All the mobile network operators in BEREC's Case Studies had deployed SIP-I (ITU-T).

Question 2:

IMDA invites views and comments on whether the Proposed SIP, based on IETF and 3GPP specifications, is appropriate and suitable to be implemented at the POIs.

Singtel's RIO for IP-based Interconnection

17. Depending on the eventual agreed migration plans by industry, IMDA notes that each operator could have differing readiness levels for implementing the Proposed SIP at all the POIs established with the other domestic operators. In such a scenario, IMDA believes that a transition period may be inevitable, whereby operators may have to support and cater for both SS7 and the Proposed SIP signalling at the POIs ("**Transition Period**").

² IETF: Internet Engineering Task Force

³ 3GPP: 3rd Generation Partnership Project

⁴ 'Case studies on IP-based interconnection for voice services in the European Union' issued by BEREC on November 2015.

⁵ SIP-I (ITU-T): SIP which is defined by IETF, but used in a specific way defined by ITU-T. SIP-I is a hybrid signalling protocol where TDM-based signalling protocol (ISUP) is transported within the IP-based signalling protocol (SIP).

18. Considering the possibility of a Transition Period, and that interconnection with Singtel (being the Dominant Licensee regulated under its RIO for TDM-based interconnection) is currently offered based on SS7, IMDA is of the view that it may be necessary to firm up the specific details of the interconnection arrangement under an IP-based interconnection environment before commencing the migration. IMDA considers that providing clarity to the industry on the specific details of any IP-based interconnection arrangement with Singtel will facilitate the migration planning and preparation of industry players who are currently directly interconnected with Singtel via Singtel's RIO. This will also serve as a reference for other IP-based interconnection arrangements between Non-Dominant Licensees which are commercially negotiated. With both sets (TDM-based and IP-based) of interconnection arrangements ready/in place, IMDA believes the Transition Period will be smoother and more manageable for the industry.
19. In this regard, following the conclusion of this consultation, IMDA intends to require Singtel to propose the offerings of the RIO services related to IP-based interconnection for IMDA to consult the industry on. Once the RIO offerings to support IP-based interconnection are finalised and approved by IMDA, IMDA will engage the industry further on implementation and migration plans.
20. Primarily, IMDA will require Singtel to propose an RIO offering that will eventually replace the current RIO Schedule 1 – Physical and Virtual (Distant) Interconnection. The proposed offer should contain a similar level of technical details, requirements and specifications (including transmission, signalling, routing, interconnect testing, etc.) to enable operators to establish IP-based interconnection with Singtel's network. At this juncture, IMDA believes that IP-based interconnection should also be on reciprocal terms and conditions, as per the current interconnection regimes, and that all parties should bear their own cost of establishing interconnection.
21. In order to ensure the public's uninterrupted access to emergency call services, IMDA will also require Singtel to propose a similar service to be offered under IP-based interconnection, if the implementation of IP-based interconnection affects Singtel's provision of emergency call services under Schedule 4A of the RIO.

Question 3:

IMDA invites views and comments on the proposed approach to finalise the offerings of the RIO services related to IP-based interconnection, before commencing the migration to IP-based interconnection.

Impact to Number Portability

22. In the Public Consultation, some of the respondents submitted that a shift to IP-based interconnection might have an impact on the existing Fixed Number Portability (“FNP”) arrangements, and that therefore would be a need to study the implications.

23. IMDA understands that the FNP service is currently implemented using an Intelligent Network (“**IN**”) solution based on the Query-on-Release (“**QoR**”) method. In order to support the QoR method, the network is required to implement a signalling option to indicate to the originating network that the dialled number has been ported out. Each network has its own database as the solution requires the originating network operator to query its database for the routing number to route the call to the port-in operator. Given that the current signalling option used to support the QoR method is based on SS7, IMDA believes that the migration to IP-based interconnection will require changes to the technical solutions currently implemented for the FNP service.
24. In this regard, IMDA would like to propose the following options for FNP operators’ consideration:
- (a) The FNP operators can review whether there is a similar “Release” message with a specific cause value under SIP signalling, or a similar signalling function under SIP signalling, which all FNP operators can agree to use as an indication to the originating network that the dialled number has been ported out; or
 - (b) To adopt an All-Call-Query (“**ACQ**”) method, given that all FNP operators have their own database.

IMDA seeks FNP operators’ comments on the feasibility of the proposed options to change the technical implementation of the FNP service, following the migration to IP-based interconnection. IMDA also welcomes FNP operators’ suggestions on other feasible solutions.

25. As for Mobile Number Portability (“**MNP**”), IMDA understands that the technical implementation of the current MNP service is not related to SS7 signalling. Thus, IMDA believes that the implementation of IP-based interconnection will not have an impact on MNP service.

Question 4:

IMDA invites views and comments on the feasibility of IMDA’s proposals to revise the technical implementation of FNP service in an IP-based interconnection environment.

Network Security and Quality of Service

26. In the Public Consultation, one of the respondents submitted that SS7 was an established technology which was reliable and secure, with high Quality of Service (“**QoS**”). The respondent opined that in comparison, there could be security and QoS issues if operators were to migrate to IP-based interconnection. A lower QoS standard would be a concern for operators, especially those with regulatory obligations to meet IMDA’s QoS requirements.

27. On network security, IMDA has taken reference from BEREC's Case Studies and notes that almost all of the EU operators analysed by BEREC had interconnected their networks using direct physical interconnection links (mostly 1 Gigabit Ethernet), and not the public Internet. BEREC noted that such arrangements would already provide substantial protection against threats from the Internet. Further, BEREC found that almost all of the EU operators studied had implemented the recommended security measures for IP-based networks, such as the use of a Session Border Controller ("**SBC**"), external Border Gateway Protocol ("**eBGP**") authentication, topology hiding, and firewall, etc. to protect their networks.
28. IMDA emphasises the importance of operators securing their IP-based networks to address cyber security risks and vulnerabilities. IMDA believes that a baseline set of network security requirements that are aligned with industry best practices should be adopted. These baseline requirements will be in addition to other security measures and protection that operators should undertake to protect their own IP-based networks, and/or avoid technical harm to the telecommunication network and/or system of another operator. Such baseline requirements can include the following:
- a) Monitor and analyse signalling messages to detect malicious traffic⁶;
 - b) Adopt signalling firewalling to filter malicious traffic;
 - c) Harden interconnect infrastructure such as Signalling Transfer Points ("**STP**") and Diameter Signalling Controllers ("**DSC**"); and
 - d) Perform external network security assessments and penetration tests periodically, if domestic exchange points are used.
29. On how a network should be connected to another network under an IP-based interconnection environment, IMDA will continue to leave it to the industry to discuss the appropriate and mutually agreed arrangements in good faith, be it via direct physical transmission links (ethernet or otherwise) or via domestic exchange points, if operators choose not to take up the RIO for interconnection purposes. IMDA notes that BEREC's observation of the EU operators' deployments reflects the trend that the number of POIs is usually reduced with the migration to Next Generation Network ("**NGN**") and all-IP networks. Thus, with fewer POIs and the corresponding decrease in the overall number of transmission links deployed by operators to interconnect the IP-based networks (as compared to the current overall number of E1 transmission links deployed), IP-based interconnections may result in cost savings and reduced complexity for operators in the steady state.
30. Further, IMDA would like to highlight that at any point in time (whether during the Transition Period or otherwise), IMDA will require each operator to prevent or minimise any adverse impact on the voice services it is providing to end-users (including any emergency call services).

⁶ Malicious traffic includes those used to perform unauthorised interception, service disruption, data theft, etc.

Question 5:

IMDA invites views and comments on IMDA's preliminary views on network security and QoS under an IP-based interconnection environment.

Migration Approach

31. Broadly, the following is IMDA's preliminary proposals on the migration approach:
- (a) If industry can agree on and co-ordinate a common cut-over time to deploy the Proposed SIP at the POIs, then a co-ordinated single migration approach may be more efficient overall; or
 - (b) If there is differing readiness of the operators to deploy the Proposed SIP at the POIs, then a phased approach with a Transition Period may have to be adopted for industry to migrate in phases.

Further, to avoid/minimise migration issues, IMDA considers that it may be prudent for industry to conduct a co-ordinated industry-wide trial migration on testing platforms first before actual migration, while IMDA will remain involved in facilitating the exercise.

32. IMDA is of the view that the assessment of whether a co-ordinated single approach or a phased approach is more appropriate can only be carried out at a later stage when there is more clarity on the various aspects of the implementation of IP-based interconnection, specifically the technical details. As such, IMDA will consult and engage the industry on migration plans after completing (a) this consultation and (b) the proposed RIO consultation to finalise the RIO offerings for IP-based interconnection.
33. The broad outline of IMDA's proposed steps to implement IP-based interconnection in Singapore is appended as Annex 1.

Question 6:

IMDA invites views and comments on IMDA's preliminary views on the broad migration approach.

CONCLUSION

34. While this consultation broadly outlines IMDA's proposals and preliminary views on implementing IP-based interconnection in Singapore, IMDA recognises that a migration of this scale will involve many considerations for each operator to plan, implement and operationalise the change to IP-based interconnection. Sufficient time needs to be catered for each individual operator's preparation and procurement of necessary hardware and/or systems, and careful planning and co-ordination amongst all operators is critical to a successful migration. In this regard, IMDA will work closely with the industry

to address the issues for the proposed implementation of IP-based interconnection.

35. Following the close of this consultation, IMDA will give careful consideration to all views and comments received, in implementing IMDA's decision on the matter. In this regard, IMDA may issue a direction and/or make the relevant changes to the specific regulatory instruments as may be necessary, to effect the same.

INVITATION TO COMMENT

36. IMDA invites interested parties to submit written comments to this consultation on the proposed implementation of IP-based interconnection in Singapore.
37. All respondents are requested to keep their comments clear and succinct. All views and comments should be submitted in soft copy (in both Adobe PDF and Microsoft Word format) via email to Consultation@imda.gov.sg with the email header "Consultation on IP interconnection".
38. All submissions should reach IMDA by **12 noon, 26 April 2021**. All views and comments should be addressed to:

Ms Aileen Chia
Director-General (Telecoms and Post)
Deputy Chief Executive (Connectivity Development & Regulation)
Infocomm Media Development Authority
10 Pasir Panjang Road
#03-01 Mapletree Business City
Singapore 117438

39. In its submission, the respondent should include the following:
 - (a) Respondent's statement of interest in the consultation;
 - (b) Summary of the respondent's submission; and
 - (c) Specific comments to IMDA's consultation questions which are as follows:

Question 1:

IMDA invites views and comments on whether operators should follow a standardised set of technical requirements to implement IP-based interconnection at the domestic Points-of-Interconnection across all operators' networks that are interconnected to provision voice services.

Question 2:

IMDA invites views and comments on whether the Proposed SIP, based on IETF and 3GPP specifications, is appropriate and suitable to be implemented at the Points-of-Interconnection.

Question 3:

IMDA invites views and comments on the proposed approach to finalise the offerings of the RIO services related to IP-based interconnection, before commencing the migration to IP-based interconnection.

Question 4:

IMDA invites views and comments on the feasibility of IMDA's proposals to revise the technical implementation of Fixed Number Portability service in an IP-based interconnection environment.

Question 5:

IMDA invites views and comments on IMDA's preliminary views on network security and Quality of Service under an IP-based interconnection environment.

Question 6:

IMDA invites views and comments on IMDA's preliminary views on the broad migration approach.

40. IMDA reserves the right to make public all or parts of any written submission made in response to this consultation, and to disclose the identity of the respondent. Any part of the submission which the respondent considers to be commercially sensitive must be clearly marked and placed as a separate annex to the comments raised. IMDA will take this into consideration when disclosing the information submitted.

Annex 1

Broad outline of IMDA's proposed steps on implementation of IP-based interconnection in Singapore

