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Feasibility Report & Recommendations on the Technical Options for High Availability Partial Private Circuit

Issue 1

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Normative Information

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EXECUTIVE SUMMARY

The Public Network Operators Transport Interconnect Group (PNO-TIG), has met on a number of occasions to discuss NICC Study 59 with the goal of producing a feasibility report for the DG of Oftel on High Availability Partial Private Circuit (PPC).

Its preliminary investigations looked at ten schematics for potential architectures that could provide a PPC interconnect with higher availability between all operators with similar functionality to that of the BT ‘Genus’ service in order to promote discussion. It was also decided to widen the debate by close co-operation with the PPC Operators Technical Forum so as to ensure maximum participation. After these early investigations, it was decided that the major criteria for a particular architecture was that it should provide a service with no single point of failure as opposed to merely a higher availability PPC.

The discussion with the PPC Operators Technical Forum generated six architectures and after further consideration within the two industry groups, managed to reduce the candidates to three based upon a ranking process. PNO-TIG has considered each of these candidates and has given each of the three candidate architectures an order of merit based on various criteria.

These criteria include operational issues (for maintain and repair), engineering issues, 3rd party customer impact, network costs and an assessment of whether they meet the original criteria of a PPC that should provide an end-to-end service with no single point of failure.

That the PNO-TIG recommends:

- **That Overlapping SNCP functionality for Drop and Continue Sub Network Connection Protection (SNCP) meets the industry requirement for No Single Point of Failure (NSPF) through dual point of handover.**

- **That the Overlapping SNCP protection mechanism described in ITU-T Recommendation G.842, Figure 17 based upon SNCP rings and Figure 25 based on the primary node Functional Model for non intrusive SNCP/N meets UK requirements for Higher Availability PPC (although the network isolation proffered by Drop & Continue means that the mode of SNCP used by each operator is not relevant, BT will operate SNCP/N).**

The PNO-TIG is now reporting back with its detailed feasibility report of its findings and recommendations subject to approval by the PNO and the NICC for delivery to the DG of Oftel.

1. BACKGROUND

The Director General of Oftel sought advice from the NICC on the technical options for a High Availability Partial Private Circuit that exhibits higher resilience in terms of diversity, separation and would include timescales for deployment and implementation proposals.

This was in response to a request from Other Licensed Operators who wished to be able to provide High Availability PPC Leased Lines in competition with BT's High Availability Leased Lines called 'Genus' without the need to purchase a retail BT Genus leased line. Phase 1 of PPC Leased Lines were launched as products on August 1st 2001, but specifically excluded Genus variants. Genus services have been available since 1996, offering high availability (99.995%) and no single point of failure between customer end sites.

The DG also requested that the feasibility report back by the 1st September 2002, with the proviso of taking into account such issues as any necessary upgrades to BT's Operational Support Systems and, also, any issues connected with the hand-over of circuits between BT and the Other Licensed Operator, issues with Sub-Network Connection Protection at the points of hand-over between BT and the Other Licensed Operator.

There is a secondary aspect to consider any necessary new specifications that might be required however this was seen as a later activity depending upon the initial investigations and conclusions drawn.

The request to the NICC was promulgated as study No 59 (see Annex A) to the Public Network Operators (PNO) Interest Group in April 02 who directed that the study be undertaken by their Transport Interconnect Group (TIG) committee of industry experts. The calling notice to all industry representatives in the PNO and PNO-TIG went out in May 02 for its first start up meeting on the 19th June 02 with a call for input work packages.

2. ABBREVIATIONS

CSH	Customer Sited Handover
EPM	End Point Monitoring
ISH	In Span Handover
MESH	Narrow Band SDH Network
MSH	Marconi Synchronous Hierarchy (Broadband Network)
MSP	Multiplexor Section Protection
NSPF	No Single Point of Failure
OSS	Operations, Service & Support
POH	Point Of Handover
SNCP	Sub Network Connection Protection
SDH	Synchronous Digital Hierarchy
TCM	Tandem Connection Monitoring
TPM	Through Path Monitoring

3. TECHNICAL OPTIONS

During its start up meeting TIG considered BT's initial thoughts on potential architectures that could provide a PPC interconnect with higher availability between all operators with similar functionality to that of the BT 'Genus' service in order to promote discussion. Ten schematics were considered.

The issues are complex and reflect the different operator technology deployments in switching and transport practice from several vendor/manufacturers used in the architectures deployed over the past 10 years.

A part of this input package had been seen by industry before during a post BT Genus service launch exercise to determine industry demand for In Span Handover (ISH) & Customer Sited Handover (CSH) scenarios based on MESH and MSH architectures. Nevertheless, TIG decided to start its preliminary investigations with these 10 options & a summary of their strengths and weaknesses are shown in Table 1 which sets out a Higher Availability PPC capability matrix based upon the BT architectures currently deployed.

Table 1 Higher Availability PPC capability matrix

Option	MESH	MSH	No Single Point of Failure (NSPF)	Higher Availability
A	Yes	Yes	Not True	99.95
B	Yes	No	Not True	99.95
C	Yes	Yes	Not True	99.95
D	Yes	No	Not True	99.95
E	Yes	Yes	Not True	99.95
F	Yes	No	Not True	99.95
G	Yes	Yes	Not True	99.95
H	Yes	No	True	99.995
I	Yes	No	True	99.995
I mod	Yes	No	True	99.995

The initial considerations and discussions from the above capability matrix were that:

- The BT MSH Network implementation does not support SNCP, although the Network Elements employed do.
- NSPF is not the same thing as Higher Availability
- The BT MESH Network does not support TCM and TPM but rely upon EPM
- The BT OSS does not support Option I configurations currently and would need considerable cost and development time for an unknown demand
- Industry is moving away from SNCP architectures for VC4 and VC4xC products and services.

It was also discussed that we needed to identify which areas of Networks and Operations would make the interoperation of Sub Network Handover more difficult than the existing PPC product. The working document produced on ***"Interoperability for Sub Network Handover to Support Higher Availability PPC"*** is shown as Annex B and sets out key issue areas that were anticipated as potential show stopping risks to sub network handover as follows:

- Interoperability
- Configure & Re-arrange tasks
- Circuit Provision
- Planned Engineering Works
- Maintenance & Repair
- Background Error Performance
- Compatibility (for SNCP/N non intrusive & SNCP/I partial non intrusive)

At the close of the first PNO-TIG meeting the decision was taken to widen the debate by contacting the PPC Operators Technical Forum. This step was taken so as to ensure maximum participation and close co-operation on the basis of a joint PNO-TIG and PPC Operators Technical Forum meeting in July.

During the joint PNO-TIG & PPC Operators Technical Forum meetings it became apparent that what industry wanted were architectures through interconnect which were functionally commensurate with those of the BT 'Genus' PPC product, not necessarily commensurate with the availability issue, so as to offer a choice in the market place through the 'separacy' concept competing on both aspects of Genus, availability and No Single Point of Failure.

The 10 original schematics A-I were therefore further discussed & the PPC Operators Technical Forum proposed 6 new alternative designs to meet the criteria of reduced Single Points of Failure & to solve &/or mitigate against the risks identified within the ***"Interoperability for Sub Network Handover to Support Higher Availability PPC"*** document.

4. SHORT LIST

These "new" options 1-6 are set out in Annex D and were developed during the PNO-TIG & PPC Operators Technical Forum discussions. After these early investigations, it was decided that the major criteria for a particular architecture was that it should provide a service with no single point of failure as opposed to merely a higher availability PPC.

- **Option 1**. Delivery of unprotected, but Separate & Diverse transport, through the BT network with STMn presentation to customer site, whereby OLO will place their own element at the circuit end points & provide SNCP managed from their domain.

- **Option 2.** Delivery as above but no BT NTE at customer site i.e. Fibre Handover

- **Option 3.** Back to Back SNCP at BT ISH mux.
- **Option 4.** Drop & Continue SNCP
- **Option 5.** SPRing Drop & Continue integration to BT Mesh Network
- **Option 6.** On Site Handover variant of Option 3

After further consideration within the two industry groups, the list of candidates was reduced to three based upon a ranking process.

Table 2. Analysis of Ranking (1=Low Cost & Time,.... 5=High Cost & Time)

New Options		NSPF	Operations & Repair		Dev. Costs (Time & £)	Time to Deploy	Physical Cost Incl Network	TOTAL	RANK
			BT	OLO					
1		True	2	3	1	1	5	12	3rd
2		True	3	3	1	1	1	9	2nd
3	<STM16	Not True	5						
	>STM16	Not True	5						
4		True	1	1	4 **Note 1**	4	2	12	1st
					2 **Note 2**	2	2	8	
5		Not True	5	5					
6		Not True							

Notes

1. High Volumes, PACS based
2. Low Volumes. Manual based

PNO-TIG/PPC-OTF in consideration of each of these short listed candidates has given each of the three candidate architectures an order of merit based on various criteria. The remainder were eliminated due to their failure to meet NSPF requirements and their selection was not pursued.

The criteria adopted in reaching the above values for the 3 remaining candidates include operational issues, engineering issues and an assessment of whether they meet the original criteria of a PPC that should provide an end-to-end service with no single point of failure.

The final ranking award also reflects the long term Operational & Repair costs, customer impact, network costs and not just the short term time and development cost elements to meet the operator market.

5. RECOMMENDATIONS

5.1 That Overlapping SNCP functionality for Drop and Continue Sub Network Connection Protection (SNCP) meets the industry requirement for No Single Point of Failure (NSPF) through dual point of handover.

5.2 That the Overlapping SNCP protection mechanisms described in ITU-T Recommendation G.842, Figure 17 based upon SNCP rings and Figure 25 based on the primary node Functional Model for non intrusive SNCP/N meets UK requirements for Higher Availability PPC (although the network isolation proffered by Drop & Continue means that the mode of SNCP used by each operator is not relevant, BT will operate SNCP/N).

ANNEX A NICC STUDY 59 for High Availability PPC

STUDY TITLE: Development of a High Availability Partial Private Circuit.

LEAD IG: PNO-IG

DESCRIPTION:

Background

1. Partial Private Circuits were launched as products on August 1st 2001. However, there is no Partial Private Circuit product that provides diversity, separation and higher availability than the standard Partial Private Circuit offering.
2. This means that Other Licensed Operators will not be able to provide High Availability Leased Lines in competition with BT's High Availability Leased Lines called 'Genus' unless they purchase a retail BT Genus Leased Line.
3. The Director General is aware that the development of such a Partial Private Circuit might involve an upgrade to BT's Operational Support Systems and, possibly, some issues with Sub-Network Connection Protection at the points of hand-over between BT and the Other Licensed Operator.
4. The issue of these High Availability Partial Private Circuits is referred to in this consultation document:
   http://www.oftel.gov.uk/publications/broadband/leased_lines/ppcs1201.htm

Description of Work

1. The Director General seeks advice from the NICC on the technical options for higher resilience and produce associated specifications of such a High Availability Partial Private Circuit.
2. This would have to take into account such issues as any necessary upgrades to BT's Operational Support Systems and, also, any issues connected with the hand-over of circuits between BT and the Other Licensed Operator.

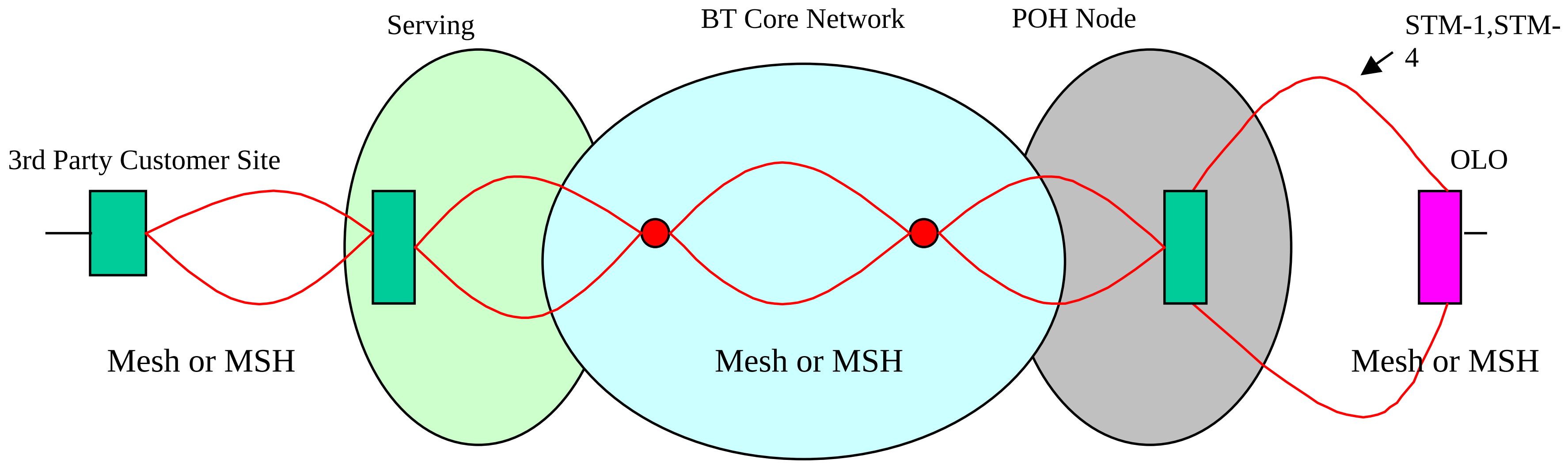
Required Output

The required output from the NICC will be one document:
1. Technical specification including timescales for deployment and implementation proposals for 'Genus' PPCs at all bandwidths from 2 Mbit/s and above.

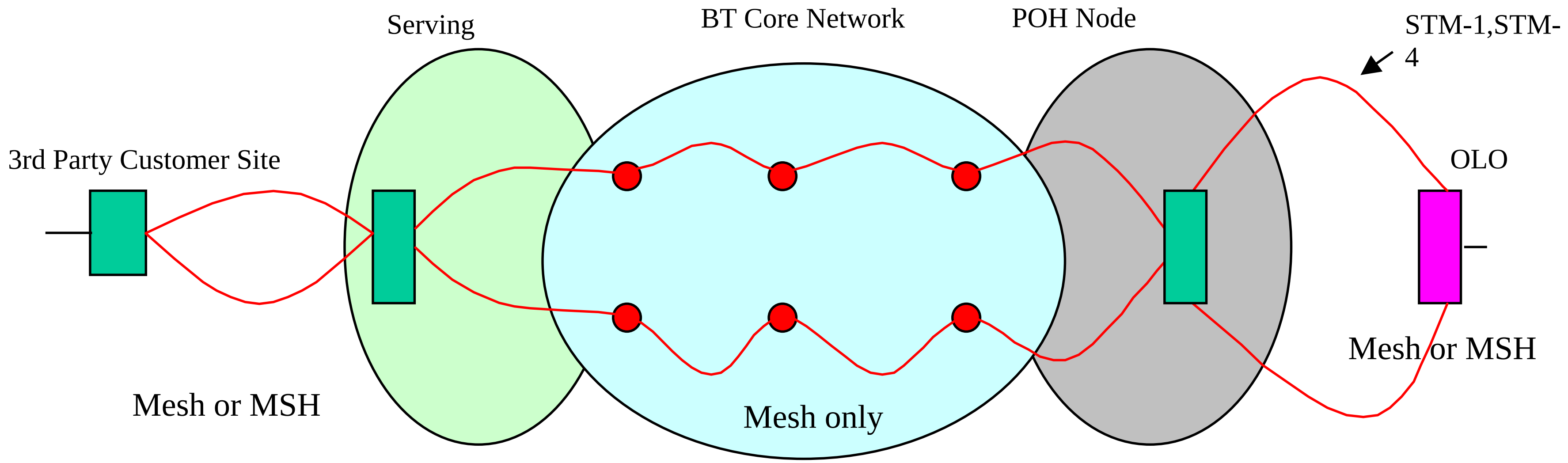
MILESTONES:

1. Final feasibility report to be submitted to the Director General on 1 September 2002.

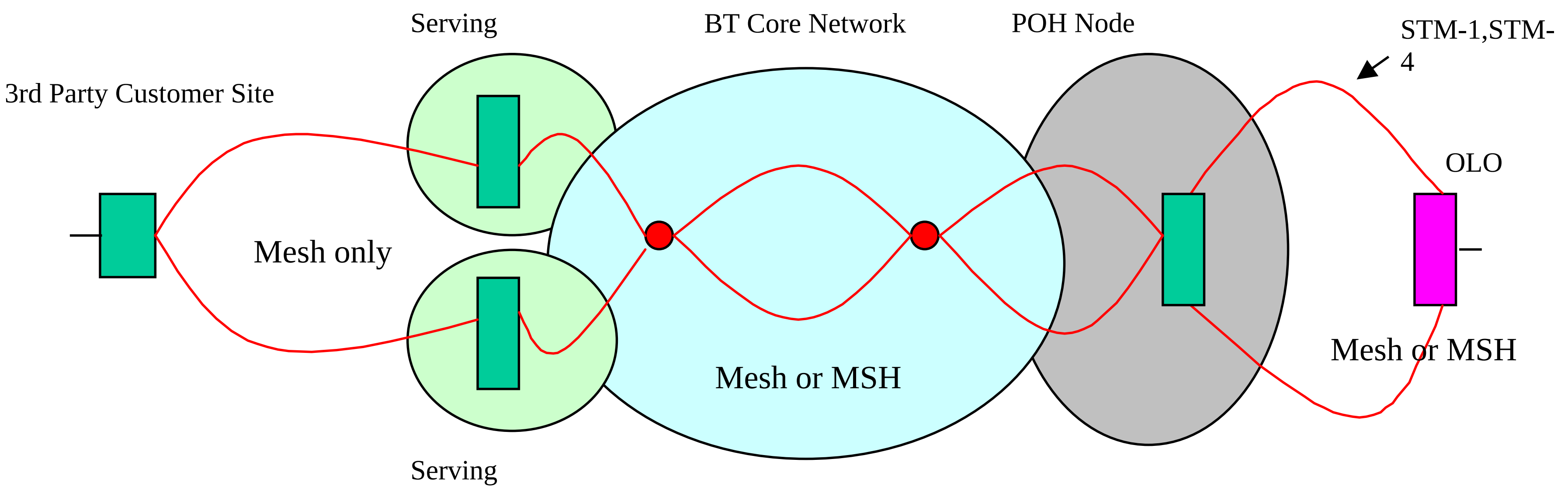
Higher Availability PPCs - ISH option A



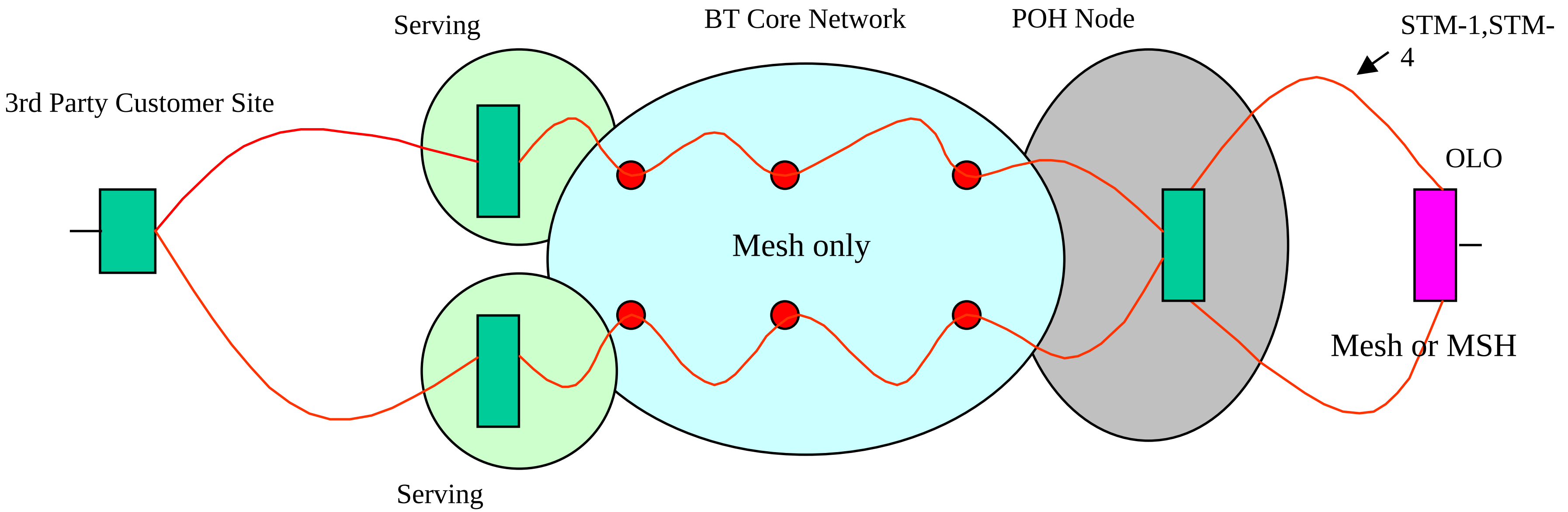
Higher Availability PPCs - ISH option B



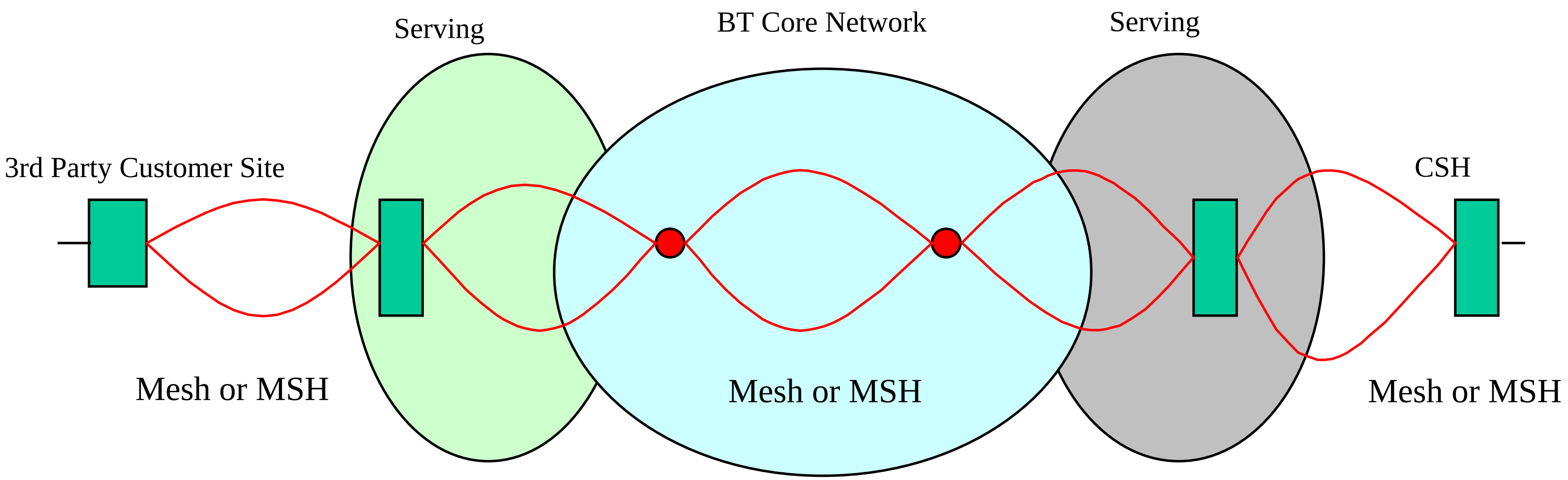
Higher Availability PPCs - ISH option C



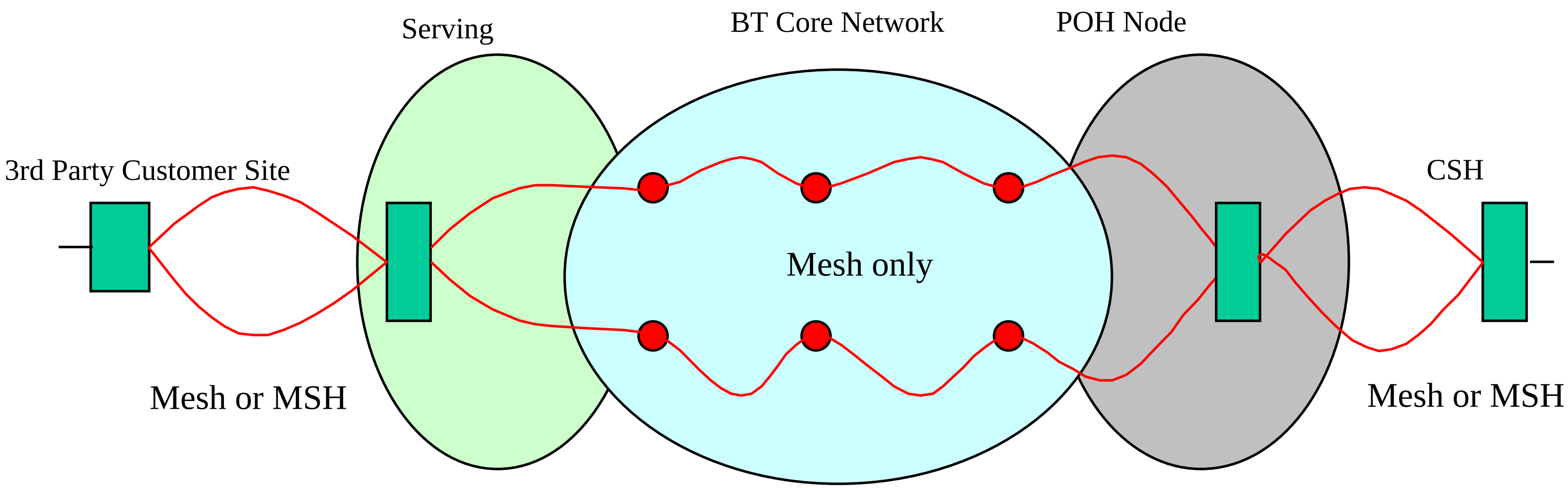
Higher Availability PPCs - ISH option D



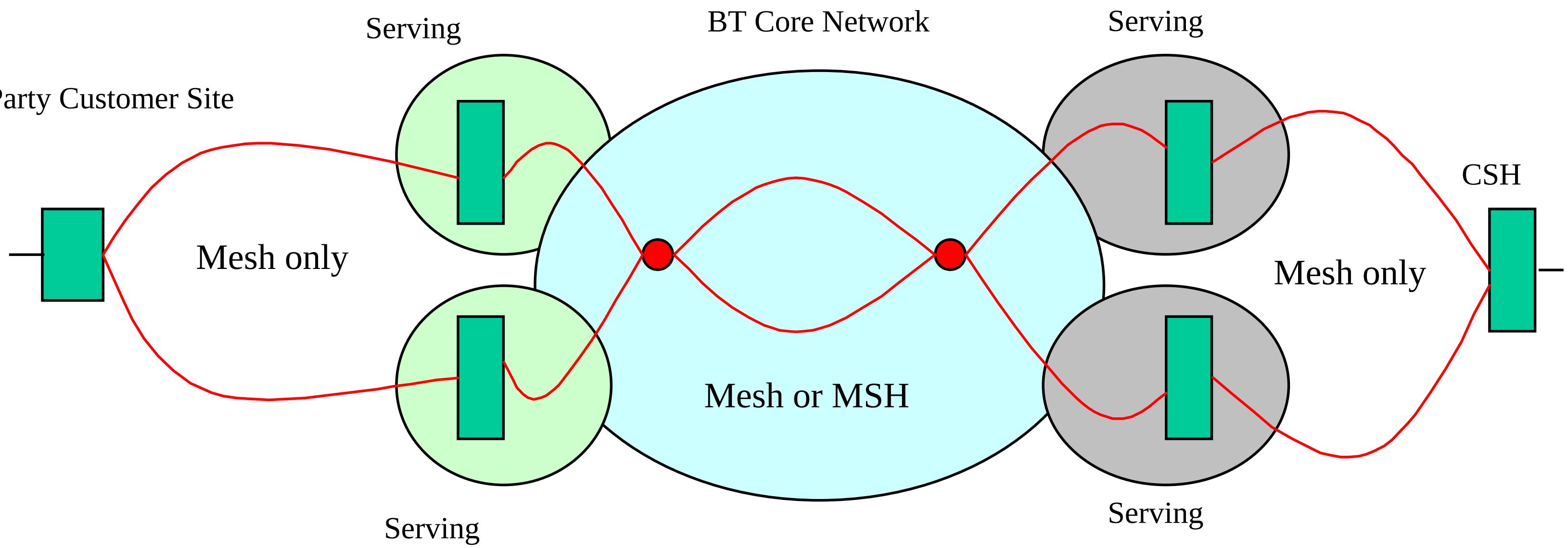
Higher Availability PPCs - CSH option E



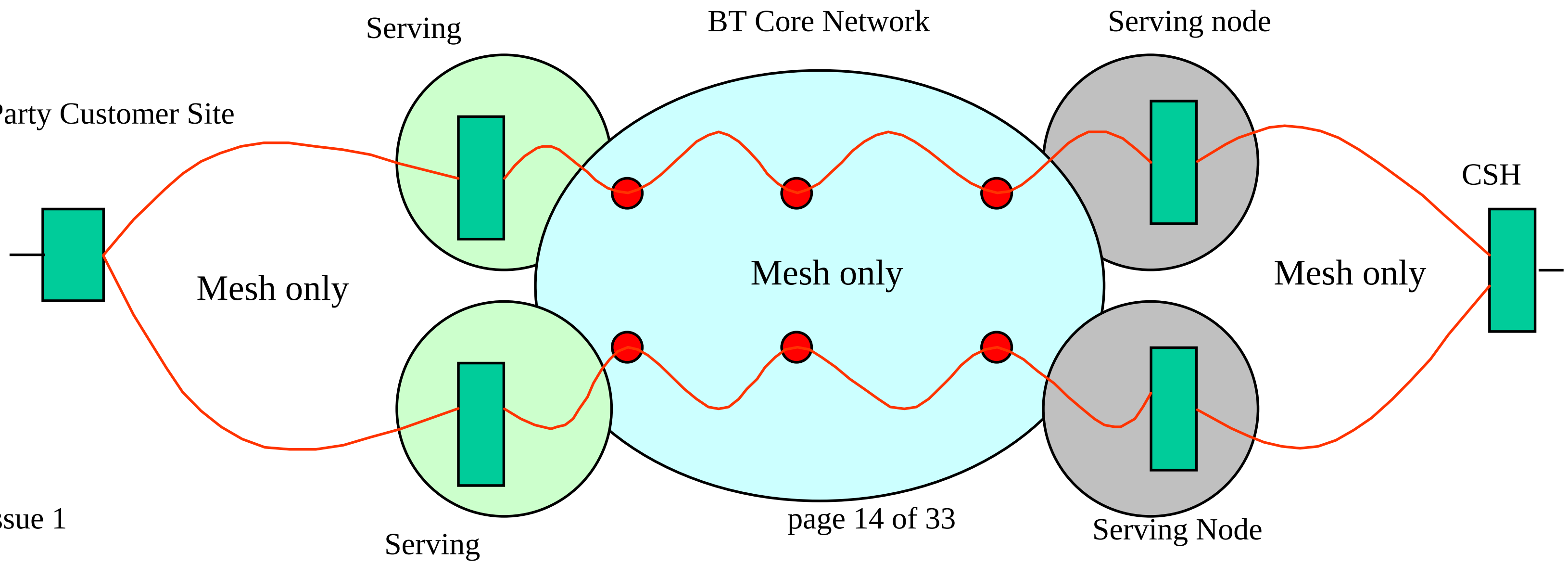
Higher Availability PPCs - CSH option F



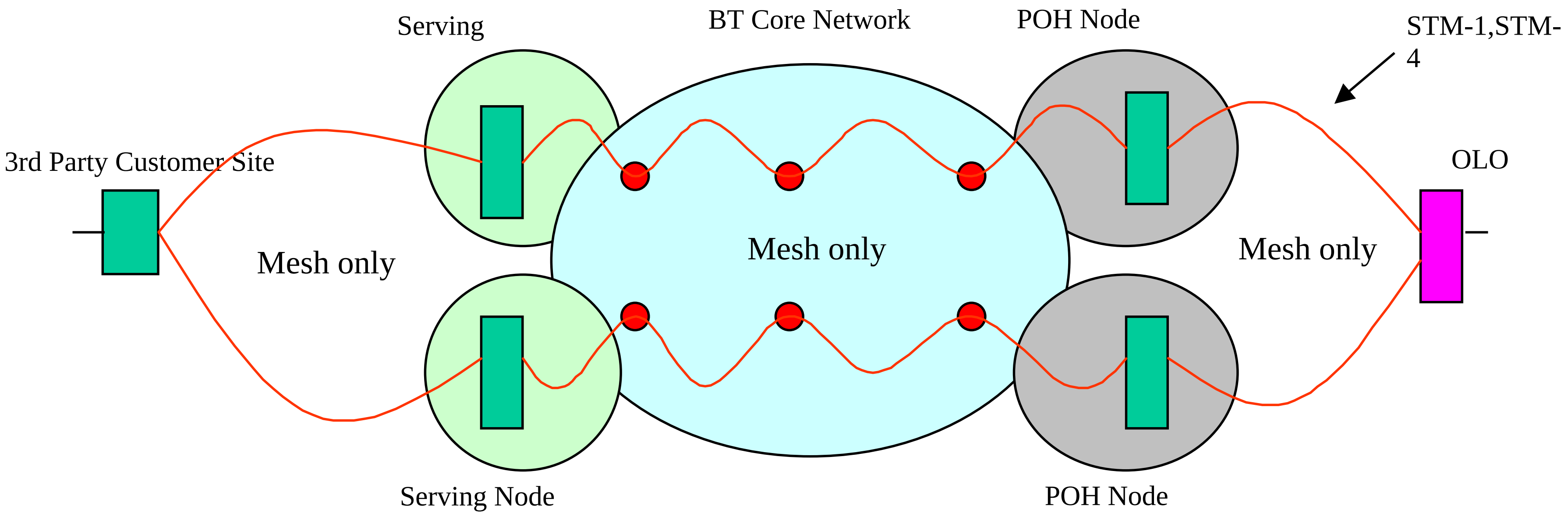
Higher Availability PPCs - CSH option G



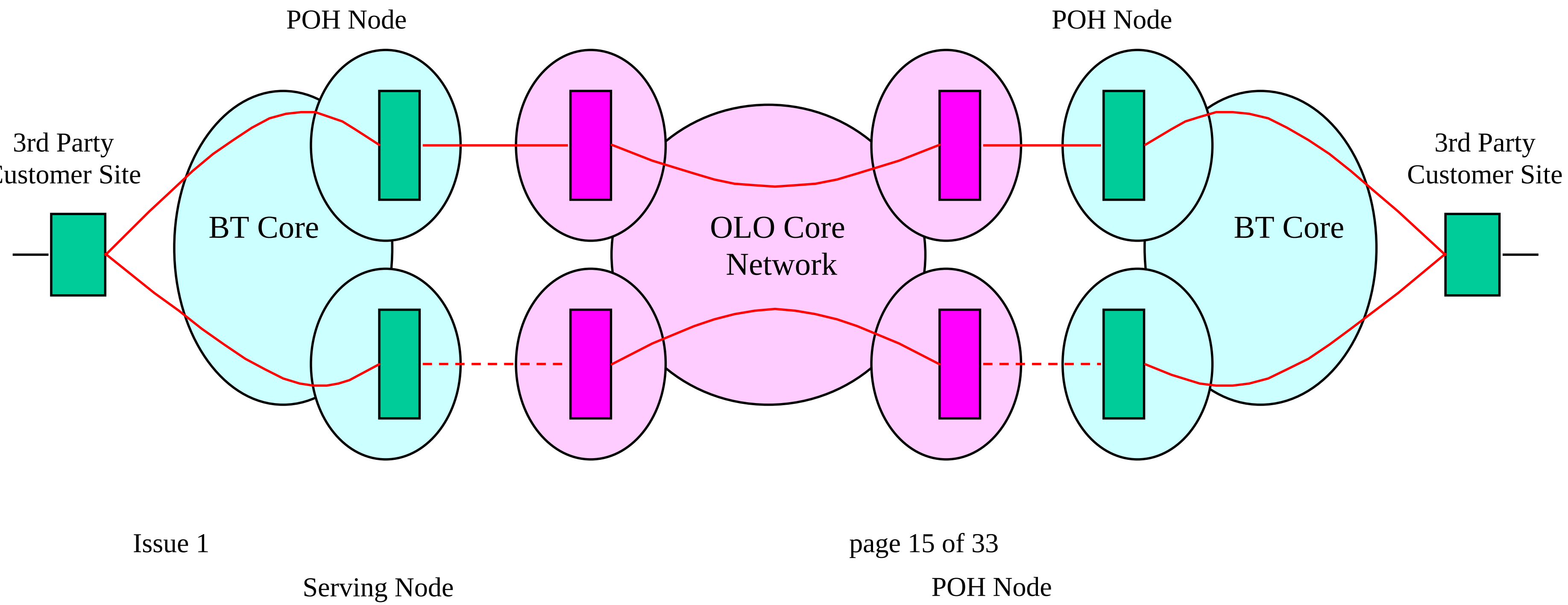
Higher Availability PPCs - CSH option H



Higher Availability PPCs - ISH option I



Possible implementation of option I



ANNEX C Interoperability for Sub Network Handover to Support Higher Availability PPC

Working Document No 1 (PNO-TIG 22(02)04)

Introduction

This paper identifies some of the areas of Network and Operations that make Interoperation of Sub Network Handover more difficult than the existing PPC design. It does not address the additional issues of Operational Support System capability or Planning and Assignment modelling and assumes a knowledge of SDH standards, functionality and terminology.

Sub Network Handover applicability

The BT Narrowband SDH network (colloquially known as the ‘Mesh’) supports Sub Network Connection Protection (SNCP). This network gives VC12, VC3 and VC4 transport and path layer protection at the VC rate of the circuit. It does not support VC4-xC transport.

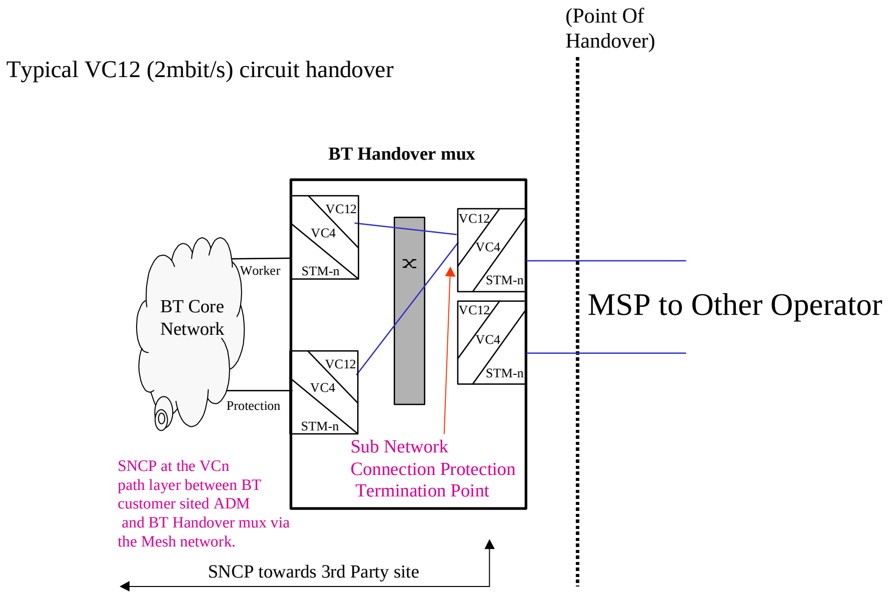
With the introduction of higher bandwidths through concatenation and the growth in demand for VC4 transport, BT has introduced the Broadband network (colloquially known as the ‘MSH’). This network supports VC4 and VC4-xC transport and has no development to support Sub Network Connection Protection in the BT implementation. Although supported by the equipment and Standards, BT does not support or offer SNCP on this network. It is not current BT policy to introduce protection at the Path Layer in any Broadband network, either existing or developing. It is BT policy to restrict path layer protection to the Mesh network only. Using the current definition of a BT Genus product, BT will not be offering Genus to any BT customer on MSH customer infrastructure.

Therefore, this paper will address the issues surrounding the transport of VC12; VC3 and VC4 path layer and does not address VC4 and VC4-xC on MSH handover or Customer architectures.

Background

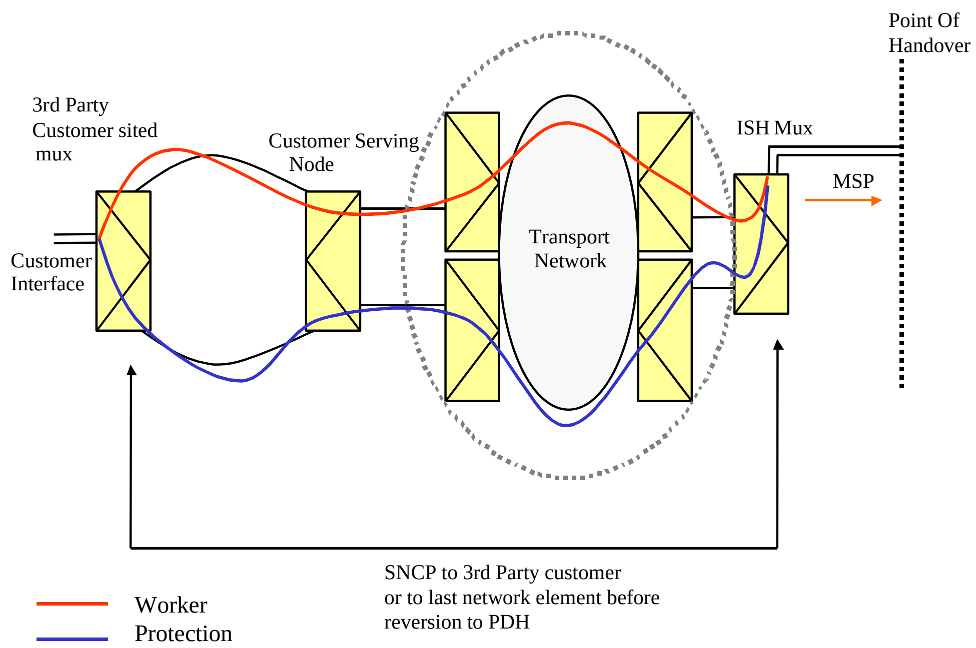
The existing Partial Private Circuit (PPC) handover architecture offers circuit routing in an Operators network between a 3rd party customer site to a Point Of Handover (POH) with another operator. The circuit may then be connected to another 3rd party customer site by the second operator or routed across their network to another point of handover where it connects to a second PPC.

The Line Sections across the POH between operator’s domains are afforded Multiplex Section Protection. This gives rise to a generic Handover model for BT sold PPCs as follows. In both ISH and CSH variants, it can be seen that the circuit level protection from the 3rd party customer is terminated before the point of handover, thereby ensuring that both ‘Worker’ and ‘Protection’ paths of the PPC sub network are retained within the carrier operators network domain.



This ensures that Network domains are isolated from a provision, maintains and repair perspective and each domain can supply a discreet circuit with handover to the next domain. When the domains are joined together, the circuit is contiguous end to end. From a circuit design perspective, this imitates current customer interface practice. Each operator has a customer style interface with the next operator for a discreet circuit. This gives a generic architecture as follows:

Narrowband In Span Handover



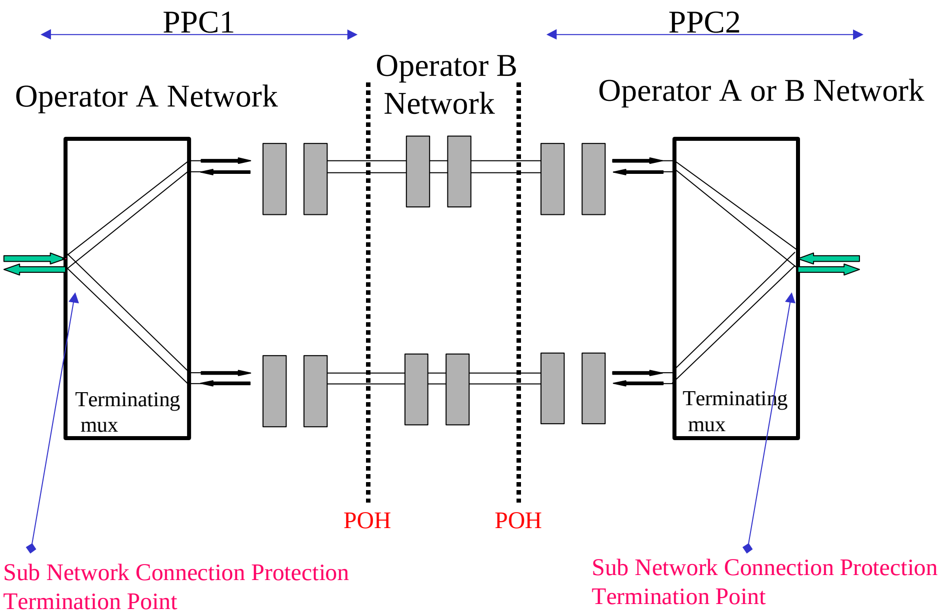
Each operator provisions and maintains their circuit within a discreet network. Co-operation requests should not be necessary if each operator faults their own domain. Problem reports should only cross between one operator and another when faults have been proved to the boundary of an operator's domain. Sub-networks do not extend beyond an operator's boundary and there is no requirement for collaborative maintenance procedures other than on the multiplex sections that join the two domains together. This policy reflects the way in which BT operates its interface with Operators in the International Network, with In Span and Customer Sited handover developing to an MSP interface separating discreet network domains.

<u>Sub Network Handover</u>

Such a delivery requires a PPC carrier to handover each of the two paths of the sub network at different physical locations. The consequence of this architecture is that the PPC Carrier no longer has total control and visibility of the End to End Sub Network, having only one end of the Sub network terminating within its domain.

When two PPCs are placed together to create a circuit, it would look like this end to end:

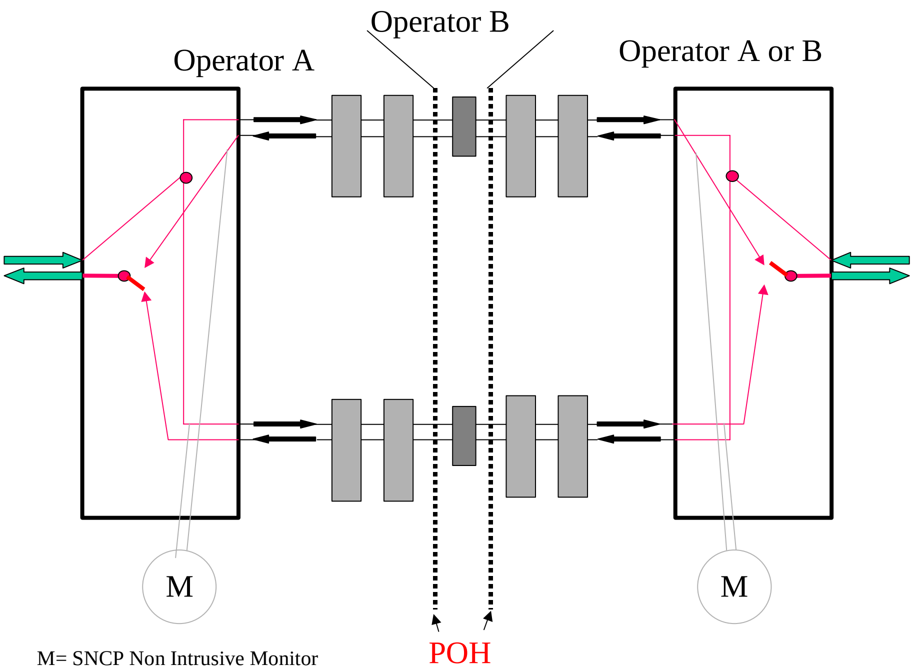
- Where one end is the Network of Operator A,
- the middle is one or more Operator B networks
- and the other end is the Network of Operator A or Operator B.



In the initial implementation of PPCs, Operator A (the PPC carrier operator) is assumed to be BT for the purposes of developing this working document.

Interoperability
The following sections are suggested areas for discussion, which contain interoperability problems and will require resolution and agreement.

Issues for Sub Network Handover



Reference the drawing above:

Sub network Connection Protection operates in a non-revertive, single ended mode with dual fed Transmit (Broadcast) and switched receive paths.

Network element functionality becomes crucial in a Sub Network Handover situation. Some operators rely on end point monitoring only whereas other network operators have implemented Tandem Connection Monitoring (TCM, ITU-T-G707 and ETSI EN 300 417-1) in some form. Some network elements will support Through Path Monitoring (Non Intrusive via HPOM/LPOM) although such capability is available from a limited number of suppliers and tends to be on their latest kit only.

The BT Core mesh network relies on End Point monitoring and has not implemented (and has no plans to implement) TCM. The BT Core Mesh Network does not support Non Intrusive Through Path Monitoring. The above points lead to problems on a Genus handover, which are not encountered on the existing PPC design:

Configure and re-arrange activity
These activities, when carried out within one Operators network will impact on the Protection Termination Point on another Operators network. The Operator terminating

the Sub Networks will encounter protection switching events at the 3rd Party Customer Element triggered by the activity in the Other Operator network or other end provision (noting that both end could be within one operators domain but are not correlated as one circuit). These events can create significant amounts of alarm and event information in an Operators Network Control layer. Although processes can be instigated whereby each operator advises the other on network activities (doubt this would be supportable given that there could be multiple operators involved in any one circuit), these sort of activities can swamp alarm systems. It would not be practical to leave one end of the circuit in NONMON state until the other end is provisioned since an operator is entitled to charge for a PPC once it is available for service (meets the required by date). With the current PPC architecture and its implicit domain separation, an Operator can provision a PPC, place it in service (monitored) and charge immediately. With Sub Network Handover, the PPC carrier must provision a circuit to two Points of Handover, place the circuit into service (monitored) with live alarms, and more to come while provisioning progresses.

In the Sub Network handover scenario, the un-terminated sub network could be left in an alarming state for days/weeks before circuit completion end to end. It should also be noted that there is no responsibility with the PPC carrier to associate one PPC with another (e.g. to create an End to End circuit model). This is not a requirement of the PPC product; therefore the PPC carrier cannot provision both ends as one circuit and must treat each PPC order as an independent circuit.

Circuit Provision activity

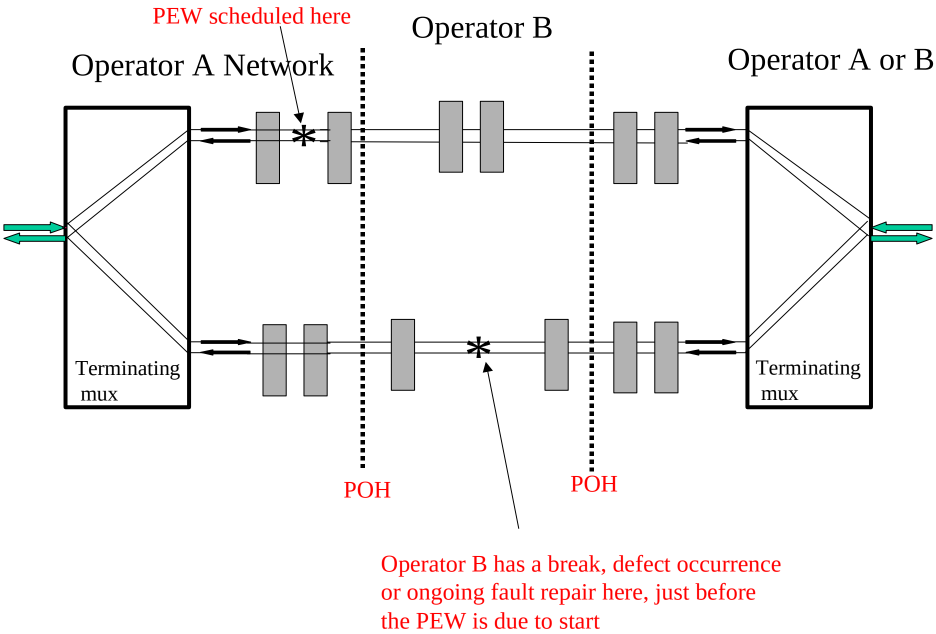
Since one end of the sub network is outside of the PPC Carrier Operators control, provision and test activities are no longer straightforward. As stated above, when one operator configures first, then activities by the second operator will affect the first operators network. There could potentially be several operators involved.

A solution would be to make provision activities collaborative or consultative so that the PPC carrier does not place the circuit into a monitored state until all provision activity for an end to end circuit is complete. This could delay the PPC Carrier’s ability to bill the Purchasing Operator and add to Provision activity tasks, making them iterative rather than one time build. There are many process possibilities here but they will add expense to Provision activities and delay cost recovery by the PPC carrier, especially if correlation of two PPCs to create an end to end circuit is required by the PPC Carrier, since this would be an added modelling responsibility. One or other operator would need to assume the role of provision control (normally the Ordering Operator), however, cost recovery and billing must now be detached from circuit readiness, allowing an operator to recover costs before the circuit is provisioned end to end.

Planned Works activity

Agreements must be built into a Sub Network style handover for Maintain and repair activity, specifically “Planned Engineering Works” (PEW) involving PPC circuit trails. The Operation and Maintenance manual must explicitly identify the commercial agreements made for PPC PEW in a Sub Network handover environment.

Consider a PEW scheduled on an Operator A cable carrying (among others) PPC services. Protected services are notified and agreed where lack of resilience will exceed a certain period. What happens now, if Operator B notices events within their own network or has a breakdown on the other leg of the protected services?



If we consider whether there is a need for a Veto be introduced to the PPC agreements (to ensure that circuits are not disrupted by Planned Works), then if a veto is permitted, the PPC carrier now has a significant overhead to reach agreement with all the other customers involved (possibly both Retail and Wholesale) with the risks of inconveniencing its other affected customers if this happens repeatedly. This will increase operating costs of a Sub Network Handover PPC and can disrupt activities planned for other customers.

If a Veto is not a permitted mechanism for halting a Planned Work activity then this circuit product can never be marketed as a “Higher availability” product since no such availability could be guaranteed. This issue becomes Volume dependent, since small quantities of High Availability PPCs, requiring a greater attention to detail than normal PPCs, will affect a large number of other services. As volumes of Sub Network Handover PPCs increase, then incidence of cancelled PEWs due to veto will increase non-linearly as circuits promulgate through the network.

No PPC Carrier has any responsibility for linking the two PPCs in Assignment systems, and it would therefore be incumbent on the circuit ordering Operator to understand the impact of a PEW on works in their own network (no-one models a circuit end to end). With no such correlation between Worker/Protection legs on an End to End basis, the most likely situation is that the service will only be affected when the PPC Carrier commences their Planned Work. Both PPC Carrier and PPC ordering Operator will need to ensure circuits are modelled with worker/protection legs specifically identified and correlated between operators.

In a second scenario, a PEW is scheduled on both PPC1 and PPC2 but alternate legs. Again, the Carrier operator will not correlate these two PPC and will not recognise the resultant loss of service. It is therefore incumbent on the ordering operator to correlate activity on an end to end circuit. Such difficulties do not arise in the current PPC architecture where network separation gets round this problem.

Maintain & Repair

At the point of handover, it will be necessary for Operators to have the ability to rapidly access whether a reported fault originates within or outside of their network domain. In order for this diagnosis to be carried out non-intrusively an operators network elements will require Through Path Non Intrusive monitoring via HPOM/LPOM or employ Non Intrusive Tandem Connection Monitor, including TCM Defect as well as performance.

Since the BT network and possibly other operator networks, currently employ neither of these two mechanisms, all domain isolation testing will be intrusive. It is normal with SNCP circuits to align both transmit and receive paths onto the “good” leg before performing intrusive testing on the “bad” leg. This alignment causes a switching ‘hit’ if the circuit was not already aligned. If the fault proves to be outside of that operator’s domain, then the defect is handed to the next operator where further intrusive testing may take place.

For defect isolation performed by the middle Operator from the diagrams above, some form of Non intrusive through path monitoring is essential. This circuit configuration could not be maintained, nor any availability guaranteed unless such functionality was available at the middle Operator network since there would be no visibility of the Path status or trail performance. Any Operator in this situation could not reliably liaise with their customer regarding defect reporting and could not indicate to their customer likely repair times, nor could they confirm whether this was a genuine defect or a fraudulent attempt to reduce costs.

Where through path monitoring is not universally available on an end to end basis, the alternative to relying on each operator to isolate the defect from their domain before handing over the fault is to operate a Correspondent repair process whereby operators collaborate on defect location. By this means, the operator receiving the defect at the 3rd Party Site will collaborate with other Operators in the circuit path to isolate the defect. The unfortunate consequence of correspondent process is that the product cost must increase accordingly to cover additional the resource. Collaborative maintenance may also prolong circuit repair times.

Without Correspondent interworking, a principle must be built into this product whereby each operator is responsible for defect isolation before handing over a fault. The purchasing Operator will be responsible for proving and handing the fault to the Operator whose domain is defective.

Background Error performance

Defects, which cause background error rates, may be reported to the PPC carrier by the purchasing Operator for fault investigation, having first proved them out of their domain, or are operating Correspondent process. In the existing PPC architecture, long term Non Intrusive performance monitors can be established within each Operator network. A performance monitor can be established on the working or protections receive trails to ascertain whether there is any performance problems on the circuit within the each operator's domain. In Span Sections are self monitoring at the Section Layer.

However, in a Sub Network handoff situation, short term non intrusive performance monitors can only be established where TCM has been universally adopted, correspondent interworking is established or where both ends of a circuit are provided by one operator who has correlated the circuit model for each end (not currently supported in the PPC definition). Without TCM, short term performance monitoring has to be performed by intrusive testing on the protection path (i.e. loop back) to the edge of an operators network, therefore circuit resilience is not available for the duration of such a test period.

<u>Compatibility</u>

There should be an established product standard for SNCP and this should be the full Non Intrusive SNCP (SNCP/N). Some manufacturers implement sub sets of this protection, i.e. partial Non Intrusive or Inherent SNCP (SNCP/I). When the two types of protection interwork, each direction receives a different level of protection and performance guarantees may be difficult to defend. A default configuration will remove interoperability issues and standardise maintain/repair process.

<u>Summary</u>

Any activities which employ collaborative processes for End to End circuit management will increase circuit costs for network operators by increasing resource requirements, increasing time to repair, introducing new practice and procedure. It will entail common procedures and process, common circuit recording techniques, i.e. circuit designations standardising, e.g. M1400.

The nature of PPC is such that any one operator does not have a designated responsibility across other operator domains so Correspondent working is a complete turn around in PPC operation. One operator must assume provision/repair control and communicate any circuit activity to all affected parties throughout the trail so that generated alarms can be ignored. PPC volumes do not render themselves to Correspondent interworking techniques (it is a growth area); they would become resource hungry between operators and proactive path layer monitoring unsupportable. The Middle operator (ordering operator) would therefore assume repair/provision control and have responsibility for co-ordinating any circuit layer activity/re-configuration and informing all other parties of intended activity so that alarms can be ignored.

- Planned Works procedures must be defined before a product can be launched. These must be agreeable to all parties and the procedures accommodated into the cost of the product.
- Through Path monitoring capability must be a pre-requisite of any operator requesting this product.
- Through Path monitoring capability is a desired requirement of PPC Carriers and would become a pre-requisite if collaborative process is not workable.

Any operator should have means of recompense for fault localisation activity when the defect is proved back to the domain from which it was handed. Without universal

Through Path Monitoring, the practice of passing over faults before proving could develop resulting in more expensive maintain/repair and lower circuit performance.

END

ANNEX D Industry Development of 6 new options

Overview

The original PNO-TIG discussion papers (which identified 10 different PPC options with its companion paper on the Pitfalls of Subnetwork Handover), were not discussed in detail, however they had clearly established the immense problems facing industry in trying to build a PPC solution that mimics the BT Genus product. These problems are mainly due to the many different network suppliers that each operator has implemented within their core networks. These had differing capabilities with incompatible functions so as to frustrate a common denominator across all operator domains.

During these discussions a number of alternative options were considered which BT agreed to take away and investigate in order to meet the requirements of those operators present. The main point of progress from the meeting was that although “high availability” was required, of prime importance was sepracy with no single points of failure. Industry wanted architectures which were commensurate with those of the BT Genus PPC product through interconnect, not necessarily commensurate with the availability.

The “revised” 6 alternative options are summarised as:

- **Option 1**. Delivery of unprotected, but Separate and Diverse transport, through the BT network with STMn presentation to customer site, whereby OLO will place their own element at the circuit end points and provide SNCP managed from their domain.
- **Option 2.** Delivery as above but with no BT NTE at the customer site (i.e. Fibre handover).
- **Option 3.** Back to Back SNCP at BT ISH mux.
- **Option 4.** Drop & Continue SNCP
- **Option 5.** SPRing Drop & Continue integration to BT Mesh Network
- **Option 6.** On Site Handover variant of Option 3

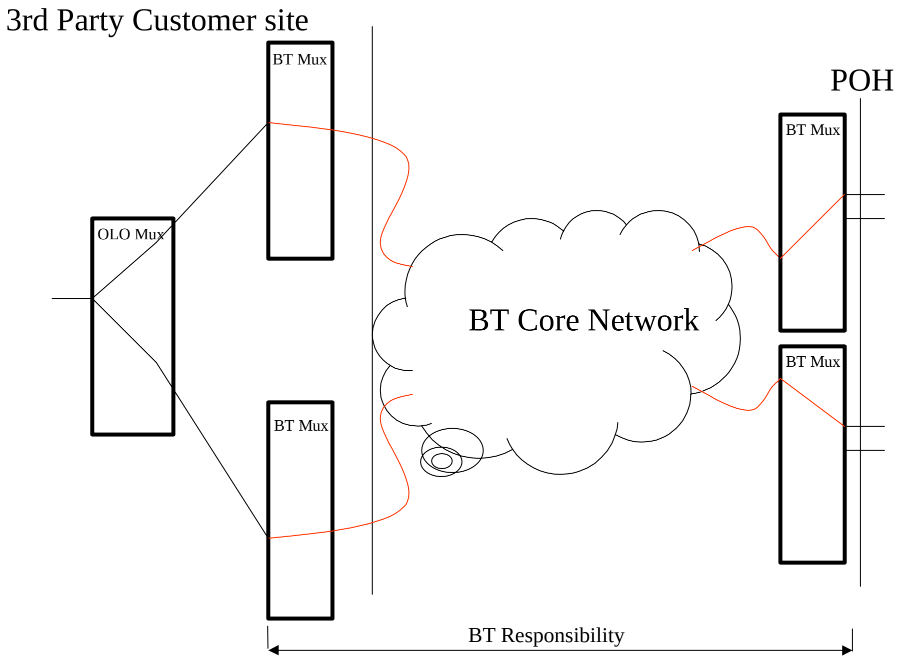
The rest of this document attempts to look at each of these options in turn however some of them do have significant issues in their own right. Whilst the meeting benefited from a frank exchange of views there were compatibility issues that arose during discussions.

For example, arguments were advanced which suggested that any operator with non terminating sub networks passing through their domain, would be unable to diagnose faults without prompting by BT, because they would not be aware of which routing each of the current working paths were taking.

Operators argued was that they were assisted in fault diagnosis by virtue that SNCP can be deployed Bi-directionally. That's fine if you implement Bi-Directional SNCP but is a classic case of assuming that everyone has the same build functionality within their networks. They do not and it would be a mistake to press for solutions which only meet a narrow set of industry views at significant cost of time & resources with an unknown demand.

Sub network interworking issues

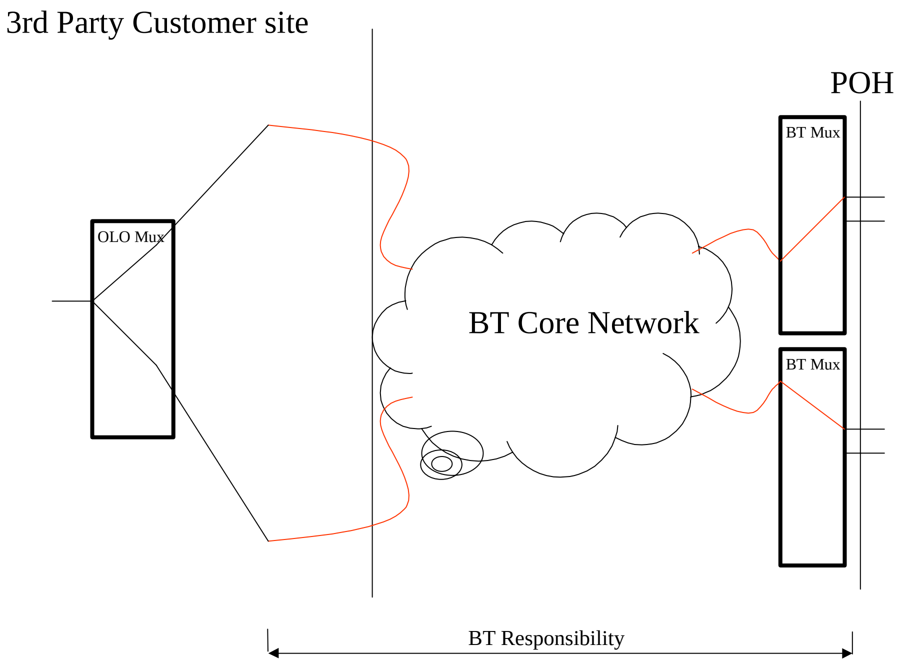
Option 1 - Delivery of Bronze Pairs through the BT network to customer site, whereby OLO will place their element at the circuit end points and provide SNCP managed from their domain. Diagram 1.



BT will deliver bronze circuits to aggregate interfaces at each end. The protection termination is placed firmly in the OLOs domain and they will be able to respond directly to their customer and "see" any problems reported by their customer.

The main problem for BT with bronze circuits is that lack of through path monitoring combined with no trail or protection termination means that BT has no visibility at the circuit layer whatsoever. BT could maintain the service by alarm monitoring at the section layer and assume everything is OK at the path layer. For path layer performance defects, analysis gets more complex. BT is still investigating the Operational aspects, but see this option as difficult to maintain but simple to provide with the previously identified Planned Works issue problems outlined in the "Pitfalls of SNCP" still valid for this architecture. Cost of implementation is medium . It would probably drive the introduction of alternative monitoring techniques (e.g. TCM at the edges of the BT network) and would therefore be relatively resource hungry to develop.

Option 2. Delivery as above but with no BT NTE at the customer site (i.e. Fibre handover). Diagram 2



This is fibre handover at the 3rd party customer site possibly using some form of Optical interface panel. BT has no visibility on the fibre serving sections and can see only fibre break type events and REI/RDI conditions returned in the section layer.

Circuit provision activity will be to the last BT mux in the route, then handoff to an aggregate "customer type" interface. With a customer interface panel to terminate our fibres, there are benefits in maintenance when compared to ISH extension, where the point of handover is a joint in a foot way box or on OFR. The biggest issue with the fibre handover and bronze pair routings is lack of visibility of the path layer. The previously identified Planned Works issue outlined in the "Pitfalls of SNCP" is still valid for this architecture.

Even implementation of monitoring techniques such as TCM will not give BT the ability to monitor path layer to the edge of its responsibility. BT would therefore need to develop a mixture of Section and path layer diagnosis for fault handling. Availability could therefore be compromised by the diagnostic process and attribution of fault to appropriate operator.

Cost of development would be similar to Diagram 1, but availability would be further compromised by diagnostic process.

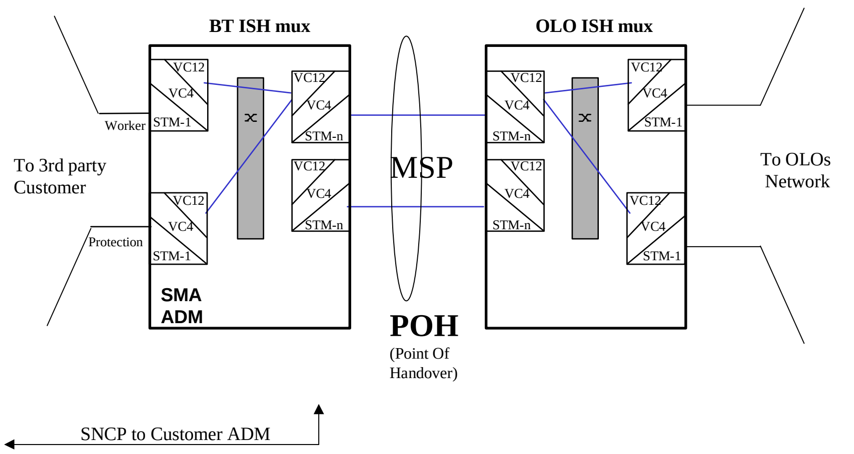
Bi-directional SNCP

This method of SNCP working is confirmed as still not standards compliant (ITU-T-G841 states – "*1 +1 SNC protection should support unidirectional protection switching. Other architectures are for further study*".). BT does not employ proprietary interworking which cannot be supported by all operators buying the same product and BT only supports Uni-directional SNCP working. BT has a policy of supporting universally available products, but not bespoke solutions for one operator, e.g. Operator A uses Vendor 1 with proprietary Bi-directional switching, Operator B uses Vendor 2 with uni-directional capability only.

Option 3 Sub Network Interworking from a single Point of Handover

It was proposed that BT should change the existing MSP handover to that of SNCP at single points of handover. The rationale for this argument was based on the fact that the operators have to terminate the MSP before starting up two new sub network routes diversely in their network and that this handover method adds a 'Single Point of Failure' in their network.

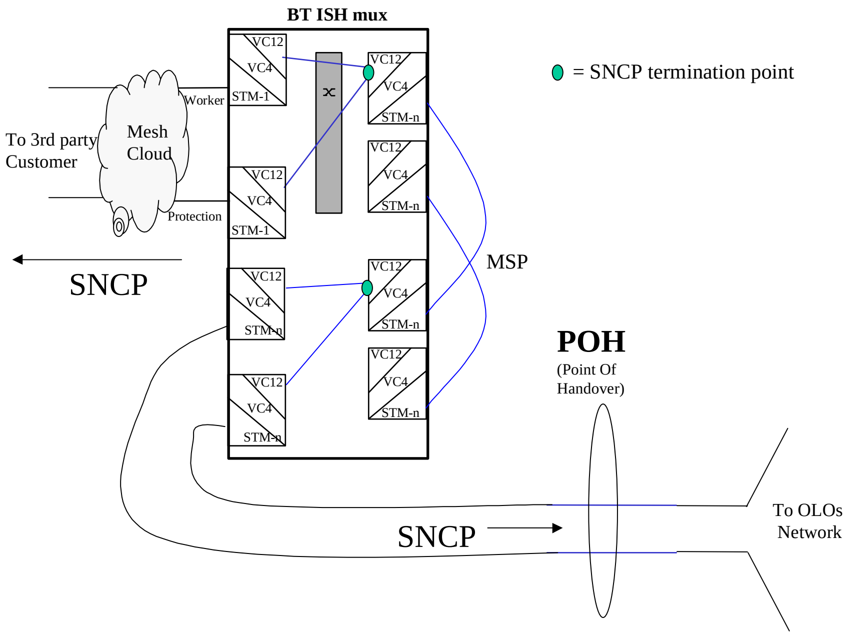
Currently supported In Span Handover Diagram 3



This architecture is specifically designed for Interoperator connection. It give complete domain isolation and ensures that activity, defects and failures within one operators network cannot affect the other operators network. Sub networks do not extend beyond each operators ISH mux, domains can be discretely monitored and fault diagnosis performed to ensure that fault handover is legitimate. This is the logical method for interoperability and each operator faces the same implementation costs.

Proposal from Industry: Diagram 4

In Span Handover



In this scenario, BT is expected to provide back to back SNCP. The operators therefore proposed the above change to existing Handover which removes an ADM from their network -.To support back to back SNCP it is necessary to cross the switchplane twice by exiting the ADM and re-entering, as shown above. This will increase the cost of ISH according to extra ports used. Cost could be reduced slightly by removing the MSP on the ADM external turnaround connections. This move a single point of failure from the OLO network to an existing single point of failure in the BT network.

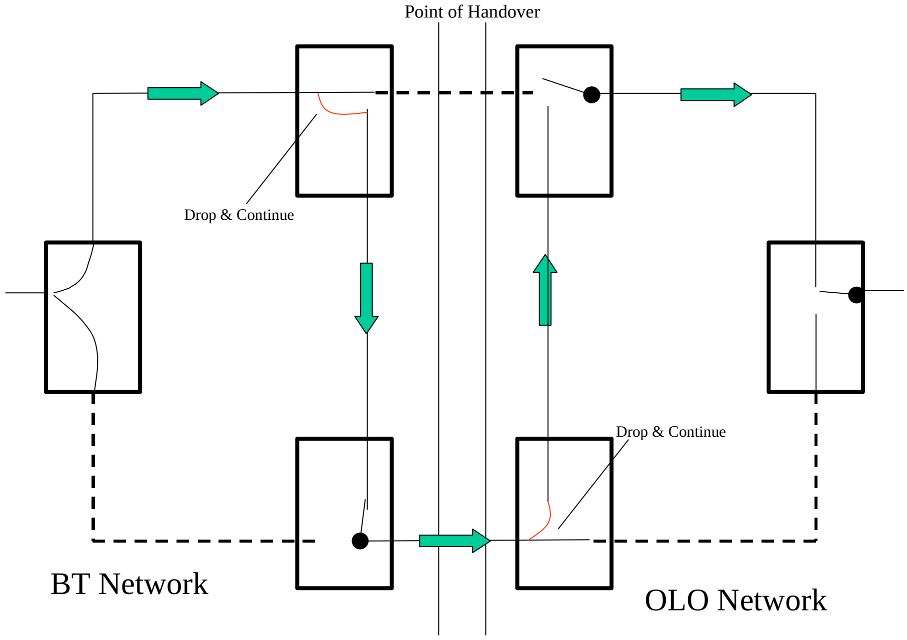
This architecture could be supported on STM4 ISH. For STM1 handover from an STM4 ADM, in fully protected configuration (as shown above) it can only support 3 x STM1 ISH (as opposed to 4 normally) and it can support 4 x STM ISH with no protection on the external turnaround connections. It cannot be supported on STM16 ISH as there are simply not enough connections on the ADM. The only alternative for STM16 would be to put a second ADM in the BT Handover (Modelling diagram 3), but moving the single point of failure into the BT domain so that both ADMs are at a BT locality. Also, reference Option 6.

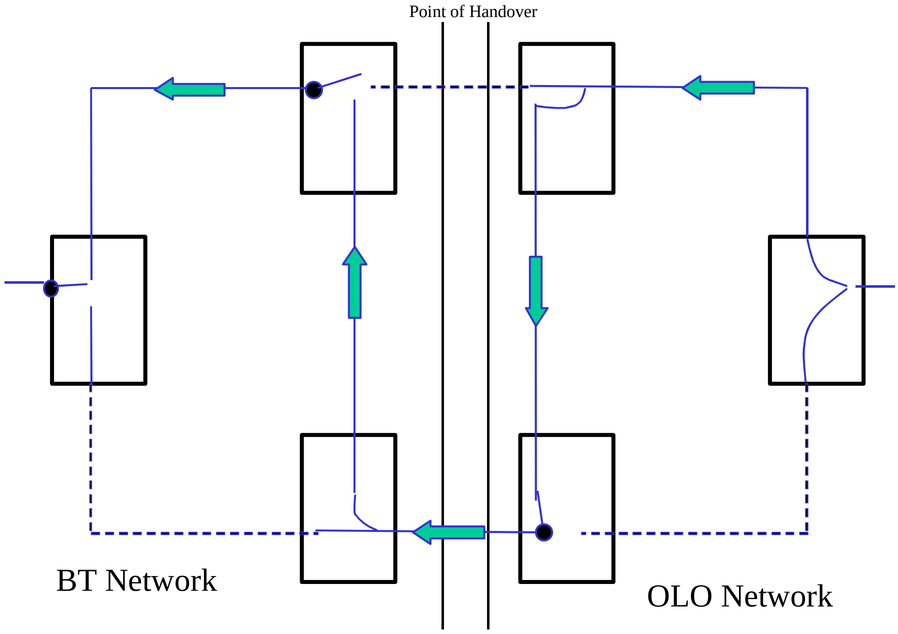
In terms of impact to BT, the Sub Network Connection Protection Termination point for OLO networks has now moved from the OLO network (diagram 3) to the BT network (diagram 4). It adds load to the BT narrowband DCN because any event in the OLO network (including re-arrange, Planned Works, and maintenance), will create a protection switching event in the BT ISH ADM. This architecture takes us back towards the PSTN Interconnect scenario whereby BT are providing circuit layer protection across one or more OLO networks. Although it does not experience all the issues previously raised on sub network handover, this subtle change of moving the sub network termination point to the BT ADM will have impact on the BT management domain. For operators with no through path monitoring capability, BT will need to collaborate with them and assist in fault localisation and for operators with through path monitoring, they will be unaware of which paths and direction are workers and so may need BT assistance in corroborating their analysis.

The consequences for BT Operational process, resource and DCN loading could be large but difficult to apportion cost to and build into product rental. The operators have benefited by the removal of an alarming point from their network and would now rely on BT or their own through path monitoring (if available) for diagnosis. Even simple acts of proving faults to the edge of their domain could cause switching events in BTs.

Option 4 - Drop and Continue interworking

In drawing below, each direction is represented separately:





This functionality offers dual points of handover (no single point of failure) but also isolates the sub networks within each operators domain. It's kind of the Industry answer to the age old problems that the MSP handoff design tries to address (see issues in the "Pitfalls of SNCP" document.)

This would represent a good compromise solution, with all the domain isolation advantages of MSP handover but gives OLOs the dual handover points they require.

In order for BT to offer such a solution for all handover rates, it would need to be available on the BT Mesh network. Initial response from the BT supplier of Mesh network infrastructure suggests:

The SMA supports an equivalent protection mechanism to that described in ITU-T G.842. This is known as Overlapping SNCP which provides the level of protection required by G.842. It complies with the spirit of the recommendation, but does not follow exactly the implementation described. It handles most double fault conditions.

However, any such implementation is fraught with opportunities for interwoking problems. G842 recognises that contentions can occur if other protection mechanisms are brought into play within an operators network. Such a change would require trialling and compatibility testing to ensure each operators implementation was supportable. Also, due to the potential for improper configuration and set up, each implementation should go through a robust commissioning stage and test procedure before being declared operational. This would involve collaborative commissioning for a circuit layer (end to end), would require a test circuit implementation and would result in additional time and cost for the commissioning activity.

The BT specific issues relate to the Circuit design and Planning & assignment model. Existing BT support systems cannot design circuits or support plan, build and routing on Drop and Continue architectures. This configuration is a significant contradiction to the design of the BT OSS systems. Broadcast connections are not currently supported.

Service design could be developed to support all routing and assignment as a manual operation, however this is volume dependent. Since this is such a detraction from current operational practice, significant training and familiarisation would be required to support this network interoperation technique.

In terms of impact, BT has not fully investigated the development costs however, it was anticipated that they would be moderate to high for an automated solution and depend upon volumes. Alternatively, development could be restricted to a manual design, assignment and configuration approach that by itself would also have a different set of cost versus volume limitations.

Option 5 SPRing Drop & Continue

This proposal requires further exploration and definition. Spring interoperation could follow a number of variants which include:

- Making use of existing BT SPRing elements but this could make BT Core Network plan & build reactive to ISH demand.
- Building specific SPRings for ISH, this would probably be based the MSH51 Network Element in order to control costs, however, a SPRing by definition must have a minimum of 3 Network Elements so architectures need further investigation. Provision of a SPRing for each operator at specific nodes may create a product requiring significant infrastructure investment.

The solution would could be integrated into the BT Core Mesh network for routing narrowband services onward to the 3rd party customer site. However, BT uses SNCP to protect circuits in the Mesh layer and so creates a single point of failure unless we use SNCP drop and continue also, back to back with SPRing drop and continue. Since BT only deploys MSH at the VC4 path layer, any narrowband services must be delivered to 3rd Party sites on Mesh architectures unless the PPC Higher Availability product becomes a bearer based delivery mechanism. This option requires further qualification since it offers no benfit to narrowband products and is not representative of Broadband architectures used by BT today.

Option 6 On Site Handover Model

This emulates diagram 3 with the exception that both muxes are on BT premises, the OLO mux is supplied, installed and managed (including sync) by the OLO. This is similar to the current IFA ISH model. The BT ISH mux could be removed and connectivity across the floor from the OLO mux would be directly connected to Core rings with SNCP terminated in the Core ring and MSP across the floor. This could remove one of the single points of failure in the In Span Connection, however, the across the floor connectivity could not be provided to two separate rings and the Sub network protection to the 3rd party site must start on the first BT element.

END