Draft Determination Supporting Document NGET ETAnnex Q9a NGET A10.08 OpTel Refresh Telecoms DD Update v1.2

As a part of the NGET Draft Determination Response

nationalgrid

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1. Executive Summary

In response to Draft Determination, we are seeking to clarify the common factual understanding between NGET, Ofgem & Atkins of the OpTel equipment refresh (£108.9m), explaining why it is independent and fundamentally different to the fibre replacement work (£78m), with different function, proposed investment, risks and justifications.

To clarify our independent justification for the two portfolios of activities proposed in our December 2019 Final Submission we have therefore split the equipment refresh justification and fibre deliverability justification into two separate standalone papers. We have set out the principles driving our refresh proposal to ensure we deliver value for the energy consumer. Our principles are: to deliver in time, to apply lessons learnt, and to drive efficiency through designing the refresh to maximise market competition.

We provide evidence that the unintended consequence of the 3 year delay to funding (and therefore equipment refresh work) proposed by Ofgem in Draft Determination would make a timely network refresh impossible and put 90 core sites (34%) at risk of unrecoverable and simultaneous failure for 4 years from 2026 to 2029. Failure could manifest as complete loss of monitoring and control of these 90 substations simultaneously, including complete loss of Control Telephony, complete loss of high-speed protection and operational tripping. The transmission grid would become inoperable and the GB energy system would be at real risk of sudden collapse by cascade tripping failures.

Through our support contracts with Original Equipment Manufacturers (OEMs) we are currently resolving hundreds of critical and very high priority cyber vulnerabilities each year across the OpTel systems and software as they are discovered and resolved by the OEMs. Without the proposed refresh investment from 2021, continuing to use these network equipment components without OEM support could expose multiple sites across the network to attack through an unpatched unknown vulnerability. In the worst case a complete loss of the Optel network would leave us unable to monitor or control or protect the network effectively enough to avoid a black start situation, which we would not be able to recover from without the Optel network functioning again. Restoration would be at the mercy of OEMs resolving vulnerabilities in unsupported obsolete equipment, which they may be unable or unwilling to do, and which may take days or weeks to deploy to all the affected sites. Collapse of the GB energy system as described above would result.

We provide evidence that our submitted plan for a 7 year refresh, 2 years faster than the last refresh, is both deliverable and has a robust critical path that delivers replacement in time and in

the shortest time to control these risks. We explain further how as a responsible Critical National Infrastructure (CNI) operator and asset manager we have already taken and will continue to take steps to maximise the life of the current assets with extended support contracts, repair loops and strategic spares holdings, in order to minimise telecom lifecycle costs to the energy consumer.

We provide evidence that OEM End of Support means the network equipment will be exposed to [redacted] and be at risk of unrecoverable failure if we don't invest from 2021 as proposed in our December 2019 Final Submission, and that this will be compounded from 2027 by a lack of availability of further spares. The telecoms equipment life is typically 10 years; a refresh starting in 2021 already requires that we negotiate up to 5 years of OEM extended support beyond this point and which is the industry maximum for this equipment.

We provide evidence that our telecoms network refresh strategy and asset management approach is consistent with UK cyber security standards and the approaches of other comparable CNI OpTel/telecoms networks, such as Network Rail for the core network refresh and RTE (NGET equivalent) of France for the High Bandwidth Overlay.

We provide evidence that the full and timely funding of the OpTel network refresh from 2021 will allow us to maximise consumer value from procurement synergies with wider NG CNI system procurement in the same T2 years, and to meet Procurement Law requirements. We also outline the steps we are already taking and will take to ensure efficient costs in T2, such as removing commercial OpTel traffic, pre-RFI work to drive clearer procurement requirements and packaging work so that a wider range of suppliers can compete and innovate for the OpTel refresh.

We are seeking to clarify the common factual understanding between NGET, Ofgem & Atkins of the High Bandwidth Overlay, explain its deliverability, independence from the fibre replacement work, and justification.

Supplemented by the evidence presented in this paper, we therefore propose that our December 2019 Final Submission request for £108.9m for OpTel network refresh (excl. fibre wrap replacement), is a justified, deliverable, and timely T2 investment to ensure energy consumers continue to benefit from a secure reliable CNI OpTel network at lowest cost.

2. OpTel refresh justification

This supplementary justification document covers the majority of the total proposed OpTel network refresh investment (£108.9m), but excludes the fibre wrap replacement aspect (£78m) and should be read in conjunction with our separate Draft Determination response document NGET_A10.08_ OpTel Refresh_DD Update_Fibre for Fibre-wrap replacement for justification of the whole £187m OpTel investment proposal. We have split our reply into these two documents for clarity when describing the differing drivers, risks and consequences and approaches we have taken in our RIIO-T2 proposal for these different components of OpTel.

The principle outputs (excluding fibre) proposed for the RIIO T2 Period are listed below:

Output	Description	RIIO T2 Cost (£m)
OpTel Network Refresh	Existing OpTel communications equipment at 274 sites requires replacement by 2029 to maintain service within manufacturer end-of-support dates for these devices. End of support is expected between 2024-2029 and varies between platforms and vendors	77.4
High Bandwidth Overlay	By investing in a high-capacity additional overlay network that uses existing OpTel fibre paths, current OpTel low bandwidth, low latency capacity will be maintained to support existing services (including Teleprotection), and significant additional high bandwidth packet-based capacity can be enabled. This additional capacity is required to support increases in demand for current OpTel services and the introduction of new electricity network management and monitoring technologies	19.8
Control Telephony	The systems providing Control telephony were last refreshed through a project that completed in the early years of T1 and will require a further cycle of asset health replacement at the end of RIIO T2	8
Improved Comms Link Performance	[redacted] of Teleprotection services do not meet the technical specification and are currently subject to performance concession, additional fibre routes will allow reconfiguration to eliminate these concessions.	3
Improved Physical Security	At high priority sites, physical security is enhanced by fitting enhanced protection of the fibre running down tower legs and fitting security inserts to chambers on dug sections. This investment proposes to extend the number of high priority sites in line with the number of “hardened” substations.	0.7
TOTAL		**108.9**

The table below provides detail of the proposed spend profile (excluding fibre) within the RIIO-T2/ T3 period:

Output	Fy22 (£m)	Fy23 (£m)	Fy24 (£m)	Fy25 (£m)	Fy26 (£m)	T2 Total (£m)	T3 Total (£m)
OpTel Network Refresh	1	6.4	30	20	20	77.4	17.6
High Bandwidth Overlay	1	10	8.8			19.8	0
Control Telephony					8	8	4
Improved Comms Link Performance	0.6	0.6	0.6	0.6	0.6	3	0
Improved Physical Security		0.35	0.35			0.7	0
TOTAL	**2.6**	**17.35**	**39.75**	**20.6**	**28.6**	**108.9**	**21.6**

Investment of £21.6m is required in the first two years of the T3 period to complete installation works and to complete the migrate of services.

2.0 Network refresh principles for efficient delivery

We have applied the following principles in preparing our OpTel network equipment refresh proposal in order to deliver an efficient refresh at lowest overall cost to the energy consumer.

- **Deliver in time** – we have negotiated with suppliers to maximise the life of our existing network, and then proposed a 7 year refresh that delivers an operational replacement network in the shortest time to meet the end of life dates. To ensure uninterrupted OpTel reliability and cyber security this refresh needs to begin in 2021.
- **Apply lessons learnt** – we have applied learning from the previous OpTel refresh that took 9 years from initiation to completed transfer of all services. By doing so we have optimised and reduced the critical path of this refresh to a minimum of 7 years, allowing it to begin two years later than otherwise, in 2021.
- **Efficient delivery** – We will also apply learning from procurement, contracting and management of the last refresh. In particular we will maximise **market competition** in the specification and procurement of the refresh solution by coordinating with other NG CNI refreshes in 2021 and work packaging the refresh to allow more suppliers to bid and more flexibility for them to innovate in proposing solutions.

2.1 The OpTel Network Equipment

The OpTel network consists of extensive telecoms equipment located at over 274 substations and 125+ tertiary sites and the associated point-to-point optical fibre links that together connect the network throughout England and Wales and to 3 Control Centres. OpTel equipment provides over 5,000 point-to-point services which carry all protection, control and signalling information fundamental to the safe, reliable and economical operation of the transmission system in England and Wales and for GB System Operation. The equipment also delivers services for ESO and interconnects the Scottish TOs telecoms networks to our network for England and Wales. It also carries essential Control Telephony for all operational locations. Without this equipment the GB transmission network would be impossible to operate and manage economically, efficiently and safely. Network equipment populations are summarised in Appendix 5.1.

Figure - OpTel network topology of services across OpTel links

The Figure above is a blown-up schematic diagram of the connection between two substations showing a fraction of the range of OpTel services, each substation has almost a hundred services between them and multiple substations linked in rings, consequently requiring the use of multiplexers throughout the access and core sections of the network. It is therefore not possible to isolate and replace an individual service without interruption to a wide range of interacting OpTel services and system functions. Service transfer during network refresh requires the coordinated migration of all the interacting services to ensure there is no disruption of the normal operation of the GB transmission network.

In order to minimise the amount of infrastructure used by the OpTel network, substation sites in a region are connected in a mesh or ring. During equipment faults the OpTel services for all sites in the region will suffer from depletion in resilience and are exposed to a single point of failure, risking safe operation and control of the GB Electricity Transmission System. This requires the OpTel equipment to have a high level of availability, which will not be maintained in future if obsolete and unsupported assets are not refreshed in a timely manner.

Figure: Photo of a typical OpTel network equipment cabinet at an NG substation

The core of the current OpTel network system was installed, commissioned and put into service between 2011 and 2014 ahead of the transfer of the 1600+ OpTel services which was completed by 2018. At this core are the Ericsson (Optical Multiservice platform) OMS and ABB FOX multiplexers. The Ericsson OMS are the higher order multiplexers providing core backhaul and edge connectivity for the cisco multiprotocol label switching (MPLS) tertiary traffic and supports both TDM (PDH, SDH) and Ethernet-based connectivity, supporting the bandwidth requirements for our substation and caring traffic also for secondary and tertiary sites. The ABB FOX are the

lower order multiplexers providing connectivity for the primary and secondary sites TDM (PDH, SDH) edge traffic into the core backhaul.

In response to a question from Ofgem in August 2020, we confirm that replacement of fibre links (not equipment) with microwave links was considered in our December 2019 OpTel submission and discounted for numerous reasons, see page 12 of NGET_A10.08_OpTel Refresh document for further detail.

2.2 Network equipment refresh drivers

The OpTel network equipment refresh is driven by condition-related asset health of the telecoms equipment which comprises an inseparable system of services, software and hardware which will reach and exceed their end of life without timely refresh. Without timely refresh before end of life the network equipment will transition to a state where it is unsupported, unreliable, at risk of unrecoverable failure, vulnerable to security flaws, will not meet cyber security standards or industry best practise for critical national infrastructure. In the following sections we also discuss these drivers of the network equipment refresh in more detail. The consequences of OpTel failure are summarised in the next section.

We have also taken a range of measures, as outlined below, to maximise the life of the existing services, software and hardware in RIIO-T1 to maximise value extracted from the existing OpTel network for energy consumers. We explain why the proposed the network refresh investment plan is required now from the first year of RIIO-T2 as the most efficient way to continue to provide a reliable secure OpTel network at minimal cost to the energy consumer.

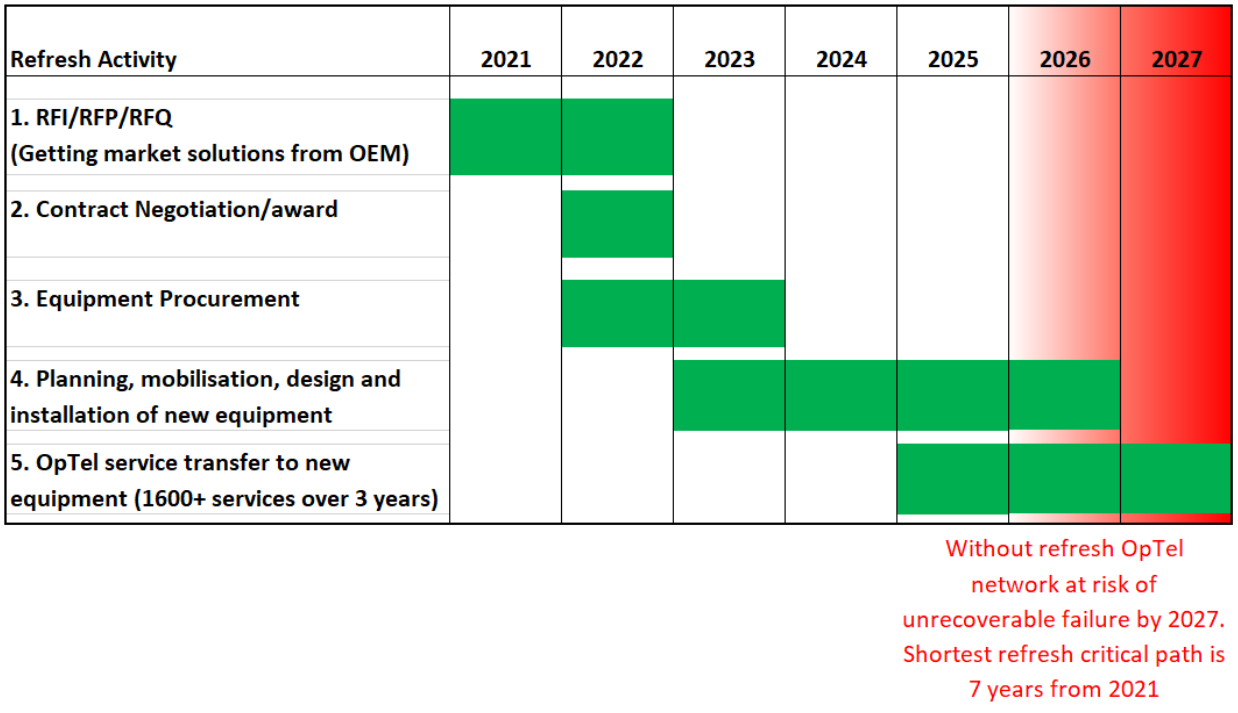


Figure - OpTel replacement timeline, shortest possible refresh

The figure above shows the project plan critical path is 7 years, this is the minimum number of years required for the refresh project to design, procure, build and migrate the 1600+ OpTel services to a new secure and reliable network solution before the existing equipment is obsolete

and vulnerable to unrecoverable failures and cyber threats. The last refresh took 9 years and we have applied lessons learnt from that refresh to reduce this refresh to a minimum of 7 years, beginning in 2021.

2.2.1 Consequence of OpTel failure

The UK Business/transmission procedure (UKBP/TP 118, appendix A3) outlines the consequence and system incident management procedure to follow in an OpTel failure incident. Loss of part or all of the OpTel network will cause the loss of the following operational telecommunication system services:

- Protection signalling between sites
- Data communications between sites and control centres (TNCC and ENCC)
- Voice communications between site and control centres
- Voice and data communications between National Grid control centres and DNO, Scottish companies, and larger power station control rooms
- Voice communications with certain third parties, including BEIS incident rooms(s).

The Optel network is essential for monitoring, controlling and protecting the HV electricity transmission system. The complete loss of monitoring and/or control of multiple substations would lead to a requirement to man all the affected sites simultaneously and for 24 hours a day. This is not achievable with the engineering resource available and so sites would be prioritised based on their criticality, and some sites would be left unmonitored and uncontrolled. This situation would quickly become unsustainable, and during a period of heightened network risk such as bad weather would likely mean we would be unable to manage the network within SQSS.

A loss of protection (which would occur for a loss of Optel circuits) that leads to HV circuits being unprotected then requires us to switch those circuits out of service for safety and system stability reasons. If this is sufficiently widespread then this would ultimately lead to widespread loss of supply.

Complete loss of Control Telephony – STCP 04-5 specifies the requirements on TOs to ensure a resilient operational telephony network. Loss of this network would make us reliant on CTN or third party networks/mobile networks which do not meet the required resilience standard.

In the worst case a complete loss of the Optel network would leave us unable to monitor or control or protect the network effectively enough to avoid a black start situation, which we would not be able to recover from without the Optel network functioning again. Restoring functionality would

depend on the goodwill and urgent action by suppliers to investigate and resolve the responsible vulnerability in obsolete equipment, which they may be unable, unwilling and not contractually obliged to do. Even if possible, resolution could take days or weeks across hundreds of affected sites. The ESO is also equally heavily reliant on visibility of the system parameters including generator data etc to operate the system second by second. Depending on the dynamics of the transmission system at the time, the loss of the HV network could take seconds to hours to happen following a complete Optel loss. As the energy network transitions to a low carbon network with more renewable intermittency and lower system inertia then second by second system operation (energy balancing) will depend more strongly on a functioning OpTel network over time, heightening this risk further.

2.2.2 OpTel network condition at the end of T2

The critical core OpTel services are carried on hardware installed across the 274 sites. Each item of hardware is controlled by native software (installed locally on each hardware), which is configured and monitored using centralised management systems running OEM software.

At the end of RIIO-T2 the core network equipment will be 12 to 15 years old. Telecommunication companies refresh their equipment at an average of ten years[3], although it is not uncommon for utilities to maximise and seek to extend the lifespan of their OpTel network equipment to fifteen years where possible on a risk basis. Network Rail have agreed a 15-year lifespan of their similar scale and complexity telecoms network with the ORR[4] (see section 2.2.6 below).

The end of life or to be more precise the last date for extended support as defined by the OEM is based on several factors, some of which are given below[5]:

a. The designed life of the device as defined by the OEM
b. Cyber Security Implications
c. The availability of parts/components/boards for repair and cost of repair in comparison with the benefits offered by newer devices and the mean-time-to-replace
d. Failure Rates, Performance, Change in Failure Rates (Statistical Data)
e. Firmware changes
f. Documentation and Loss of Knowledge
g. Technological Advances
h. Support is no longer available
i. Lack of qualified personnel to support antiquated equipment and software

OpTel network equipment software and hardware become more vulnerable to malicious attacks

when OEM support for them ends and they are declared obsolete. NGET's proposed plan ensures we comply with **OFGEM RIIO-T2 cyber resilience guidelines**[6] for "temporary mitigations" and "obsolete technology," by ensuring we can replace the software and hardware just before OEM support services end.

Considering the site equipment in a region are connected in a mesh or ring configuration to allow point-to-point services, if there is an equipment fault or optical fibre fault, the OpTel services for all sites in the region will suffer from depletion in resilience and are exposed to a single point of failure risking operation and control of the Electricity Transmission System.

2.2.3 End of Life/End of Support driver

Definitions:

End of life (EOL): The end of life process consists of a series of technical and business milestones and activities communicated to customers by the OEM. The completion of this process indicates a product, service or subscription is obsolete. Once obsolete, the product, service or subscription is not sold, improved, maintained, supported or repaired by the OEM.

Last time buy dates (LTB): The last time buy dates indicates the last date an OEM will accept requests for equipment hardware (spares and whole equipment).

End of support date (EOS): The end of support date indicates when no more hardware and software support can be provided by the OEM for the product in question and is the effective obsolesce date. Many OEMs allow negotiation for a support extension date "extended support end date" (ESE) on a case by case basis.

Cisco end of sales (EOS-C): For Cisco, the end of sale date, indicates the product, service or

subscription is no longer for sale. This is also the last date to order the product, service or subscriptions through Cisco point-of-sale mechanisms. The EOS-C date is documented in the EOL notification. Based on the customer type of subscription, the maximum period support can be provided after the EOS-C date is 5 years.

Implication:

EOL communication notifies customers of the important dates leading to the obsolescence of equipment hardware and software and services, such as the EOS, LTB, ESE dates.

When customers such as NGET receive the hardware and software EOL announcements they must implement proper life cycle plans to mitigate against having unsupported hardware and software in their networks and take steps to replace the equipment before the final obsolete date or implement a risk mitigation plan to reduce the impact to acceptable levels until the equipment can be refreshed.

For the software, the EOS or obsolete date is the date from which no more improvements or fixes will be provided for the software versions in consideration, beyond this date cybersecurity vulnerabilities and defects will not be identified and remedied leading to a greater risk of malicious attacks. It is common practise in the industry to negotiate extended support dates on a case by case basis with the OEM. NGET has taken advantage of this industry practice and is in ongoing negotiation for the extension of the software life span to the furthest date possible with each OEM.

For the hardware, the LTB dates indicate the last time orders can be placed for complete systems and spares, once all the orders are fulfilled, manufacturing and repairs of the hardware in consideration ceases. Once spares are exhausted failed hardware cannot be replaced. NGET in line with industry standard practices put in place a risk mitigation plan together with our managed services contractor to ensure we have a repair loop and spares holding to extend the hardware effective life as far as possible, but this cannot be indefinite.

Good industry software maintenance practice which NGET follows, is guided by ISO/IEC/IEEE international standard for software engineering, software life cycle processes and maintenance standard “IEEE/ISO/IEC 14764-2006” which on a high level consist of corrective, adaptive, perfective and preventive maintenance throughout the life span of a software. Once a software has reached the end of its life cycle phase, best practices requires the software to be replaced or upgraded.

2.2.4 End of Life/End of Support for Key Equipment

In this section we detail the end of life situation for key classes of network equipment across the network. The Gantt charts in later sections further visualise when the first of these unsupported end of life dates are reached in relation to the multi-year process to design, procure and bring online the replacement equipment.

OpTel Equipment Status

Critical OpTel equipment RAG Status during T2 period:

HW Product	EOS Date	LTB Date	ESE Date	Failure Risk	Cyber Security Risk	Notes	Numbers	Years in NGET service by 2026
Ericsson OMS 1654 / 1664/846 & MV 36	07/19	04/15	*12/26			To mitigate for the LTB of hardware, NGET had ordered spares and have a 3rd party repair loop in place to repair components that can be repaired, while the mitigation allows us sweat the hardware, nothing can be done about the firmware and OS software, which are no longer eligible for updates, patches and upgrades from the obsolete date 2025	159	15 Years
ABB Fox 515 /512 & FoxMan	05/24	05/17	**05/29			[redacted]	561	12 - 15 Years

[redacted]

End of life Mitigation:

The NGET OpTel core network is currently dominated by the Ericsson OMS and ABB Fox which account for approximately 84% of the critical core equipment. The OMS and FOX system was installed and commissioned with live traffic between 2011 and 2014, ahead of the transfer of the 1600+ OpTel services which was completed by 2018. This equipment will have been in service for 12 to 15 years at the end of the RIIO-T2 period.

NGET is aware that this is telecommunication equipment which generally has a 10-year productive life-cycle in the Telecommunication industry and cannot be compared to protection and control systems both in equipment longevity and the criticality impact of failure. While protection and control systems have a longer life span than the Telco equipment, the failure of even just one or two pieces of telco equipment can have a far wider reaching network impact in the electricity transmission network (see above section 2.2.2).

NGET is implementing various risk mitigation plans to ensure we can maximise the operational life of this equipment at acceptable risk levels in the lead up to the optimal network equipment refresh point that minimises total life cycle cost to the energy consumer.

Ericsson OMS HARDWARE AND SOFTWARE:

NGET in line with the LTB date announced, ordered spares and commissioned a 3rd party repair loop and spares replacement agreement for the equipment. Production of spares for this hardware ceased in April 2015. The 3rd party provider salvages these used equipment from companies in the Telco industry that have refreshed, and in-turn this generate spares for NGET use. This arrangement has reduced to an acceptable level the risk of running out of spares before 2027 but does not completely element the risk. [redacted]

[redacted]

ABB FOX HARDWARE AND SOFTWARE:

[redacted]

2.2.5 Network equipment cyber security vulnerability driver

[redacted]

The "RIIO-T2 cyber resilience outcome description for B4.d vulnerability management," (Section 6 of OFGEM "RIIO-T2 cyber resilience guidelines" published on the 5th of Feb 2020), states in respect of obsolete technology that, "obsolete and/or unsupported networks and information systems supporting your essential service may have temporary mitigations for vulnerabilities while pursuing migration to supported technology." NGET has therefore followed these guidelines for OpTel where unavoidable, by starting negotiations in 2019 to temporarily extend the support for the software that will be EOS within RIIO-T2, and we will complete the negotiations in 2020/2021, in good time to allow for timely migration to supported technology in T2 as outlined in this paper.

2.2.4.1 Our investment plans align with Ofgem's RIIO-2 cyber resilience guidelines

Ofgem RIIO-2 cyber resilience guidelines publicised 5th of February 2020, provides operational guidance to support the maturing of the cyber security and resilience of utilities network and information systems. Excerpts of the vulnerability management section supporting our approach to obsolete management are presented below:

1 **Temporary Mitigations** - Some vulnerabilities that are not exposed outside the system boundary/security zone of the networks and information systems supporting your essential service may have temporary mitigations for an extended period.

1.1 Temporary mitigations may be required for an extended period due to:

A Operational reasons (e.g. change requires system shutdown and is being deferred until a planned maintenance routine);

B Technical reasons (e.g. change is not compatible with existing system or infrastructure);

C Age of system (e.g. system is coming towards end of life and change is not approved due to cost vs benefit/time).

2.1 Temporary mitigations and other compensating controls should always be implemented as the lack of exposure is insufficient mitigation on its own.

3.1 Where temporary mitigations are required for an extended period, these should be monitored and regularly reviewed, in accordance with the risk balance case.

2 **Obsolete Technology** - Obsolete and/or unsupported networks and information systems supporting your essential service may have temporary mitigations for vulnerabilities while pursuing migration to supported technology.

1.1 The networks and information systems supporting your essential service which are obsolete or unsupported should be identified and catalogued.

2.1 Temporary mitigations and alternative compensating controls should be managed as a programme where necessary while progressing migration to supported technology.

3.1 The company may decide to continue operate some obsolete or unsupported systems for an extended period. Where this approach is followed, a comprehensive and holistic physical-cyber risk assessment should be conducted to ensure an appropriate level of security is maintained for the essential service.

2.2.4.2 Our investment plans align with NIS Regulations 2018

The OpTel investment plans are aligned with our obligations to adhere to The Network and Information Systems Regulations 2018 regulations for electronic communications, as stated in Part 3, sections 8 and 10 of the regulations stated below[10].

Section 8 defines an OES which applies to NGET and section 10 requires NGET to take appropriate steps to minimise the impact of incidents affecting the security of the network and ensuring continuity of services.

Part 3, Section 8,
Identification of operators of essential services
8.—(1) If a person provides an essential service of a kind referred to in paragraphs 1 to 9 of Schedule 2 and that service—
(a) relies on network and information systems; and
(b) satisfies a threshold requirement described for that kind of essential service, that person is deemed to be designated as an OES for the subsector that is specified with respect to that essential service in that Schedule.

Part 3, Section 10
The security duties of operators of essential services
10.—(1) An OES must take appropriate and proportionate technical and organisational measures to manage risks posed to the security of the network and information systems on which their essential service relies.
(2) An OES must take appropriate and proportionate measures to prevent and minimise the impact of incidents affecting the security of the network and information systems used for the provision of an essential service, with a view to ensuring the continuity of those services.

(3) The measures taken under paragraph (1) must, having regard to the state of the art, ensure a level of security of network and information systems appropriate to the risk posed.
(4) Operators of essential services must have regard to any relevant guidance issued by the relevant competent authority when carrying out their duties imposed by paragraphs (1) and (2).

2.2.6 Network equipment spares driver

As mentioned above we have purchased spares when LTB notices have been issued by the OEMs.

[redacted]

2.2.7 Our investment plan aligns with Network Rail and ORR approach

Network Rail operate a fixed telecoms network (FTN), comparable in scale and complexity to OpTel, with over 800 network nodes GB wide and 19,000km of fibre, and the below section summarises how their strategy of timely refresh of end of life telecoms assets is consistent with ours and accepted by their regulator the ORR. Network Rail's Telecom Strategic Plan 2019 p5 states their rationale for ongoing investment in the refresh of their FTN as:

"Significant numbers of our route-based assets and infrastructure pre-date CP4 [2009] which, in telecoms technology lifecycle terms, means that they are operating beyond their designed life, are obsolete (no vendor support) and are becoming prone to increased risk of failure. We therefore need to refresh and upgrade these assets and take a smarter system engineering approach. *This will reduce complexity and cost whilst driving standardisation throughout the national network and support Network Rail's strategic plans*[4]*."*

Further to this, their regulator the Office for Road and Rail ORR, said in the 2018 Final Determination of Network Rail's costs, Section 2.61, p38, that they had accepted and used the assumption proposed by Network Rail that ***"new telecoms may typically have an asset life of***

15 years so would age by 1/15 (6%) every year" for composite sustainability index calculations[11].

Further to this, an ORR review of 5 of Network Rail's CP4 telecoms schemes in 2013 found that ***"in most instances, the telecoms renewals were driven by end of service life, product obsolescence and limited manufacturer support"*** *(p115 Table 10.3.4 Row 3)* and concluded about the 5 project scopes that ***"the telecoms schemes reviewed were necessary for the routes to deliver the required performance to support operational need."*** *(p119 Table 10.4.1 'Project Scope' row).*

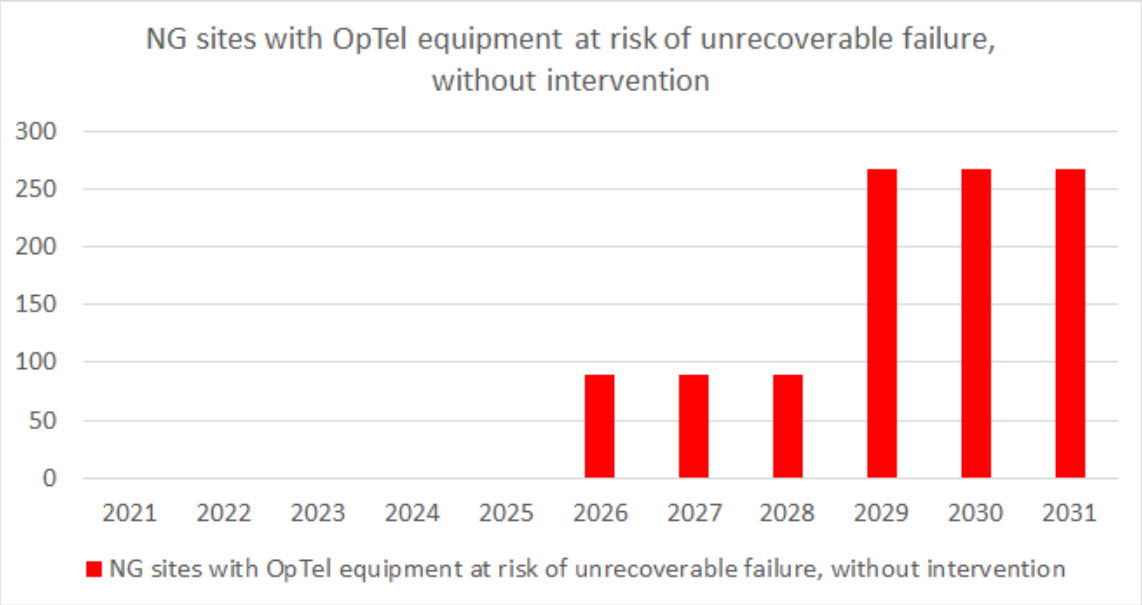
Part A Reporter Mandate AO/026: Application of CP4 Asset Policies, Section 10 - Asset Specific Findings – Telecoms[12]

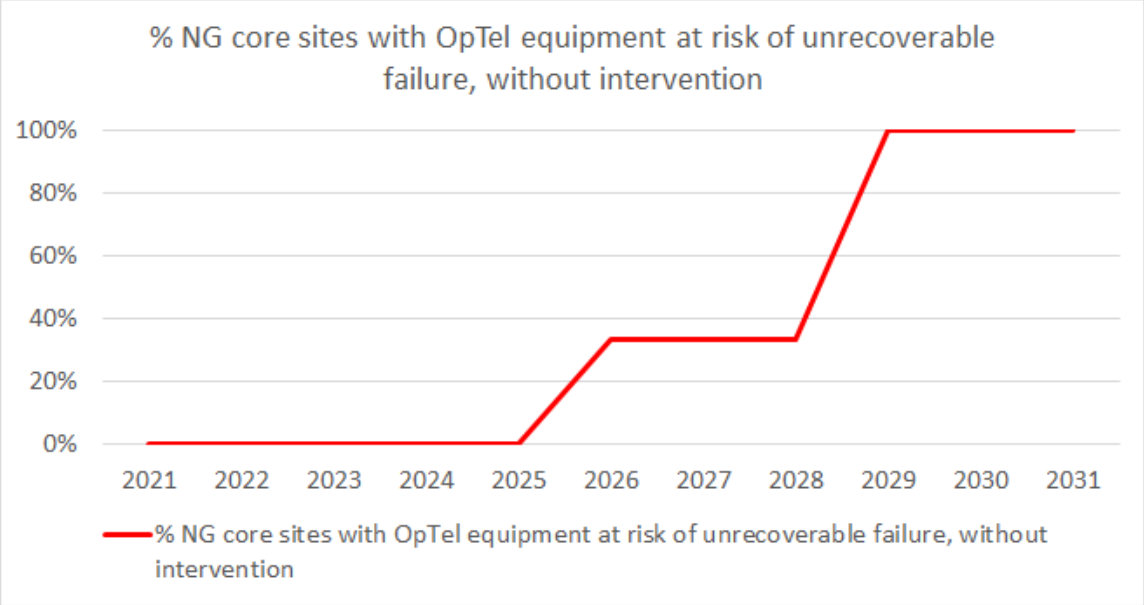
National Grid's approach, in refreshing OpTel before the oldest components are 15 years old by the end of T2, and in good time ahead of the end of vendor support and obsolescence dates as detailed earlier, in order to meet the operational need, is therefore supported by Network Rail's approach in managing a comparably complex CNI fibre telecoms network and accepted by their regulator the ORR.

2.3 Network refresh timing justification

2.3.1 Onset of unrecoverable failure risk

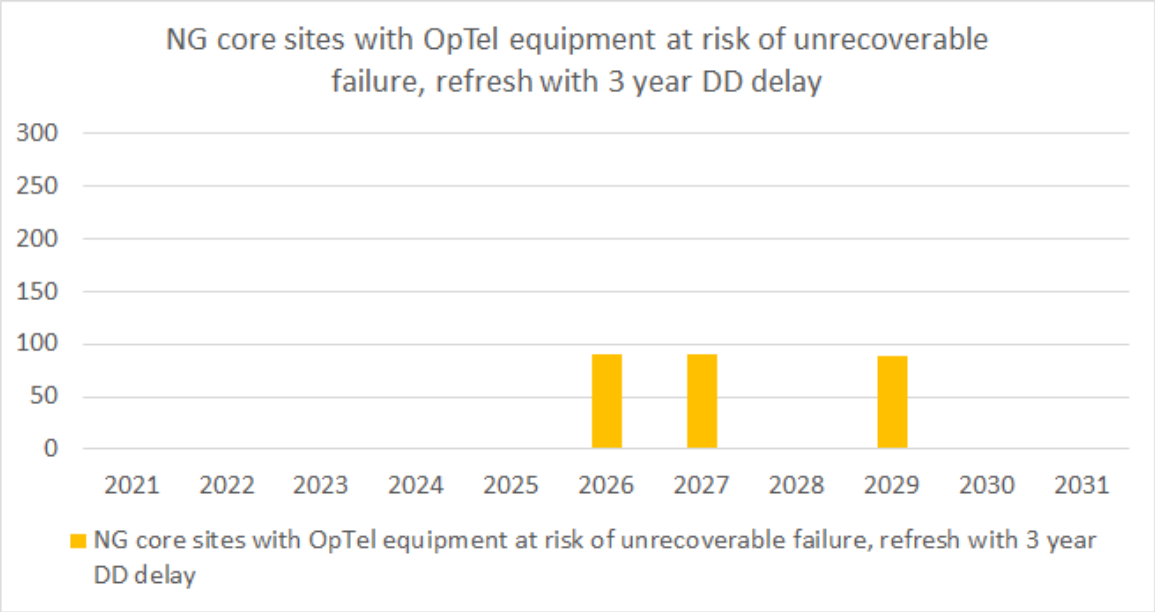
Without a timely network refresh, the number of sites at risk from unrecoverable loss of OpTel equipment grows rapidly in large steps as populations of equipment transition beyond their end of life & support date. This is principally because the two largest OpTel Equipment asset populations, 561 ABB MUX and 159 Ericsson OMS, are spread across 274 core network sites. By considering the last end of support dates achievable for these two sets of equipment and their management systems, the chart below shows that 100% of the core network becomes exposed to risk of unrecoverable failure over only four years, and that 90 sites (34% of core network) are operating at risk by the end of T2.

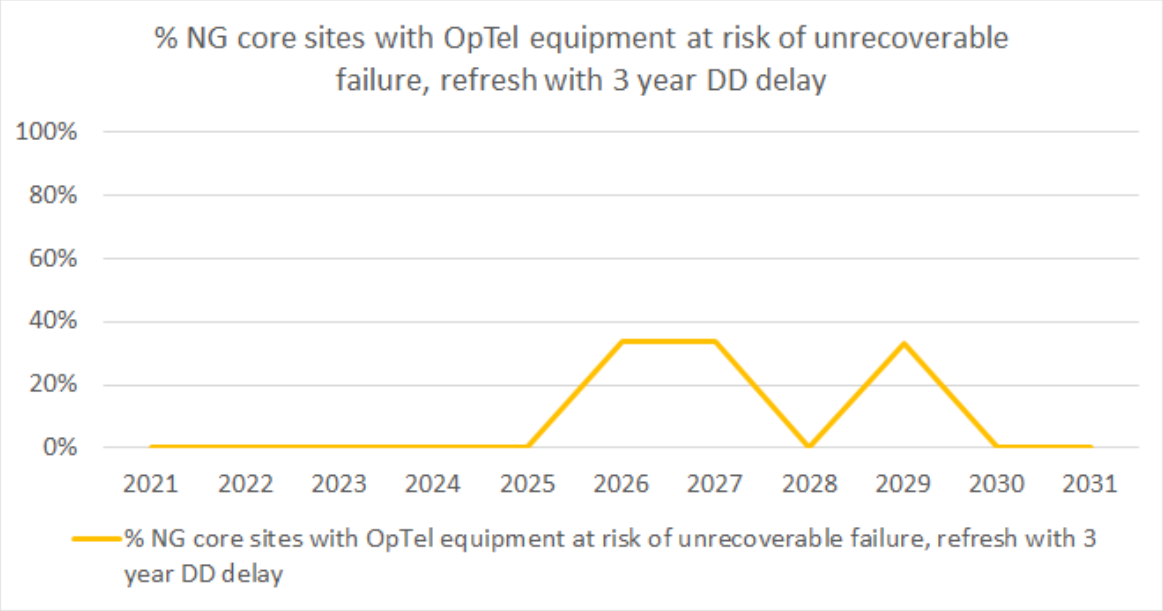




The OpTel network refresh we propose mitigates this risk by beginning the process of specifying, procuring and replacing the obsolete components before this onset of risk in the most efficient timescale. As explained further in section 2.3.2 below, the critical path for the refresh is 4 years from the project start to first service transfer and then 3-years to complete the transfer, considering procurement timescales, protection depletion restrictions, and specialist staff constraints.

In the Draft Determination, Ofgem proposed reduced funding for the refresh and deferring the start to 2024, meaning a 3-year delay compared to our proposed solution. By applying the 7-year critical path, but delaying the work by 3-years, the following risk profile is introduced:





A 3-year funding delay means that equipment and systems cannot be replaced fast enough to control rapidly emerging risk in 2026. Up to 90 sites (34% of core network) would be operating at risk of unrecoverable loss in 2026 and 2027, with a further 89 vulnerable in 2029, with the network exposed to unrecoverable failure risk over a 4-year window. The high proportion of the network simultaneously at risk means there is a risk of UK wide electricity grid collapse by cascade failures of OpTel. This could be triggered by software vulnerability and exposures that are no longer maintainable due to the obsolete state of the technology after the end of extended support date.

The OpTel network further comprises a range of smaller populations of other equipment and services with a range of LTB and EOS dates, that compound the risks outlined above. A list of

these assets is provided in the Appendix 5.3 below. We apply the same principles of negotiating extended support contracts and managing obsolescence through spares and repair loops to minimise cost to consumers for these other assets, bundling their timely refresh with the main equipment refresh to ensure we make best use of outages and limited specialist resource for efficient delivery.

The failure risks outlined above are mitigated by our proposed OpTel equipment refresh plan as per our December 2019 Final Submission, with funding from 2021 to ensure the network refresh can begin in time to traverse the shortest efficient critical path to safely remove unsupported equipment and systems from the network in T2 and T3.

2.3.2 OpTel equipment refresh project plan critical path

NGET High Level Project Plan:

NGET Proposed Project Plan

ID	Task Mode	Task Name	Duration	Start	Finish
1		Project Start	0 wks	Mon 05/04/21	Mon 05/04/21
2		Optel network (OMS/FOX) RFI dossier	5 wks	Mon 05/04/21	Fri 07/05/21
3		Overlay network (OvN)RFI dossier	5 wks	Mon 05/04/21	Fri 07/05/21
4		Optel network (OMS/FOX/OvN) RFI	8 wks	Mon 10/05/21	Fri 02/07/21
5		Optel network (OMS/FOX/OvN) review	4 wks	Mon 05/07/21	Fri 30/07/21
6		Optel network (OMS/FOX/OvN) RFP dossier	4 wks	Mon 02/08/21	Fri 27/08/21
7		Optel network (OMS/FOX/OvN) RFP	20 wks	Mon 30/08/21	Fri 14/01/22
8		Contract negotiation / award	36 wks	Mon 17/01/22	Fri 23/09/22
9		Contract award	0 wks	Fri 23/09/22	Fri 23/09/22
10		OMS/MUX/OvN Procurement	48 wks	Mon 24/10/22	Fri 22/09/23
11		Project team mobilisation and detailed planning	48 wks	Mon 26/09/22	Fri 25/08/23
12		Submit Depletion requests	1 wk	Mon 16/01/23	Fri 20/01/23
13		Project deployment start	0 wks	Fri 30/06/23	Fri 30/06/23
14		Optel network project deployment and planning	156 wks	Mon 10/04/23	Fri 03/04/26
15		Service transfer	0 wks	Fri 07/02/25	Fri 07/02/25
16		Service (depletion) transfer/cutover	156 wks	Mon 10/02/25	Fri 04/02/28
17		Equipment recovery	48 wks	Mon 28/06/27	Fri 26/05/28
18		Project Conclusion/handover	4 wks	Mon 29/05/28	Fri 23/06/28

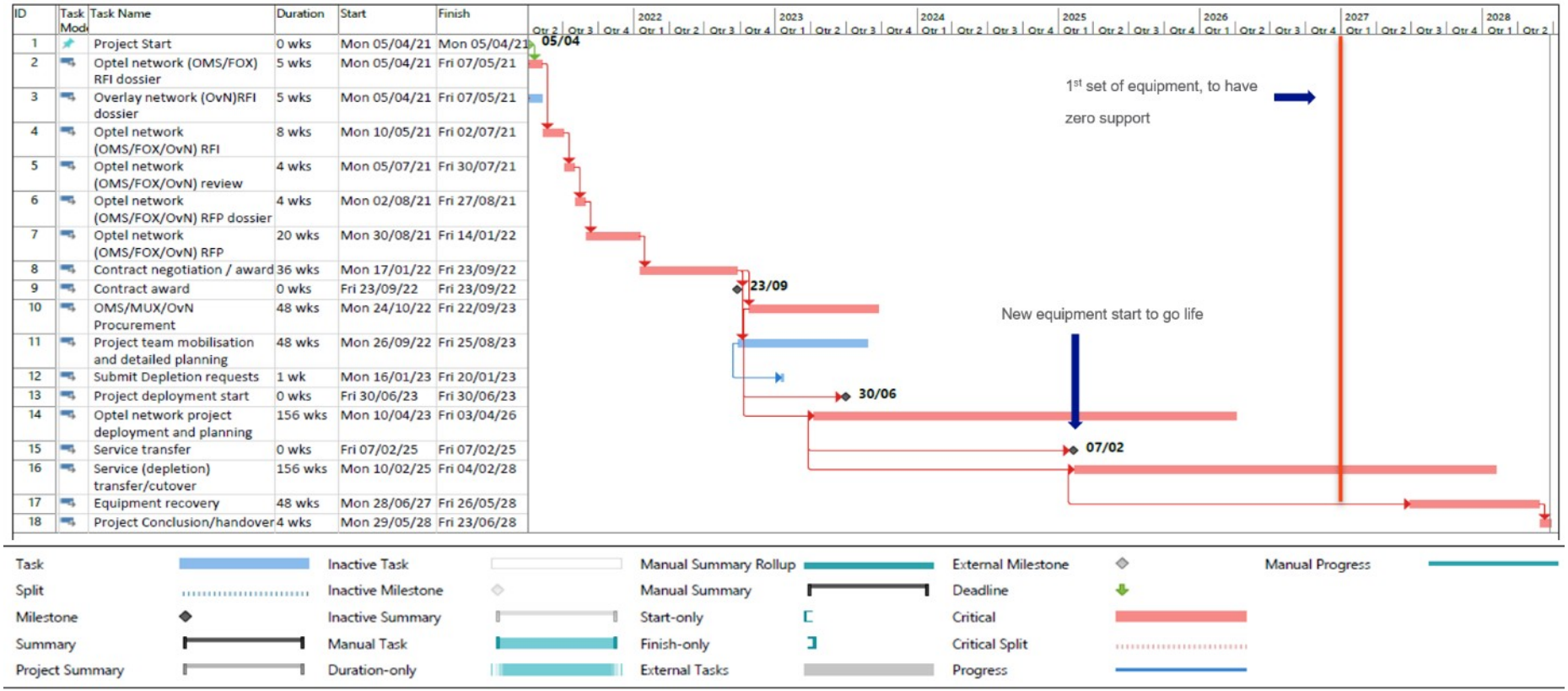


Figure 1 NGET high level project plan

NGET project plan “Figure 1” considers the age of the critical core equipment and NGET ability to continue to mitigate against the increase in risk profile.

There are three milestones in the plan, milestone one ‘contract award,’ milestone two ‘project deployment start,’ and milestone three ‘transfer of services.’ The activities leading to contract award, include, request for information (RFI), reviews, request for proposal (RFP), and contract negotiation. These activities represent the period NGET will review the various solutions put forward from the participating OEM and vendors, select and agree on the best solution that gives the best value and proceed with the legal procurement and type approval process.

The activities between milestone one and ‘project deployment start’ are the project planning team mobilisation and the submitting of depletion request, the planning team is tasked with working out the intrinsic details of the project work packages based on the final solution selected during the RFI and RFP stages. This plan will show the order in which the new equipment will be installed and commissioned (based on network topology, site and substation), the order in which the services that require protection depletion will be cutover to the new equipment, (based on new OpTel network design, resilience and safety) and the order in which the obsolete equipment will be removed. Although the depletion request is made formally between 18 to 24 months before the first service cutover, discussions with the ESO starts from the onset of the planning stage. The project planning team remains in place and transitions into a larger planning team with the achievement of milestone two.

The third milestone “transfer of services” marks the first services to be cutover to the new equipment based on the depletion request being approved. As services are cut-over a period is given for stability tests. The project concludes with the retrieval and careful recycle/disposal of the old equipment and finally the project conclusion and final handover to operations. The nature of the project work packages is such that most of them are within the project critical path, which means timely execution of each work package is critical. The periods assigned for each work package are in line with best practices and have taken into consideration various constraints within a project of this size. Constraints such as optimal use of our SAP (senior authorised person) Engineers with telecommunication expertise, procurement of equipment following regulatory guidelines, and limitation to how many protection depletions we can take at the same time, have all been considered.

NGET current project plan would see service transfer completed in 2027 and project final completion in 2028 with the removal of all obsolete hardware and software, ensuring we can decommission the first set of equipment that will have a December 2026 ESE date, on time.

OFGEM proposed project start:

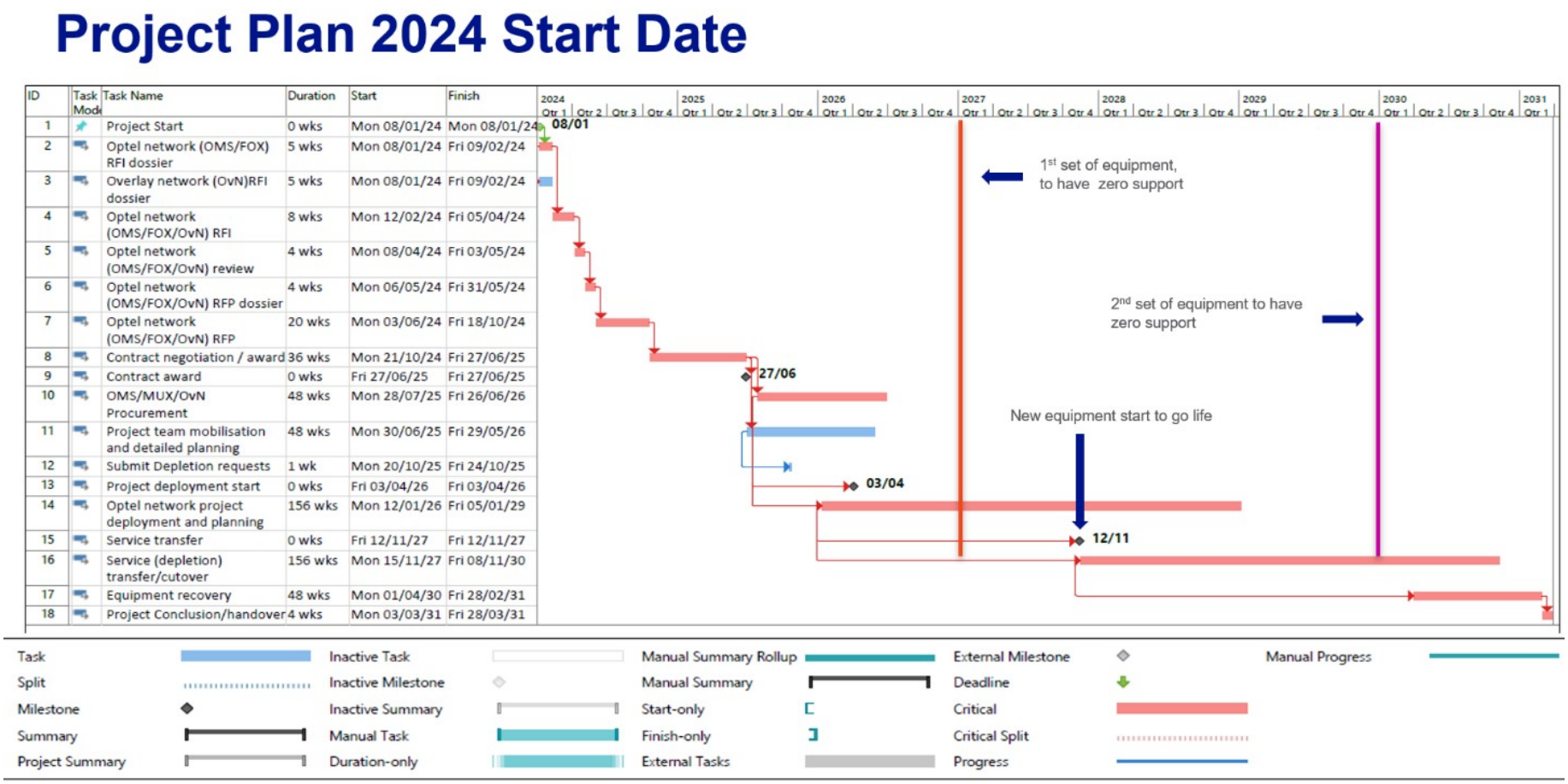


Figure 2 OFGEM Proposal for a 2024 Start Date

OFGEM has proposed we start in 2024, NGET has looked at the effect of a shift in the start date to 2024 as shown in “Figure 2”. Following the project critical path, the earliest time we can complete the project will be August 2031, and we will have the first set of equipment to go beyond the ESE date in the network for a minimum period of two years before all of them can be decommissioned. The second set of equipment will remain in the network beyond their ESE date for a minimum of a year before they can all be decommissioned, when combined NGET transmission network will be at unacceptable risk levels for about four years. The implication to NGET is we would have equipment with software that is vulnerable to cyber threats and hardware that is end of life with elevated failure risk that have to be kept on the network for three years with zero guarantee we can mitigate against the thousands of threats that are likely to exist within the three year period, increasing the risk of unrecoverable software and hardware failures.

It is therefore paramount for NGET to start this project in 2021 as proposed in its plan to avoid the possibility of operating the electricity transmission network with equipment which is vulnerable and exposed to cyber risks.

2.3.3 ESO outage engagement for Network Refresh and High Bandwidth Overlay refresh outages

Draft Determination feedback from Ofgem raised the issue of engagement with ESO around the necessary outages to deliver the network refresh and the high bandwidth overlay. The outages required for the network equipment refresh and the high bandwidth overlay are different to those needed for the fibre wrap replacement programme. Fibre replacement is done without replacement of the equipment at each end of the fibre, and equipment replacement can reuse existing fibre links. This means the network equipment refresh can be done independently of the fibre wrap replacement programme.

During the last OpTel refresh we engaged with the System Operator (ESO predecessor) to negotiate the fastest OpTel service transfer rate that could be delivered without risking disruption to the operation of the GB transmission system. We have based the submitted plan on the same service transfer rate of 3 years for the 1600+ OpTel services. We considered a faster service transition rate than 3 years but rejected it on the grounds that it would be undeliverable with the expected available control room and operational resource and the procedures in place for safe operation of the network, would be using an unproven approach for a highly complex CNI infrastructure refresh and therefore would put the Transmission system at elevated risk of disruption.

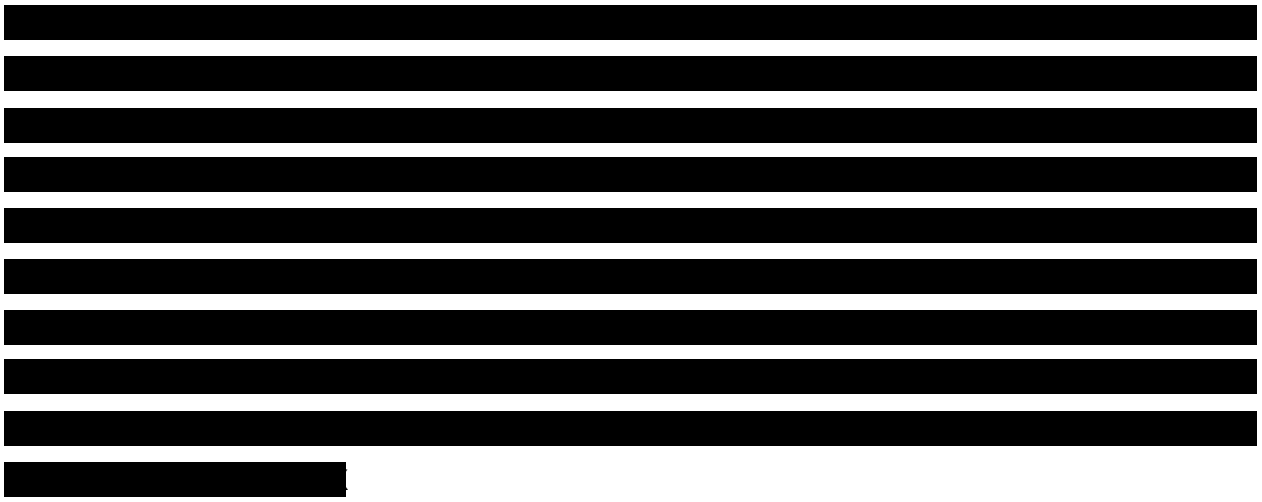
NGET and National Grid IT Engineers have and will continue to engage with ESO Engineers as the OpTel refresh is designed and procured in the first years of T2 in good time ahead of outage planning for service transfer. Due to the submitted equipment refresh plan not requiring any outages until 2025, and because for shorter timescale operational reasons the OpTel outage plan is agreed with ESO one year ahead then we will continue to engage with ESO over the next two years before formally requesting equipment refresh outages in 2023. Additionally, the outages required for the OpTel network equipment refresh are not high-voltage (HV) outages, these outages are protection depletion outages typically requiring much less lead time for approval. The planning for depletion outages requests and the order in which they are required is catered for in the detailed planning stages.

As explained further in Section 2.4 below, the high bandwidth overlay is most efficiently delivered for consumers by making use of the same outages as those for the network equipment refresh, and so for the same reasons as above it is not necessary to engage with ESO yet on outages, although we continue to engage with ESO on the design of the overlay.

2.4 High Bandwidth Overlay Justification and Deliverability

During the RIIO T2 period changes in asset management techniques and the evolving response to the cyber threat in the operational technology (OT) space will drive a dramatic increase in the volumes of data carried by our OpTel network. This additional data demand will both enable risk-based asset management vital to driving ever more efficient operations and also provide 24/7 cyber monitoring of all devices in the operational estate. In order to deliver a scalable solution capable of meeting the growing data need, we propose to invest £19.8m during T2 in building a high bandwidth overlay that can scale with this demand. This high bandwidth overlay is needed to replace the ageing Ericsson OMS equipment that currently provides ethernet bandwidth connectivity to the backhaul (see section 2.2.1) and, in addition will deliver a modern scalable bandwidth overlay network.

By leveraging the existing infrastructure and support arrangements this capability can be delivered with very low incremental operational cost if it is procured and delivered at the same time as the proposed OpTel network refresh from 2021.



If the proposed network refresh from 2021 is not leveraged to also provide the high bandwidth overlay then new and separate network infrastructure to meet these requirements for remote access and system monitoring will be needed. The additional cost differential to provide this new infrastructure separately is approximately £13m more than by using additional bandwidth provided by the OpTel network refresh.

Investing in a separate scalable modern high-capacity overlay network that uses existing OpTel fibre paths, ensures significant needed high bandwidth packet-based capacity can be enabled.

This capacity is required to support legacy requirements, the increases in demand for current OpTel services and the introduction of new electricity network management and monitoring technologies.

As at 2011 when the first of this equipment was being installed the network Ethernet bandwidth requirements were meagre compared to today and future requirements as the GB energy system continues to evolve into a smart, flexible, data driven low carbon network. At the time of the last OpTel refresh it was the cheaper solution to use an integrated multiplexer (OMS) as is the current design to deliver the former bandwidth requirement. However current advancements in technology and the increase in our bandwidth requirements mean that it is cheaper (Gb/£) to have these functions separated as an independent (i.e. overlaid) bandwidth network, additionally making it easier and cheaper to expand as the need arises in the future once the High Bandwidth Overlay is in place. Aside from the cost (Gb/£), ease of expansion and modernisation, there is only one reliable OEM that still offers a product comparable to the OMS (Ericsson /Marconi have ceased development and production of this line of equipment) which could lead to vendor-lock-in and expansion/modernisation complexities if we adapted the same solution. We have therefore proposed to build a modern, expandable bandwidth overlay network at the same time as the Ericsson OMS are being replaced in the main network refresh.

Increased Network Capacity

While volumes of data in everyday life and across business have been rising at ever increasing rates, the data requirements in operational electricity networks such as OpTel have remained stable in more recent times. Telecommunications protocols and the types of data transmitted have been largely unchanged in the electricity transmission network with only moderate growth generated by new substations.

This stability in the data requirement is starting to change rapidly with new requirements driven by Cyber monitoring of the Operational Telecom estate, video imagery for physical security (PSUP), increased use of condition monitoring driving an increase in automated sensors and introduction of new technologies to provide enhanced situational awareness for control rooms such as phasor measurement units (PMUs), which can be used to monitor dynamic events on the network and to assess power quality. In addition to these new services, the digitisation of the workforce creates greater demand on corporate networks connecting employees with e-mail, collaboration tools and video conferencing tools. Access to company intranets and the wider internet are also a vital part of enabling employees to work effectively across the 300+ sites and are a key enabler for our future digitalisation strategy.

One option to meet the demands of the increasing data is to simply increase the size of the bearers connecting the telecommunications nodes in the network. Whilst this is technically possible, it is not considered desirable as it would inevitably lead to a mix of operational and non-operational traffic, increasing potential cyber threats to CNI assets and operational services.

Our preferred solution is to engineer a high bandwidth data overlay that is capable of scaling with demand, logically separated from operational traffic but leveraging the infrastructure we have built to support the electricity transmission network. This enables us to achieve maximum utilisation from our existing assets while providing protection from the cyber risks presented in mixing traffic, thereby delivering essential services at efficient costs for our customers and stakeholders.

2.4.1 Supporting case study: RTE Project Inuit

RTE (the equivalent French TO) have previously invested heavily in fibre infrastructure to support improved Teleprotection for their HV network. To support a range of emerging requirements for high-bandwidth, packet-based services, RTE identified the same solution as us and are currently rolling out an overlay network which will provide high capacity IP/MPLS links at up to 650 sites. The key benefits they identified in deploying the bandwidth overlay solution were Capex and Opex optimisation of their existing telecoms network by complementary replacement of end of life technologies and services:

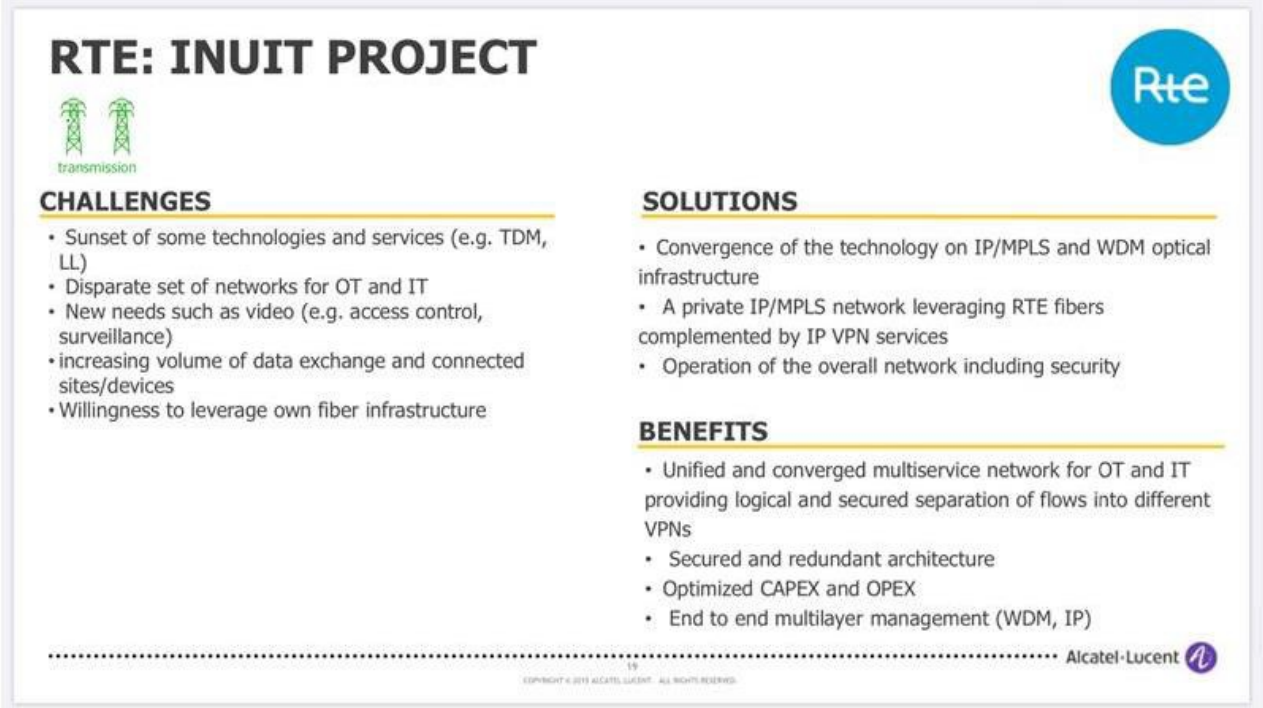


Figure: Summary of RTE's High Bandwidth Overlay solution[13]

Further information on RTE's solution which has been procured, designed and delivered from 2013 onwards:

Duration in years: 10

Information on the framework agreement

II.1.4) RTE, is in charge of the high and very high voltage electricity transmission network in France (100,000 km of circuits and 45 cross-border lines), which supplies the whole of France and provides interconnections with neighbouring countries.

To support the evolution of its telecommunications needs, **RTE plans to set up a unified IP network (INUIT network: single telecommunications integration infrastructure), relying on different types of media, owned by RTE or operated externally. At the target, this network will carry telecommunications flows carrying applications of an industrial nature relating to the maintenance and operation of the electricity network, and tertiary information transmission uses (voice, video, etc.)**. The future network could be opened up to other uses, the needs of which are not yet known.

RTE is an operator of vital importance. As such, RTE's telecommunications network contributes to the strategic dimension of its activity, by the nature of the flows that are routed and the sites that will be served.

This consultation takes the form of 3 lots:

- Lot 1: **supply and deployment of a private IP-MPLS network (based on RTE's existing optical infrastructure), an interconnection of IP networks, LAN in the sites concerned, integration, operation and administration of the entire INUIT network;**
- Lot 2: Provision of operated IP services;
- Lot 3: Provision of a point-to-point link service operated for the needs of remote protection of the electricity network.

https://centraledesmarches.com/marches-publics/Paris-La-Defense-Cedex-RTE-Reseau-de-transport-d-electricite-Projet-INUIT-Realisation-d-une-infrastructure-de-telecommunications-unifiee/765431 (in French)

2.5 Control Telephony Justification

Control Telephony provides independent voice telephony for operational personnel at NG sites, control centres, power stations and DNO & Scottish TO control centres. It is designed to continue working during extended mains power failure to enable operational personnel to manage power system restoration including Black Start and is essential to managing the assurance of electricity supply and demand. The current network is built on the OEM Cisco and IP Trade products.

a. Hardware: The current cisco hardware family (3945 and 3560) has a published EOL date of 9th September 2016. End of sale date is 9th December 2017. As previously communicated the last day of hardware support for these group of cisco equipment's is the 31st of December 2022. The BE6H/m and BE7H have a hardware end of support date of June 2023.

[redacted]

The list of equipment and their OEM announced end of support dates are given below in appendix 5.4. NGET will need to upgrade, update and modernise the control telephony system within RIIO-T2. We therefore propose to invest £8m on Control Telephony during T2 and a further £4m in T3.

2.6 Improved Comms Links Justification

The OpTel network standard[2] for communications link performance is 6ms, however approximately [redacted] of protection services currently have a legacy concession where 6ms latency cannot be achieved whilst preserving the required path separation. As the electricity grid continues to evolve towards net zero with ever more variable supply and demand patterns and a loss of system inertia there is a reduction in system tolerance to concessions in fault clearance time. Therefore, we plan to invest £3m over T2 in the minimum number of additional fibre routes that are required to allow reconfiguration of OpTel for certain Teleprotection routes and eliminate the most pressing of these performance concessions.

We attach in appendix 5.2 a list of the current OpTel links with the performance concession. NGET

will in the first phase make priority the operational tripping system (OTS) links in the list, which constitute [redacted] of the links, followed by a second phase targeting another [redacted] of the non-OTS links that are the worst offenders in terms of delay.

2.7 Improved Physical Security Justification

[redacted]

[redacted]

3. OpTel refresh efficient costs justification

As discussed in Section 2.3.2 above, the activities leading to OpTel refresh contract award, include, request for information (RFI), reviews, request for proposal (RFP), and contract negotiation. We are committed to delivering the OpTel network equipment refresh at the most efficient cost to energy consumers, and we have therefore taken, and factored into our December 2019 Final Submission funding request, the following steps to drive efficiency in the procurement, design and delivery of the OpTel refresh:

Ahead of the RFI, we have already commissioned a market research project from telecoms specialist consultant Wavestone, to report in 2020 Q4, building on their earlier OpTel analysis (see Investment Decision Pack A10.09A – Wavestone Report) to consider and identify the leading suppliers, technologies, delivery models that the OpTel refresh could use from the market today. This project will provide NGET with the information needed to prepare (in-house) a targeted RFI and agree clear OpTel refresh parameters with NGET, ESO, NG IT, IS and Security stakeholders.

By preparing this targeted RFI, and subsequent RFP, we will focus the procurement process on challenging suppliers to deliver agile, efficient and synergistic solutions (with our wider T2 IS investments across all CNI areas) to meet the refresh parameters.

The pre-RFI work will also consider which elements of the OpTel managed service, maintenance framework agreement and proactive network monitoring can be brought in house and the lifecycle cost savings of these approaches against the RFI/RFP proposals.

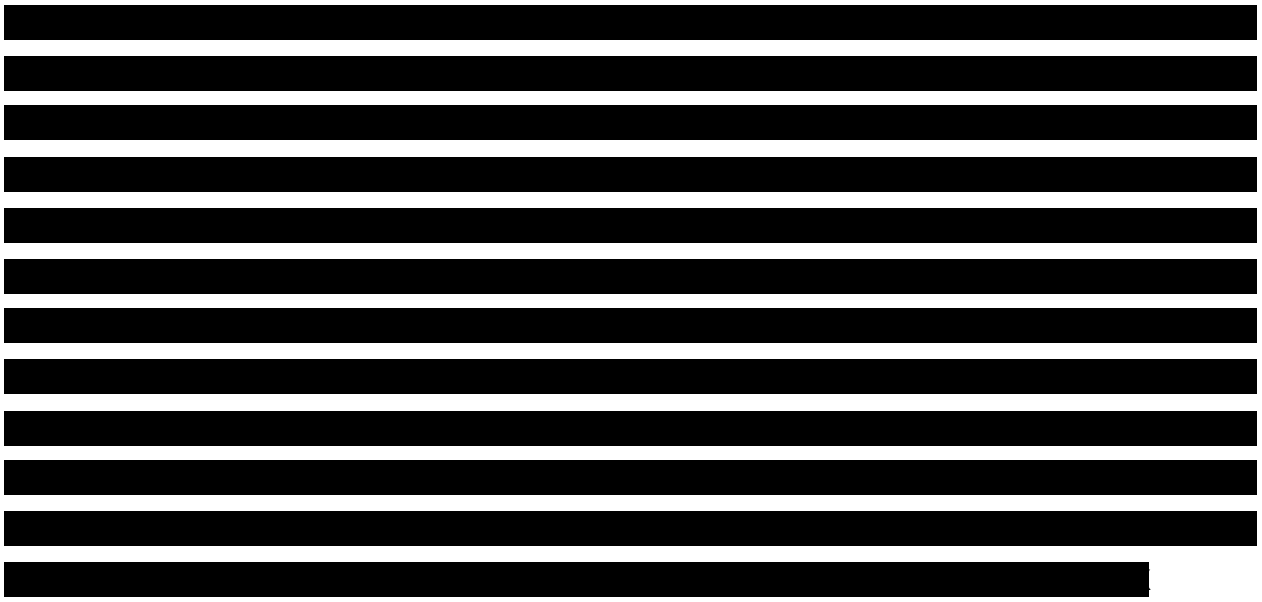
Further, there is an obligation under the Official Journal of the European Union (OJEU) Procurement Law[14] and the Utilities Contracts Regulations 2016 on NGET to procure OpTel and other CNI IS services now rather than further extend existing supplier contracts due to the long incumbency of Vodafone as monopoly supplier.

Historically the various NG CNI telecoms systems, including OpTel, has been refreshed and re-contracted in a piecemeal approach due to each managed service or framework agreement having different start and end dates. There is a unique opportunity at the start of T2 to align the refresh of multiple telecoms systems including Optel, to drive synergies to the benefit of the energy consumer. For example, by aligning the OpTel refresh with the others from 2021 we will be able to split the refreshes into a wider range of smaller packages, which can be selectively bundled by suppliers in their RFP proposals. This will open the OpTel procurement framework to a wider range

of suppliers, driving competition and innovation in the OpTel refresh solutions put forward. NGET through this process will simplify contract landscape, operating models and delivery, whilst avoiding vendor dependency/lock-in, creating a unique opportunity to set technology strategy with the future in consideration and introduce savings for the consumer.

The 3-year delay to OpTel refresh funding proposed by Ofgem would unintentionally exclude OpTel from this opportunity for a timely wider bundled procurement process in 2021 with stronger competition driving down costs, leading to poorer value for energy consumers being realised in an OpTel-only RFP three years later.

We have also terminated and removed all Vodafone commercial traffic use of the OpTel network over the last 3 years, to ensure that the procurement of the OpTel refresh is not encumbered by legacy commercial contracts, and there is no commercial interest to impede selection of the most efficient cost refresh solution for energy consumers.



The T2 OpTel network refresh costs were derived from the outturn cost of the last refresh, but inflation was not applied, and this refresh will deliver the additional capabilities as detailed in the Optel NGET_A10.08_OpTel Refresh investment decision pack. We therefore believe the submitted costs are already challenging and incentivise NGET to leverage the opportunities for efficient costs we identify in this section.

4. Further CBA Analysis

This section supplements and should be read in conjunction with the Optioneering and CBA chapters of the NGET_A10.08_OpTel Refresh document, pages 9-15.

Refreshed CBAs have been prepared to examine the options for OpTel telecoms network asset refresh and the provision of additional network capacity. These CBAs may be found in accompanying CBA02_revised and CBA03_revised files. Estimated costs have been included for the range of options, however benefits and avoided costs have not been included, enabling the CBA to be used as a net cost comparator.

The tables below summarise the CBA output.

Telecoms Equipment (CBA02_revised)

	Option	NPV @ 2.9%
1	Baseline – Do Nothing	
2	Preferred solution – Replacement	
3	Leased equipment	
4	Replacement with 3 year delay (as per Draft Determination)	

Option 1, the do-nothing option is 'fix on fail', which is not an acceptable option for a CNI network, and would necessarily lead to roll over and extension of monopoly supplier contracts which is incompatible with UK Procurement Law.

Option 2, the preferred solution, is for timely and efficient replacement according to the principles we set out in Section 2.0 above and offers best value to the energy consumer.

Option 3, leased telecoms equipment, is a more costly solution, requiring the construction, installation, integration of a third party owned hardware and software. Such solutions are unlikely to be secure, flexible and agile enough to be suitable for CNI applications, and are costly to make changes to as requirements change over time.

Since our Final Submission in Dec 2019 we have also considered one further option:
Option 4, Ofgem's Draft Determination proposed 3 year delay to OpTel refresh funding. The loss of the procurement synergy to drive innovation and competition, and loss of opportunity to transition to new technology platforms shared by other CNI systems is estimated to increase refresh costs by 10%. This leads to a worse NPV for a delayed refresh and further, this NPV does not include the cost to energy consumers of disruption to the GB transmission grid due to an unreliable unsecure network operating 3 years beyond end of life, or the cost to the UK of GB grid collapse through cascade failures in the worst case.

Additional Network Capacity (CBA03_revised)

	Option	NPV @ 2.9%
1	Baseline – Do nothing	
2	Preferred Solution – High bandwidth Overlay	
3	Lease of additional capacity	
4	High bandwidth Overlay with 3 year delay (as per Draft Determination)	

Option1, the do-nothing option would not deliver the required bandwidth and lead to inefficient working at NG sites with insufficient bandwidth. NGET would be unable to deliver the enhanced remote security and system monitoring expected by both BEIS and ESO stakeholders.

Option 2, the preferred solution, of a high bandwidth overlay, is the most efficient solution to provide increased bandwidth network capacity by achieving maximum utilisation of existing OpTel assets while providing protection from the cyber risks presented in mixing traffic, thereby delivering essential services at efficient costs for our customers and stakeholders.

Since our Final Submission in Dec 2019 we have also added two further options:
Option 3, lease of additional capacity from commercial telecoms network providers across the OpTel network. This option has the worst NPV and worst value for energy consumers.
Option 4, Ofgem's Draft Determination proposed 3 year delay to OpTel refresh funding. This would also delay the deployment of the high bandwidth overlay by 3 years and require NGET to incur the do nothing costs of option 1 for those 3 years until a high bandwidth overlay is built. Leasing additional capacity for 3 years instead would yield an even worse NPV.

Summary

As outlined earlier, the current equipment is increasingly unsupported and at end of life, meaning that asset replacement is required within the T2 period and the preferred options provide the most efficient solution to maintain the network and deliver the increased capacity that is required to meet future demand.

5. Appendices

5.1 Network equipment populations:

	Asset	Qty
1	ABB Fox 515	505
2	ABB Fox 512	56
3	Ericsson OMS 1654	88
4	Ericsson OMS 1684	7
5	Ericsson OMS 846	64
6	Transmode (Infinera) TM102	44
7	Exfo OTDR	84
8	CISCO ASA5525	4
9	CISCO ASR1002-F	4
10	CISCO 2811	6
11	CISCO 2901/K9	77
12	CISCO 2911/K9	26
13	Ruggedcom RX1100	36

5.2 List of OpTel links with performance concessions

5.3 List of other network equipment

Asset	End of Sale	End of Support	Comments
ABB Fox 515	May-2017	May-2024	Likely to extend to May 2027
ABB Fox 512	May-2017	May-2024	Likely to extend to May 2027
Ericsson OMS 1654	Oct-2014	Jul-2019	3rd party repair loop available
Ericsson OMS 1684	Oct-2014	Jul-2019	3rd party repair loop available
Ericsson OMS 846	Oct-2014	Jul-2019	3rd party repair loop available
Transmode (Infinera) TM102	Still available	Still in support	
Exfo OTDR	Apr-2019	Reasonable Endeavours	
CISCO ASA5525	Still available	Still in support	
CISCO ASR1002-F	Oct-2012	Jul-2017	
CISCO 2811	Nov-2011	Oct-2016	
CISCO 2901/K9	Dec-2017	Dec-2022	
CISCO 2911/K9	Dec-2017	Dec-2022	
Ruggedcom RX1100	Oct-2015	Oct-2024	

5.4 List of Control telephony equipment

Description	Type	Qty	In service	End of Hardware Support
IP Trade - Turrets	T4 v2	93	2017	Not yet announced
IP Trade and Cisco Servers	BE6H-M4-K9	4	2017	Jun-2023
IP Trade and Cisco Servers	BE6M-M4-K9	6	2017	Jun-2023
IP Trade and Cisco Servers	BE7H-M4-K9	8	2017	Jun-2023
IP Trade and Call Manager Routers	C1-CISCO3945/K9	32	2017	Dec-2022
IP Trade and Call Manager Switches	WS-C3560-48FS-L	10	2017	May-2021
Substation Routers	ISR4351/K9	143*	2018-2020	Apr-2025
* Qty Sites installed to date, 88 more sites to be installed in 2020. 284 Routers in Total				

5.5 BPDT References

Note the profile for Fibre-wrap replacement has been revised and is included in Section 4 – Implementation Plan and Costs of document NGET_A10.08_OpTel Refresh_DD Update_ Fibre.

The cost profile for Telecoms equipment replacement remains unchanged, and is included in Section 2 of this document, NGET_A10.08_OpTel Refresh_DDUpdate_Telecoms.

RIIO-T2 Business Plan Data Template
National Grid Electricity Transmission
Workbook C: Non Load
Version 1.9 - Submitted on 09 Dec 2019
Sheet: C2.25 Operational Protection Measures & Op IT Capex
Prices Base: 2018/19

By category type
Protection Communication Circuits - Replacement
Protection Operational Measures
Infrastructure enabling

The table below is an extract from BPDT C2.25 Operational Protection Measures & Op IT Capex

		RIIO T2					RIIO > T2						Total		
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	>2031	RIIO T1	RIIO T2	RIIO > T2
Operational IT & Telecoms Capex		£m	£m	£m	£m	£m	£m	£m	£m	£m	£m	£m	£m	£m	£m
Scheme Referer	Comments														
Optel T2 Refresh	High Speed Bandwidth Overlay	1.000	10.000	8.800	-	8.000	4.000	-	-	-	-	-	-		
Optel T2 Refresh	Fibre Wrap Replacement	15.600	15.600	15.600	15.600	15.600	-	-	-	-	-	-	-	78.000	-
Optel T2 Refresh	Improved Comms Link	0.600	0.600	0.600	0.600	0.600	-	-	-	-	-	-	-	3.000	-
Optel T2 Refresh	Improved Physical Security	-	0.350	0.350	-	-	-	-	-	-	-	-	-	0.700	-
Optel T2 Refresh	Optel Network Refresh	1.000	6.400	30.000	20.000	20.000	10.000	7.600	-	-	-	-	-	77.400	17.600
n/a	T1 Project	-	-	-	-	-	-	-	-	-	-	-	18.435	-	-

5.6 NG – Ofgem Bilateral Engagement - Clarifications

A bilateral session attended by National Grid, Ofgem and Atkins was held to receive feedback from Ofgem on their Draft Determination and to discuss NGET's revised approach for fibre-wrap replacement and broader requirements for telecoms equipment replacement.

A number of clarification points were agreed, and whilst these have now been incorporated in this document as supplementary evidence, they are set-out below for ease of reference.

Clarifications on Telecoms equipment replacement from 28th August 2020 meeting:

i) NGET to confirm dates for last Telecoms equipment refresh

We have clarified in sections 2.1 (page 8) and 2.2.4 (page 16) that although equipment was installed in 2014 the transition of all services to this equipment was not completed until 2018 in the last refresh. In the Executive Summary on page 3 we also explain that the submitted plan is for a 7 year refresh, 2 years faster than the last refresh (which took 9 years overall).

ii) NGET to provide a simple timeline setting out replacement timeline, to include support milestones

We have added in section 2.2 (page 10) a high level timeline diagram for the refresh, showing that it will take 7 years (4 years to design, procure and build, then 3 years to complete the service transfer to new network) to complete the critical path of the refresh by 2027 when the network would otherwise become at risk of unrecoverable failure. We go on to explain that last refresh took 9 years and we have applied lessons learnt from that refresh to reduce this refresh to a minimum of 7 years, beginning in 2021.

iii) NGET to provide a network topology overview, illustrating how components connect to provide systems and services

We have added in section 2.1 (page 7) a network topology overview showing the range and complexity of systems and services operated over each link of the OpTel network, to explain why it is not possible to simply isolate and replace an individual service without interruption to wider OpTel function. Our proposed 3 year service transfer in the 7 year refresh allows the coordinated migration of the interacting services without disruption of the normal operation of the GB transmission network. We have also added a reference on page 9 back to our December 2019 OpTel submission that explained why microwave links instead of fibre links were discounted as a permanent refresh solution.

iv) NGET to outline how the programme will be delivered efficiently, including learning from prior experience

We have added section 2.0 (page 6) to summarise the principles driving our refresh proposal; to deliver in time, to apply lessons learnt, and to drive efficiency through market competition. This ensures our proposals are cost efficient for the energy consumer. Section 3 (page 39) gives our efficient cost justification and explains how the principles were applied to minimise the refresh cost in detail and why starting in 2021 is critical to drive maximum value for energy consumers.

v) For the High Bandwidth Overlay (HBO), NGET to explain the distinction between high and low bandwidth services and include drivers for increased demand for high bandwidth capacity

We have added in section 2.4 (page 32) further justification and clarification for the High Bandwidth driver and function, and estimates of the data requirement and explained why this cannot be delivered by existing equipment. We have clarified the drivers of remote access monitoring, security controls, and system monitoring requirement for ESO. We have added that bandwidth requirements are forecast to require peak burst bandwidths of around 120Mbps in T2, and will continue to increase with the rapidly changing low carbon generation mix and increasingly active distribution networks across GB. The current OpTel network consists of legacy hardware that currently only supports approximately 12Mbps per site and has no support for burst bandwidth and so is not suitable. We have added the estimated cost differential of an extra £13m in costs if we do not leverage an OpTel refresh in 2021 to deliver the HBO.

vi) For Control Telephony, reference volumes of equipment to be refreshed

We have clarified in section 2.5 (page 36) that the volume of equipment are listed in Appendix 4.4.

Clarifications on Telecoms equipment replacement from 2nd September 2020 meeting:

1. Ofgem queried OpTel fibre ownership by Vodafone and stated that they would want it replaced.

We interpreted this to be a reference to previous Vodafone commercial traffic on the OpTel network. We have clarified in section 3 (page 39) of the paper that we have already removed all Vodafone commercial traffic from the OpTel network in order to clear the way for procurement of the most cost effective refresh and allow maximum market competition and innovation in the procurement process. The paper states that:

We have also terminated and removed all Vodafone commercial traffic use of the OpTel network over the last 3 years, to ensure that the procurement of the OpTel refresh is not encumbered by legacy commercial contracts, and there is no commercial interest to impede selection of the most efficient cost refresh solution for energy consumers.

Historically the various NG CNI telecoms systems, including OpTel, has been refreshed and re-contracted in a piecemeal approach due to each managed service or framework agreement having different start and end dates. There is a unique opportunity at the start of T2 to align the refresh of multiple telecoms systems including Optel, to drive synergies to the benefit of the energy consumer. For example, by aligning the OpTel refresh with the others from 2021 we will be able to split the refreshes into a wider range of smaller packages, which can be selectively bundled by suppliers in their RFP proposals. This will open the OpTel procurement framework to a wider range of suppliers, driving competition and innovation in the OpTel refresh solutions put forward. NGET through this process will simplify contract landscape, operating models and delivery, whilst avoiding vendor dependency/lock-in, creating a unique opportunity to set technology strategy with the future in consideration and introduce savings for the consumer.

The 3-year delay to OpTel refresh funding proposed by Ofgem would unintentionally exclude OpTel from this opportunity for a timely wider bundled procurement process in 2021 with stronger competition driving down costs, leading to poorer value for energy consumers being realised in an OpTel-only RFP three years later.

2. Ofgem stated that they accept the need for substation telecoms equipment but are concerned about the timing.

We have presented detailed arguments throughout the supplementary Telecoms paper to explain why the refresh needs to begin in 2021, the consequences for GB transmission grid reliability, security and operation if there is any delay, why 2021 presents the best opportunity for procurement synergies and innovation to minimise costs to the energy consumer. We have also explained why a refresh in 2021 is in accordance with best practice asset management, procurement law, and cyber security risk management principles of responsible CNI network owners, and how our approach satisfies the requirements of key OpTel stakeholders BEIS and ESO. We have explained how OpTel is fundamental to the safe reliable secure operation of the grid and why a 2021 refresh is essential to insure uninterrupted operation of GB transmission system in T2 and beyond.

6. References

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2 British Standard EN 60834-1 / IEC 60834-1 'Teleprotection equipment of power systems-Performance and testing.'

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13 'Summary of RTE's High Bandwidth Overlay solution'. Available: http://files.meetup.com/4360512/The%20future%20of%20smart%20grid%20power%20utilities_June_2015_YC_ISEA.pdf Accessed: [11-AUG-2020]14 'European & UK Procurement Regulations' https://www.ojeu.eu/Directives.aspx Available: Accessed: [13-AUG-2020]