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Editorial Team

The *Journal* is published by the Telecommunications Association (TelSoc), a not-for-profit society registered as an incorporated association. It is the Australian telecommunication industry's oldest learned society. The *Journal* has been published (with various titles) since 1935.

Editorial

From History to Infrastructure

Leith H. Campbell
Managing Editor

Abstract:

This editorial comes in three parts: encouragement to delve into the start of long-distance telecommunications in Australia; some remarks on telecommunications as infrastructure; and a brief introduction to the papers in this issue.

Keywords: History of Telecommunications, Telecommunications infrastructure, Editorial

A Long History

Last year, 2022, we celebrated the 150th anniversary of the completion of the Overland Telegraph Line, an heroic construction project that enabled the Australian colonies to be in telegraphic communication with the British Empire. It was a foundational event in Australian communications, leading, as Moorhead (2023) points out in this issue, to each Australian colony joining the predecessor to today's International Telecommunication Union. Indeed, TelSoc (the Telecommunications Association, publisher of this *Journal*) traces its history back to the foundation of the Telegraph Electrical Society in 1874, triggered partly by the success of the Overland Telegraph ("History of TelSoc", 2020).

In this issue, we publish an important account of another aspect of the Overland Telegraph Line, namely the response of the local people through whose lands the Line passed (Jones, 2023). The Line eventually led to the alienation of all Aboriginal lands along its length by incoming settlers but, in the short term, there was evidence of curiosity, hostility, and a quest to acquire exotic but useful materials on the part of the original inhabitants. I recommend this account to all readers of the *Journal*.

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Telecommunications as Infrastructure

In her Charles Todd Oration, delivered in October 2022, the Minister of Communications spoke of 'three transformational fixed-line telecommunications deployments in Australia', namely (Rowland, 2023, p. 19):

- 'The Overland Telegraph in the 1870s…;
- The copper telephone network rolled out by the Postmaster General's Department last century; and
- The National Broadband Network, initiated by the Labor Government in 2009.'

This was a reminder, if one is needed, that telecommunications is largely about infrastructure, providing the facilities to permit others to communicate or to build new communications functions on its foundation. Given the earlier history of telecommunications being dominated by monolithic and vertically integrated network operators, the realization of telecommunications as infrastructure has had a major effect on the industry, a process that continues today.

One concern has been about "Over the Top" (OTT) players, such as streaming services, which use telecommunications networks to reach their customers without direct payments to the infrastructure providers. ("OTT" was probably coined originally as a pejorative term, but is now widely accepted.) A paper by Ramli *et al.* (2023) in this issue outlines the Indonesian government's response to the introduction of OTT platforms in that country. A significant issue has been compliance by foreign-operated platforms to local customs and regulations. No doubt the Indonesian example will be closely watched by other jurisdictions grappling with the same concerns.

While the separation of infrastructure from services is now largely complete in the fixed-line sphere, due to the dominance of the Internet, there is still further change coming to the mobile world. The mobile 5G standards represent a 'networking transformation through cloud computing' (Bruce Davie, quoted in Campbell (2021)) that will potentially bring service interfaces deep inside telecommunications networks through managed edge clouds. This will be taken even further with 6G (Soldani, 2021). It will have a profound effect on how mobile networks are paid for and enhanced.

The essential importance of telecommunications infrastructure has been recognized by governments in cases of competitive or market failure, as in Australia's Mobile Blackspots program (Rowland, 2023, p. 26). One country, Malaysia, has taken this further, mandating a single operator, DNB ("5G for All", 2021), as the sole wholesale provider of 5G infrastructure. Whether or not this turns out to be good policy is not yet certain, but, whatever the case, it will serve as a key case-study on the future of telecommunications infrastructure.

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For infrastructure projects to be most effective, they should arguably be implemented as part of a wider national strategy. For Malaysia, this is MyDIGITAL ("Mission", 2021). One further paper in this issue, from the TelSoc Broadband Futures Group (2023), assesses what progress has been made in 2022 towards a Digital Communications Strategy for Australia.

In This Issue

We publish two notable items in this issue. The first is by Philip Jones of the South Australian Museum on *Aboriginal Interactions with the Overland Telegraph Line, 1870–1880*. This offers new perspectives on the construction of the Overland Telegraph Line, of which Australians are justly proud.

The second notable item is the speech made by the Honourable Michelle Rowland, MP, Australian Minister for Communications, as the *2022 Charles Todd Oration*. It lays out some policies and priorities for the government over the coming years.

In the Public Policy section, we add to the policy discussion with two papers. The TelSoc Broadband Futures Group provides the next in its series of annual reports, *Assessing Australia's Progress towards a National Digital Communications Strategy at December 2022*. We also include a paper from Indonesia on *New Regulation on Telecommunications and Over-the-Top Platforms in Indonesia*,

In the Digital Economy section, there are also two papers. *Individual Adaptation in the Face of Enterprise IT Changes in the Organization* looks at how people adapt to new IT systems in the workplace. *Electronic Communication of Entrepreneurs during the Covid-19 Pandemic in the Czech Republic* reports on how communication changed during the recent pandemic.

In the Telecommunications section, we have a paper that looks forward to the planning of future high-speed mobile networks, *Urban 5G MmWave Networks: Line-of-Sight Probabilities and Optimal Site Locations*.

The Biography section contains a tribute to Stewart Wallace, an Australian who had been involved in regulatory aspects of international radio spectrum and who died in 2022.

In the History of Telecommunications section, *Revisiting the 1965 Centenary of the International Telecommunication Union* introduces and reprints a short paper from the *Telecommunication Journal of Australia* originally published in 1965.

As always, we encourage you to consider submitting articles to the *Journal* and we welcome comments and suggestions on which topics or special issues would be of interest.

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Aboriginal Interactions with the Overland Telegraph Line, 1870–1880

Philip Jones
South Australian Museum

Abstract: Aboriginal interactions with the Overland Telegraph Line, along its 3000 kilometres, were never uniform. The Line passed through at least twenty Aboriginal territories; when construction commenced, fewer than half of those groups had met Europeans. Aboriginal people in the northern and southern sections had experienced some contact, while only Stuart and his small band had passed through the central section. Archival records concerning the Line's construction and its first years of operation reveal a consistent pattern of engagement: an initial phase of avoidance and fear followed by direct confrontation and engagement, often by the same Aboriginal group. In both cases, the trigger was not necessarily the white man's presence *per* se, but the unprecedented temptation of large amounts of a new and extraordinary resource, metal. Prudently, Charles Todd issued instructions minimising fraternisation, which repressed the growing appeal of European commodities and material; armed parties attacked three telegraph stations during the mid-1870s. A *pax Britannica* gradually ensued. This paper focuses upon the first ten years of Aboriginal interactions, proposing a sequence of dynamic engagement with Europeans, prefiguring the subsequent tightening control and dispossession of local Aboriginal groups along the length of the Line.

Keywords: Australian Aboriginal, Overland Telegraph Line, History of Australian Telecommunications

Introduction

As an infrastructure project spanning an entire continent, completed within just two years, the Overland Telegraph Line was an extraordinary technological achievement. Historians agree that its success can be attributed to Charles Todd's leadership and organisational skills, overseeing all its aspects, from conception during the late 1850s to its first regular operation, in late 1872. Todd's brief was never complicated by the realisation that the country bisected by the Line was occupied and spoken for; he shared the prevailing characterisation of Aboriginal people as nomadic and rootless. In fact, the Line would fall out of use before that

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characterisation shifted to an understanding that Aboriginal people's connection to their land was ancient and enduring. All the surviving evidence suggests that Todd and his men simply failed to grasp that connection; the concern expressed in their diaries and reports regarding Aboriginal 'pilfering' of stores and equipment was almost never balanced by reference to the loss of key Aboriginal waters or the damage or destruction of sites of significance.

Aboriginal responses to the Overland Telegraph Line construction varied significantly across space and time. For Aboriginal groups associated with the Line's southern section – from Port Augusta to the Peake – contact with Europeans had already occurred by the time construction began during 1870. This also applied in the northern section, where Aboriginal people had become familiar with the survey teams working under the Goyder Survey Expedition of 1869–1870. In the central section, though, John McDouall Stuart's small and mobile expeditions had been sighted by relatively few Aboriginal people. In those instances, the pattern of engagement followed a progression from outright consternation and fear, to attempts to shadow and gain information about the newcomers, and more particularly about the objects and materials being conveyed. This stage was followed either by outright hostility and attempts to drive the exploration parties back, or

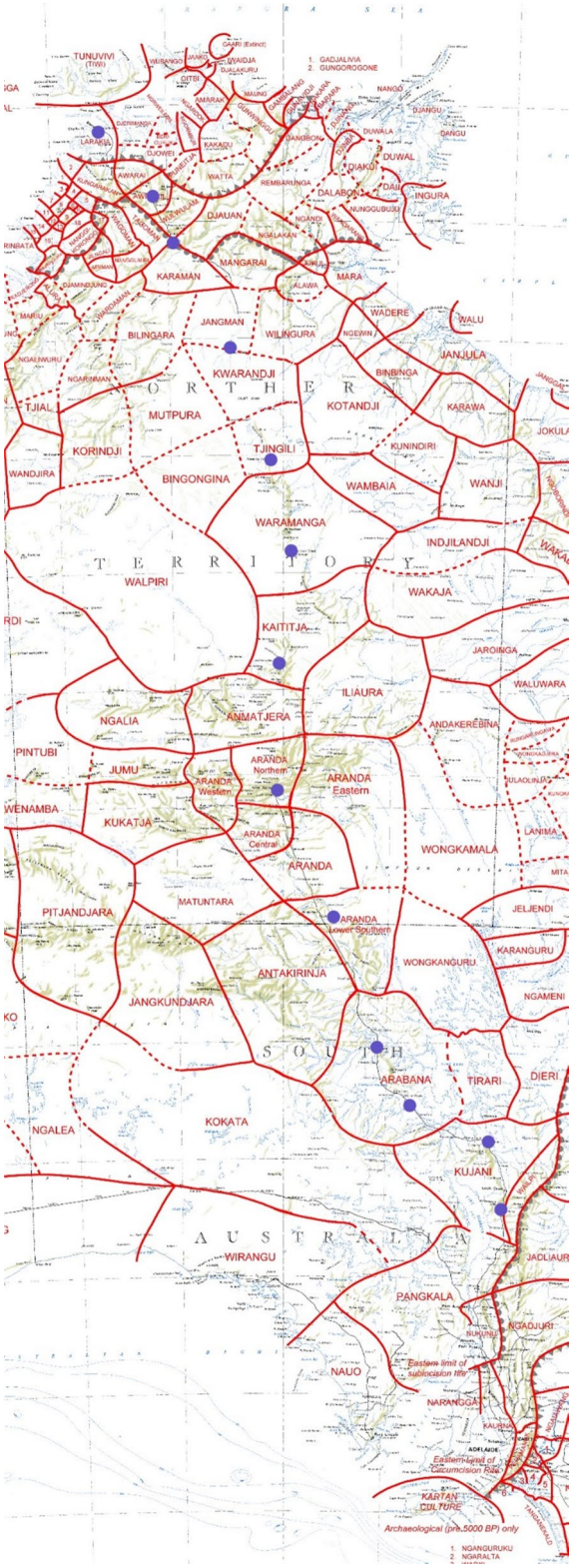

Figure 1. Detail of N. B. Tindale's 1974 map of Aboriginal group territories, with Overland Telegraph stations marked. (S.A. Museum)

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by attempts at engagement, with the principal aim of acquiring metal, cloth, leather and other commodities and materials, such as porcelain insulators.[i]

To summarise, along its length and throughout its first decade of existence, Aboriginal reactions to the Overland Telegraph Line tend to fall into three main categories: wariness or aversion; confrontation and attempts to drive the intruders out; and engagement focused upon the acquisition of European objects and materials. The encounters documented in the journals and correspondence of explorers and the Overland Telegraph employees range between these three categories. These responses were all prefigured at various stages of Stuart's expeditions from 1860 to 1863.

From Wariness to Engagement during Stuart's Expeditions

Stuart enlisted Aboriginal guides during his first and third expeditions, but neither initiative was successful. He soon found that the guides' expertise and confidence evaporated once they travelled beyond their own countries, so that, for his final push north during his last three expeditions through the Centre, he relied almost entirely on his own bush skills, while also paying close attention to Aboriginal smokes and other signs of their presence (Bailey, 2006, p. 45, p. 114). As for the attitude of Aboriginal people themselves during these expeditions, the historian Mervyn Hartwig's analysis of more than twenty separate encounters suggests that the dominant reaction by the isolated individuals and groups encountered by Stuart was 'fear and avoidance', rather than confrontation or a closer engagement (Hartwig, 1965, p. 243). As Hartwig put it, 'Stuart travelled too quickly for them to overcome their fears' (Hartwig, 1965, p. 243).

Stuart was well aware that his progress through Aboriginal land was often monitored. He saw evidence of this in the smokes sent up by hidden observers, signalling his party's presence to others, and in footprints through his old camps when he had cause to retrace parts of his route. As a general rule this avoidance suited Stuart very well, for he had formed a view during his first expedition (to the west of Lake Torrens in 1858) that little would be gained by close contact with Aboriginal people. Misunderstandings resulting from such contact could easily jeopardise his project.

Even at this early stage, though, there was evidence of curiosity; Aboriginal people shadowing Stuart's party were aware Stuart and his men carried objects and material of great interest. In June 1860, for example, two Warumungu men visited Stuart's camp at Kekwick Ponds, presenting him with parrots, a possum and some 'mice'. In turn, Stuart wrote, they were ready 'to steal everything they could lay their fingers on' (Hartwig, 1965, pp. 243–244; *Adelaide Observer*, 1897). Hartwig scanned the evidence from Stuart's last three expeditions for shifts in behaviour and response to the explorer's presence. He found that instances of 'resistance or

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incipient resistance' rose as Aboriginal people became more familiar with the explorer's movements – and became aware that Stuart had no intention of observing the standard Aboriginal protocols when entering or passing through their country. 'Resistance' suggests a reaction to an originating force; perhaps it is more accurate to describe the Aboriginal response as akin to opportunistic guerrilla warfare, more attuned to evicting the interlopers, with the associated aim of acquiring exotic materials. There were several instances of attempts to fire the grass to the windward of the party, and Stuart encountered a full-scale attack with spears and boomerangs at Attack Creek on his fourth expedition, convincing him to turn back to Adelaide (Bailey, 2006, pp. 157–160). More attacks were experienced during the final expedition.

Hartwig concludes that by the last of his six expeditions Stuart had become 'more ready to resort to force and less willing to make careful and time-consuming efforts at conciliation' (Hartwig, 1965, pp. 246–247). That may be so, but it is worth remembering that during that sequence of expeditions Aboriginal people along those routes had come to know at least some aspects of European behaviour, and a few English words and phrases. Having established that basis, their access to European goods would now be easier, either through theft or exchange. As visits by Aboriginal men to his camps increased in frequency, Stuart's patience became strained. The 1860 Attack Creek incident had been preceded a few days earlier by offers of food by Warumungu men. Stuart ordered them out of the camp, as he realised that their main aim was to acquire items of equipment, to which, as hosts to the white visitors, they felt entitled. In this instance an armed confrontation was the result, but that did not always follow; other forms of engagement were possible. During Stuart's final expedition, another encounter took place at Attack Creek, in which simple curiosity played its part. William Auld recalled it, years later:

> At Attack Creek Thring and I were washing some of our scanty wardrobe, about 200 yards [180 metres] from camp, when suddenly a tall blackfellow made his appearance. He came up to us, and after talking and making signs he untied the lace of my boot. Then I made signs to him to take it off, which he did, and he gave a whistle. Next he took off the stocking, gave another whistle, and tried to peel off more. I made signs to him to replace them, which he did, doing up the lace and tying it in a bow the same as it was before. He seemed much astonished at the whole process. We packed up our clothes, bade him a most polite good-day, and returned to camp (Auld, 1891, p. 6).

This 'tall blackfellow' may well have been one of the party attacking Stuart a year earlier. Auld's anecdote offers a reminder that public, corporate protocols of encounter might differ considerably from those applying in more personal or intimate circumstances. Hartwig's analysis suggests that those less formal, more spontaneous encounters increased as Aboriginal

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people began to see the Europeans as a resource to be exploited, rather than as invaders to be implacably turned away. The Overland Telegraph project would soon offer a test of that model.

The Overland Telegraph Line: Impact & Effect

Wariness or avoidance was not confined to the Aboriginal people encountered by Europeans along the line. Charles Todd himself had framed his instructions to the Telegraph reconnaissance and construction parties with the intention that there should be as little contact as possible with Aboriginal people. It is certainly likely that he formed this view after discussions with Stuart in Adelaide, but his approach was also directly influenced by the course of events near Port Darwin during the 1869 Goyder Survey Expedition. Surveyor J. W. O. Bennett was drawn into a reciprocal relationship with a group of Wulna men at his survey camp close to the Adelaide River. A keen philologist, Bennett compiled the earliest vocabulary of the Wulna language and attended Wulna ceremonies. He was subsequently speared to death by the Aboriginal men with whom he 'fraternised' (Jones, 2007). The accepted explanation for his death was that it was a direct consequence of his fraternisation. For Todd this was a lesson learnt, and was directly reflected in his instructions to the telegraph construction parties, drafted in the months following Bennett's death. His 'Instructions to Overseers in Charge of Works' (1870) contained the following relevant clauses ("Instructions", 1870):

> *39. Treatment of Natives.* - Should any natives be met with, they must be treated kindly but firmly. No native must be allowed to come within 100 yards of the Camp without permission from the officer in charge, and then not more than three at any one time.
>
> *40. Not to visit Native Camp without leave.* - No one is to be allowed to visit the natives' camp without special permission; and, in all cases, previous intimation is to be given to the natives.
>
> *41. No Communication with Native Women.* - The officer in charge is especially cautioned to allow of no communication between any of his party and the native women, or of any conduct likely to create jealousy on the part of the natives. This is not to apply to any woman engaged by him, in the absence of a man, as a guide to point out the situation of water.
>
> *42. Property of Natives not to be touched.* - If a native camp, or burial ground, is met with, the property of the natives, it is to be left untouched. If any natives are seen, they must be warned by cooeying of the approach of a white man, as their first impulse of terror at the unaccustomed sight often leads them to throw their spears at him.
>
> *43. Mode of Attack by Natives.* - When natives attack a party, they generally do it by setting fire to the grass, and approaching under cover of the flames and smoke. It is therefore desirable, when deciding upon a camping place where there are signs of the presence of natives, to bear this in mind, and either choose a place where the grass is scanty, or burn a piece round the intended camp. Under these circumstances, it could be well to choose a good position commanding the surrounding country, and where, for say 100 yards around, there is no shelter for a black to creep unseen towards the camp.
>
> *44. Not to Fire upon Natives except in cases of necessity. Statement of affray to be drawn up.* – It is most strictly forbidden to fire upon the natives except in the last extremity, when it may become necessary for the safety of the party; and in such a case a statement is to be drawn up by the officer in charge, detailing all the circumstances which led to this action, together with all subsequent occurrences, and this statement must be supplemented by the written evidence of such men as were present at the time, duly signed by them. These documents are to be forwarded to the Superintendent of Telegraphs by the first opportunity.

It is worth noting that none of the relevant clauses touched on the key reason for Aboriginal people's attraction to the line party camps – the commodities and resources which those

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parties had brought onto Aboriginal lands. Todd appeared to overlook this factor completely. In fact, he rather naively considered that the Line held no attractions for Aboriginal people, and might even repel them. In November 1872, as the chain of eleven telegraph stations began sending and receiving Morse code messages, Todd was interviewed in Adelaide. He was asked about the risks posed by Aboriginal groups. By that time, he was certainly aware of a rising incidence of clashes, although his parties had generally been able to work unimpeded. The journalist put his response in this way: 'Mr Todd does not apprehend much trouble in dealing with the natives, for although numerous in places they have a wholesome dread of the white man' ("The Trans-Continental Telegraph", 1872).

That 'wholesome dread' may have been cultivated to some extent by Todd himself. Two years earlier, in November 1870, Todd was at the Peake, planning the Line with his assistant, Benjamin Herschel Babbage (himself an explorer and scientist). According to the journal of linesman T. F. Smith, Todd and Babbage were experimenting with the telegraph batteries, required to send the electrical charge along the line to the next repeater stations at Strangways Springs to the south and Charlotte Waters to the north. Todd was particularly interested to see whether he could demonstrate the charge for Aboriginal people at the Peake, so that they would understand that the Line was dangerous and should be avoided. According to linesman Smith, the batteries had achieved this effect: 'He [Todd] practised or operated on them once, but he drove them clear from here. His object was to frighten them from touching or interfering with the wire when hung for communication' (Smith, 1870).

This was not the first time Todd had used this technique to send a message to Aboriginal people that the telegraph wire was dangerous. Following his lecture of 28 January 1863 to Adelaide's Philosophical Society promoting the Overland Telegraph Line project, it was suggested by F. G. Waterhouse, a member of Stuart's successful expedition, that Todd might expect trouble with Aborigines. Todd's response was that he had a solution for that problem: 'When I laid the cable at Lake Alexandrina', he recalled, 'I gave a blackfellow an electric shock, and ever since they avoid the wires most religiously. (A laugh)' (Philosophical Society, 1863, p. 6). In a further response Todd made the reductive simplicity of his approach clear: 'the best protection of the line against the natives would be by working on their superstitions' (Philosophical Society. 1863, p. 8).

Such indications might suggest that Todd had no meaningful engagement with Aboriginal people, and perhaps a low opinion of them. That is difficult to gauge, but it does appear that he felt a duty to record details about Aboriginal people, and there is evidence that he promoted this approach among telegraph staff, particularly in the Line's central section. Todd gathered a 101-word vocabulary of Southern Arrernte at the Peake Telegraph Station during his visits there, and submitted it to the ethnographer E. M. Curr's 1886–1887 compilation of Aboriginal

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vocabularies (Curr, 1886–1887). Curr published at least seven other vocabularies gathered by telegraph staff at stations between the Peake and Tennant Creek. It is likely that Todd encouraged those contributions, which suggests Todd had some expectation of the contribution the telegraph stations might make to Australian science. It is also an indication that Todd's non-fraternisation policy no longer applied once the telegraph stations were operational.

Todd assumed that non-fraternisation would prevent conflict during the construction phase. His instructions were framed accordingly, but as Aboriginal people began focusing their attention on the metal objects found so plentifully in the camps of the white fellows, and as telegraph staff began taking in interest in Aboriginal language, the non-fraternisation policy appeared increasingly irrelevant. But within an eighteen-month period following the Line's successful inauguration in August 1872, three telegraph stations came under concerted attack. Before that wave of attacks began, Todd was confident enough to downplay any risk to his project, stating publicly in November 1872 that:

> The blacks are not troublesome, nor do I think it likely they ever will be. If they are kept at a proper distance, and no injury is done, then they will apparently never do any harm nor even attempt It; but should the whites despoil them in any way, or give them cause to think themselves wronged, there can be no doubt the savage spirit will crop out quickly. It therefore depends on management, and so far as it is possible to foresee in such a matter I am inclined to think the men who will be left here and at the other stations I have visited quite understand the position, and will act with care and judgement ("The Transcontinental Telegraph: Public Recognition", 1872).

Todd had sufficient evidence to suggest that the basis for this reassurance may not have been solid. Even with well organised camps and his rigorous policy of non-fraternisation, there had been numerous cases of Aboriginal people raiding stores and temporarily unoccupied camps and wagons, removing caches of wire, telegraph insulators and even the footplates of telegraph poles. Todd himself had acquired three Aboriginal axes fashioned from those cast-iron footplates. He passed one of these axes to the Adelaide collector, Dr A. H. Davis, who inscribed it with the following text (and see Figure 2):

> Tomahawk made by the natives at Newcastle Waters on the Northern Line, from the footplate of an iron telegraph pole. The natives dug up the pole, broke the footplate and formed it into several tomahawks like this one. They sharpened it. Given me by C. Todd, C.M.G., S.A. 1884.[ii]

Once broken, porcelain telegraph insulators provided the ideal material for fashioning spear-points and knives. In April 1873 one of the Line maintenance workers, Charles Johnston (later a telegraph station-master), came upon three Aboriginal men near Katherine, 'at a case of

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insulators which they had broken open and were employed breaking them up' (Johnston, 1873). By the 1890s the telegraph operator and pioneer anthropologist, Francis Gillen, found it necessary to place another favoured material, glass from broken bottles, at the foot of telegraph poles, to prevent the insulators being smashed (Jones, 2017, p. xvi).

Figure 2. Axe fashioned from an iron footplate of a telegraph pole at Newcastle Waters, originally in Charles Todd's collection. (A3941, S.A. Museum)

Surveyor Christopher Giles accompanied the initial exploration parties sent out by Todd to reconnoitre the Line's route through Central Australia. Giles was appointed as the first telegraph station-master at Charlotte Waters. His memoir confirmed an increasing focus by Aboriginal people on European commodities:

> … at first we saw but little of the natives, though we had good reason to know that they saw a great deal of us. Axes began to disappear in a mysterious way, and the men's clothes, hung out on bushes to dry, near the camp, would be missing in the morning. A large and heavy tarpaulin, brand new, vanished also and was never seen again. Though I never saw the missing axes again, I often saw traces of them. When piloting a cutting party to the Finke for poles I frequently found that the natives had been there before us cutting down saplings with our own axes, to make weapons with (Giles, 1894).

Todd also appointed Christopher Giles's brother, Alfred, to John Ross's exploratory expedition to fix the Line's route through the MacDonnell Ranges. Alfred Giles made similar observations on the growing Aboriginal interest in European infrastructure and *materiel*, noting that any stray metal object was readily souvenired if not watched carefully during Aboriginal visits to their camps. On 3 June 1871, Giles and his party passed an unattended wagon 200 miles [320 km] south of Darwin, 'nearly new and perfectly sound'. Five weeks later, on 6 July, Giles noted

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that 'it was a perfect wreck, cut and hacked about, all iron bolts and clamps having been carried away by the savages [*sic*], who prized any iron or metal work, and converted it into knives, tomahawk blades, and spear-points' (Giles, 1995, p. 85, p. 92; Jones, 2007, pp. 91–129).

Figure 3. James Harvey's watercolour drawing of an attack on John Ross's advance exploration party in the MacDonnell Ranges, July 1870. (AA402, S.A. Museum)

Christopher Giles himself did not spend long wondering about the fate of his men's purloined clothing. Leading a pole-cutting party to the Finke he came across a 'native granary', consisting of a number of different grains stored in large bags on a tree platform. These large bags were of closely woven fibre string, but on examination Giles discovered that these in turn contained smaller bags 'constructed from the legs of our trousers and sleeves of our shirts, tied up at each end and filled with seeds'. Giles left the bags intact and investigated further, unwrapping a parcel containing a 50-metre length of possum-fur string and a 150-metre length of human hair string. At the centre of the parcel was a glass marble and a piece of engraved pearl shell. This was, as Giles put it, 'a curious example of extremes meeting. Here was a boy's marble from Adelaide, handed on and bartered from tribe to tribe, perhaps twenty or thirty years ago, and side by side with a pearl shell from the extreme north coast, obtained originally likely from the Malays' (Giles, 1894).[iii]

Christopher Giles was one of the few Overland Telegraph diarists to offer a view of the Aboriginal perspective on the Line and what it offered. He had also noted another phenomenon – that of Aboriginal people making their own versions of the telegraph line itself. 'I have also several times been amused', he wrote, 'by seeing where the native children had been playing by putting up telegraph lines on the broad sandy bed of the river [Finke] by

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ranging long sticks in a line' (Giles, 1894). This suggests that Aboriginal children at the Finke had already adjusted to the Line's presence, but their construction was not the only one of its kind. Richard Knuckey, in charge of the southern section of the Line's construction, had also observed 'mock' telegraph lines, but noted that these had been erected by adult men. The Line's supply wagons 'used to lay a coil of wire at the foot of the posts at certain intervals, and several times we found that the Aborigines … had imitated our work by fastening long lengths of wire from bush to bush for miles, about the scrub' ("A veteran bushman", 1914). This was not simple imitation for its own sake, as with the Finke children. Was there a link between the 150 metres of human hair string discovered by Giles, possibly used to construct ceremonial headgear, and the intentions of those stringing the telegraph wire across the landscape? Had Aboriginal people perceived a link between stringing the wire and the regular appearance of wagon-loads of provisions and desirable goods? How did Aboriginal people comprehend the phenomenon of an apparently endless wire, stretching from one horizon to another, erected by teams of men and strange animals, as if in preparation for an extraordinary ceremony?

What is suggested by these abstractions of material from the Line is a determination by Aboriginal people to turn the presence of Europeans and their commodities to their own account, rather than to necessarily adopt any 'civilising' practices or tendencies. The apparent sociality displayed by Aboriginal people on approaching the telegraph camps was only partly founded in curiosity about the Europeans themselves. The key motivation or attractor was metal, cloth, leather, flour and, later, tobacco. Undoubtedly, many of the Arrernte, Kaytej and Warumungu artefacts which made their way to the South Australian Museum collection from those early years of contact along the Line were acquired in exchange for those commodities.

In the meantime, Todd's directives to his men to minimise contact with Aboriginal people inevitably had the effect of constricting the supply of desired European commodities in the face of increasing Aboriginal demand. Surviving diaries and correspondence suggest that, where the telegraph parties adhered to Todd's instructions, relations with Aboriginal people were smooth, during the construction phase at least. From the point of view of the overseers for each section of the Line, the instructions had the benefit of clarity and the ring of common sense. Aboriginal visits to the construction camps were often difficult to manage, with Europeans attempting to treat their visitors with respect, while scrutinising their every move. Reporting from Charlotte Waters, Richard Knuckey put it in these terms: 'The natives gave no trouble beyond displaying some tendency towards kleptomania' ("The Overland Telegraph", 1871). The simplest thing was to follow Todd's directive, and to enforce a hundred-yard [90-metre] exclusion zone around the camps. This also had the effect of heightening tension. By the time that most of the fortified telegraph stations were constructed to Todd's design, Aboriginal men were prepared to run the risk of attacking the stations.

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That pressure began to build as soon as the construction phase was completed, when the chain of telegraph stations began operation, each staffed by fewer than a dozen men, with occasional maintenance teams travelling up and down the Line. In this early period, from their construction until the late 1870s, the telegraph stations were operated essentially as fortified redoubts. The attack on the Barrow Creek station in February 1874 is often seen as an isolated event, but it was not the only station to have experienced a frontal attack. At least two other attacks, at Charlotte Waters and Tennant Creek, seem to have gone unreported in official channels. In mid-April 1871, when most of the staff at Charlotte Waters had moved north to erect the line, a group of twenty armed Southern Arrernte men saw their chance to gain access to the station store, guarded only by three men. 'They commenced a kind of war dance', Knuckey wrote, 'and then made signs for us to be off and leave the place, or they would spear us' (Knuckey, quoted in Giles, 1894, p. 22). The attack was repelled, but it is clear that the phase of 'fear and avoidance' had passed. 'Evidently they are getting accustomed to us', Knuckey wrote, 'and seeing that we are on our guard against thieving, think that they can conquer us by force' (Giles, 1894, p. 22). Christopher Giles detailed a similar account of a foiled attack at the Goyder Creek, in which a group of Aboriginal men sat together at a distance from a small encampment of line workers, and worked their way gradually closer:

> These natives, about 15 in number, were all in reality well armed, and had adopted their usual plan of trailing their spears along the ground, holding them between their toes. Besides this – also according to their custom – they had bundles of spears 'planted' in the grass (Giles, 1894, p. 23).

On 21 January 1873, the Tennant Creek telegraph station had also experienced a frontal attack, by 50–60 Warumungu men armed with spears and boomerangs. The station was only a three-room timber structure at that time, but the telegraph officers were armed and had sufficient warning to be able to fire on the Warumungu, who 'retired in haste', with unspecified casualties. Perhaps the lesson learnt by Aboriginal men here was to choose a more advantageous time to mount an attack, when the officers were distracted and away from their firearms. The Barrow Creek telegraph station was attacked by Kaytej warriors under such conditions, a little over a year later, on 23 February 1874. The attack came at dusk as John Stapleton, the station-master, played the violin for his staff on the station verandah. On both the day of the attack and on the preceding day, apparently unarmed Kaytej men had approached the station asking for flour and had been refused. It is possible that these men may have given notice, or at least a hint, of the impending attack, in which two of the staff, Stapleton and the cook, John Franks, were fatally wounded and an Aboriginal member of the staff, Jemmy (probably from the Peake) was badly injured. The remaining staff were able to drive the attackers away with gunfire, resulting in the deaths of several Kaytej men (Jones,

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2017, pp. 127–130). Reprisals quickly followed, led by the police-trooper (and ethnographer of the Diyari people) Samuel Gason, who had been at the station during the attack. Estimates of Kaytej and Anmatyerre deaths in these reprisals range from 30 to 90 men, women and children (Hartwig, 1965, pp. 272–276). These numbers can only be estimated, partly because the South Australian government had effectively relinquished oversight, allowing local officials to pursue retributive justice without accountability.

The Barrow Creek affair and its aftermath signalled that the ground had shifted in terms of Aboriginal and European relationships along the telegraph line. On the European side, the ideal of 'conciliation' now seemed impossible to promote or defend. Stapleton had been known for his interest in Aboriginal culture, and, like the surveyor Bennett, this interest and sympathy was judged to have been a factor in the attack on the station. It was broadly concluded in newspaper editorials that the 'white man's kindness' was interpreted by Aboriginal people as a sign of weakness.

More attacks were to follow. By 1875, a year after the Barrow Creek killings and reprisals, a traveller reported that a 'large board … with the hand-written warning "Beware of Natives"' had been fixed to a tree about 150 kilometres south of the station, 'as the hostile district is supposed to commence about there' ("Central Australian Notes", 1875). In that year, an overlanding party led by Alfred Giles was attacked by Warumungu warriors between the Gibson and Hayward Creeks and at least two Warumungu were shot. That pattern was repeated in April 1875, when two employees of the Daly Waters telegraph station were speared to death by Aboriginal men at the Roper River. When pastoralists began stocking their newly acquired leases in the MacDonnell Ranges during the early 1880s, Aboriginal men understandably regarded cattle and sheep, grazing on their ancestral land, as fair game. Violence and reprisals increased, and it is reasonable to consider this escalation as resulting directly from the Overland Telegraph Line.

In his reminiscences of the Overland Telegraph Line's construction, Christopher Giles reflected on how easily Aboriginal people might have driven the telegraph parties out of their country:

> It is to me still a wonder that it never occurred to these natives to cut off our retreat from the country by spearing our horses and bullocks. These were turned out every night in hobbles, and would wander to a distance of perhaps two or three miles [3–5 km] from the camp, and how exceedingly easy a prey they would have proved can readily be imagined… It is passing strange that while they did not hesitate to attack our sacred persons, they should have avoided a safe, easy, and certain method of placing us in extreme peril, if not of cutting us off entirely, by destroying the animals which

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> had carried us here, by which alone we could pursue our work, and on which we relied to carry us away when our task was ended (Giles, 1894, p. 20).

The construction of the fortified telegraph stations, largely complete by the late 1870s, signalled a decisive shift in power relations. The Line with its chain of stations was now a hard and permanent reality, and as Hartwig relates, this accompanied a shift towards a more concerted policy of pacification and paternalism. By this time, the consensus in academic circles and the popular press was that Aboriginal people were primitive examples of mankind, hardly capable of improvement and likely to perish as a casualty in the contemporary struggle for existence. The best course was to provide succour in accordance with Christian ethics, while guarding against the perceived duplicity of Aboriginal people. In all the discourse around the 'Aboriginal problem', the people themselves tended to be characterised as 'savages' and therefore as children. The paternalism implied by this attitude found its expression in the ration distribution network, as it gradually extended from South Australia to the Northern Territory, via the Overland Telegraph Line's stations. Rations were eventually dispensed from the telegraph stations, but apparently not until the beginning of the twentieth century, despite South Australia's own commitment to ration stations for needy and displaced Aboriginal people as early as the 1850s.[iv] Charles Todd did not want his efficient system jeopardised, and issued instructions 'that natives should only be supplied with food in return for work done, or in case of sickness and infirmity' ("Supplies to Natives", 1874). Two phrases were later coined to refer to the period which followed — 'culture of dependency' and 'intelligent parasitism' (Rowse, 1998; Elkin, 1951). Both relate to the shift from a period in which Aboriginal people camped at the telegraph stations for short periods while maintaining a life centred on hunting and gathering, to an era in which sedentism and dependency began to take hold.

Under these circumstances the telegraph stations took on a new role, as neutral zones in an increasingly adverse environment for Aboriginal people. The stations also offered a limited source of employment and a means by which individual Aboriginal people could gain some of the skills required to make a living on the fringe of the emerging European economy. Much depended on the goodwill of individual telegraph station operators. When we think of the Overland Telegraph and the staff who worked at the eleven repeater stations, each separated from the other by 250 km of forbidding country, we tend to gain an impression of isolated individuals, committed to one task, that of receiving and sending messages. In fact, many of these men had already displayed a curiosity about the world which led them to these remote localities. Christopher Giles was an example. In later life he became 'a recognised authority on the writings in the Koran and in the Greek Testament' ("The Late Mr Christopher Giles", 1917). At Charlotte Waters in 1875 he contributed the first published vocabulary of Arrernte to George Taplin's *Folklore, Manners, Customs, and Languages of the South Australian*

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Aborigines (1879) and collected botanical specimens for the Victorian botanist Ferdinand von Mueller. It is likely that Giles exerted a formative influence on the young Francis Gillen, who joined the staff at Charlotte Waters in 1875.

Gillen accumulated insights into Central Australian Aboriginal culture and became a crucial link between the remote Australian bush and the centres of international discourse about the origins of religious belief, totemism and kinship (Jones, 2017). After Gillen's transfer to Alice Springs in 1890, he met the Director of the South Australian Museum, Edward Stirling, and subsequently became a key figure in the Horn Scientific Exploration Expedition of 1894. Gillen's insights into Arrernte cosmology and his partnership with Walter Baldwin Spencer soon brought the Arrernte into international focus. These insights were possible because of the trust he had established with the Arrernte at the Alice Springs Telegraph Station, particularly after he had used his position as stipendiary magistrate to arrest the senior police-trooper in Central Australia, W. H. Willshire, for the murder of Aboriginal people at a nearby cattle station (Jones, 2017, pp. xiv–xv).

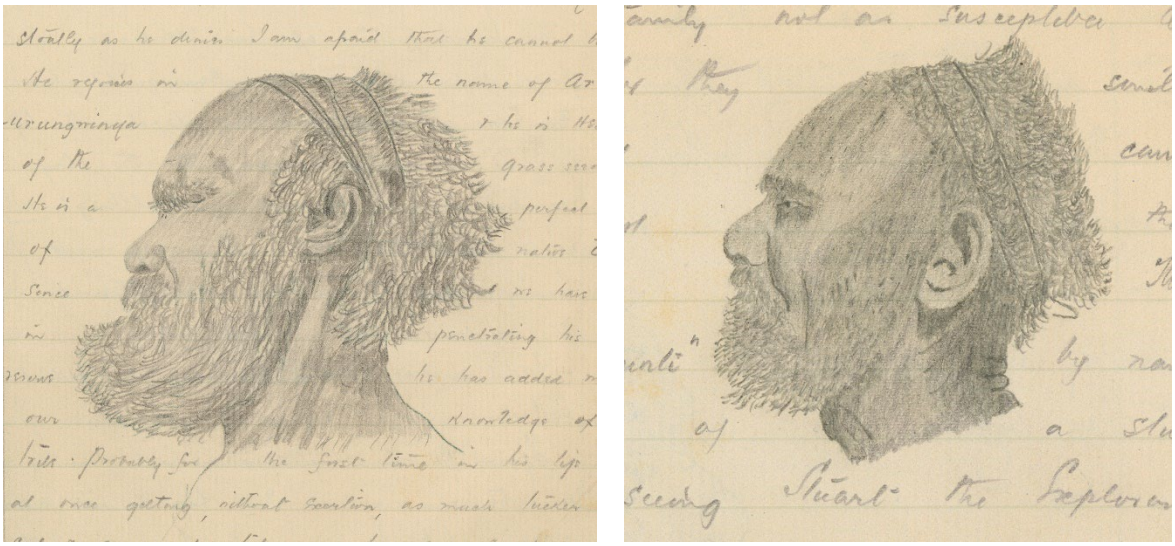

Figure 4. F. J. Gillen's 1901 pencil sketches. *Left:* Tungilla, a Kaytej man involved in the 1874 attack on the Barrow Creek telegraph station. *Right:* Murramunti, a Warumungu man who recalled seeing the explorer McDouall Stuart, fifty years earlier. (PRG54, State Library of South Australia)

As the historian John Mulvaney has noted, the Horn Expedition had a transformative effect on telegraph station staff in Central Australia. Gillen wrote to Spencer in December 1894 that 'every member of the staff' at Alice Springs, is anxious to contribute something to your collection' (Gillen, 1897). This was not confined to Alice Springs. Paddo Byrne at Charlotte Waters continued to engage Aboriginal collectors to seek out zoological specimens for Spencer, and for Stirling at the Adelaide Museum. Stirling was an especial beneficiary; being the first to scientifically describe the marsupial mole from specimens collected by Aboriginal people at Charlotte Waters. His later knighthood hinged partly on that discovery. James Field at

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Tennant Creek also provided specimens, as did Frank Scott at Barrow Creek. All of these men were able to compare notes on their discoveries and, while the Aboriginal collectors may not have understood exactly how it was that their familiar animals were now so appealing to Europeans, we have the sense of a common project, bearing on the land itself. Gillen's exuberance and enthusiasm seemed to spread up and down the Line. Stirling tapped that enthusiasm, and his form letter to telegraph station operators and police, seeking artefacts for the South Australian Museum before, like Todd's axe, they were transformed by modernity, resulted in the most significant and wide-ranging collection of Central Australia material culture.

The Overland Telegraph Line was an extraordinary and unprecedented infrastructure project without doubt, but it was more than that. For a small group of like-minded Europeans, working with Aboriginal people whose knowledge and traditions opened up new fields, the Line became a line of enquiry, a means of generating knowledge about an unfamiliar and confronting landscape and its people. As for the Aboriginal people, the Line was a vector, a means of obtaining material benefit and entirely new technologies which could be adapted, in the first instance, to their existing material culture. Any benefit to Aboriginal people from the Telegraph Line, though, would come at a price: a loss of land and autonomy, together with a massive fracture in the social fabric. This damage would become most apparent in the years which followed the construction of the telegraph stations, beyond the scope of this paper.

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Endnotes

[i] John McDouall Stuart led six expeditions into inland Australia from 1858, culminating in the successful transcontinental crossing of 1861–1862. See Serle (1949) and Bailey (2006).

[ii] Register entry for A3941, South Australian Museum. For an Aboriginal account of the destruction of a telegraph pole in order to obtain the iron footplate for use as an axe, see Koch & Koch (1993), pp. 20–21.

[iii] Christopher Giles was unaware that the pearl shell was likely to have originated from the Kimberley coast, the source for an ancient Aboriginal trade network circulating such objects into the Western Desert. The marble may well have originated in Adelaide.

[iv] See, for example: https://sahistoryhub.history.sa.gov.au/subjects/aboriginal-ration-depots

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2022 Charles Todd Oration

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Minister for Communications

Abstract: The Charles Todd Oration is an annual event run by TelSoc and is named for Charles Todd, the Postmaster-General of South Australia, who was responsible for completing the Overland Telegraph Line from Darwin to Adelaide in 1874. The 2022 Oration was delivered in Sydney on 21 October 2022 by The Hon. Michelle Rowland, MP, Minister for Communications. At the time she had been in the role for about 5 months following the change of government at the Federal election on 21 May 2022. The Minister used her speech to set out the Government's aims for the communications sector and its initial priorities, and to reflect on her appreciation of the circumstances and potential for the sector, its stakeholders and end-users of communications services. References and endnotes have been added by Jim Holmes, Chair of TelSoc, to enable further reference by interested readers on the matters noted, and for the accuracy and relevance of which TelSoc accepts complete responsibility.

Keywords: Minister for Communications, Charles Todd, Overland Telegraph Line, Digital Inclusion, Regional Connectivity

The Minister's Oration

I acknowledge the traditional custodians of the land on which we meet, the Cadigal people of the Eora nation, and this is an important occasion to acknowledge the traditional owners of the lands on which the overland telegraph was built. I acknowledge all their elders, past present and all First Nations Peoples with us today.

Thank you to Dr Jim Holmes for the kind introduction. And thank you to TelSoc, not just for inviting me today, but for the serious and considered approach you take to public policy. I met with TelSoc as Shadow Minister in February 2021 and again in Melbourne, not long after being sworn in as Minister.

Just this week I was revisiting my notes from that earlier meeting last year. They spoke about the importance of focusing on not what the NBN Co is — but what it can do. We covered the benefits of expanding fibre, the role of ownership on the objectives of NBN Co, and the often unproductive duplication in Federal-State investments schemes.

Those conversations, and the generosity of their time, left a formative impression on me.

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There is a special quality to engaging with true telecommunications enthusiasts who, by virtue of their profession and experience, have seen much change in the sector and retain an ongoing passion for sharing ideas and making a contribution.

So, I want to put on record my appreciation to the hardworking engineers and technicians of today who are making a great contribution to Australia's economy and indeed to Australia's Society.

Charles Todd

It is a great honour to be delivering the Charles Todd Oration, particularly in this anniversary year. The Overland Telegraph was an extraordinary feat which demonstrated vision, perseverance and delivery.

The three transformational fixed-line telecommunications deployments in Australia over the last 150 years were underpinned by public investment:

- The Overland Telegraph in the 1870s, which we recognise today;
- The copper telephone network rolled out by the Postmaster General's Department last century; and
- The National Broadband Network, initiated by the Labor Government in 2009.

It took someone with a different, unique set of skills to plan and deliver this project in nineteenth century Australia.

This was Charles Todd who – in what we'd now call a 'sliding doors' moment – almost didn't come 'down under'. In the 1850s, the Colonial Office asked the Astronomer Royal, George Biddell Airy, to recommend someone as a "superintendent of electric telegraphs with desirable experience in astronomical and meteorological observation". The job on offer was to construct a telegraph line between Port Adelaide and Adelaide for the South Australian government, and Airy originally recommended a former employee, J. C. Henderson.[1] Henderson was working in Canada and declined the offer, concerned there may not be permanent work once the project was completed.

Airy's second choice, Charles Todd, was more optimistic — you could say a 'glass half full' kind of person. After accepting the job, and before setting off to the colony, he married Alice, after whom Alice Springs is named. Todd told those at the wedding reception he was '*going to Australia in the hope of being instrumental in bringing England and Australia into telegraphic communication*'.[2]

The first messages sent on key telegraph lines are always fascinating, especially the ones staged for posterity.

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The much publicised and ever-so-slightly pompous official first message sent on the Washington to Baltimore line is the legendary: "what hath God wrought?"[3] But that wasn't actually the first message sent on that line. Although the line had not yet been completed end-to-end and only went as far from Washington as Annapolis, one of Samuel Morse's associates saw an opportunity to get a jump on the political news of the day. He met the train coming from Baltimore where the telegraph to Washington started. From there he telegraphed the news ahead: that the Whig Party had nominated Henry Clay for President (Kirk, 1892).

So let it be known that the first use of the electric telegraph was for one of the most important things in life: to confirm a political pre-selection.

The electric telegraph was the core of the world's communications system for over 150 years: from a multi-technology mix of carrier pigeons, ponies, trains and foot, to virtually instantaneous global communication.

Australians rapidly became one of the most enthusiastic users of the telegraph in the world. The magic of the telegraph compressed distance and time, shifting Australia's communications networks from arduous months to effortless minutes.

However, it's important that we acknowledge the impact it had on the First Nations people in the local area, with reports of violence and conflict along the frontier shortly after the telegraph was established. I note this because I believe that reconciling with our past is important to our future.

As do my colleagues in the Albanese Government. At the recent opening of Parliament, the Governor-General's speech made clear that we have:

> … a renewed ambition for Australia to reconcile with our past, to tell and know the truth about history, and to place a First Nations voice at the heart of our democratic process ("Opening", 2022).

Our understanding of the Indigenous perspectives of the history of the Overland Telegraph has been scant. The National Communications Museum with Professor Marcia Langton, supported by Telstra, will be leading an important initiative to document the building of the Overland Telegraph from the perspective of First Nations.

This will be a landmark project which will ensure that Indigenous perspectives are given due weight and recorded for posterity. I look forward to hearing and seeing the results.

In 1902, Todd celebrated a sixty-year career in the English and Australian civil services, with forty-six of them in South Australia. This included a long stint as a colonial Postmaster General, then as a Deputy Postmaster General in the newly federated nation; where the 'various Post and Telegraph departments' were 'the first and largest department to be transferred to the Commonwealth' (Moyal, 1984, p. 88).

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As a fourteen-year-old, I visited the Overland Telegraph Station in the Northern Territory with my parents, and as a young teenager, I couldn't have begun to even imagine the interconnected world we live in today, nor the role that I would play in it.

Back then, we didn't have email, and we didn't have mobile phones. The word Internet didn't exist in my dictionary, and I would avidly record my favourite music from the radio onto my cassette player. It was a different time and a different era.

So today, on this 150th anniversary, we honour the contribution of Charles Todd to the communications landscape in Australia.

A better future

On 21 May 2022, there was a change of Government and Anthony Albanese was elected as Prime Minister on a platform of renewal.

Several key elements of the Labor platform were:

- Working together for a better future for all;
- Improving trust and integrity in politics;
- Action on climate change;
- Responsible cost of living relief;
- Improving the lives of First Nations Australians; and
- A more resilient Australia.

And all of this is underscored by a focus on delivery that is focused on people, not politics.

In discharging my responsibilities as Communications Minister, I will bring focus to each of these areas as they relate to the portfolio. But I want to make a very important point to this audience. Governments do come and go. That is the nature of life, and it is indeed the nature of democracy.

But as the Prime Minister has said:

> I want every parent to be able to tell their child no matter where you live or where you come from, in Australia, the doors of opportunity are open to us all. And like every other Labor government, **we'll just widen that door a bit more** (Albanese, 2022).

That is what Labor governments do, and it's a responsibility this Government takes very seriously.

This brings me to our priority for a more digitally included society, particularly within First Nations Communities, unconnected school students, and in regional Australia.

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Digital inclusion

In 2020, the Australian Digital Inclusion Index[4] showed that First Nations people had relatively low levels of digital inclusion – approximately eight points below the national average.

The inclusion of Target 17 in the National Agreement on Closing the Gap[5] – which commits parties to the goal of equal levels of digital inclusion by 2026 – reflects the importance of addressing the digital divide.

While there are a number of existing programs that contribute to addressing digital inclusion in rural and regional Australia, we are exploring options to leverage them and investments more effectively, focusing on the initiatives that have been shown to achieve meaningful results in First Nations communities.

For example, we have observed the success of programs such as IndigiMOB[6] to improve digital inclusion and cyber safety awareness. This program is funded by Telstra and operates in 24 remote communities across the Northern Territory.

There is also NBN Co's Communities in Isolation Program,[7] which enabled Wi-Fi in 52 isolated communities during the early stages of the pandemic, using SkyMuster satellite services.

NBN Co has also developed a Public Interest Premise (PIP) policy which enables schools, emergency services, Indigenous organisations, Government facilities and health facilities in the Sky Muster footprint to access additional data of up to 300 Gigabytes (GB) per month. This policy supports about 100 First Nations communities to better access much needed services.

Closing this Gap matters. We have inherited a massive challenge in terms of closing the digital inclusion gap. Together we need to make meaningful progress against Target 17. I will be seeking the insight, energy and engagement of industry and stakeholders in co-designing programs which make a real difference. I will also ensure that Indigenous voices are heard loudly and clearly in the communications sector and policy space.

More broadly, the Australian Digital Inclusion Index 2021 (ADII) ("Digital Inclusion", 2021) shows that digital inclusion is trending in a positive direction at the national level.

However, there is still a digital divide for regional and rural Australia, with a score of 67.4 compared to a national score of 71.1. The gap between regional Australia and the national average is greatest for affordability and access. It's clear we need a continued focus on supporting key elements of digital inclusion – access, affordability and ability – across regional Australia.

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One of our early focus areas will be unconnected school students. Over the course of the pandemic, schools and state education bodies learned a lot about the scope of this problem, as remote learning forced previously unseen issues to become visible. There is a relatively modest cohort of families with no connectivity at home, but for those families, a bit of support can make a meaningful difference.

The upcoming 2022–23 Budget next week will reveal our commitment to help connect up to 30,000 families who do not have Internet at home. I want to thank my Department and NBN Co for their ongoing work in seeking to simplify the program design of this initiative. The local partnerships with state education systems, charities and welfare groups will be critical in identifying families who can most benefit.

Regional connectivity

I would now like to turn to regional connectivity.

Labor cares deeply about quality of life in the regions, and next week will be one of the most regional focused communications budgets. Nearly all my travel as Minister to date has been in the regions, including centres such as West Wyalong, Griffith, the Central Coast, Hunter Valley and Gladstone, with many more planned.

A key mission of previous Labor Governments has been expanding access to better communications services for Australians. Some of the significant contributions include:

- Establishing the Overseas Telecommunications Commission in 1946 under the Chifley Government. The OTC was the functional descendent of the Overland Telegraph.
- On 1st July 1975, the Whitlam Government passed the Telecommunications Act.[8] That, for the first-time, separated telecommunications from postal services. The entity that later morphed into today's Telstra. And, of course, under Whitlam, Telecom Australia was an Australian Government owned entity.
- In 1991, universal service was legislated and competition, including in mobiles, was introduced under the Hawke-Keating Government;[9] and
- In 2009, the National Broadband Network, which for the first time provided for universal access to high-speed broadband, was legislated and commenced under the Rudd Government.

Improving regional telecommunications is a top-order priority for the Australian Government.

This Government is focused on expanding mobile coverage, improving the quality of the NBN, making communications systems more resilient, boosting productivity in agriculture through connectivity, and deepening co-investment partnership models with states and territories.

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On top of this, we want to see progress made in how planning is undertaken for new development estates, to ensure mobile infrastructure is considered as part of the planning process, just as with other essential infrastructure, such as energy and water.

What has really struck me about regional connectivity is the passion it endears in people who know what a difference it makes. Last week, I paid a visit to the NBN Co offices in North Sydney to meet with staff and executives. One of the most enjoyable aspects was engaging with teams working on the regional networks, and the sense of purpose and mission evident in their endeavours.

There is an extraordinary amount of innovation happening in regional telecommunications.

In one of my first substantive acts as Minister, the Australian Government signed off on $480 million in funding to NBN Co to upgrade the fixed wireless network under the *Better Connectivity Plan for Regional and Rural Australia*[10] and I want to take a moment to explain how engineers at NBN Co and their delivery partners intend to use this investment.

At present, the maximum range of a cell on NBN Co's Fixed Wireless network is approximately 14 kilometres, using current spectrum. This distance is limited by the time it takes for a signal to perform a round trip between the wireless tower and an end user's modem, in addition to the time required to decode a particular segment of that signal, known as the "RACH" [Random Access Channel] sequence. NBN Co worked with their technology vendors as part of an extensive research, development and testing process to validate that shortening the RACH sequence would enable the signal to be recognisable on the network at greater distances. This enabled an increase in the coverage radius out to 29 kilometres.

This breakthrough, in conjunction with the reuse of its existing spectrum, augmented with high frequency spectrum, and integration of new miniaturised lens antennae, will enable NBN Co to significant boost the capacity and coverage of existing towers.

At present, NBN Co fixed wireless towers are divided into three 120-degree sectors with 2 or 3 wireless cells per sector. The NBN plan will result in a 3- to 5-fold increase in the typical number of wireless cells per sector. This is a unique global achievement, and should enable NBN Co to reduce the number of users per wireless cell to no more than 10.

Once upgraded, 750,000 households and businesses within the fixed-wireless footprint will be able to benefit from access to increased download speeds of up to 100 Megabits per second, with up to 85 per cent able to access speeds of up to 250 Megabits per second.

The extended signal distance will also enable a further 120,000 currently satellite-only premises to access fixed wireless.

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This means students, families and businesses can access a significant jump in speeds, and also access more data — a meaningful improvement in day-to-day quality of life and productivity.

There is also significant innovation happening in the area of Low Earth Orbit (LEO) satellites. These rapid developments are bringing choice and a step change in broadband capability to businesses and households in regional and rural Australia. LEO satellites are also now being used to support text messaging on mobile devices.

This is why I've asked my Department to commence work on the establishment of a Low Earth Orbit working group to help inform Government about how this emerging capability might play a role in future telecommunications policy.[11]

There is also an ongoing challenge with the legacy of copper broadband NBN lines, with parts of the regional network more than 60 years old. These lines are deteriorating and don't mix well with water, which unfortunately Australia has seen a lot of lately — and which will continue to be a challenge, both in cost and reliability of services for consumers.

As the Prime Minister and I announced yesterday, the Government is investing $2.4B, through phased equity injections to NBN Co, which will be used to expand full-fibre access to 1.5 million additional premises by late 2025.[12] I'm also pleased to share we expect this investment will benefit over 660,000 homes and businesses in regional Australia.

This is what Australians voted for and that is what the Government is now delivering.

But optical fibre is not just about better speed. It is also about delivering more reliable and resilient connectivity, with significantly reduced operating and maintenance costs. This can be seen clearly in the consumer fault data that is encouraging, especially after each flood event.

A technical audit of the NBN Fibre-to-the-Node (FTTN) network predicted long-term degradation in average FTTN attainable speed rates of between 2.2 per cent to 3.7 per cent per annum, and this will rise if we continue to see more frequent or extreme rainfall.

Fifty-seven billion dollars spent by the Coalition in office, effectively double their originally promised cost estimate, and the performance in parts of the Fibre-to-the-Node network is moving backwards, not forwards. It doesn't take an engineer or an economist to understand that fibre was always the best choice for our current and future Internet needs.

And while that aspect of the debate has been well and truly settled, this is just another reminder of why the Government's latest investment is important for the future of the NBN and the needs of Australians.

Finally, I have also announced a series of substantial additional investments in regional and rural Australia which demonstrate the very real commitment of the Albanese Labor government to leaving a legacy of improved regional and remote communications.

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Our Better Connectivity Plan for Regional and Rural Australia[13] will provide an additional $656m of investment for a raft of important initiatives, including a national mobile network audit, improved mobile coverage, resilience initiatives, further rounds of the Regional Connectivity Program, and an extension of the Regional Tech Hub. As part of this, Labor also committed $30 million towards expanding on-farm connectivity, and I assure you, we were the only party that had such a plan.

You will also be aware that one of my pre-election commitments was to evolve Mobile Blackspots to incorporate multi-carrier mobile coverage. While there has been significant positive community feedback regarding Mobile Blackspot improvements, the concern which has been raised time and again is that substantial taxpayer funding has gone into these programs, but less than 1 in 5 towers have two or more mobile operators on them.

This is not good enough and we have to do better.

Low population density and high deployment costs are fundamental reasons why the government has stepped in to help co-fund mobile infrastructure, and we expect public programs will need to subsidise a higher proportion of tower deployment costs in uneconomic areas due to the diminishing revenue opportunities for remaining areas which are underserved.

I have been careful not to specify, to date, a specific or inflexible model for multi-carrier coverage. I am closely following the many trials which are being conducted around Australia with different forms of active sharing and neutral hosting. But I wish to make clear that this is a path we are committed to, and standing still is not an option. Those trials have at least established that there are few technical barriers — the problem is strategic and commercial.

There are many ways to cut this cake and I am keen to hear which possibilities the industry believes can work best. The Department will be running public consultations in due course, and I have asked the House of Representatives Standing Committee on Communications and the Arts[14] to examine this. On both fronts, we look forward to continuing a robust and healthy discussion on how best to deliver on our commitments.

Conclusion

In closing, let me once again thank TelSoc for the honour of delivering the 2022 Charles Todd Oration, and a sincere thank you to everyone in attendance for your indulgence.

The Overland Telegraph and the NBN are both game-changing infrastructure projects, with immediate and huge benefits to business and the community. And while we have made progress over successive generations, there remains much to do.

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I have been very fortunate to be entrusted by Prime Minister Anthony Albanese with a portfolio that is my passion and was my professional life before public office.

As I told the Sydney Institute in 2019, I am even more fortunate to have maintained the mentoring and confidence of some of the smartest people I know whom I worked with or for over a decade as a lawyer, and nearly a decade since moving to this new life. The periods where I learned the most were when I was seconded into other businesses, working with engineers and economists. Having the engineers draw the picture and be solutions-focused really shaped how I approached my profession. This drives my optimism, because there are so many smart people in this sector who want to make a contribution to good public policy.

One of my biggest insights as a new Minister, which won't be surprising to anyone, is that government and governing is hard. There are many challenges, resources and time are constrained, and even with the best intentions you cannot address all issues at once. So, it's important to be clear about your priorities and principles. You have to focus on where you can make a meaningful impact. Always striving to make making things better — making the future better — even if challenges continue to linger.

The NBN, wireless communications, and machine-to-machine connectivity hold out the promise of 'turbo charging' productivity in 21st century Australia – but it drives so much more than that. Communications touches the lives of every Australian, each day, each week, and each year. Our purpose remains to promote opportunity in a disrupted, broadband-enabled world. Growth and innovation are the goal, and it must be inclusive.

The Government will remain focused on the priorities I have outlined today, and I look forward to working with you on that journey.

Thank you for your time.

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Endnotes

[1] See Cryle (2017), p. 49. Note that this biography was reviewed in the *Journal* (Holmes, 2018).

[2] Dodwell, G. F., 'Sir Charles Todd' Obituary, 1910, cited in Cryle (2017), p. 53.

[3] https://americanhistory.si.edu/collections/search/object/nmah_713485

[4] https://www.digitalinclusionindex.org.au/

[5] https://www.closingthegap.gov.au/national-agreement/targets

[6] https://indigimob.com.au/

[7] https://www.nbnco.com.au/content/dam/nbn/documents/about-nbn/reports/reports-and-publications/Customer-experience-partnerships-and-connected-communities.pdf

[8] Telecommunications Act 1975 (Cth), http://classic.austlii.edu.au/au/legis/cth/num_act/ta1975214

[9] Telecommunications Act 1991 (Cth), http://classic.austlii.edu.au/au/legis/cth/num_act/ta1991214/

[10] https://www.infrastructure.gov.au/media-communications-arts/better-connectivity-plan-regional-and-rural-australia

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[13] https://www.infrastructure.gov.au/media-communications-arts/better-connectivity-plan-regional-and-rural-australia

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Assessing Australia's Progress towards a National Digital Communications Strategy at December 2022

TelSoc Broadband Futures Group

Abstract: This report, prepared by a working group of TelSoc, examines the progress during 2022 towards a national Digital Communications Strategy in Australia, using TelSoc's report on the need for such a strategy, first published in 2020, as a basis for the dimension upon which progress might be measured. TelSoc made a similar assessment of progress in 2021. The progress assessment is an important public statement that reflects TelSoc's beliefs in reporting and accountability in this important area of public policy.

Keywords: Digital Communications Strategy, Telecommunications Policy, Australia

Introduction and Background

TelSoc has advocated for a long-term bipartisan strategic framework to best ensure that all Australians are able to make effective use of world-class broadband services. TelSoc has committed to monitor and facilitate progress towards achieving such a strategy and to reporting on the nature and extent of the progress regularly.

TelSoc has considered how best to describe the strategy that it seeks, originally referring to a National Broadband Strategy and now considering that the term Digital Communications Strategy should be preferred because it avoids excessive emphasis on technological and supply-side dimensions at the expense of user requirements and capabilities.

As a means of assessing progress towards a national Digital Communications Strategy during 2022, TelSoc has used a gap analysis approach – that is, assessing the extent to which developments during the year have affected the gap between where Australia is, and where it ideally needs to be, in establishing and implementing a Digital Communications Strategy (DCS).

TelSoc

The Telecommunications Association (TelSoc) is an independent not-for-profit society registered as an incorporated association. TelSoc's purpose is to support the development of

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the telecommunications and related sectors and harness the potential of the sector for Australia's economic and social development. TelSoc does this by promoting public discourse and assessment of the key telecommunications and digital economy issues of the day through public forums, member newsletters and publication in the *Journal of Telecommunications and the Digital Economy*.

TelSoc Broadband Futures Group

In February 2019, the NBN Futures Project,[1] later renamed the TelSoc Broadband Futures Group (TelSoc BFG), was established by interested TelSoc members to examine in greater detail issues associated with the rollout of the National Broadband Network (NBN) and a range of related issues such as public policy settings in Australia for broadband, harnessing the potential to transform Australia to a digital economy and an online society, and equitable and fair access to broadband services.

In November 2020, the TelSoc BFG completed and launched its report, Towards a National Broadband Strategy for Australia, 2020-2030 (TelSoc NBS Report; Holmes *et al.*, 2020). The themes and proposals in this report are discussed in more detail below.

In December 2021, the TelSoc BFG published Assessing Australia's Progress towards a National Broadband Strategy at December 2021, using the themes and proposals in the TelSoc NBS Report as a framework. This report builds on the 2021 Report, particularly seeking to examine whether gaps then identified have been addressed. The BFG has been transformed within TelSoc and its work is being taken forward by newly established more specifically focussed working groups.

Executive Summary

During the first part of 2022, there was little further progress towards a Digital Communications Strategy (DCS). Largely, this was because of the impending Federal Election (held on 21 May 2022) and a general inability to gain sufficient attention to longer term issues, such as long term DCS imperatives, during the lead-up to an election in which policy and political focus was elsewhere.

With the change of Government, clearer indications of the possibilities for a DCS have emerged.

In particular, the incoming Minister for Communications, Michelle Rowland, has met with TelSoc representatives and committed that her Office will explore and scope the prospects for a DCS. This commitment has been met and from September 2022 discussions have been

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ongoing with a senior member of the Minister's Office on the issues. The discussions are continuing as at year's end and are encouraging.

While the Government has made a number of specific commitments to enhance the broadband network during its current term, there appears to be a recognition that a broader perspective needs to be taken for subsequent developments.

A number of other Government initiatives since the election have also added to the components needed for an overarching strategic framework, including:

- The joint letters from the Ministers for Communications and Finance in August 2022 to NBN Co and the ACCC, setting out the Government's expectations for the resolution of issues associated with NBN Co's proposed Special Access Undertaking, a long-term undertaking that will affect price, availability, and many other aspects of NBN Co's broadband service over the life of the network until 2040;
- The Statement of Expectations (SOE) published by the Ministers for Communications and Finance on 19 December 2022, which states the Government's intention to maintain NBN Co in public ownership and sets out the expectations of Government on the broad directions that NBN Co will take to achieve a range of social, economic and other goals associated with broadband service. The latest SOE replaces earlier statements that have been provided by the former Government; and
- NBN Co's Corporate Plan 2023 which was published on 20 December 2022 and sets out NBN Co's priorities and aims for 2023 and beyond.

There have been a number of announcements affecting specific programmes being undertaken by NBN Co or reviews by various bodies, such as the potential for LEOs which will be conducted by the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (the Department).

Some initiatives of the previous Government have either terminated or remain uncertain. They include:

- The Digital Economy Strategy (DES), which was launched in May 2021: It is not clear how the elements in the DES will be taken forward, if at all;
- The Joint Standing Committee on Broadband Services: The remit of this committee expired with the dissolution of the 46th Parliament in April 2022. No final report from the Committee has been published and it is unclear how and if its work will continue in some new form; and
- The Australian Broadband Advisory Council (ABAC): The remit of this body ceased on 30th June 2022. It is unclear how the work of ABAC might be continued.

The year 2022 has been one of change and of changing priorities, as well as of hope that initiatives since the election will lead to a more specific commitment to a coherent, overarching

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Digital Communications Strategy in 2023. The prospects are considered by TelSoc to be positive, notwithstanding uncertainty on much of the detail.

Towards a National Broadband Strategy for Australia: 2020–2030 (TelSoc NBS Report)

The TelSoc NBS Report (Holmes *et al.*, 2020) provides a framework for an assessment of the progress towards a Digital Communications Strategy in 2022.

The TelSoc NBS Report was launched in November 2020. It argued for adopting a clear vision and objectives for broadband access and usage in Australia and for a long-term, coordinated, bipartisan national strategy to achieve the best social and economic outcomes as Australia further transforms to a digital economy within an online society. The TelSoc NBS Report recognised that the NBN would be a central part of such a strategy, especially in the earlier years, but that a comprehensive policy framework needed to recognise the contribution of mobile and other access technologies and provide a strong demand-side emphasis.

Recognising the initial central role of the NBN, the Report was also concerned to ensure that NBN Co was not privatised either in the shorter term (next five years) or without substantial consideration of all of the issues that need resolution beforehand. The incoming Federal Government has given the assurance needed on this point.

The other elements highlighted in the TelSoc NBS Report were:

- Developing a bipartisan national strategy
- Vision and Objectives – clarity and general agreement
- Extending Social and Economic Benefits

  In recognising an increasing emphasis being given to realising the social and economic benefits of broadband services, particularly evidenced in the experiences during the COVID pandemic, the TelSoc NBS Report observed a number of requirements to ensure these benefits be achieved. including: a continuing “demand side” policy focus; a broad consideration of benefits across a range of applications, supported by underpinning inclusion; the generation of continuing research and discourse; and taking a long-term, effectively scaled, approach.

- Technology and technical pathways, including use of new technologies
- Finance, regulation and ownership

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Progress towards a National Digital Communications Strategy during 2022

In this section the programs, activities and initiatives that may be discerned as contributing to a DCS, given the lack of any overarching approach, are described, together with an assessment of the contribution of each towards achieving the proposals in the TelSoc NBS Report.

New Government's commitments

The major election commitments by the ALP during the 2022 federal election were substantially supply-side measures and included $650 million additional spending following the 2021 Regional Telecommunications Review, of which $400 million would be directed to improving regional mobile communications and coverage and $200 million towards upgrade and extension of regional fixed broadband networks, including increased fibre rollout.

In the October 2022 federal budget, the Government budgeted for $2.2 billion over the forward estimates for regional network improvement and $480 million for upgrading fixed wireless services. The budget included $2.4 billion over the 4 years of the forward estimates to enable an additional 1.5 million premises to have fibre access. Of this amount, $660 million will be directed to regional areas.

NBN rollout

In its 2022 Annual Report NBN Co reported 12.1 million premises ready to connect to the network, compared to 12 million at the end of FY2021. This figure has increased to 12.2 million as at December 2022.

In its 2022 Annual Report NBN Co reported 5.1 million premises able to access Home Ultrafast Speed services (between 500 Mbps and 1 Gbps download), compared to 3.9 million at the end of FY2021.

Network availability has improved in the past year to 99.95%.

Assessment:

NBN Co has continued to deliver further fibre and improved fixed wireless coverage and, partly through specific Government funding, committed to further improvement in both areas.

Some customers have noted improvements in rural and remote services through SkyMuster 2.0 satellite services, but there has been a shift by many customers (full figures not available) to LEO services, and to StarLink services in particular.

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Statement of Expectations of NBN Co

The Ministers for Finance and Communications issued a revised statement of expectations of NBN Co on 19 December 2022.

In summary, the 2022 Statement of Expectations:

- Sets out objectives for the NBN and NBN Co and for operating NBN Co on a commercial business;
- Sets out service expectations, including:
    - that NBN Co will upgrade technologies to expand access to peak download speeds of up to 1 gigabit per second for 90% of premises in the fixed line footprint; and
    - that NBN Co will efficiently implement upgrades to the fixed wireless network and improve satellite services and data allowances, and undertake proactive network planning to position itself to utilise emerging and future technologies to meet future demand, promote innovation and improve services and service delivery efficiency;
    - that NBN Co will promote equitable access through improving service and consumer experience, promoting access through improved digital inclusion for low-income households and other vulnerable groups, and connecting First Nation Australians;
    - that NBN Co will continue to improve connectivity to regional and remote Australians through expanding full fibre access to a further 1.5 million premises, including 660,000 in regional and remote areas; and
    - that NBN Co will provide all premises with download access speeds of 100 megabits per second (50 Mbps in the busy hour), with, specifically, 80% of regional and remote premises having download speeds of at least 100 Mbps by 2025.

Assessment:

The 2022 Statement of Expectations combines broad targets with specific ones. It is an important component part of any national Digital Communications Strategy, and important in itself.

However, many of the expectations need to be operationalised and provided with more specific time-bound targets and milestone expectations.

NBN Pricing and Special Access Undertaking (SAU)

The SAU process is still continuing at the end of 2022.

The Ministers for Finance and Communications wrote to the ACCC and to NBN Co in August 2022 with a view to providing guidance that might assist in the resolution of fundamental

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issues, such as the extent to which past accumulated losses might need to be recovered from future revenues. The guidance was intended to help development of wholesale prices that might be commercially acceptable to the industry, meet the regulatory requirements for approval by the ACCC and ultimately deliver affordable broadband services in the retail market. A key aspect of this letter was that the commercial returns expected from NBN Co might be relaxed and could take account of the Government's intention not to privatise NBN co in the foreseeable future. Nevertheless, NBN Co would be expected to maintain an investment grade credit rating.

NBN Co has provided a revised SAU in November for consideration by the ACCC and the industry. It is based on an accelerated removal of CVC (volume) components in service charges and recovery of $12.5 billion of accumulated losses (ICRA) rather than the full amount (circa $32 billion in 2022).

Assessment:

The Ministerial intervention has been very important, and the further revisions to the proposed SAU have reasonable prospects for being approved by the ACCC in 2023 following further industry consultation. The SAU is a long term (40 year) commitment and its resolution will therefore have significant strategic implications for broadband take-up and use in Australia.

Other Infrastructure Developments

5G Rollout

The roll-out of 5G continued during 2022 with little noticeable effect on broadband usage. This is as expected given that most of the changes from 4G to 5G are within the network, such as control and user plane separation (CUPS) and network function virtualization (NFV). All mobile network operators (MNOs) offer a fixed 5G service as an alternative to NBN Co's services, but these services only appear to be displacing the NBN on the fringes. The substantial use of mobile services for online access remains via 4G at present.

MNOs are investigating new 5G features such as slicing, but this is still at the stage of trials rather than of providing commercial services. Telstra might exploit wireless-wireline convergence to support both mobile and NBN services from a common 5G core. There is no sign that MNOs are considering using PONs for 5G midhaul (between the gNB-CU and the gNB-DU).

The most significant change will be the establishment of neutral hosts in regional and remote areas, most likely using multi-operator core networks (MOCNs). The Government is currently investigating how it will implement this policy, which was part of its election manifesto. Given

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that each MNO using a MOCN must contribute spectrum to be shared with other participating MNOs, the outcome will have implications for spectrum policy.

LEO (Low Earth Orbit) Satellites

The Government is by default adopting a laissez-faire approach to LEO services, i.e., it is allowing them to operate without significant regulation. Starlink offers services in Australia, and OneWeb has established a number of distributors. However, the government is reviewing its position through a Departmental working group.

Assessment:

A comprehensive strategy is needed to ensure that all technologies and platforms for the provision of broadband services are fully utilised. The proposed review by the Department working group of LEOs will be an important part of this.

Digital Economy Strategy

The Digital Economy Strategy (DES) was developed by the Digital Technology Taskforce, within the Department of Prime Minister and Cabinet (PM&C) and launched in May 2021 in association with the 2021 Federal Budget. However, it has not been taken further by either the former Government or the current Government.

Assessment:

TelSoc included an assessment in its submission to the Digital Technology Task Force to extend and deepen the DES.[2]

TelSoc considers the DES to be a potentially important statement by Government because it attempts to be strategic and to take a longer-term view (albeit for 10 years) of issues and programs to address them. However, it is not comprehensive enough to be a National Strategy of the kind envisaged in TelSoc's NBS Report.[3]

Australian Broadband Advisory Council (ABAC)

ABAC Expert Working Groups (EWG) produced a number of important sector reports during 2022, namely:

- Health EWG: Report, January 2022
- Creative Industry EWG: Position Paper, March 2022
- Construction EWG: Construction Tech Scoping Study, March 2022

The remit of ABAC terminated on 30 June 2022 and there has been no statement from the new Government on whether and how its work might be continued.

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Assessment:

TelSoc's assessment from the end of 2021 still applies. Many of the recommendations are well aligned with the recommendations in the TelSoc NBS Report. It is not at all clear where responsibility lies to take these recommendations further and to turn them into actionable programs that can be specifically funded and/or managed. The members of former ABAC expert working groups are unlikely to perform that role.

ABAC has indicated that the purpose of its work is to start conversations leading, hopefully, to more concrete action plans in many areas. But this approach runs substantial risks of fading away without result, potential losing the advantage of substantial work and valuable insights in the reports.

Regional Telecommunications Review

The 2021 Regional Telecommunications Review: A step change in demand[4] was tabled in parliament in February, with a Government response in March.[5] The new Government subsequently released its **Plan for Better Connectivity for Rural and Regional Australia** during the 2022 Commonwealth election, taking up a number of the Review's recommendations.[6]

The Review identified four themes:

1. The 'Patchwork Quilt' of connectivity
2. Reliability, resilience and redundancy
3. The demand for data, and
4. Connectivity literacy and digital inclusion

in which were identified 16 key findings, leading to 12 Recommendations in regard to:

1. Longer term approach to regional communications infrastructure anddigital skills
2. Enhanced Connectivity Investments
3. Regional Telecommunications Resilience
4. Emerging Technology Trial
5. Connectivity Literacy
6. NBN Co regional delivery
7. Network Performance and Reliability
8. Adequacy of USO/USG
9. Mobile Services
10. Shared Network Access
11. Indigenous Communities
12. Affordability

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Assessment:

The Regional Telecommunications Review, conducted by a newly-appointed Committee every three years, and its associated Government responses stands as one of the most overtly strategic elements in the present Digital Communications System, with its Terms of Reference including being a "review of the adequacy of telecommunications services in regional, rural, and remote parts of Australia" and identifying "whether changes are warranted to existing Government policies and programs to ensure they continue to be effective, fit for purpose and are maximising the social and economic potential from existing and emerging technological advances".

The Review Committee places its considerations within the framework of the Digital Economy Strategy, noting "It is clear that regional, rural and remote Australia will have a vital part in realising the DES goals".

As such, it is an important monitoring, review and regenerative element of an ongoing DCS, but it also stands to mark the history of sporadic strategic initiatives and the lack of a substantial, agreed bipartisan and continuous strategic approach. The Digital Economy Strategy it references is now of unknown status, and the Review process itself lacks continuity in not taking the previous Review as a starting point for examination.

An enormous amount of work is embraced in the six-month process of issues identification, consultation and refinement of recommendations. As a long-term DCS process is established the RTR, required by legislation, should continue to be a central component, having relevance beyond its important regional and rural focus.

It is significant that its ToR point to ensuring the realisation of the social and economic benefits of the telecommunications infrastructure, although the Review seems not to have fully opened up the nature of these benefits and the requirements for support, still having a largely supply-side emphasis (with notable exceptions in its recognition of the underlying requirements of inclusion, affordability and connectivity). More specifically, what is required to get the greatest benefits in health, education, government services, home working, social communications, agriculture, business and industry in regional and rural areas? The broad answer of the Review is the capacity to handle hugely increased demand for data. The full story may require more attention than a concentrated six-month review.

Joint Standing Committee on NBN

The remit of the JSC expired with the dissolution of the 46th Parliament in April 2022. No final report from the Committee has been published and it is unclear how and if its work will continue in some new form in the 47th Parliament.

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Assessment:

The main role of the JSC appears to have been to provide a forum for discussion of NBN rollout and performance. There have been other forums in which these matters have been able to be discussed, such as in the submissions to the Regional Telecommunications Review. The absence of the JSC seems to have made little difference since it was not pursuing an explicitly policy agenda, nor did it claim to be contributing to the development of a strategic framework for digital communications or broadband.

Inclusion and Affordability

There have been no major reorientations of approach to Inclusion and Affordability in 2022.[7] Various organisations have repeated measurement and reporting activities – including ACMA, Good Things Foundation and auDa. The anticipated Indigenous Digital Inclusion Plan initiated by the previous Government did not emerge, although it is understood to still be under consideration. The next version of the Australian Digital Inclusion Index will be released in July 2023.

Two major research projects have continued and provided interim reports – the ARC Centre of Excellence for Automated Decision-Making & Society at RMIT's Mapping the Digital Gap project, focused on First Nations communities,[8] and the QUT Digital Media Research Centre's Advancing digital inclusion in low-income Australian families.[9]

The Government has taken several initiatives, promising the provision of free internet access for 12 months through NBN for 30,000 families to improve use in education and establishing a First Nations Advisory Committee. The SoE more explicitly places an obligation on NBN Co to consider issues of Inclusion and Affordability.

The Good Things Foundation called for the establishment of a national digital inclusion strategy, which was echoed by the Australian Digital Inclusion Alliance with a specific emphasis on the development of a standard Digital Capability Framework.

Assessment:

The matters identified in the 2021 Assessment remain, namely: agreement about the extent to which digital exclusion and problems of affordability are significant issues; the establishment of accepted national benchmarks; and the need for a co-ordinated approach.

Apart from the SoE and the limited free access to NBN, there is no evidence of the issues of inclusion and affordability being addressed or progressed by the Government in any direct way during 2022, although the Minister has stated digital inclusion is a major concern.

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Assessment of Progress in terms of TelSoc NBS Report Proposals

As for last year, there are developments which indicate underlying strategic perspectives. Principal among these are:

- a decision on the public ownership of NBN Co. which settles a substantial uncertainty for the time being
- other directional elements of the new Statement of Expectations for NBN Co.
- the tabling of the Regional Telecommunications Review
- exploring neutral hosting, which suggests reconsideration of how market approaches may be directed towards provision of essential services.

Most Government actions have, however, largely been addressing supply-side enhancements of the system as it stands, rather than reflecting a conception of how an overall system, embracing multiple access technologies and linking supply and demand sides, might evolve.

The Minister's stated disposition to consider a long-term strategic approach, focusing on the social and economic benefits of the system, does suggest this situation could soon change.

Rather than repeating last year's detailed examination of unfulfilled components of a strategic approach, we have chosen to rest on this prospect and simply do a brief update of last year's assessment in the following table.

An appropriate test question for the digital communications system, given our recent experience with COVID, could be: are we getting better prepared for managing living with a future pandemic with the support of the digital communications system?

While digital inclusion and capability are key components of this preparedness, so is the viability of applications, including preparedness of people to use them, in health, education, government services, home working, social communications, agriculture, business and industry and so on. While we recognise many efforts are being made, we do not have the research capacity to track them as a fully-fledged DCS should do.

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Table 1. Assessment of Key Gaps

Strategic Component	Key Gaps 2021	Proposed Action	Status 2022
Bipartisan agreement on developing a National DCS	Elements of a national strategy can be observed, but there is **no explicit strategy or bipartisan support for one at this stage.** No apparent **continuity/cohesion** of policy development, implementation, monitoring and review.	Ultimately the leadership in developing a National DCS and achieving bipartisan agreement must come from the Federal Government. The task it includes the important role of coordinating the various activities and initiatives of State, territory and local governments. The Federal Government should establish the coordinated institutional structure, with clear accountabilities, to ensure continuity and cohesion of policy development, research, monitoring and review.	The new Minister has indicated a disposition to the development of a strategy in some form, and her office is scoping the matter.
Vision and Objectives *Vision*	Statement proposed, but lacks **a sense of national intent.**	Further work should be undertaken by the Federal Government to expand and strengthen existing statements of vision in the proposed National Broadband Strategy.	No further work apparent
Objectives	**Statement of Expectations for the NBN** contain key constructs which need clarification for monitoring through appropriate measures and standards; including: • *maximise the economic and social benefits of the NBN* • *current and future needs of Australians, wherever they live* • *reliably* • *affordably* • *digital capability* • *inclusion* These and objectives such as in Digital Economy Strategy need application **to the broadband system as a whole**, including mobile service provision, with NBN's role delineated within that.	These key constructs need to be given meaningful targets and measures, to be effective and to define accountabilities. Note however that it cannot be a matter only for NBN Co to achieve, since they are operating at the wholesale level in the broadband market. Achieving these objectives will involve the whole system of industry, Federal Government and other policy-making bodies at State level.	A new Statement of Expectations has been developed but only recently published (19 December 2022). In August 2022 the Ministers for Finance and Communications have written to the ACCC and NBN Co about the Government's expectations in relating to developing longer term pricing for wholesale broadband services.

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Strategic Component	Key Gaps 2021	Proposed Action	Status 2022
	Establish accurate, regularly updated **national databases** of broadband availability, usage and affordability Establish regularly updated **'gap analysis'** of activities and timing required to advance current status of Australian broadband to the level of its aspirations.	The Federal Government should establish institutional arrangements to ensure that research, monitoring and data collection is implemented in a coordinated and comprehensive manner, together with regular assessments.	There is no evidence of a consolidated and comprehensive approach at this stage
Extending Social and Economic Benefits			
Demand-side policy focus	**User-centred approaches** need to be built in to policy and research (use construct of "effective use" as core	Methods for ensuring user-centred approaches need to be established.	There is no evidence of systematic attention to this focus.
Broad consideration of social and economic benefits	Strong focus on **digital inclusion and affordability** Comprehensive approach to applications deployment, development and support	Review of Inclusion and Affordability of Broadband Services should be conducted by the Federal Government.	The Minister is placing strong emphasis on the issues in digital inclusion, but so far, no programmatic approach has emerged. Focus on applications may be reduced through the termination of ABAC and, apparently, the Digital Economy Strategy
Long-term coordinated activity	Ensure **long-term research and policy development**	Devise and establish a Broadband Institute or similar agency. This links with the institutional focus referred to above.	No relevant action at this point.
Technology Pathways			
Establishment of future targets for moving to data speeds of 100/50 and 1000/500	Apparent acceptance, but ubiquitous nature in the longer-term needs to be made **explicit target**	These targets, together with clearer descriptions of the service characteristics that need to be better and more comprehensively specified, need to be built into the National Broadband Strategy.	Targets increasingly underlie policy decisions but are not explicit and addressed through an overarching strategy.
Establishment of pathways towards targets	Technology pathways to long-term objectives for a **fixed-mobile-wireless-satellite system**		Department is establishing a working group on LEOs. In response to the RTR the Government has included specific supply side funding for mobile coverage, fibre extension and fixed wireless development in regional areas.

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Endnotes

[1] https://telsoc.org/blog/nbn-futures-project

[2] TelSoc, *Submission about the Digital Economy Strategy*, August 2021.

[3] The DES does, however, seek to deal with new technologies affecting digital economy futures, such as artificial intelligence. The assessment relates only to its coverage of longer term social and economic dimensions of broadband.

[4] https://www.infrastructure.gov.au/department/media/publications/2021-regional-telecommunications-review-step-change-demand

[5] https://www.infrastructure.gov.au/department/media/publications/australian-government-response-2021-regional-telecommunications-independent-committee-report-2021

[6] https://www.infrastructure.gov.au/media-communications-arts/better-connectivity-plan-regional-and-rural-australia

[7] Note that as part of the SAU variation in November 2022 NBN Co has committed to the establishment of a 'Low Income and Digital Inclusion Forum', to meet initially in March 2023: https://www.nbnco.com.au/rsps/industry-consultation/low-income-and-digital-inclusion-forum. In addition, a 'School Student Broadband Initiative' has been announced by the Australian Government in conjunction with NBN Co, service retailers and other industry participants, commencing in February 2023: https://www.infrastructure.gov.au/media-communications-arts/internet/national-broadband-network/school-student-broadband-initiative-ssbi. In both cases, the substantive programs associated with these 2022 announcements are for delivery in 2023.

[8] https://www.admscentre.org.au/mapping-the-digital-gap/

[9] https://research.qut.edu.au/dmrc/projects/advancing-digital-inclusion-in-low-income-australian-families-2/

New Regulation on Telecommunications and Over-the-Top Platforms in Indonesia

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Abstract: Qualified telecommunication facilities and infrastructure complement the convergence of technology applications. One of the most widely used by the public is Over-the-Top (OTT) platforms. However, it raises a new problem as domestic operator service providers are aggrieved by OTT platforms that are gaining more popularity despite their unclear legal standing. The Indonesian government responded by issuing a number of regulations. This study describes the regulations governing telecommunications and OTT platforms in Indonesia as well as pointing out the consequences and challenges of the issuance of these new regulations by taking into account the conditions of the national electronic system. This study applied a qualitative method with a normative juridical approach. Data was collected through an online literature review with analytical descriptive data processing. The results of this study elucidate the four latest regulations governing the telecommunications service sector and OTT platforms. These regulations are complementary, even though digital taxes are still seen as challenges in the form of whose outcomes are considered to have not touched the Indonesian people in general. In this instance, it demonstrates that regulations are complementary, as is the case with natural law theory, and that the law adapts to social life.

Keywords: Telecommunications, Regulations, OTT Platform.

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Introduction

Continual innovations in the technology industry indicate an increase in digital media use in daily life (Safiranita Ramli *et al.*, 2019). The growing use of digital media in everyday life is largely driven by continuous innovation in the technology industry. In comparison to the era prior to digital technology, it is undeniable that the industrial revolution 4.0 era has brought numerous global benefits, including to the Indonesian people, due to increased interconnectivity and artificial intelligence. Indonesian President, Joko Widodo, stated that the COVID-19 pandemic had indirectly initiated a digital disruption era in Indonesia from which innovative forces originated in the technology sector and this will continue even after the pandemic ends (Widodo, 2021). The rapid development of technology occurs in all sectors without recognizing national boundaries (Ramli, 2006). Amidst the COVID-19 pandemic that affects the global community, technology emerges as a tool that maintains or even improves human productivity. Currently, the world has entered Industry 5.0, which, in principle, continues the prior achievements and advances with a central human role or what is described as Cyber-Physical Human Centred (CPHC).

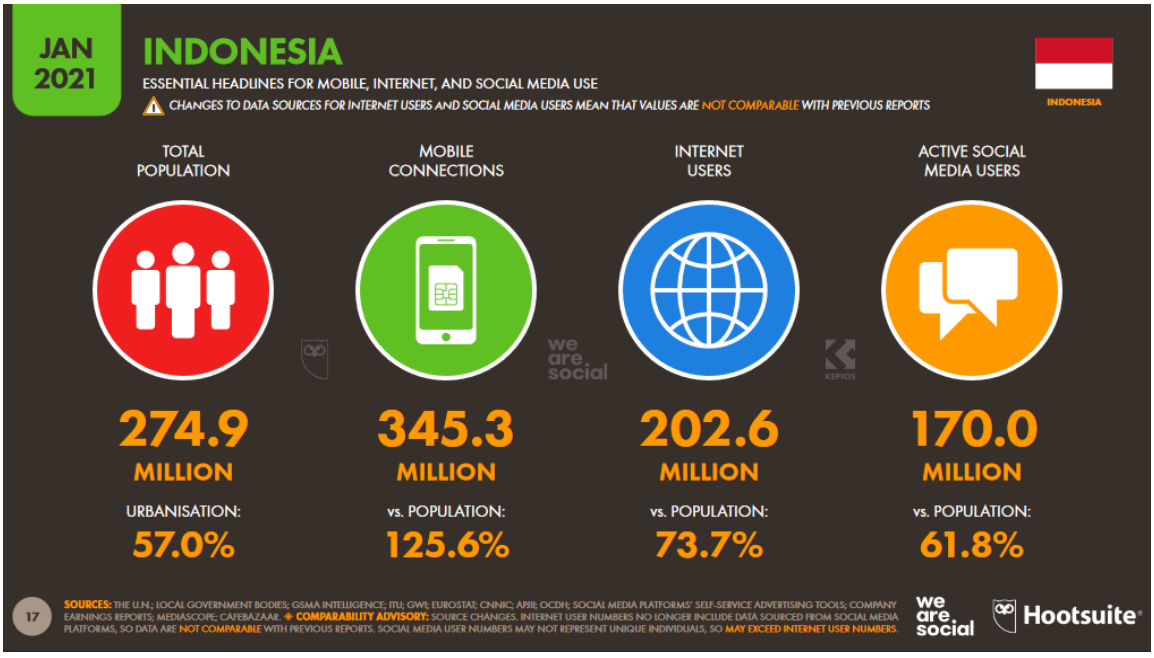

Figure 1. Indonesian Digital 2021 (We Are Social, Hootsuite, 2021)

Information technology's dynamic and broad reach leads to changes in habits towards the use of the Internet in all sectors of life. In this regard, Indonesia guarantees the right to use information technology as stipulated in Law Number 19 of 2016 in the Amendments to Law Number 11 of 2008 on Information and Electronic Transactions, especially, in the Elucidation of Article 17, paragraph (1) of the Law. From the Elucidation of the said Article, it can be

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understood that everyone has the right to use and relish the benefits of information technology. Figure 1 highlights the use of information and technology in Indonesia.

The aforementioned data shows that, as of January 2021, there is a huge number of cellular network and Internet users exceeding the total population. In fact, cellular users alone can exceed the population since many are using more than one SIM card. Furthermore, the number of active users of social media also shows that there has been a convergence in the use of conventional media to the use of Internet media at all levels of Indonesian society; this shows that humans and the Internet network live in complementarity. One tangible form of media convergence is over-the-top (OTT) platforms. This suggests that the best option for regulation relating to OTT services in Indonesia is to encourage the development of local OTT services; in order for foreign OTT services to distribute taxes to the Indonesian government, they must have a representative office and a Permanent Establishment in Indonesia.

An OTT platform is an application that provides services in the digital Internet world (Ramli *et al.*, 2020). Examples of OTT platforms that are widely used in Indonesia are YouTube, Netflix, Instagram, Facebook, WhatsApp, Twitter, and others. Until recently, the OTT platform has become one service that is rapidly developing as it is widely used by the public, especially the millennial generation. In addition to facilitating communication, OTT offers services that attract public interest using communication tools such as smartphones, to simply enjoy "surfing" on social media.

In providing convenience and comfort for Indonesian users, OTT service providers are mostly foreign players who have entered the business sector that had become the main source of income for domestic cellular operators: the main source of revenue for domestic mobile operators is their retail customers. OTTs earn revenue from advertisers. (Hartana, 2018). This raises a problem, as many domestic operator-service providers feel aggrieved by the OTT platforms' existence that is becoming more popular with the public but whose legal standing is still unclear. The main reason is the loss of revenue suffered by domestic operators as OTTs provide similar services (voice, SMS) for free; not to mention the lack of restrictions on content provided by OTT service providers — negative content is often found disseminated on OTT platforms. Meanwhile, in the early 2000s, SMS was one of the biggest revenue generators for mobile operators.

To overcome these problems, the Indonesian government issued a number of regulations regarding telecommunications and OTT platforms. On this basis, this study aims to elucidate the regulations governing telecommunications and OTT platforms in Indonesia, as well as to describe the consequences and challenges of the issuance of these new regulations by taking into account the conditions of the national electronic system implementation. This initiative

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is expected to facilitate government and operator cooperation in the telecommunication sector.

Research Method

In this article, the authors used a qualitative research method with a normative juridical approach. The qualitative method, as referred to by Bogdan and Biklen, is a research procedure that produces descriptive data in the form of writing or verbal outputs from people and observable behaviour (Bogdan & Biklen, 1982). In accordance with a normative juridical approach, this study refers to the application of legal rules and norms contained in positive laws or national regulations, especially those related to telecommunications and OTT platforms, which are then adapted to the current situation.

Data collection was carried out through online and offline literature reviews. Furthermore, this study uses secondary data sources consisting of primary legal materials in the form of Regulation of the Minister of Communication and Information Number 5 of 2021 on Telecommunications Operations; Government Regulation Number 46 of 2021 on Postal, Telecommunications, and Broadcasting; Government Regulation Number 71 of 2019 on the Implementation of Electronic Systems and Transactions; Circular Letter of the Minister of Communication and Information Number 3 of 2016 on Provision of Application Services and/or Content through the Internet. The secondary legal material in this article was in the form of related literature review. In addition, tertiary legal materials were applied in the form of legal journals, the Indonesian Dictionary, as well as articles and data from the Internet. Subsequent to the data collection, the authors processed and analysed the data in more depth and compiled the overall conclusions, which are then presented in this article.

Findings and Discussion

Regulations in Indonesia Governing OTT Services and Telecommunication Sector

Prior to utilizing OTT services, most Indonesian people engaged in linear TV shows and non-OTT services such as Short Message Service (SMS) (Sri Ariyanti, 2018). On the contrary, nowadays, as OTT platforms proliferate in Indonesia, there is a shift in people's preference to using OTT platforms. The OTT platforms that dominate the telecommunications market come from abroad or foreign countries. This is certainly a serious problem for domestic operator service providers as Europe and the Asia-Pacific region, including Indonesia, are the areas where telecommunication operators are most affected by the thriving of OTT platforms ('OTT Platform success') (Ningrum, 2012). The estimated losses experienced by telecommunications

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operators due to the OTT services' emergence in 2016 alone could reach Rp 555 trillion or 58 billion US dollars.

Therefore, the Indonesian government drafted several regulations to manage the telecommunications service sector and OTT services. The goal of this OTT regulation is to give telecommunication operators legal protection from all illegal activities in the sector, particularly when it comes to content infringement that violates rules and laws governing OTT-based businesses (Ningrum, 2012).

Circular Letter of Minister of Communication and Information Number 3 of 2016 on Provision of Application and/or Content Services through the Internet (Over the Top)

The massive use of OTT platforms became the forerunner to the issuance of the Circular Letter of the Minister of Communication and Information of the Republic of Indonesia Number 3 of 2016 on Provision of Application and/or Content Services through the Internet (Over the Top) (Circular Letter of Minister of Communication and Information on Provision of OTT Application). While preparing more rigid regulations on OTT services, this Circular Letter was issued by the Ministry of Communication and Information to educate the public and provide understanding to OTT service providers and telecommunications operators so that they are prepared to comply with regulations that will be enforced subsequent to this Circular Letter. The issuance of Circular Letter on Provision of OTT Application is expected to provide adequate time for OTT service providers to prepare everything prior to the regulations governing OTT taking effect.

Referring to Point 5.1 of the Circular Letter on Provision of OTT Application, OTT media is divided into three parts, namely (Abimayu Rhesa Agatha, 2020):

1. **Services in the Form of Applications Using Internet Media**. Utilizing telecommunications networks using the Internet for communication services, either in the form of short messages (chat), video or voice calls, application media to play games, financial and commercial transaction services, and their derivatives;
2. **Digital Content Services via the Internet**. They provide digital information in the form of writing, images, sound, music, video, and animation, some and/or all of which are used by downloading and streaming using telecommunications services via the Internet; and
3. **The provision of Services in the Form of Applications or Content via the Internet**. It is a provision of application services and/or content services utilizing the Internet.

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Based on the aforementioned description, it can be concluded that the OTT platform is a medium that provides application or content services; OTT is an application that allows users to chat, make a video or audio conversations, and view or listen to content. Even though at that time, the term 'OTT' was still relatively new, the issuance of the Circular Letter on Provision of OTT Application can make it easier for the public to understand the scope of OTT.

Furthermore, Point 5.5 of Circular Letter of the Minister of Communication and Information Provision of OTT Application describes OTT service providers' obligations, including complying with the laws and regulations on OTT services operation, as well as paying attention to and filtering the content provided so as not to violate the prevailing laws and regulations. It is interesting to point out the provisions in Point 5.5.5 of this Circular Letter, which explains that OTT services must use a national payment gateway with an Indonesian legal entity. With this provision, transactions in OTT services can be tracked by the Directorate General of Tax. Further, the prohibition of content provided by OTT services is regulated in Point 5.6 of the Circular Letter.

Even though it can be used as a reference in defining OTT services as well as their obligations and content arrangements, this Circular Letter has not yet been made into a Ministerial Regulation, thus the Circular Letter does not have permanent legal force (Abimayu Rhesa Agatha, 2020). Bearing in mind the importance of further regulations and policies, a regulation is formulated to understand and supervise OTT service implementation as a medium whose usage rate is escalating in Indonesia.

Government Regulation Number 71 of 2019 on the Implementation of Electronic Systems and Transactions

The issuance of Government Regulation Number 71 of 2019 on the Implementation of Electronic Systems and Transactions (Government Regulation on the Implementation of Electronic Systems and Transactions) automatically revokes the previous Government Regulation Number 82 of 2012 on the Implementation of Electronic Systems and Transactions. The regulation offers significant differences, one of which is that it stipulates an electronic system operator in two categories, namely electronic system operator in the public sphere and one in the private sphere (IndoTelko.com, 2021). This is to allow business actors to run their business as they already have a position that is clearly regulated in the legislation.

With regards to the aforementioned explanation, Article 2 paragraph (5) letter b of the Government Regulation provides the following.

> **Private Scope Electronic System Operator** as referred to in paragraph (2) letter b includes:

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b. **Electronic System Operators who have web portal(s), website(s), or application(s) in the network via the internet**.

Furthermore, the Explanation of Article 2 paragraph (5) letter b of the Government Regulation on the Implementation of Electronic Systems and Transactions states that:

> What is meant by "Electronic System Operator having web portal(s), website(s), or application(s) in a network via the internet" is **Electronic System Operator whose Electronic System is used in Indonesian territory, and/or offered in Indonesian territory**.

Based on all these provisions, it can be concluded that domestic and foreign OTT service providers are included in the scope of private electronic system operators according to the Government Regulation on the Implementation of Electronic Systems and Transactions. In other words, although the new Government Regulation does not explicitly mention the phrase "OTT service", business actors, especially OTT service providers, can be oriented to the provisions of Article 2 paragraph (5) letter b of the Government Regulation.

Furthermore, the electronic system operator in the private sphere, i.e., the OTT service provider, "*can perform the management, processing, and/or storage of electronic systems and electronic data in the territory of Indonesia and/or outside the territory of Indonesia*", as stated in Article 21 paragraph (1) of the Government Regulation. This provision has prompted pros and cons, as it is considered to threaten the OTT platform users' personal data security (Fauzan, 2019), considering that, until now, the Personal Data Protection Bill has not been ratified by the Indonesian government. In addition, law enforcement is deemed ineffective since foreign OTT service providers can hide behind the laws of their respective countries (CNN Indonesia, 2019). In addition, by allowing data processing and storage to be carried out outside Indonesian territory, foreign OTT companies have no obligation to invest in Indonesia and can still offer their services even though they are located outside Indonesian territory. This, of course, causes economic losses incurred directly by domestic business actors.

Government Regulation Number 46 of 2021 on Postal, Telecommunication, and Broadcasting

In responding to current problems related to the OTT platforms, the government continues to innovate: one of the efforts is by issuing Government Regulation Number 46 of 2021 on Postal, Telecommunications, and Broadcasting (Government Regulation on Postal, Telecommunications, and Broadcasting). This policy is a follow-up regulation of Law Number 11 of 2020 on Job Creation. This is considered a bright spot in the regulation of OTT services in Indonesia. In general, foreign OTT companies do not have an official form of cooperation

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with domestic telecommunications operators. Of the many laws and regulations governing the telecommunications sector, it is only in this Government Regulation that cooperation between domestic operators and OTT service providers is governed. This Government Regulation needs to regulate cooperation between domestic operators and OTT service providers. Furthermore, Article 15 paragraph (1) of the Government Regulation on Postal, Telecommunications, and Broadcasting regulates the following.

> (1) Business actors, both national and foreign, who carry out business activities through the internet to users in the Indonesian territory, in conducting their business cooperation with Telecommunication Network operators and/or Telecommunication service providers, are carried out based on fair, reasonable and non-discriminatory principles, as well as maintaining services quality in accordance with the prevailing laws and regulations.

The explanation of the article states as follows:

> What is meant by "business activities via the internet" is Over-The-Top (OTT) in the form of substitution of Telecommunication services, audio and/or visual content service platforms, and/or other services stipulated by the Minister.

Referring to the aforementioned description, the government stipulates that OTT companies, both domestic and foreign, cooperate with telecommunications operators fairly in order to maintain the service quality provided to the public (Jati, 2021). This provision is the answer to the problem of OTT platforms, especially for foreign companies that do not have a Permanent Establishment in Indonesia but still offer OTT services to Indonesians. This is often problematic as the services accessed are abroad, while the customer market share is domestic, hence escalating Indonesian international bandwidth spending (Media Indonesia, 2021). In addition to draining the country's foreign exchange, domestic operators also experience economic losses as they are charged high fees, even though it is the OTT companies that are making big profits.

Not only domestic operators and business actors, but also the government participates in realizing good telecommunications operations by providing facilities in the form of land, buildings, and/or passive telecommunications infrastructure to be used by telecommunications operators, in accordance with Article 21 paragraph (1) of the Government Regulation on Postal, Telecommunications, and Broadcasting. Then, for the sake of the national interest and improving service quality, the government, represented by the Ministry of Communication and Information, can manage traffic through telecommunications operators, in accordance with Article 15 paragraph (6) of the said government regulation (Jati, 2021). One aspect that is monitored in traffic management is the content provided by OTT

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services, because, as is widely known, there are many OTT platforms that distribute negative content. The negative content in question is content that is contrary to applicable laws and regulations, for instance, immoral content and content that is related to sentiment discussion on SARA (ethnicity, religion, race and intergroup). This activity is deemed to produce many benefits for various parties. Then, referring to the Elucidation of Article *a quo*, traffic management is carried out in accordance with the principles of fair business competition as well as the prevailing laws and regulations.

The cooperation policy between business actors and telecommunications network operators excludes individual business actors who are owners of social media channels, content platform channels, marketplace channels, and other types of channels. This exclusion provision aims to provide space for creativity by them. This demonstrates that individuals are excluded from the scope of the legislation, and it can be said that it is only for business actors who are individuals and not companies.

Regulation of the Minister of Communication and Information Number 5 of 2021 on Telecommunication Implementation

As at the time of writing, this regulation is the latest telecommunications policy, issued on 1 April 2021. In the Regulation of the Minister of Communications and Information Number 5 of 2021 on Telecommunication Implementation (Regulation of the Minister of Communications and Information on Telecommunication Implementation), OTT services are regulated in Chapter V under the title of Business Activities through the Internet. The definition of a business actor, which in this case is an OTT service provider, is similar to the definition of a business actor in the Government Regulation on Postal, Telecommunication, and Broadcasting, as well as the form of business activity, and the terms of cooperation between telecommunication operators and OTT service providers.

What distinguishes the Regulation of the Minister of Communication and Information on Telecommunication Implementation from the Government Regulation on Postal, Telecommunication, and Broadcasting is that the former provides further provisions on the criteria for the significant presence of OTT service providers. The criteria in question are the percentage of traffic used by OTT service providers greater than or equal to 1% (one per cent) of domestic traffic, and/or having 1,000,000 (one million) or more active daily users in Indonesia within a period of three months. In addition, the Ministerial Regulation has refined the rules on OTT services with the provision of Internet of Things (IoT) services, in Article 12 of the said Ministerial Regulation. A significant matter is also related to article 11 paragraphs (1), (2) and (3) of the Ministerial Regulation on Telecommunication Implementation. This provision provides legal certainty for collaboration to occur between OTT and national

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Telecommunications Operators; otherwise, the telecommunications Operators can manage traffic to maintain the service quality (Quality of Service/QoS).

Consequences and Challenges of Implementing Regulations Governing the Telecommunications Sector and OTT Services in Indonesia

The enactment of the Circular Letter of the Minister of Communication and Information on Provision of OTT Application; Government Regulation on the Implementation of Electronic Systems and Transactions; Government Regulation on Postal, Telecommunication, and Broadcasting; and Regulation of the Minister of Communication and Information on Telecommunications Implementation has greatly affected the telecommunications service sector, particularly OTT services operation. Broadly speaking, regulations on telecommunications and OTT services, in particular, the Government Regulation on the Implementation of Electronic Systems and Transactions have had a significant impact on the operation of the electronic systems. This is due to the provisions of cooperation between telecommunications operators and OTT service providers, both domestic and foreign. With the implementation of the aforementioned regulations, it is expected that this will overcome the longstanding problem between domestic operators and OTT service providers. Equally importantly, OTT services content can be better managed by adjusting the aforementioned laws and regulations.

Nevertheless, there are challenges that must be addressed promptly, namely those related to tax. With all these regulations, especially the Government Regulation on Postal, Telecommunication, and Broadcasting, another critical aspect is income tax from OTT platforms and foreign digital companies (CNBC Indonesia, 2021). In response to this problem, the Ministry of Communication and Information conjointly with the Ministry of Finance can realise revenues for the State from the digital industry through the OTT platform income tax and foreign digital companies. This is important because, when referring to the problems of foreign versus domestic OTT platforms, there is an imbalance in terms of tax payment obligations, where it is the domestic OTT platform that suffers. It is expected that this issue can be resolved with further policies regarding digital industry taxes that are applied equally between domestic and foreign OTT service providers.

It is important to note that OTT services are cross-border beyond jurisdiction. Thus, extraterritorial jurisdiction application is relevant. The Indonesian government grants freedom for OTT service operation as long as it is registered; hence, the registration regime is opted for over a complicated licensing regime. This is because the government recognizes the OTT benefits for the public. In the Indonesian legal system, telecommunication companies are

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encouraged to mutually collaborate with OTT operators. As telecommunication infrastructure providers, telecommunication companies have lost the market for voice and SMS, but, as digital technology develops, they have gained the market for Internet quota packages. OTT and telecommunication companies' cooperation is critical to create a good quality of service for telecommunications.

Conclusions

The dynamic and broad reach of information technology supports the rapid change in people's habits towards the use of the Internet in all sectors of life. There has been a convergence phenomenon from the conventional media to Internet media use at all demographic levels in Indonesia. One of the tangible forms of media convergence is the use of the OTT platform, an application that provides services in the digital Internet world. Besides providing convenience and comfort for its users, OTT, which is dominated by foreign players, has entered the business sector that was the main source of income for cellular operators. Responding to this problem, the government made a number of regulations in the telecommunications service sector, especially OTT services.

The regulations include:

- Circular Letter of the Minister of Communication and Information Number 3 of 2016 on Provision of Application Services and/or Content through the Internet (Over the Top);
- Government Regulation Number 71 of 2019 on the Implementation of Electronic Systems and Transactions;
- Government Regulation Number 46 of 2021 on Postal, Telecommunications, and Broadcasting;
- Regulation of the Minister of Communication and Information Number 5 of 2021 on Telecommunication Implementation.

In general, regulations on telecommunications and OTT services have had a significant impact on the electronic systems' operation. This is due to the provisions of cooperation between telecommunications operators and OTT service providers, both domestic and foreign. In addition, the content of OTT services can be better managed by fine-tuning the laws and regulations.

The presence of regulations related to telecommunications and OTT services, however, still leaves challenges, namely income taxes from OTT platforms and foreign digital companies. In this case, it is expected that the Ministry of Communication and Information will cooperate with the Ministry of Finance so that Indonesia can also reap the benefit of the digital industry.

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Individual Adaptation in the Face of Enterprise IT Changes in the Organization

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Abstract: Individual adaptation plays an important role in using enterprise information technology (IT). In the life cycle of enterprise IT in the organization, various factors can change IT and its related work tasks. Therefore, users have to adapt to these changes. Since the use of information technology depends on the capabilities acquired through individual adaptation behaviours, it is essential to examine these behaviours in more detail. This study presents the factors affecting individual adaptation behaviours as a model. The results of the experimental test of the model show that technology experience and IT knowledge affect an individual's perception of task difficulty, and personality traits moderate the relationship between task difficulty and individual adaptation behaviours. One of the advantages of the proposed model is separating the roles of managers and users in different periods of enterprise IT adaptation. Also, paying attention to users' personal characteristics in explaining the differences in adaptation behaviours among employees is another advantage of this model.

Keywords: Individual Adaptation, Use, Enterprise IT, Work Tasks, Information Technology Features

Introduction

Individual adaptation behaviours play an important role in using enterprise IT by empowering employees (Bravo & Ostos, 2021). The use of enterprise IT — such as the Enterprise Resource Planning (ERP) system — is often mandatory in the organization (Elie-Dit-Cosaque, & Straub, 2011; McAfee, 2006; Rezvani, Dong & Khosravi, 2017). The reason is that organizations spend a lot to implement these technologies to meet industry standards and achieve the expected

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benefits (Bhattacherjee, Davis, Connolly & Hikmet, 2017; Wu, Choi, Guo & Chang, 2017). However, achieving the mentioned benefits is impeded by many problems due to the failure to use the features of these technologies optimally. The features of enterprise IT refer to "the building blocks or components" which help users undertake work tasks (Griffith, 1999). At the initial stages of adopting enterprise IT, the desired benefits of the organization are not usually realized due to the low use of IT features by users. Therefore, organizations seek to create conditions to use IT dynamically after initial adoption (Lumor, 2019; Hassandoust & Techatassanasoontorn, 2021; Carter, Petter, Grover & Thatcher, 2020). Accordingly, it is inevitable for organizations to face periods of change in the features of enterprise IT and the work tasks supporting it.

In enterprise IT, senior executives often make decisions about changes in the features and tasks (Bagayogo, Lapointe & Bassellier, 2014) as they support organizational processes (Techakriengkrai, Techatassanasoontorn, & Tan, 2021). In the face of these changes, users must acquire the required capabilities as soon as possible, ensuring that the service provision flow in the organization is not threatened (Tyre & Orlikowski, 1996). The behaviours that lead to acquiring these capabilities are known as individual adaptation behaviours. Studies conducted on individual adaptation behaviours (e.g., Bagayogo *et al.*, 2014; Barki, Titah & Boffo, 2007) have solely categorized these behaviours and have not examined the factors influencing them.

It should be noted that individual users perceive changes in technology features and work tasks in idiosyncratic ways and engage in individual adaptation behaviours based on them (Jasperson, Carter & Zmud, 2005). This issue, along with the users' differences in using enterprise IT (Fadel, 2012b; Grgecic, Holten & Rosenkranz, 2015), has led to the main question of the present study as follows:

> What factors explain the differences in individual adaptation behaviours in the face of enterprise IT changes and work tasks?

Failure to identify the factors influencing individual adaptation behaviours poses problems in planning and providing the resources needed to manage the different periods of change in the features of enterprise IT in the organization. We believe that providing a model can make it possible to actively manage enterprise IT in the organization. In this regard, with the help of the concepts proposed in Giddens' (1984) theory of structuration, a conceptual model is proposed to explain the reasons for the differences in individual adaptation behaviours. Then, the proposed model is tested using experimental data. Thus, the main contribution of this research is to provide a model to explain individual adaptation behaviours in different periods of enterprise IT adaptation in the organization. Changes in enterprise IT features may be

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caused by factors such as productivity improvement requirements, technological developments, and changes in laws and regulations.

The rest of this article is organized as follows: First, the literature related to adaptation behaviours is reviewed, and then the research model and hypotheses are developed. In the following sections, the research method and data collection method are discussed. Then, the results and findings of the research through the experimental test are reported. In the discussion section, the implications of the study in both theory and practice are explored.

Literature review and theory development

One of the widely-used models in the study of adaptation behaviours is the Coping Model of User Adaptation (CMUA), proposed by Beaudry and Pinsonneault (2005). In this model, the individual evaluates the new enterprise IT in two stages. In the primary appraisal, the consequences of IT are classified as an opportunity or threat. One individual may find IT enhancing his effectiveness in the organization, while another may view technology as a factor in losing his job. The high or low degree of the individual's control over the situation is measured in the secondary appraisal.

This appraisal is performed according to the three components of work, self, and technology control. In continuation, such appraisals will lead to adaptation strategies that can be emotion-focused or problem-focused. In emotion-focused adaptation, the individual's perception of the situation undergoes a change, and the situation itself remains unchanged. Problem-focused adaptation, on the other hand, causes people to adapt their environment, technology, or themselves. Table 1 presents the studies that have used CMUA to examine how users react to a new enterprise IT in the organization.

As shown in Table 1, individual adaptation behaviours can be divided into two general groups of communication behaviours and independent exploration behaviours (Bagayogo *et al.*, 2014; Barki *et al.*, 2007). Users' appeal to any of these behaviours might have various reasons. For example, Saeed and Abdinnour (2011) consider the two factors of novel situations and the possibility of other people having more knowledge as reasons people want to seek help and assistance from others. Other studies (e.g., Bruque, Moyano & Eisenberg, 2008; Jasperson *et al.*, 2005) examined the role of individual adaptation behaviours in the successful implementation of enterprise IT in the organization. However, these studies have not examined the factors affecting adaptation behaviours. It should also be noted that the common point among all these studies is their focus on implementing new enterprise IT in the organization. In other words, these studies have not dealt with the issue of enterprise IT changes after implementation and the need for the personnel's adaptation to it.

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Table1. Types of individual adaptation Behaviour in different phases of IT implementation

Study	Target IT	Stage of IT Implementation	Individual Adaptation Behaviour
Beaudry & Pinsonneault (2005)	Account management system	Acceptance (Resistance), Use	Seeking Training
Beaudry & Pinsonneault (2010)	Integrated account management system	Acceptance (resistance), usage	Seeking social support (looking for advice, Understanding, and moral support from colleagues)
Elie-Dit-Cosaque, & Straub (2011)	ERP systems	Acceptance (resistance), usage	Looking for Training
Fadel (2012a)	Enterprise electronic medical system (EMS)	Acceptance, usage	Seeking social support, Training, Seeking help from colleagues, Practicing with the system, Seeking moral support
Fadel (2012b)	Enterprise electronic medical system (EMS)	Usage, Infusion	Seeking social support
Stein *et al.* (2015)	Software package	Acceptance (resistance), Usage	Seeking social support
Bala & Venkatesh (2016)	ERP system, multi-module PLM system	Acceptance (resistance), Usage	Looking for Training, Learning from Peers, supervisors, and Help desk
Bhattacherjee *et al.* (2017)	Computerized patient order entry system (CPOE)	Acceptance (resistance), Usage	Seeking social support, Experimentation with IT features
Wu *et al.* (2017)	EMR system	Usage	Exchange information among peers

With the beginning of the use of enterprise IT and its intertwining with the operational and managerial processes of the organization, the expected advantages of IT gradually appear in the organization (Zmud & Apple, 1992; Carraher-Wolverton & Burleson, 2021). However, events that arise from inside or outside the organization (such as requirements for performance improvements, technological improvements or changes, and changes in regulations) cause changes in the enterprise IT, which in turn, lead to periods of IT adaptation (Aanestad & Jensen, 2016; Carraher-Wolverton & Burleson, 2021). During this adaptation, work tasks also undergo some changes (Tyre & Orlikowski, 1994; Tyre & Orlikowski, 1996). These changes will allow users to re-appeal to individual adaptation behaviours to gain the necessary capabilities in this way.

In these periods of change, users are not confronted with a new enterprise IT, but with a set of new or modified tasks that they must evaluate. In other words, since the individual's work has become dependent on enterprise IT, the issue of appraising the expected consequences of technology loses its function. In addition, users employ different adaptation behaviours in these periods of change due to differences in characteristics such as knowledge, skills, experience, and personality (Bruque *et al.*, 2008). Considering the change of the unit of analysis from "IT level" to "task level" as well as the difference in individual behaviours, in this study, we decided to provide a model to explain individual adaptation behaviours.

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Research model and hypothesis development

The structuration theory was used to develop the model. Structuration is the process through which the existing structures (IT and work tasks) are altered by human factors (Giddens, 1984). A set of actions and interventions (by managers) causes the enterprise IT and its related work tasks to change. The result of such changes is a set of new or modified tasks confronting which the users must appeal to a set of adaptation behaviours at the individual level. These adaptation behaviours take different forms depending on users' knowledge, experience, and personality traits.

Accordingly, one engages in the cognitive activity of "appraising the task difficulty" before engaging in individual adaptation behaviours. An individual's perception of the task difficulty is affected by their knowledge level. Therefore, the first set of hypotheses in this study examines this relationship. In the second set of hypotheses, we discuss the moderating role of personality traits of individuals and indicate that the relationship between an individual's perception of the task difficulty and the type of adaptation behaviour is affected by their personality traits.

The impact of IT knowledge on an individual's perception of the task difficulty

When implementing enterprise IT, organizations spend a lot of money on training (Gupta & Bostrom, 2006; Sein, Bostrom & Olfman, 1999). The output of the learning process is defined by the levels of knowledge individuals acquire. With the help of this knowledge, people evaluate the assigned tasks. Typically, task characteristics that affect IT use are divided into three levels: analyzability (difficulty), interdependence, and complexity (Bagayogo, 2014). Among these three characteristics, task difficulty is determined based on the user's evaluation (Li & Belkin, 2008; Parkes, 2017). It should be noted that complexity has two aspects, objective and subjective (Hærem, Pentland & Miller, 2015; Wood, 1986). However, task complexity is considered an objective characteristic to simplify the model in this study.

The changes made in the tasks are of specific complexity and interdependence. However, task difficulty depends on the users' appraisal that can have different levels. According to the explanations presented so far, the first research hypothesis is formulated as follows:

The individual's enterprise IT knowledge affects their perception of task difficulty.

In enterprise IT, mere knowledge about how that technology works is not enough, and people must have a broader level of business knowledge to fully understand its capabilities (Coulson, Olfman, Ryan & Shayo, 2010; Gupta & Bostrom, 2006; Sein *et al.*, 1999). The framework developed by Olfman, Bostrom & Sein (2006) can appropriately reflect the individual's

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required levels of knowledge about enterprise IT. These levels of knowledge include Command-based, Tool Procedural, Business Procedural, Tool Conceptual, Business Conceptual, Business Motivational, and Meta-cognition. Here, it is hypothesized that the different appraisals of the task difficulty are performed due to individuals' different levels of knowledge. Therefore, the sub-hypotheses of the first section are presented as follows:

> Hypothesis 1. (a) Command Based, (b) Tool Procedural, and (c) Business Procedural knowledge are related to the individual assessment of task difficulty.
>
> Hypothesis 1. (d) Tool Conceptual, (e) Business Conceptual, and (f) Business Motivational knowledge are related to the individual assessment of task difficulty.

According to Parkes (2017), task difficulty results from task and user characteristics. In other words, a task with a certain level of complexity and interdependence can have different degrees of difficulty for users.

The moderating role of personality traits in the relationship between an individual's perception of task difficulty and individual adaptation behaviours

Users engage in a set of adaptation behaviours based on their assessment of the difficulty of the task(s) assigned. In addition to the individual, peers (other users), work and technology experts, and managers play a role in the formation and occurrence of individual adaptation behaviours. These adaptation behaviours can be divided into learning activities such as using the documents provided, experimenting with IT features and work tasks, communicating with peers and work and technology experts, and even managers (Jasperson *et al.*, 2005). Table 2 classifies individual adaptation behaviours into two categories of communication and exploratory activities, and presents examples of each.

Table2. Individual Adaptation Behaviours (adapted from Barki *et al.* (2007); Jasperson *et al.* (2005))

Exploration activities		Communication activities	
Experimentation (learning by doing)	Documentation	Communication with experts (internal/external)	Communication with Peers
Take advantage of the simulated environment, Experimentation with IT features	written comments, images, flowcharts, manuals, conceptual models, workflows, video/audio files…	Virtual Classroom Webcasting Video Broadcasting Email, …	Online networks Phone calls Email, …

Personality traits affect learning in the workplace (Rausch, 2013). Personality traits are the basis of individuals' adaptation to the environment (Huang, Ryan, Zabel & Palmer, 2014), and individuals can describe their behaviours by referring to personality traits (Roccas & Sagiv, 2010). Given the issues mentioned above, it is predicted that one of the factors that affect the

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relationship between an individual's perception of the task difficulty and their adaptive behaviours is their personality traits.

In this respect, the second main hypothesis is formulated as follows:

> Personality traits have a moderating effect on the individual's perception of task difficulty and their individual adaptation behaviours.

Figure 1 depicts the conceptual model examining individual adaptation behaviours in using enterprise IT.

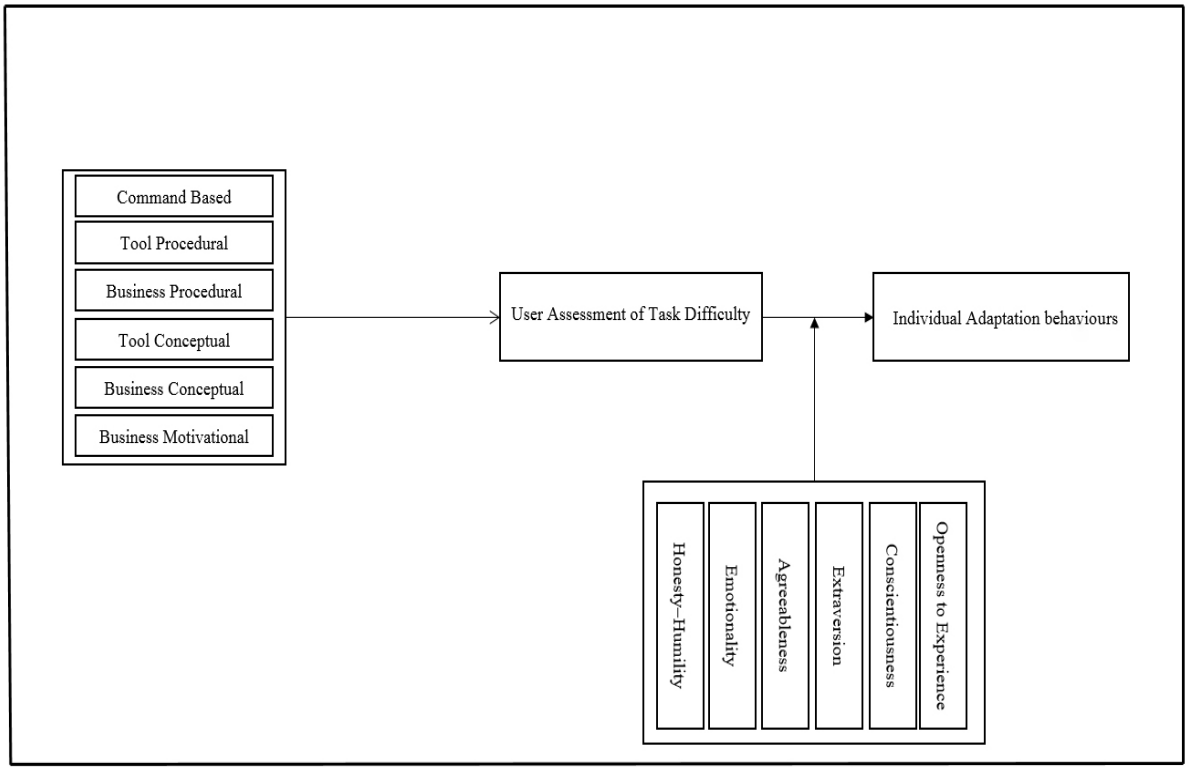

Figure 1. Conceptual Model of Individual Adaptation Behaviour Within the Context of Enterprise IT Use

Various models have been developed to measure personality traits. The Five-Factor Model (FFM) is a typology of traits that have been the subject of most studies. These five factors include the dimensions of openness to experience, agreeableness, extraversion, conscientiousness, and neuroticism. However, in recent lexical research conducted at the level of different languages, a six-factor HEXACO model has been proposed to measure personality traits. In this model, a sixth factor called "honesty-humility" has been added to the five personality traits.

The HEXACO model has three factors in common with the FFM. In the HEXACO model, a relatively updated definition of "agreeableness" has been used, and "neuroticism" has been revised to include the "emotionality" factor. Also, in this model, a new factor called "honesty-humility" has been introduced (Hilbig *et al.*, 2013). The present study uses the HEXACO

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model to measure personality traits. Therefore, the sub-hypotheses in the second part are presented as follows:

> Hypothesis 2. (a) Honesty-Humility, (b) Emotionality, and (c) Agreeableness have a moderating effect on the impact of assessment of task difficulty on individual adaptation behaviour.
>
> Hypothesis 2. (d) Extraversion, (e) Conscientiousness, and (f) Openness to Experience have a moderating effect on the impact of assessment of task difficulty on individual adaptation behaviour.

Research method

Sampling and data collection

In order to experimentally test the proposed conceptual model (Figure 1), the status of using CB[i] software in the headquarters of the state-owned Bank A and its four branches in Tehran was investigated. The CB software covers the stages of registering a loan application to its approval. Using this system, all operations performed through the branch by the customer are recorded and maintained in the system in a centralized manner and can be followed and acted upon. At the time of data collection, a relatively large set of changes had taken place in the CB software, and the features of the technology and work tasks had undergone profound changes. A set of intra-organizational requirements to increase system productivity was mentioned as the reason for such changes.

The total number of experts who used CB software was 250. To facilitate and expedite the research work, instead of studying the whole statistical population, a sample of 153 people (sample size was calculated using Cochran's formula) was used. Of the respondents, 53.3% were male, and 46.7% were female. Age: 9.9% of the respondents were under 30 years old, 39.4% were between 30 and 35 years old, and 50.7% were over 35 years old. Education: 59.2% of respondents had a master's degree or higher. Experience: 91.4% of the respondents had more than ten years of working experience in the organization, and 68.4% were familiar with CB software for 2 to 5 years.

Measurement of constructs

Measurement scales in this study were developed based on a review of the literature and using the existing measurement scales (see Table 3).

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Table 3. Conceptual Model Constructs

Construct	Source/Dimension
IT Knowledge	Developed by Sein *et al.* (1999); Coulson *et al.* (2010); Olfman *et al.* (2006).
Task Difficulty	Mostly adapted from Van de Ven & Delbecq (1974).
Personality traits	Adapted from de Vries (2013).
Individual Adaptation Behaviours	Developed from Gupta & Bostrom (2006); Barki *et al.* (2007); Jasperson *et al.* (2005); Bagayogo *et al.* (2014).

One of the most important issues in designing a measurement instrument is ensuring its content validity. Content validity is realized based on literature review and expert judgment (Boudreau, Gefen & Straub, 2001; Mingers & Standing, 2020). Content validity can be defined as "the ability of selected questions to reflect the characteristics of the measured construct". In this study, to ensure content validity, the relevant literature was reviewed, and the opinions of five experts familiar with the research area were used. In designing the questionnaire items, simplicity and impartiality were tried to be observed as much as possible. In Appendix 1, Table A, the questionnaire items are presented. Table 3 lists the constructs of the conceptual model and their theoretical origins. As shown in Table 3, the conceptual model constructs include IT knowledge, task difficulty, personality traits, and individual adaptation behaviours.

Data analysis

In this study, Partial Least Squares (PLS), as a component-based structural equation modelling method, was used for analyzing the data. PLS makes it possible to model latent constructs in small and medium-sized samples (Chin, Marcolin & Newsted, 2003; Mateos-Aparicio, 2011). Also, PLS allows simultaneous modelling of structural and measurement paths. It is useful for testing moderating effects (Chin *et al.*, 2003).

Measurement model

The measurement model is evaluated by examining construct validity (including discriminant and convergent validity) and reliability. In this study, two methods were used to estimate convergent validity:

1. The indicators of each construct should have a load greater than 0.70[ii] (Chin, 1998).
2. The average variance extracted for each construct should be more than 0.50 (Fornell & Larcker, 1981).

Table B in Appendix 2 shows the indicators of each construct. Two issues are important in measuring discriminant validity. First, each factor load in its corresponding construct must be higher than the other. Second, the value of AVE calculated for each construct must be greater than the common variance between that construct and the other constructs (i.e., the square of

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the correlation coefficients among the constructs) in the model (Chin, 1998). Table C in Appendix 2 shows the discriminant validity indices.

To estimate reliability, composite reliability and Cronbach's alpha method were used. The composite reliability method, proposed by Werts, Linn and Jöeskog (1974), provides a better reliability estimation along with the traditional Cronbach's alpha. As shown in Table 4, the constructs studied have acceptable reliability.

Table 4. Reliability and Validity indices

Constructs investigated	Cronbach's Alpha	CR	AVE	Constructs investigated	Cronbach's Alpha	CR	AVE
Tool procedural	0.882	0.927	0.808	Experimentation	0.833	0.900	0.750
Honesty - humility	0.813	0.887	0.640	Communication with experts(work and technology)	0.913	0.931	0.661
Documentation	0.728	0.846	0.647	Communication with peers	0.838	0.879	0.511
Tool conceptual	0.802	0.879	0.708	Business motivational	0.910	0.937	0.788
Business conceptual	0.726	0.845	0.647	Individual's perception of task difficulty	0.873	0.908	0.663
Agreeableness	0.717	0.825	0.545	Extraversion	0.800	0.870	0.626
Emotionality	0.813	0.877	0.640	IT knowledge	0.679	0.906	0.558
Conscientiousness	0.740	0.830	0.567	Command based	0.878	0.916	0.732
Personality traits	0.944	0.950	0.643	Individual adaptation behaviours	0.941	0.947	0.679
Openness to experience	0.791	0.865	0.617	Business procedural	0.781	0.873	0.697

The findings of the study are presented in Figure 2. The values of 0.19, 0.33, and 0.67 are respectively considered weak, medium, and strong R^2 coefficients (Chin, 1998). Hence, the values calculated for R^2 coefficient indicate that the model enjoys a good fit.

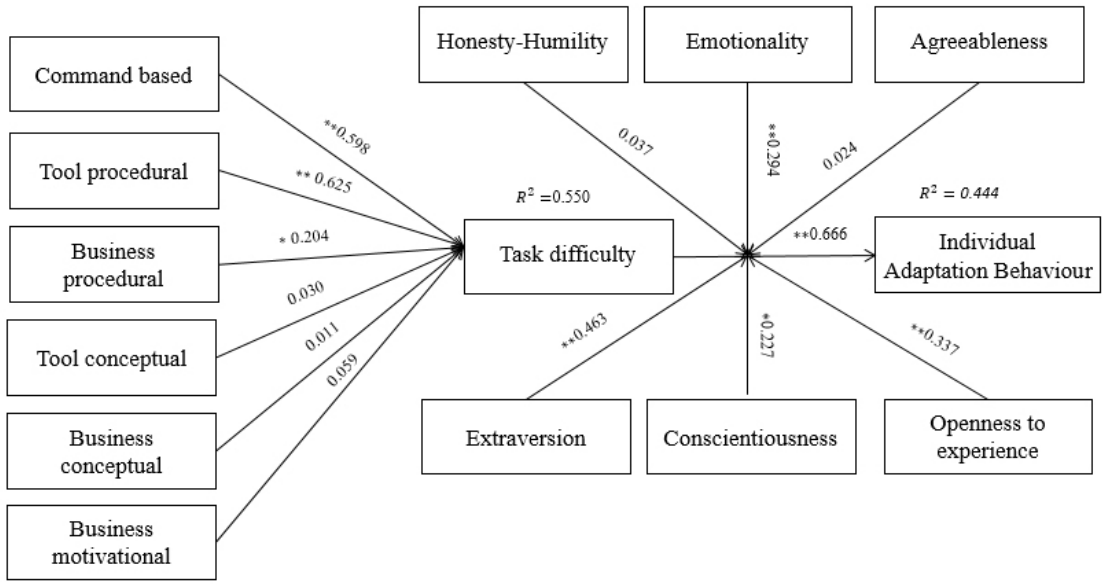

Figure 2. Structural model and hypotheses tests

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Results

The results of the main variables of the model

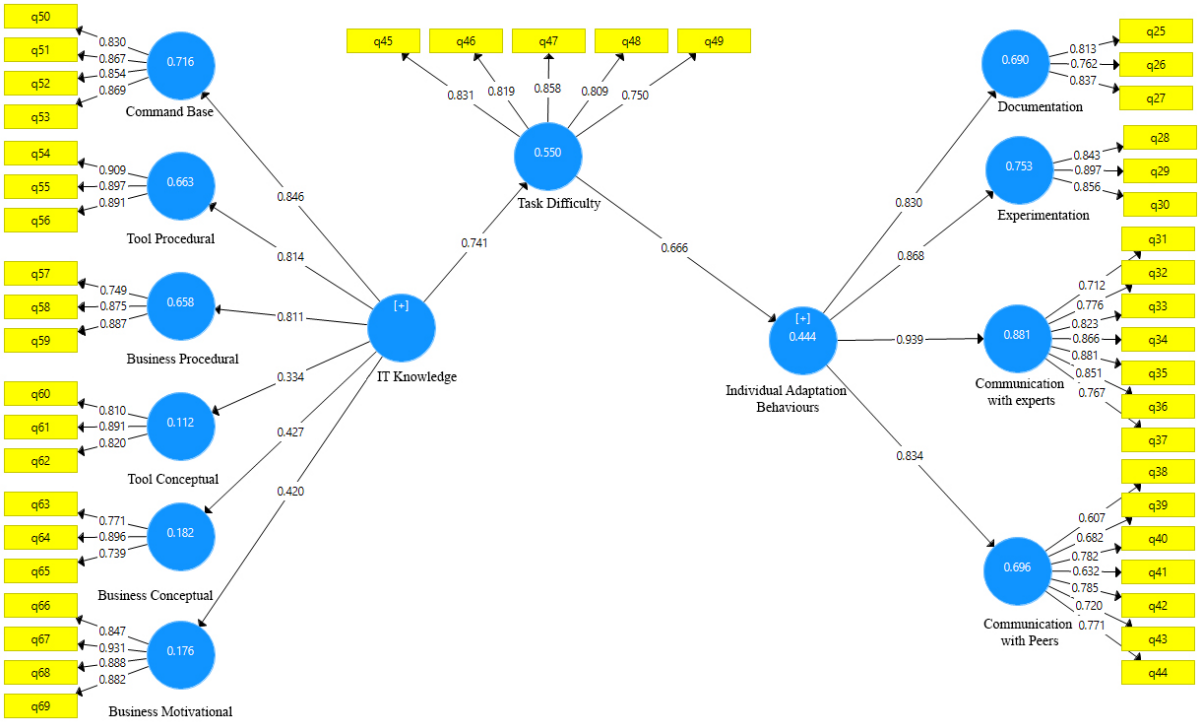

Figure 3. Structural equation model estimating path coefficients

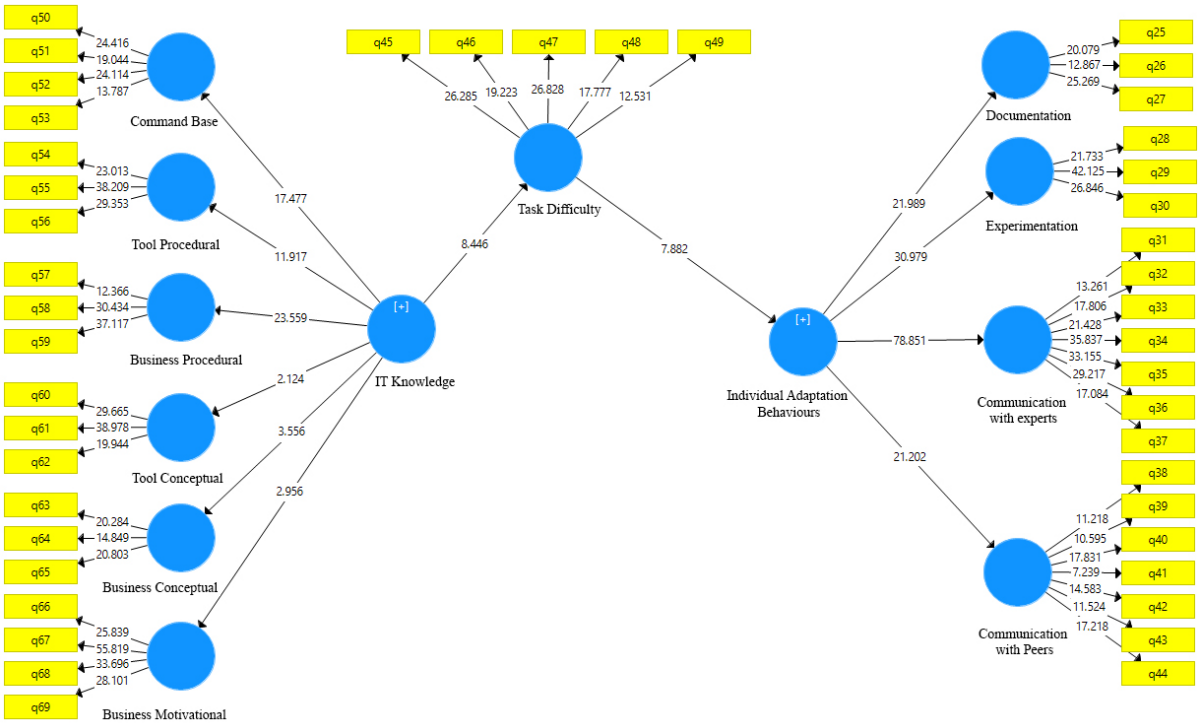

Figure 4. Structural equation model with significant coefficients

Based on the analysis of the collected data, the results of the model fit in the two states of "regression coefficient estimation" and "test of significance of these coefficients" are shown in

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Figures 3 and 4. The regression coefficients have standardized values in the approximate range of -1 to +1. The closer these estimated coefficients are to +1, the stronger and positive relationships they indicate in the structural model (the same applies to negative values). The closer the estimated coefficients are to zero, the weaker the relationships are.

In line with the test of significance of the estimated path coefficients, experimental values of *t* are calculated. When *t* is larger than the critical value, it is concluded that with a certain probability of error (i.e., significance level), the corresponding path coefficient is significantly different from zero. The common critical values are 1.65 (significance level of 10%), 1.96 (significance level of 5%), and 2.57 (significance level of 1%) (Hair *et al.*, 2017). Based on these results, the knowledge related to enterprise IT affects the individual's perception of task difficulty (t=8.446, β=0.741), and the individual's perception of task difficulty affects individual adaptation behaviour (t=7.882, β=0.666).

To investigate the effect of each level of technology knowledge on the individual's perception of task difficulty, the model of this section was run in the SmartPLS software, whose results are shown as path coefficients and t-statistics in Table 5.

Table 5. Path coefficients and t statistics (independent variable: individual's perception of task difficulty)

Independent variable	Path coefficient (β)	t Statistics	Status
Command based	0.598	**7.619	supported
Tool procedural	0.625	**8.026	supported
Business procedural	0.204	*2.145	supported
Tool conceptual	0.030	0.382	-
Business conceptual	0.011	0.120	-
Business motivational	0.059	0.783	-

** $P < 0.01$ * $P < 0.05$

As shown in Table 5, the three knowledge levels "command-based" (t = 7.619, α <0.01), "tool-procedural" (t = 0.026, α <0.01), and "business procedural" (t = 2.145, α <0.05) affect an individual's perception of task difficulty. That is, hypotheses 1(a), 1(b), and 1(c) are supported. In contrast, hypotheses 1(d), 1(e), and 1(f), which represent the impact of knowledge levels "tool conceptual," "business conceptual," and "business motivational" on the individual's perception of task difficulty, are rejected.

To investigate the hypothesis about the impact of personality traits as a moderating variable on the relationship between the perception of task difficulty and individual adaptation behaviours, the structural equation model was run in two states to estimate the path coefficients and the significance of these coefficients. The results are shown in Figures 5 and 6. As can be seen, first, the moderator variable (personality traits) is entered into the model as an independent variable. Then, it is defined as a moderator variable in the software. This

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moderating variable (latent variable shown in olive) is the product of the individual's perception of task difficulty and personality traits. In other words, this variable shows the simultaneous effect of personality traits and the individual's perception of task difficulty on individual adaptation behaviour. According to the estimated regression coefficient (β = 0.226) and the *t* statistic (t = 2.240), personality traits have a moderating effect on the relationship between the individual's perception of task difficulty and individual adaptation behaviour.

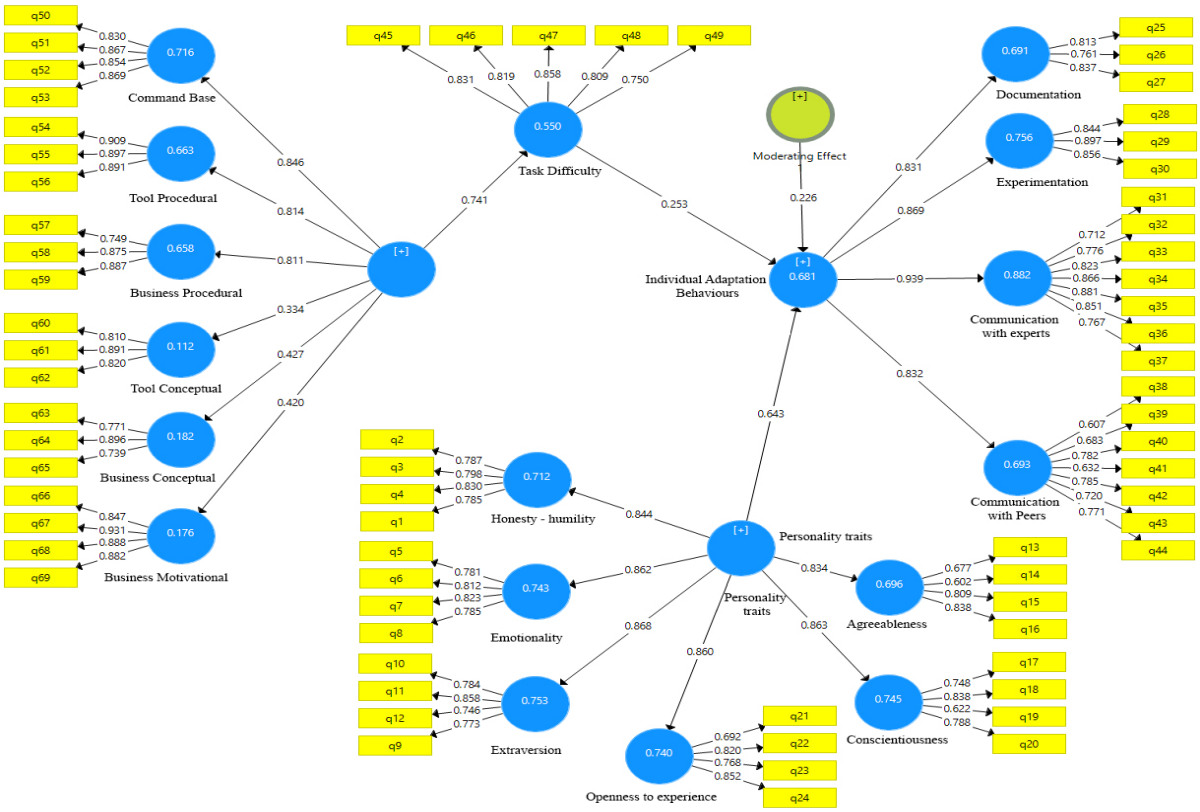

Figure 5. Structural equation model estimating the path coefficients of the moderator variable

To examine the moderating power of personality traits, Cohen's F² (Cohen, 1988) was used:

$$F^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

$$F^2 = \frac{0.681 - 0.444}{1 - 0.681} = 0.743$$

Since the obtained value is 0.743, it can be said that personality traits are of high moderating power. The path coefficients and t statistics for examining the moderating role of different personality types are presented in Table 6. (Each personality trait was first entered as an independent variable into the model, then defined as a moderating variable.)

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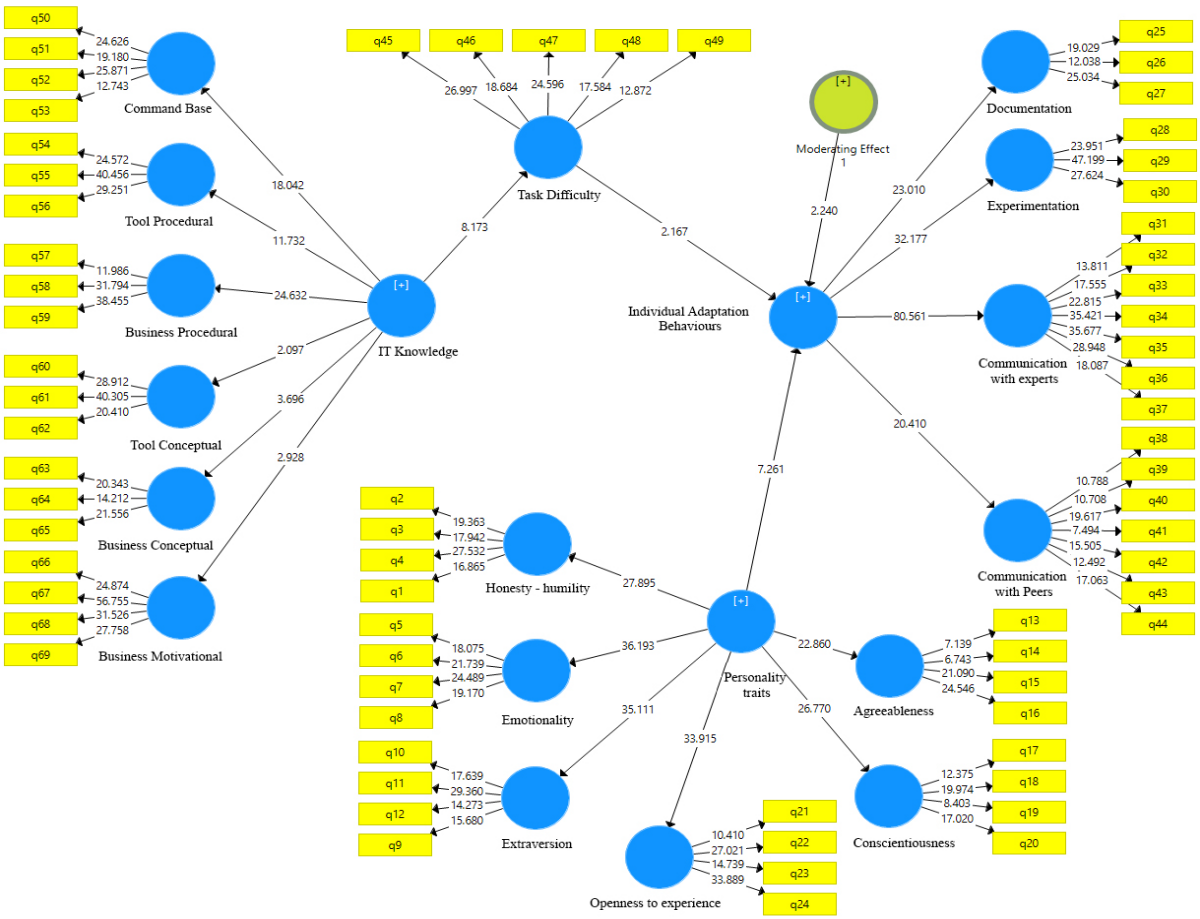

Figure 6. Structural equation model with significant coefficients of the moderator variable

Table 6. Path coefficients and t statistics (independent variable: individual adaptation behaviour)

Variable	Path coefficient (β)	t Statistic	Status
Honesty and humility	0.037	0.618	-
Emotionality	0.294	**3.375	Supported
Agreeableness	0.024	0.552	-
Extraversion	0.463	**5.353	Supported
Conscientiousness	0.227	*2.465	Supported
Openness to experience	0.337	**4.451	Supported

** $P < 0.01$ * $P < 0.05$

As shown in Table 6, the four personality traits of "emotionality" (β = 0.294, t = 3.375, α <0.01), "Extraversion" (β = 0.463, t = 5.353, α <0.01), "Conscientiousness" (β = 0.227, t = 2.465, α <0.05), and "openness to experience" (β = 0.337, t = 4.451, α <0.01) have a moderating effect on the relationship between an individual's perception of task difficulty and individual adaptation behaviour. In other words, hypotheses 2(b), 2(d), 2(e), and 2(f) are supported. In contrast, hypotheses 2(a) and 2 (c), which represent the effect of the personality traits of "honesty and humility" and "agreeableness", respectively, are not confirmed.

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Analysis of demographic variables

One of the issues analyzed at the end is demographic variables. The variables of work experience, technology experience, and gender cause differences in individual behaviours (Jasperson, 2005) and can effectively explain individual adaptation behaviours. Here are three general hypotheses:

1. Work experience significantly affects the individual's perception of task difficulty.
2. Technology experience significantly affects the individual's perception of task difficulty.
3. Gender has a significant effect on individual adaptation behaviours.

Work experience and technology experience

One-way analysis of variance (ANOVA) was used to investigate the effect of work experience and technology experience on an individual's perception of task difficulty (Table 7). In this test, when the significance level is less than 0.05, there is a significant difference among the means of the samples. It should be noted that ANOVA alone does not determine which means are different, which is why we also used post hoc tests.

Table 7. ANOVA Results

		Sum of squares	df	Mean square	F	Sig
Work experience	Between groups	0.589	2	0.295	0.916	0.402
	Within group	47.899	149	0.321		
	Total	48.488	151			
Technology experience	Between groups	23.256	3	7.752	45.471	0.000
	Within group	25.232	148	0.170		
	Total	48.488	151			

As shown in Table 7, the significance level of the work experience variable is 0.402, higher than the error level of 0.05, so the significance of the test is not confirmed. In other words, work experience does not significantly affect an individual's perception of task difficulty. Although work experience is one of the components that determine individual differences and lead to the familiarity of employees with the information flow in the organization (Fuerst & Cheney, 1982; Jasperson *et al.*, 2005), the results of the experimental test in this study show that differences in work experience do not cause a difference in adaptation behaviours. A possible explanation for this result could be related to the relatively long work experience of most people surveyed: 91.4% of the respondents had more than ten years of experience in the bank, which shows a good knowledge of work processes among the majority of employees.

As can be seen in Table 7, the significance level of technology experience is 0.000, which is less than the error level of 0.05, so the significance of the test is supported. In other words,

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people with different technology experiences have different perceptions of task difficulty. The differences between the means of the groups using Least Significant Difference (LSD) and Tukey tests are presented in Tables 8 and 9.

Table 8. The results of the LSD Test

I	J	Mean differences (I-J)	Mean standard error	Significance	95% Confidence interval	
					Lower	Higher
1 year and less	1-2 years	0.22857	0.18020	0.584	-0.2397	0.6968
	2-4 years	0.95439*	0.17721	0.000	0.4939	1.4149
	4-5 years	1.11064*	0.17900	0.000	0.6455	1.5758
1-2 years	1 year and less	-0.22857	0.18020	0.584	-0.6968	0.2397
	2-4 years	0.72581*	0.08397	0.000	0.5076	0.9440
	4-5 years	0.88207*	0.08767	0.000	0.6543	1.1099
2-4 years	1 year and less	-0.95439*	0.17721	0.000	-1.4149	-0.4939
	1-2 years	-0.72581*	0.08397	0.000	-0.9440	-0.5076
	4-5 years	0.15625	0.08135	0.224	-0.0551	0.3676
4-5 years	1 year and less	-1.11064*	0.17900	0.000	-1.5758	-0.6455
	1-2 years	-0.88207*	0.08767	0.000	-1.1099	-0.6543
	2-4 years	-0.15625	0.08135	0.224	-0.3676	0.0551

*mean difference is significant at 0.05 level.

In presenting the results of the Tukey test (Table 9), the technology experience is divided into homogeneous subgroups. These results indicate that the means are significantly different. The mean technology experience of 1 year and less is homogeneous with 1-2 years, and they fall into one category. The mean technology experience of 2-4 years and 4-5 years is homogeneous and falls into the same category. The mean of groups shows that, as the technology experience increases, people evaluate the assigned task(s) as less difficult. The results reported in the literature also confirm this finding. The technology experience affects behaviour through its positive effect on the richness of individual knowledge (Vankatesh & Davis, 2000). As the experience of working with technology increases, the user spends less time on tasks (Jeyaraj, 2022). Therefore, technology experience is also one of the components leading to individual differences, and its different levels can cause different adaptation behaviours.

Table 9. The Result of Tukey Test

Technology experience	N	1	2
4-5 years	47	2.8894	
2-4 years	57	3.0456	
1-2 years	42		3.7714
1 year and less	6		4.0000
Level of significance		0.679	0.362

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Gender

A paired comparisons test was used to investigate the impact of gender on individual adaptation behaviour. To this aim, two hypotheses are considered:

$$H_0: \mu_f = \mu_m$$

$$H_1: \mu_f \neq \mu_m$$

Table 10. The results of the t-test with two independent samples

	Levin's test		t-test with two independent samples						
	F	Sig.	t	df	Sig.	MD	SE	95% Confidence interval	
								Lower	Higher
Equal variances	0.117	0.732	0.674	150	0.501	0.06544	0.09705	-0.12632	0.25720
Non-equal variances			0.677	149.04	0.500	0.06544	0.09671	-0.12566	0.25655

Since, in Table 10, the significance value of Levin's test is 0.732 and is more than 0.05, the results of the first row are used. Given that the value of the two-way significance level is greater than 0.05% (0.501), then H_1 is rejected, and H_0 is substantiated. In previous studies (such as Vankatesh & Morris, 2000), gender was identified to influence the adoption of new IT in the organization. So far, the effect of this variable on individual adaptation behaviours during the change of enterprise IT characteristics has not been studied. The experimental test results in this study show that gender does not affect the relationship between an individual's perception of task difficulty and individual adaptation behaviours. In other words, there is no significant difference between the individual adaptation behaviour of males and females.

Discussion

User adaptation plays a key role in the successful implementation of enterprise IT in the organization (Wu *et al.*, 2017). In this study, an attempt was made to gain a proper understanding of the type of users' reactions to the beginning of an enterprise IT adaptation period and work tasks in the organization.

As shown in Table 5, user knowledge is limited to three levels: command-based, tool procedural, and business procedural. It should be noted that deeper levels of users' knowledge lead to a proper understanding of enterprise IT by them (Coulson *et al.*, 2010). Therefore, due to the users' insufficient knowledge, it can be argued that users evaluate the difficulty of the assigned tasks at a high level. The main reason for the insufficiency of users' knowledge levels is the cost of training. The lack of appropriate training programs by organizations causes users to use different adaptation behaviours to cover their knowledge weaknesses.

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Table 6 shows the effect of different dimensions of the HEXACO model on the relationship between individual perceptions of task difficulty and individual adaptation behaviours. In the HEXACO model, the dimensions of honesty-humility, emotionality, and agreeableness reflect altruism, and the dimensions of extraversion, conscientiousness, and openness to the experience reflect engagement. Altruism is a trait that leads people to activities, thoughts, and feelings such as sympathy, kindness, compassion, caring and concern for others. Engagement or investment of energy in areas of interest is a prominent feature for differentiating individuals and manifests itself in three different areas of social, task, and idea (de Vries, Wawoe & Holtrop, 2016). As can be seen in Table 6, dimensions of the HEXACO model that reflect engagement have a moderating effect on the relationship between an individual's perception of task difficulty and individual adaptation behaviour. This is the first time this issue has been explored, and the results can be useful for researchers to gain a deeper understanding of individual adaptation behaviours. Different characteristics have been mentioned in the literature for each dimension of extraversion, conscientiousness, and openness to experience. Extraversion involves actively investing energy in the social sphere (such as socializing, leading, and entertaining). Conscientiousness includes the active investment of energy in the task area (such as working, planning, and organizing), and openness to experience is related to an active investment of energy in the area of ideas and opinions (such as learning, imagining, and thinking) (Ashton & Lee, 2007; de Vries *et al.*, 2016).

As shown in Table 6, among the dimensions that reflect altruism, only emotionality has a moderating effect on the relationship between an individual's perception of task difficulty and individual adaptation behaviour. Although this is the first time this issue has been explored, it should be noted that some characteristics of the emotionality dimension, such as help-seeking and empathy/attachment, are associated with individual adaptation behaviours. Agreeableness and honesty-humility do not moderate the relationship between an individual's perception of task difficulty and individual adaptation behaviour. De Vries *et al.* (2016) do not consider agreeableness as related to job performance. Fairness and sincerity are among the dimensions of the honesty-humility factor, and tolerance and forgiveness are among the characteristics of agreeableness (Ashton & Lee, 2007).

Implications for theory

In this study, the issue of individual adaptation behaviours during different periods of enterprise IT adaptation and work tasks was investigated. One of the most widely used models in the literature for examining employee adaptation with enterprise IT is the CMUA model. The CMUA model is often used when introducing a new IT in the organization to study the

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different reactions of users to it. Contrary to the claims of Beaudry and Pinsonneault (2005), we believe that the CMUA model does not work well for examining individual adaptation behaviours during changes in technology features and work tasks. The reason is that, during the changes, the user is not faced with a new enterprise IT to decide whether to use it or not. Here, due to the dependence of the organization's workflow on enterprise IT, the user must acquire the necessary capabilities as soon as possible. Therefore, this study presents a new conceptual model for investigating individual adaptation behaviours during different periods of change.

Table 11 compares the components of the proposed conceptual model and the CMUA model to clarify the issue further. The first comparative component deals with the users' cognitive evaluation. In the CMUA model, the cognitive assessment takes place in two stages. The nature of these evaluations is commensurate with the introduction of a new enterprise IT in the organization; whereas, in the proposed conceptual model of this study, the user evaluates the changes in the enterprise IT in one step and based on their perception of the difficulty of the task(s) assigned. The cognitive assessment has a complete conceptual relationship with the research topic presented in this article. The second comparative component deals with the issue of individual adaptation behaviours.

Table 11. Comparing the components of the proposed conceptual model and the CMUA model

Models	Cognitive Appraisal	Individual Adaptation	Level of Analysis	Reappraisal	Individual characteristics	Context of use
CMUA	Primary appraisal: Perceived opportunity Perceived threats Secondary appraisal: Perceived controllability	Benefits Satisficing, Benefits Maximizing, Self Preservation, Disturbance Handling	Users	Y	N	Introduction of New IT in Organization
Our conceptual-ization	Assessment of Task Difficulty	Exploration activities: Experimentation (learning by doing) Documentation Communication activities: Communication with Experts (internal/external) Communication with Peers	Users & managers	Y	Y	Continuous use of IT

Note: Y = has been considered; N = has not been considered

In the CMUA model, based on the cognitive assessment performed by users, the following four adaptation strategies are proposed: **benefits maximizing** (high opportunity-control), in which the adaptation strategy is problem-focused, and the individual takes complete advantage of the opportunities provided by IT; **benefits satisfying** (low opportunity-

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control), where adaptation efforts are minimal, so people satisfy themselves with the benefits IT provides; **disturbance handling** (high threat-control), where the individual engages in problem-focused efforts to handle the situation and emotion-focused efforts to minimize negative consequences; and **self-preservation** (low threat-control), in which the adaptation strategy is emotion-focused. In this case, the individual withdraws from the new IT and uses it as little as possible. As shown in these strategies, moving from a "benefits maximizing" strategy to a "self-preservation" strategy reduces an individual's willingness to use enterprise IT. However, in various periods of change in the enterprise IT in the organization, the goal is the full and optimal use of IT. Therefore, adaptation efforts that focus on employee empowerment are relevant. For this purpose, in the proposed conceptual model, after the user evaluates the difficulty of the task(s) assigned, a set of adaptation behaviours that are divided into two groups of exploratory and communication behaviours are presented.

The third comparative component deals with the level of analysis. The level of analysis in the CMUA model is limited to users, while in the proposed conceptual model, the analysis is performed at both managerial and individual levels. As shown in Figure 7, in enterprise IT, managers and employees play different roles in changing technology features and work tasks. Therefore, differentiation between roles makes it possible to properly identify individual adaptation behaviours. The fourth comparative component deals with the issue of re-evaluation. The CMUA model is based on a recursive pattern. In this model, the output of adaptation strategies adopted by users can affect (strengthen/weaken) the perception of IT. This shift in perception can, in turn, lead to different adaptation strategies. In the proposed conceptual model, the individual's assessment of task difficulty is moderated by adopting individual adaptation behaviours and routine use of IT (Figure 7). Learning that takes place during individual adaptation behaviours enhances one's knowledge, and the routine use of IT raises one's level of experience.

The fifth comparative component deals with demographic characteristics. The CMUA model does not address the individual characteristics that cause behavioural differences. Individual characteristics affect the use of and adaptation to IT in the organization (Xu & Lu, 2022). In the proposed conceptual model in this study, to explain the differences in adaptation behaviours among employees, various individual characteristics are examined. Among the studied characteristics (personality traits, knowledge, gender, work experience, and technology experience), the influence of personality traits, knowledge, and technology experience on individual adaptation behaviours was observed to be significant. The sixth and last comparative component deals with the area of use. The CMUA model is most used when introducing new enterprise IT in the organization. In contrast, our proposed conceptual model can be applied during the life cycle of enterprise IT in the organization (Carraher-Wolverton

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& Burleson, 2021), and make it possible to properly understand the mechanism of adopting individual adaptation behaviours.

This research can also shed some light on the relationship between the tasks assigned to employees during the use of enterprise IT and their performance. Users' evaluation of assigned tasks based on knowledge and experience leads to adopting various adaptation behaviours. Since individual adaptation behaviours and the use of IT are closely related (Barki *et al.*, 2007), a better understanding of these behaviours can facilitate employee performance appraisal.

Implications for practice

Implementation of enterprise IT in the organization is associated with different periods of IT adaptation and work tasks. In the conceptualization presented in this article, managers and employees play different roles at two different levels. Managerial decisions lead to changes in enterprise IT and work tasks, and, at the individual level, employees make it possible to use IT through various learning activities by adopting individual adaptation behaviours (Deng & Chi, 2012; Hsieh, Rai & Xin Xu, 2011). Managing different periods of enterprise IT adaptation and work tasks and gathering information about individual adaptation behaviours can lead to the organization's success in the use of enterprise IT.

Managing various IT adaptation periods and work tasks

The extent to which expectations from an enterprise IT adaptation period and work tasks are met is crucial in determining when and how to launch subsequent periods. Figure 7 shows the relationship between the different periods of these changes. During the routine use of enterprise IT, it is possible to evaluate the effectiveness of the modifications made (Tyre & Orlikowski, 1996). If the interval between adaptation periods is too short, employees cannot adapt to continuous changes, so the flow of service delivery in the organization will be disrupted. Also, if this interval is too long, the organization cannot properly respond to requirements such as changes in business rules or those related to productivity. Therefore, creating a proper balance between periods of change and stability can bring more benefits to the organization.

Collecting information about individual adaptation behaviours

During the use of enterprise IT, users engage in a variety of adaptation behaviours, which, as shown in Table 2, are of different types. Collecting adequate information about the details of each adaptation behaviour will help managers to provide the resources needed (such as communication infrastructure[iii]) for the success of these behaviours. Regarding the type of individual adaptation behaviours in the face of assigned tasks, it is possible for managers to

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accurately assess the output of the training process in the previous stages. This can lead to proposing complementary training courses or using new methods to transfer knowledge to employees. Therefore, it can be concluded that without a rich dataset, it is unlikely that the organization can tangibly develop the management of different periods of enterprise IT use.

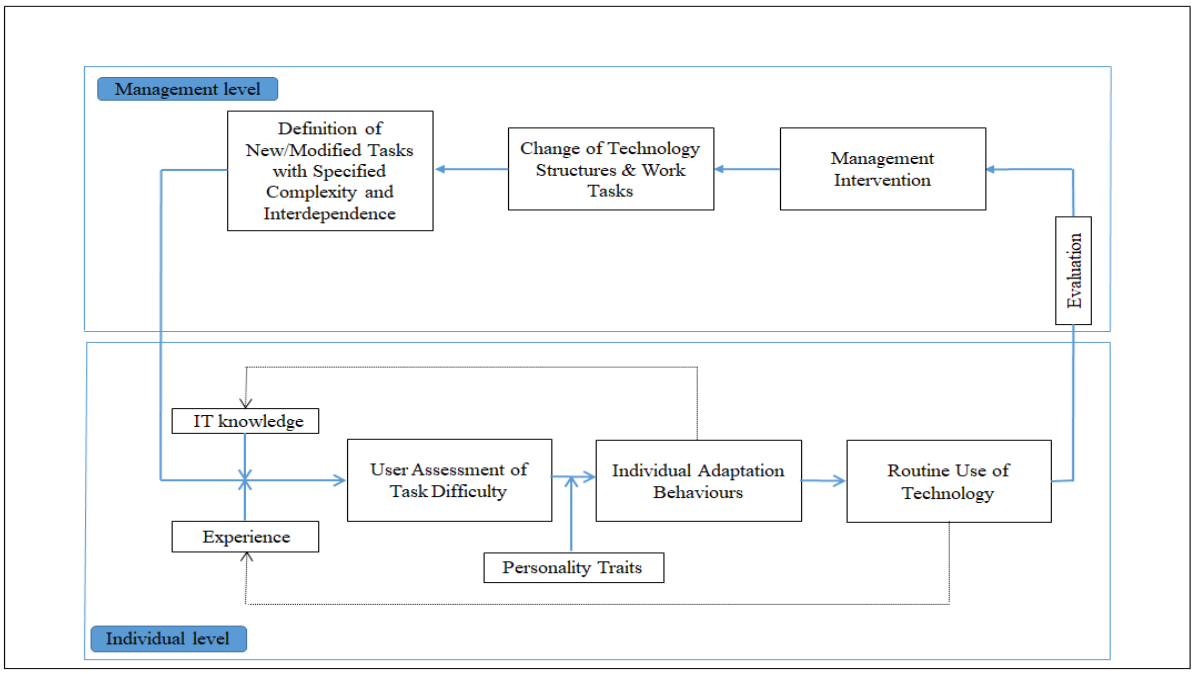

Figure 7. The relationship between the individual and management actions

Conclusion

Given the various periods of enterprise IT change in the organization, it is important to understand the mechanism of individual adaptation behaviours to make use of IT possible. In this study, using structuration theory, the factors affecting individual adaptation behaviours in the framework of a conceptual model were presented. With the help of this conceptual model, it is possible to explain the reasons for differences in individual adaptation behaviours.

The focus of this study is on a period of change in the features of enterprise IT in isolation, while organizations are usually faced with different periods of change in technology and work tasks (Jasperson *et al.*, 2005). Future research can examine adaptation behaviours throughout the enterprise IT lifecycle in the organization. Usually, the extent and severity of changes in technology features and work tasks require different individual adaptation behaviours. Creating a portfolio of these behaviours and interpreting their evolution can help to better understand adaptation behaviours and clarify the relationship between different IT adaptation periods and work tasks.

This study also focuses on an IT type (enterprise IT) implemented in a specific organizational context. By focusing on other types of IT implemented in various organizational contexts,

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future studies can help to further generalize the findings of this study. In addition, investigating the impact of each of the individual adaptation behaviours on the use of enterprise IT can be considered a topic for future research.

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Appendix 1

Table A. Questionnaire Items

		Row	Please indicate the degree to which you agree or disagree with each of the following statements.	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
Personality traits	Honesty–Humility	1	I find it difficult to lie.					
		2	I would like to know how to make lots of money in a dishonest manner.					
		3	I want to be famous.					
		4	I am entitled to special treatment.					
	Emotionality	5	I am afraid of feeling pain.					
		6	I worry less than others.					
		7	I can easily overcome difficulties on my own.					
		8	I have to cry during sad or romantic movies.					
	Extraversion	9	Nobody likes talking with me.					
		10	I easily approach strangers.					
		11	I like to talk with others.					
		12	I am seldom cheerful.					
	Agreeableness	13	I remain unfriendly to someone who was mean to me.					
		14	I often express criticism.					
		15	I tend to quickly agree with others.					
		16	Even when I'm treated badly, I remain calm.					
	Conscientiousness	17	I make sure that things are in the right spot.					
		18	I postpone complicated tasks as long as possible.					
		19	I work very precisely.					
		20	I often do things without really thinking.					
	Openness to Experience	21	I can look at a painting for a long time.					
		22	I think science is boring.					
		23	I have a lot of imagination.					
		24	I like people with strange ideas.					

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		Row	Please indicate the degree to which you agree or disagree with each of the following statements.	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
Individual Adaptation Behaviours	Documentation	25	To achieve the required capabilities, I use the photos and flowcharts provided.					
		26	To achieve the required capabilities, I use the conceptual models and instructional videos provided.					
		27	To achieve the required capabilities, I use the written notes provided.					
	Experimentation	28	To understand how the system works, I personally enter data on different pages.					
		29	Based on the predesigned scenario, I investigate the function of different system sections.					
		30	I gain functional skills through trial and error.					
	Communication with experts (Work & Technology)	31	To achieve the required capabilities, I communicate with the experts through email.					
		32	To achieve the required capabilities, I communicate with the experts through short messages and phone calls.					
		33	To achieve the required capabilities, I communicate with the experts through face-to-face contact.					
		34	To achieve the required capabilities, I communicate with the experts through LAN Messenger.					
		35	To achieve the required capabilities, I communicate with the experts through social networks (Instagram and Twitter).					
		36	To achieve the required capabilities, I communicate with the experts through domestic messengers (Gap, Sorush, Bale).					
		37	To achieve the required capabilities, I communicate with the experts through foreign messengers (Whatsapp, telegram, WeChat, Line).					
	Communication with Peers	38	To achieve the required capabilities, I communicate with colleagues through email.					
		39	To achieve the required capabilities, I communicate with colleagues through short messages and phone calls.					
		40	To achieve the required capabilities, I communicate with colleagues through face-to-face contact.					

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		Row	Please indicate the degree to which you agree or disagree with each of the following statements.	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
		41	To achieve the required capabilities, I communicate with colleagues through LAN Messenger.					
		42	To achieve the required capabilities, I communicate with colleagues through social networks (Instagram and Twitter).					
		43	To achieve the required capabilities, I communicate with colleagues through domestic messengers (Gap, Sorush, Bale).					
		44	To achieve the required capabilities, I communicate with colleagues through foreign messengers (Whatsapp, Telegram, WeChat, Line).					
Task Characteristics	Difficulty	45	Your perception of the assigned task is that it is immediately executable. (R)					
		46	Your perception of the assigned task is that the sequence of its steps is understandable (R)					
		47	Your perception of the assigned task is that its execution requires time to think					
		48	Your perception of the assigned task is that its execution requires communication with informed people.					
		49	Your perception of the assigned task is that its successful execution requires having necessary knowledge resources.					
IT Knowledge	Command Base	50	The training course was focused on the general functions of the system.					
		51	The provided training course explains the system commands and its general structure (syntax).					
		52	The provided training course explains the meaning of system commands (semantically).					
		53	Without the help of the training course provided, it is impossible to recover from the error.					
	Tool Procedural	54	The provided training course makes it possible to use methods for performing a general task.					
		55	The provided training course makes it possible to collect different commands for performing a function.					

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		Row	Please indicate the degree to which you agree or disagree with each of the following statements.	Completely agree	Agree	Neither agree nor disagree	Disagree	Completely disagree
		56	Without the help of the training course provided, it is impossible to recover from the error.					
	Business Procedural	57	The training course provided focused on learning a complete business process.					
		58	The training course provided focused on providing relevant information about different specialized tasks.					
		59	The training course provided makes it possible to gain a proper cognitive understanding of the system.					
	Tool Conceptual	60	The training course focused on the workflow of all processes and their impacts on the organization.					
		61	The training course provided comprehensive information about the system structure and its general goals.					
		62	The training provided makes it possible for the learning to be transferrable to new situations.					
	Business Conceptual	63	The training course focused on the relationship between different processes of the system.					
		64	With the help of the training course provided, it is possible to face errors engaging several processes.					
		65	With the help of the training course, it is possible to understand the interdependence of activities in the system.					
	Business Motivational	66	The training course focused on learning the functions of technology for people and the organization.					
		67	The training course provided information about the system's usefulness for the organization.					
		68	The training course increased people's willingness to learn.					
		69	The training course led users to have a positive view of the results of using the system.					

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Appendix 2

Table B. Convergent validity indices

Latent Variable	Observed variables	factor loadings	Latent Variable	Observed variables	factor loadings	Latent Variable	Observed variables	factor loadings	Latent Variable	Observed variables	factor loadings
Honesty–Humility	Q1	0.785	Documentation	Q25	0.813	Difficulty	Q45	0.831	Business Motivational	Q66	0.847
	Q2	0.787		Q26	0.762		Q46	0.819		Q67	0.931
	Q3	0.798		Q27	0.837		Q47	0.858		Q68	0.888
	Q4	0.830		Q28	0.843		Q48	0.809		Q69	0.882
Emotionality	Q5	0.781	Experimentation	Q29	0.897		Q49	0.750			
	Q6	0.812		Q30	0.856		Q50	0.830			
	Q7	0.823	Communication with experts (Work & Technology)	Q31	0.712	Command Base	Q51	0.867			
	Q8	0.785		Q32	0.776		Q52	0.854			
	Q9	0.773		Q33	0.823		Q53	0.869			
Extraversion	Q10	0.784		Q34	0.866	Tool Procedural	Q54	0.909			
	Q11	0.858		Q35	0.881		Q55	0.897			
	Q12	0.746		Q36	0.851		Q56	0.891			
	Q13	0.677		Q37	0.767	Business Procedural	Q57	0.749			
Agreeableness	Q14	0.602		Q38	0.607		Q58	0.875			
	Q15	0.809		Q39	0.682		Q59	0.887			
	Q16	0.838	Communication with Peers	Q40	0.782	Tool Conceptual	Q60	0.810			
	Q17	0.748		Q41	0.635		Q61	0.891			
Conscientiousness	Q18	0.838		Q42	0.785		Q62	0.820			
	Q19	0.622		Q43	0.720	Business Conceptual	Q63	0.771			
	Q20	0.788		Q44	0.771		Q64	0.896			
Openness to Experience	Q21	0.692					Q65	0.739			
	Q22	0.820									
	Q23	0.768									
	Q24	0.852									

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Table C. Discriminant Validity Assessment results

	1	2	3	4	5	6	7	8	9	10	11	12	13
Experimentation	0.866												
Communication with experts (work & technology)	0.798	0.813											
Communication with peers	0.587	0.663	0.715										
Business motivational	0.234	0.200	0.272	0.887									
Individual perception of task difficulty	0.476	0.560	0.708	0.237	0.814								
IT knowledge	0.539	0.528	0.651	0.420	0.741	0.746							
Command-based	0.473	0.478	0.626	0.224	0.779	0.646	0.855						
Individual adaptation behaviour	0.818	0.739	0.634	0.256	0.666	0.648	0.590	0.824					
Business procedural	0.486	0.454	0.530	0.224	0.552	0.711	0.557	0.565	0.834				
Tool procedural	0.470	0.509	0.537	0.233	0.644	0.714	0.621	0.589	0.644	0.899			
Documentation	0.719	0.721	0.603	0.190	0.552	0.559	0.473	0.810	0.552	0.562	0.804		
Tool conceptual	0.180	0.202	0.160	0.269	0.114	0.334	0.116	0.134	0.350	0.115	0.111	0.841	
Business conceptual	0.133	0.173	0.166	0.300	0.190	0.427	0.111	0.123	0.350	0.183	0.168	0.702	0.805

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Endnotes

i. CB is the name that refers to the enterprise IT under study to observe the privacy requirements.

ii. Although the indicators of some constructs are less than 0.7 (between 0.6 and 0.7), given that the average variance extracted for each construct is over 0.5, the measurement model has an acceptable convergent validity.

iii. Table 2 lists some of these communication infrastructures, such as Webcasting and Online Networks.

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Electronic Communication of Entrepreneurs during the Covid-19 Pandemic in the Czech Republic

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Abstract: The aim of this article is to find out the attitudes of business entities towards the helpfulness and frequency of the use of electronic communication with government administration institutions in the Czech Republic during the Covid-19 pandemic. The research was conducted in the form of a questionnaire survey of 464 respondents. Based on the primary research, the change in the use of electronic communication was verified. The most important factors influencing satisfaction in communication are functionality, speed and delivery confirmation. The increased need for electronic communication was found especially in micro and small enterprises and in the services sector.

Keywords: Electronic communication, Government administration institutions, Covid-19 pandemic, Entrepreneurs, Factors influencing satisfaction.

Introduction

Government institutions around the world are embracing digital services and online communications. Their aim is to provide user-friendly services while reducing the cost of providing them. According to the Statista Research Department (2022), electronic public administration, eGovernment, is characterised by the use of information and communication technologies by state institutions. It involves a wide range of digital interactions between governments and their citizens, businesses and international organisations. Due to the ever-growing number of Internet users and the constant worldwide increase in the use of online

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communication, this technological form of public administration has become almost indispensable in recent years. According to the European Commission (2016), the EU eGovernment Action Plan aims to modernise public administration, achieve a digital single market, and increase the involvement of citizens and businesses to provide high quality services.

The Covid-19 pandemic emphasised the need for digital communication with state institutions. Common e-government activities include publishing information and data on government websites, communicating between citizens and state institutions through digital platforms, and providing online transaction services.

Although most governments in the world are gradually moving towards full digitisation, the stages of digital transformation vary greatly from country to country. The Covid-19 pandemic, which forces the population to work from home and communicate through a variety of technologies, shows the readiness of individual governments. As Mohit (2020) or Silaškova (2020) state, in some countries, such as Singapore or Estonia, services provided to the public by government agencies have been almost completely digitised, allowing public administrations to continue to function normally during the Covid-19 pandemic.

The electronic form of communication is widely used especially by entrepreneurs who have to communicate regularly with institutions within their business activities. For this reason, it is important to evaluate eGovernment from their point of view. All entrepreneurs in the Czech Republic must communicate with the Financial Administration, the Czech Social Security Administration and health insurance companies when fulfilling their tax and levy obligations. Excise duty payers must also communicate with the Customs Administration. The aim of this article is to focus on electronic communication of entrepreneurs with these four government administration institutions during the Covid-19 pandemic in order to find out their attitudes towards helpfulness and frequency of use.

Background and Related Literature

According to the Commission of the European Communities (2003), eGovernment is the use of ICT in public administration. The intention is to provide and improve public services and democratic processes and strengthen public policy support. As Mates & Smejkal (2012) state, the aim of eGovernment and electronic communications is to provide private entities with greater comfort in contacting public entities, using modern electronic tools. The intention is to speed up and simplify communication as well as streamline the internal processes of public authorities. This will lead to greater accessibility and transparency of public administration for citizens.

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The Organisation for Economic Co-operation and Development (OECD, 2003) defines eGovernment as the use of information and communication technologies as a means to achieve good (better) governance. According to Manoharan & McQuiston (2018), the successful implementation of an eGovernment project requires the identification of important factors (technological, organisational and environmental). As reported by Veber (2018), the advantages of the introduction of eGovernment include cost reduction, e.g., in the area of reducing labour costs, the implementation of the administrative process or the introduction of electronic documents. There is also an improvement in the business environment by easing or reducing the administrative burden on entrepreneurs. Digital communication between government and citizens is key to eGovernment. Above all, the digitisation of public administration leads primarily to huge savings. According to Grant & Chau (2005), three key activities can be identified within eGovernment: the development and provision of quality, integrated public sector services; the implementation of effective relationship management within individual components; and support of the economic and social development of citizens and companies at the national and international level.

The implementation of eGovernment is an ever-evolving process. Strouhal (2019), for example, deals with different approaches to its implementation and analyses the system of regulation of eGovernment in selected European Union (EU) countries in connection with the application of a decentralised or centralised approach. The development of eGovernment and the digitisation of public administration has long been monitored by evaluation reports of the European Commission, which are prepared and published within the ISA program (Interoperability solutions for public administrations, businesses and citizens) in cooperation with relevant national authorities.

Krøtel (2021) examines how the development of digital solutions for communication and everyday interaction between the Danish government and its citizens affects satisfaction and the perceived importance of information. According to the author's findings, the digitisation of the communication form has little effect on citizens' trust and satisfaction with the information received; and the perception of the importance of the information received is lower for information received digitally. Jørgensen (2021) argues that, unless a more critical and human-centric approach to 'smart governance' is taken, the digital welfare state will advance a digital technocracy that treats its citizens as data points suited for calculation and prediction, rather than as individuals with agency and rights.

As Marciniak *et al.* (2020) state, according to a McKinsey study, the digital economy in Central and Eastern Europe accelerated greatly during the first months of the restrictions due to the Covid-19 pandemic. The growth rate from January to May 2020 of 14.2 percent was almost twice as high as the year-on-year change recorded in 2017–2019. With respect to the rapid

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migration of consumers to digital technologies caused by the pandemic, policy makers could consider introducing more public online services. The spread of the coronavirus disease in 2019 all over the world has created a better understanding of the importance of organizations' ability to keep up with digital innovations.

As Crivelli (2019) points out, the key features of an efficient tax administration are well established, but there is a lack of an objective assessment of the relative strengths and weaknesses of tax administrations. In his paper, he proposes a simple index of the strength of tax administration based on objective indicators reflecting key organisational and operational aspects of revenue administration in relation to international best practice. Savić *et al.* (2015) analysed the performance of the tax administration using data envelopment analysis (DEA) and regression analysis in 13 European countries. Their findings showed that improving the capacity of the tax administration is an important element in fighting tax evasion.

The Covid-19 pandemic in the Czech Republic has (as well as in other countries) highlighted the need to accelerate the digital transformation in public administration. Our research is motivated by the effort to find out how the scope of electronic communication among entrepreneurs has changed in connection with the restrictions that were introduced during the Covid-19 pandemic. Factors influencing the attitude to electronic communication and differences between individual selected government administration institutions (the Financial Administration, the Czech Social Security Administration, the Customs Administration and health insurance companies) were examined. The aim of the research was to evaluate the electronic communication with these government administration institutions from the point of view of entrepreneurs (respondents). To fulfil the aim of the study, it was necessary to establish research questions (RQ):

RQ1: Are there differences in the perceived helpfulness of communication among institutions?

RQ2: Has the Covid-19 pandemic affected the perception of electronic communication with institutions?

Institutions of Government Administration in the Czech Republic

The digitisation of the Czech government administration is responding to the Digital Europe project, which is sponsored by the European Union. The Ministry of the Interior of the Czech Republic (2016) characterised the topics for the next stage of modernisation and development of public administration and eGovernment in the Strategic Framework for the Development of Public Administration in the Czech Republic for the Period 2014 to 2020. For this programming period, a major modernisation of public administration was envisaged through

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the use of eGovernment tools. The Committee for the Digital Economy and Society in the Czech Republic stated that, due to the Covid-19 pandemic, increased digital activity was recorded in a number of sectors.

The Act No. 12/2020 Collection of Laws (2020), on the Right to Digital Services, stipulates the obligation of public authorities to provide digital services and accept digital acts and certain other rights and obligations related to the provision of digital services. The modernisation and digitisation of public services of government administration institutions in the Czech Republic can lead to an increase in the efficiency of public administration and its actions for citizens and entrepreneurs. However, the level of digitisation may vary significantly between institutions.

Entrepreneurs communicate mainly with the Financial Administration, the Czech Social Security Administration, the Customs Administration and health insurance companies in their business activities.

The main institution in the field of taxation is the Financial Administration (FA). The FA administers value added tax (VAT) and all direct taxes, including income taxes, real estate taxes and road tax. As part of a comprehensive external communication strategy, the FA should inform taxpayers about new tax policies and any changes and support related to the Covid-19 pandemic. The communication strategy should also promote social solidarity and discourage fraudulent requests for assistance, for example by drawing attention to the consequences.

One of the main tasks of the Czech Social Security Administration (CSSA) is to collect and enforce payable social security premiums, which includes pension insurance, sickness insurance and a contribution to the state employment policy. The CSSA has been ready for electronic communication with clients for several years. It actively supports it as an effective way of communication, offering a reduction in administrative burdens on both sides. Electronic submissions can be made via the data mailbox, but also without its use, if it is signed with a recognised electronic signature.

The Customs Administration (CA) administers excise duties and energy taxes. Forms published by the CA are a technical tool for creating submissions in the required structure (as well as for the FA and the CSSA). Smart forms allow for filling in and sending data directly to the tax administrator via a data mailbox or electronic registry.

The Czech Republic has a universal health care system, based on a compulsory insurance model. Public health insurance (HI) is provided by seven health insurance companies (the General Health Insurance Company of the Czech Republic (VZP) and six employee health insurance companies). Especially in times of worsened epidemic situation, health insurance

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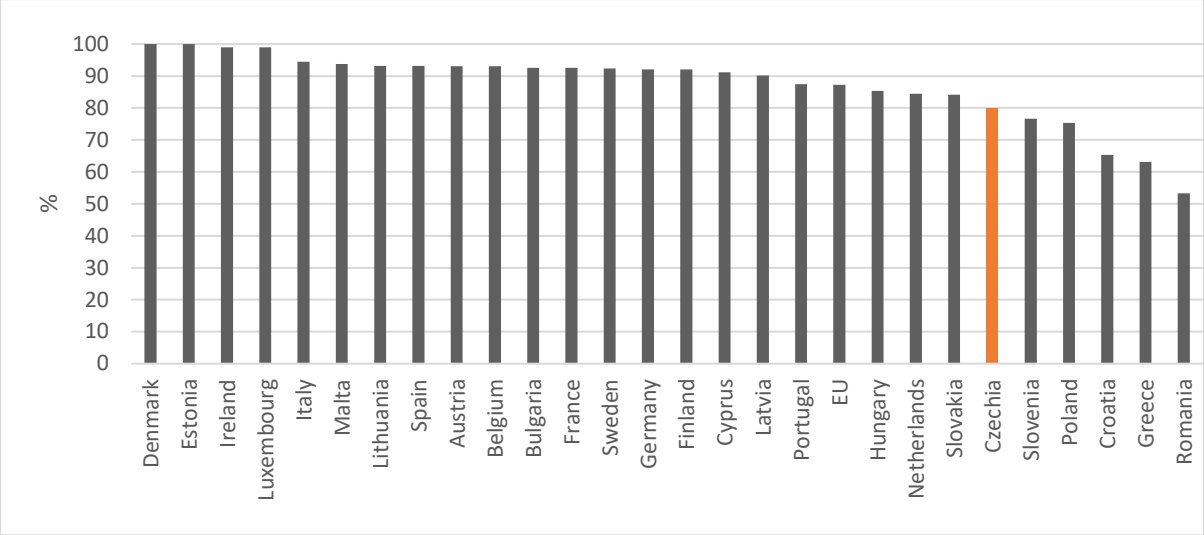
companies recommend using the option of contactless communication using interactive forms.

Data and Methods

Effective eGovernment can provide a wide range of benefits, including greater efficiency and savings for both governments and businesses, and is therefore monitored by the European Commission. Among other things, the indicator Digital Public Services for Businesses is monitored (Figure 1).



Source: https://digital-agenda-data.eu/datasets/digital_agenda_scoreboard_key_indicators/visualizations

Figure 1. eGovernment digital public services for businesses (Score 0 to 100), 2019

This indicator assesses the extent to which basic public services for businesses are available online and across borders in other EU Member States when starting a business and conducting regular business operations. Services provided through the portal receive higher scores, while services that provide information only online but require operations to be performed offline receive lower scores. A total of 18 countries received more than 90 points out of 100. With eighty points, the Czech Republic is the sixth worst-ranked country (EC, DESI, 2021).

The evaluation of the Czech Republic within eGovernment services for businesses was one of the motivations for our research. The research was focused on the electronic communication of entrepreneurs with government administration institutions in the Czech Republic. Specifically, these were the FA, the CSSA, the CA, and HI companies. The aim of the research was to evaluate the electronic communication with the selected government administration institutions from the point of view of entrepreneurs. Based on the primary research, the change in the use of electronic communication in relation to selected government administration institutions in connection with the Covid-19 pandemic was also verified.

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The research tool was a questionnaire, which contained both closed and open questions, in which the respondent was not presented with the possibility of answers, and the respondent was able to express his/her opinion. The answers were evaluated using a five-point Likert scale, which allows one to determine not only the content of the attitude, but also its approximate strength. A total of 464 questionnaires were processed. The results of the questionnaire survey were evaluated in the SPSS program. To determine the dependence of the monitored variables, non-parametric tests were used. These tests are used to compare sets of statistical data for which a normal distribution of probabilities of the monitored characteristic cannot be assumed. The chi-squared test and the Mann-Whitney U test were used.

The basic idea of the chi-squared test is to compare the observed n_{ij} and the expected n'_{ij} frequencies. The calculation assumes that the null hypothesis holds. Thus, if we perform the test of independence, the null hypothesis assumes that there is no dependence between two qualitative quantities.

$$G = \sum_{i=1}^{r} \sum_{j=1}^{s} \frac{(n_{ij} - n'_{ij})^2}{n'_{ij}} \quad (1)$$

In this article, the chi-squared test is used to determine the differences of views of individually monitored business groups in the evaluation of electronic communication with state institutions.

The Mann-Whitney U test is used to compare the differences between two independent groups, n_1 and n_2, where the dependent variable is ordinal or continuous but not normally distributed. The Mann-Whitney U test is often considered a non-parametric alternative to an independent two-group t-test. The null hypothesis assumes that the medians of both samples are identical.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \quad (2)$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2 \quad (3)$$

The Mann Whitney U test monitored the difference in the assessment of the importance of factors in electronic communication across the monitored business entities and how it was reflected in this assessment of the Covid-19 pandemic. The validity of selected research methods was checked by statistical significance at the level of 5%.

Results

A total of 464 questionnaires were included in the processing, 172 from natural persons (NP) and 292 from legal entities (LE) (Table 1). The division of respondents was made according to

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sector into secondary (manufacturing) and tertiary (services). The division according to the size of companies was made in accordance with the directive 2013/34/EU Article 3 (2013). Companies were divided into micro, small, medium and large. Due to the low number of respondents (only 4 respondents for large), medium and large enterprises were merged into one category called larger.

Table 1. Descriptive statistics of subjects surveyed (in absolute numbers)

Firm (Sector)	Micro	Small	Larger	Total
Legal entities	64	156	72	**292**
Natural persons	124	48	0	**172**
Total	**188**	**204**	**72**	
Secondary	48	128	36	**212**
Tertiary	140	76	36	**252**
Total	**188**	**204**	**72**	

Source: Data from questionnaires

Electronic Communication

As part of the analysis, attention was first paid to the evaluation of electronic communication with individual government institutions. Table 2 shows the final rating, where the lowest value means the best rating.

Table 2. Average rating of electronic communication (1 = best, 5 = worst)

Institution	Total score	Form of Business		Size of Companies			Sector	
		LE	NP	Micro	Small	Larger	Secondary	Tertiary
FA	1.70	1.68	1.74	1.48	1.80	1.94	1.92	1.49
CA	2.05	2.02	2.18	1.57	1.92	2.44	2.27	1.82
CSSA	1.65	1.51	1.92	1.86	1.58	1.35	1.72	1.59
HI	1.89	2.00	1.68	1.71	1.98	2.06	1.94	1.84

Source: Data from questionnaires

Overall, the CSSA achieves the best rating in electronic communication with business entities (Table 2). In particular, larger companies and legal entities assessed communication with the CSSA very positively. The communication with the FA also had a similarly good rating, which was positively evaluated especially by micro-enterprises in the tertiary sector. On the contrary, the CA and HI achieved the worse rating. For HI, the results may be affected by the fact that there are seven health insurance companies in the Czech Republic and the level of electronic communication may vary.

The factors that individual respondents perceive in electronic communication with state institutions were identified (Table 3). Based on the average evaluation, it was found that functionality and clarity were the most important factors. Within the evaluation of the CSSA and the FA, the confirmation of the submission is also an important factor. For the CA, the

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respondents identified speed as the most important factor. At the FA, time savings were also an important factor, and, at the CSSA, the accuracy check.

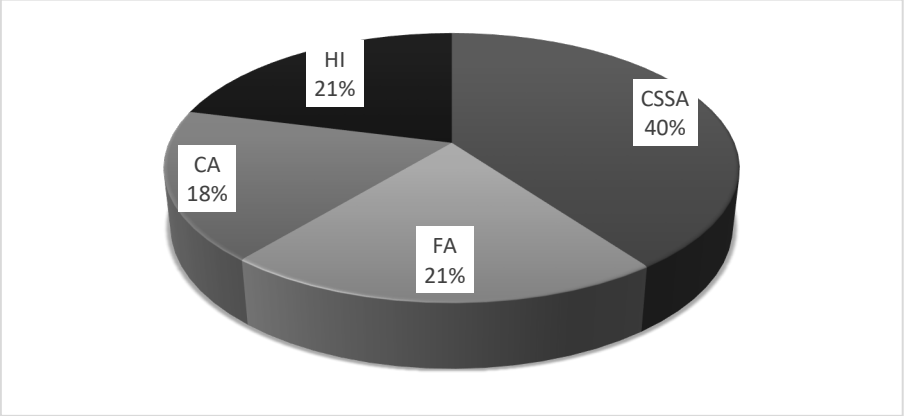
Table 3. Average evaluation of the importance of electronic communication factors (1 = most important, 5 = least important)

Factors	FA	CA	CSSA	HI
Functionality	1.70	1.68	1.63	1.67
Clarity	1.88	1.85	1.93	1.97
Speed	1.86	1.63	1.91	2.20
Time Savings	1.75	1.98	2.10	2.16
Confirmation of Submission	1.86	2.08	1.62	2.43
Feedback	1.96	2.03	2.02	2.26
Accuracy check	2.01	2.16	1.78	2.60

Source: Data from questionnaires

Helpfulness

Respondents described the CSSA as the most helpful institution (almost 40% of respondents). There were no significant differences with other institutions and the lowest percentage at the CA could be influenced by the fact that not all respondents communicate with this institution (Figure 2).



Source: Data from questionnaires

Figure 2. Results of the survey of the most helpful institution in electronic communication with business entities (in %)

Based on the Chi-Squared test, it was verified whether there is a difference between the perception of helpfulness depending on the selected factors. According to the research question RQ1, hypothesis H_0 was established: There is no difference between the perception of helpfulness among respondents in the context of the form of business (LE and NP), the size of the company (micro, small, larger) and the sector (secondary and tertiary). The evaluation of the test is shown in Table 4, where, on the basis of the significance indicator, it was possible to reject the null hypothesis at the level of significance of 5% in all cases.

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Table 4. Results of the Pearson Chi-Squared test with differences in the perception of helpfulness

	Form of Business	Size of Company	Sector
Pearson Chi-squared Value	27.224	83.539	16.223
df	3	6	3
Significance	0.000	0.000	0.001

Source: Data from questionnaires

In terms of the form of business, there is a significant difference between legal entities and natural persons. Almost 48% of legal entities perceive the CSSA as the most helpful institution. On the other hand, for natural persons, the differences between institutions are not significant. The explanation for the differences may be that legal entities are usually larger companies with a higher number of employees and therefore they communicate with the CSSA more often. Significant differences were also found between respondents' opinions according to the size of companies. While the majority of small companies (60.78%) described the CSSA as the most helpful institution, at larger companies it was only 38.89%. Micro companies, on the other hand, perceive the FA as the most helpful, namely 34%; and, on the contrary, the CSSA was stated the most helpful by the smallest number of respondents, only 17%. As part of the Covid-19 support, compensation bonuses were introduced, the rapid payment of which could affect the perception of helpfulness at the FA, especially for micro companies and natural persons. There is also a difference in the perception of helpfulness between the secondary and tertiary sectors, especially in relation to the FA. In the tertiary sphere, the FA was perceived as helpful by 28.57% of the respondents and in the secondary sector only by 13.21% of respondents. The helpfulness of the FA could be assessed in connection with the communication regarding compensation bonuses, when the tertiary sector was more affected by restrictions.

The open-ended question identified which factors most influenced the assessment of helpfulness at individual institutions. For all, the speed of communication and the willingness of employees prevailed. The FA was also stated as very responsive with respect to submitted applications for compensation bonuses and their prompt settlement. The waiver of the payment of mandatory minimum advance payments was assessed positively at the CSSA. At both institutions, this was a measure that was introduced for entrepreneurs in connection with mitigating the effects of the Covid-19 pandemic.

Increase in Communication

In connection with the Covid-19 pandemic, communication increased, especially with the FA and the CSSA (Figure 3). However, even in these institutions, less than half of the respondents indicated an increase in communication.

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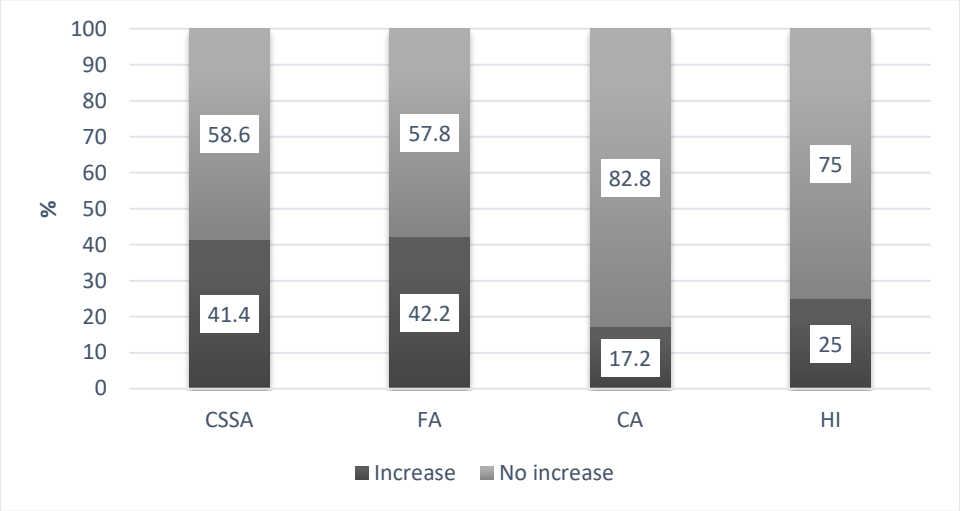

Source: Data from questionnaires

Figure 3. Increase in communication of business entities with individual institutions during the Covid-19 pandemic (in %)

The existence of a difference between the increase in communication in connection with the form of business, the size of the company and the business sector was examined at the FA and the CSSA. At these institutions, we could observe the highest increase in communication during the Covid-19 pandemic. According to the research question RQ2, hypothesis H_0 was established: There is no difference between the increase in communication among respondents in the context of the form of business (LE and NP), the size of the company (micro, small, larger) and the sector (secondary and tertiary). To determine possible differences, the Chi-Squared test at the monitored level of significance of 5% was used. The results can be seen in Table 5. Based on the results shown on the Significance line, it was possible to reject the null hypothesis in a total of five cases. In most cases, it can be argued that there are differences in the frequency of increased electronic communication during the Covid-19 pandemic between the individual monitored groups. Only the form of business did not have a statistical effect on communication with the CSSA.

Table 5. Results of the Pearson Chi-Squared test with differences in communication increase during the Covid-19 pandemic

	FA			**CSSA**		
	Form	Size	Sector	Form	Size	Sector
Pearson Chi-squared Value	20.636	13.474	6.538	0.383	18.759	9.485
df	1	2	1	1	2	1
Significance	0.000	0.001	0.011	0.536	0.000	0.002

Source: Data from questionnaires

Increased communication in relation to the FA was reported by 196 respondents (42.24%). A difference was found between natural persons and legal entities, as the increase in communication was reported by 55.81% LE but only 34.24% NP. There is also a difference in terms of the size of companies, with increased communication reported mainly by larger

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companies (55.56%). There is also a difference in relation to the business sector: a higher percentage of increased communication was identified in the tertiary sector (47.62%).

In relation to the CSSA, there is no difference between natural persons and legal entities. In terms of the size of companies, a difference was found in the increase in communication. Just as with the FA, increased communication in relation to the CSSA was reported mainly by larger companies (61.11%). There is a difference in relation to the sector: respondents more often reported an increase in communication in the secondary sector (49.06%) when compared to the tertiary sector.

In relation to the CA, there is no difference between natural persons and legal entities even in relation to the size of companies. Communication with the CA increased more in the tertiary sector, but, as already mentioned, the total number of respondents communicating with the CA is relatively small.

The open-ended question identified the reasons for increased communication with individual institutions. Requests for compensation bonuses, permission to pay tax in instalments and the provision of information predominated at the FA. At the CSSA, communication in connection with nursing allowance, illness and quarantine prevailed. Some respondents also mentioned other communications about employees and waivers of monthly advance payments.

Table 6. Results of the Mann Whitney test for perceiving the importance of communication factors during the Covid-19 pandemic.

Factors	FA	CSSA
Functionality	-0.905	-1.808
Clarity	-0.406	-2.532 **
Speed	-2.264 **	-2.806 **
Time Savings	-2.089 **	-5.139 **
Confirmation of Submission	-5.138 **	-1.874
Feedback	-1.226	-2.100 **
Accuracy check	-3,458 **	-5.153 **

** mean statistical significance at the level 5%. Source: Data from questionnaires

In the case of the FA and the CSSA, where electronic communication increased the most during the Covid-19 pandemic, the Mann Whitney test was performed to recognise the perception of the importance of communication factors (Table 6). According to the research question RQ2, the null hypothesis examines the statement that the Covid-19 pandemic did not affect the assessment of electronic communication factors. These two institutions showed

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increased electronic communication, especially in the evaluation of factors such as speed, time savings and accuracy check. The higher the number in absolute value, the higher the importance of the factor. The validity of the test was checked by statistical significance at the level of 5 %.

In the case of the FA, the factors of speed, time savings, confirmation of delivery and accuracy checks are statistically significant. In the CSSA analysis, these are the factors of clarity, speed, time savings, feedback and accuracy checks. Compared to the overall assessment of individual factors, during the Covid-19 pandemic in particular, the importance of speed, time savings and accuracy check factors increased. These factors are directly related to the period of uncertainty that the pandemic has brought. For individual institutions, finding out the importance of these factors for business entities in electronic communication means an opportunity for further development of activities related to the strengthening of these competencies.

Discussion

In connection with the Covid-19 pandemic and in accordance with the government regulation on the restriction of the operation of public administration offices, the FA, CA, CSSA and HI companies adjusted their activities and began to prefer electronic submissions. This situation should contribute to a better evaluation of the Czech Republic within eGovernment.

Based on the research, increased communication, especially with the FA and the CSSA, was found at almost half of the respondents. In relation to the FA, these were mainly legal entities and entrepreneurs in the tertiary sector. At the CSSA, this was especially the case for larger companies and the secondary sector. Respondents identified the functionality and clarity of electronic communication as the most important factors influencing the evaluation.

The first research question, RQ1, could be answered in the affirmative. Respondents described the CSSA as the most helpful institution, especially by small companies. Micro companies, on the other hand, perceived the FA to be the most helpful. As part of the Covid-19 support, compensation bonuses were introduced, the rapid payment of which could affect the perception of helpfulness at the FA, especially for micro companies and natural persons. There is also a difference in the perception of helpfulness between the secondary and tertiary sectors, especially in relation to the FA. In the tertiary sector, there is a higher percentage of respondents who perceived the FA as helpful, which may again be influenced by communication regarding compensation bonuses.

On the other hand, increased communication may conflict with the helpfulness of the institution. However, companies that recorded increased communication during the Covid-19 pandemic with the FA (especially natural persons operating in the tertiary sector) do not

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always rate it as the most helpful. The companies also record increased communication with the CSSA, which is considered to be the most helpful, in particular by natural persons that operate mainly in the secondary sector and by their size rank among small and larger companies (50 or more employees).

Based on the Man-Whitney test, the factors that are most important for entrepreneurs during the Covid-19 pandemic were evaluated (research question RQ2). In the case of the FA, the factors of speed, time savings, confirmation of delivery and accuracy checks are statistically significant. In the CSSA analysis, these are the factors of clarity, speed, time savings, feedback and accuracy checks. Our findings do not correspond with the results of a study conducted in Denmark in which Krøtel (2021) concluded that the digitisation of the communication form has little effect on citizens' trust and satisfaction with the information received and that the perception of the importance is lower for information received digitally. On the contrary, respondents positively assess the provision of current information by government institutions.

Conclusion

The quarantine measures introduced during the Covid-19 pandemic have become the catalyst for digital transformation. In addition, measures taken to reduce the spread of coronavirus have put stronger pressure on the digitisation of the economy. Companies and governments were forced to change the way they communicate. E-Government represents the transformation of internal and external relations of public administration using information and communication technologies in order to optimise internal processes.

Entrepreneurs regularly communicate with government administration institutions as part of their business activities. These are mainly the Financial Administration, the Czech Social Security Administration, health insurance companies and possibly also the Customs Administration. The scope, manner and frequency of communication depends on the form of business, the size of the company, the number of employees and other factors.

Among other things, the research found that the CSSA achieves the best evaluation of electronic communication, especially with legal entities operating mainly in industry (secondary sector). The CSSA was also evaluated by small companies as the most helpful institution. Micro enterprises in the tertiary sector positively assessed electronic communication with the FA.

In connection with the Covid-19 pandemic, the highest increase in communication was observed just with the FA and the CSSA, especially in the legal entities of the secondary sector. As respondents stated, the communication with the FA during the Covid-19 pandemic increased mainly due to the requests for compensation bonuses, permission to pay tax in

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instalments and the provision of information. At the CSSA, communication in connection with nursing allowance, illness and quarantine prevailed. From the point of view of HI companies, electronic communication increased in connection with employees' hiring or termination of employment.

Functionality, clarity, speed, feedback and accuracy check are the factors that individual respondents perceived to be the most important in electronic communication with government institutions during the Covid-19 pandemic. Finding out the importance of these factors for business entities in electronic communication with individual institutions creates an opportunity for further development of activities related to strengthening the competencies of government administration institutions.

Acknowledgment

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Urban 5G MmWave Networks: Line-of-Sight Probabilities and Optimal Site Locations

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Abstract: In this work, we implemented line-of-sight (LoS) ray tracing functionality to investigate problems in millimetre-wave propagation modelling and network planning in 3D city model environments. First, we validated an existing LoS propagation probability model expressed as an exponential rule with the link distance. By fitting ray tracing simulation results under different scenarios to the model, the relationships between key parameters in the model and factors including the building density and the transmitter height were qualitatively analysed. Next, we developed a network planning framework for a multi-hop outdoor urban network by formulating a mixed-integer linear programming problem which minimises the overall deployment cost through optimal site selection. Taking the sets of potential site locations and potential links as inputs, we selected a subset of the sites that comprise a tree-structured network that satisfies all the user demands at a minimum deployment cost. We also analysed the time required for solving this optimisation problem in order to provide a prediction of the execution time for larger-sized problems.

Keywords: Ray tracing, line-of-sight communications, network planning, mixed-integer linear programming, 3D visualisation.

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Introduction

The fifth generation (5G) wireless networks are expected to deliver high data rates with low latency and high spectral efficiency to support the rapid increase in mobile data demand (Anjinappa *et al.*, 2021; Rappaport *et al.*, 2013). In order to overcome spectrum scarcity and provide wider bandwidths ranging from hundreds of megahertz (MHz) to several gigahertz (GHz) (He *et al.*, 2019; Rappaport *et al.*, 2013; Rangan *et al.*, 2014), 5G needs to expand into the under-utilised millimetre-wave (mmWave) bands between 30 GHz to 300 GHz, or more generally, above 10 GHz. However, compared to the traditionally used sub-6 GHz frequency bands, mmWave bands present new challenges for network design.

The path loss is greater for the mmWave bands and propagation is also susceptible to blockage from buildings and foliage, making performance highly location-specific. Due to this high path loss and the paucity of useful reflected paths, line-of-sight (LoS) propagation assumes far greater importance than non-line-of-site (NLoS) propagation at mmWave (Al-Hourani, 2020; Cui *et al.*, 2020). The significant difference in path loss between LoS and NLoS paths is also evident from existing stochastic propagation models (Baum *et al.*, 2005; Meinila *et al.*, 2009). Stochastic propagation models use a LoS probability parameter to account for variation in the occurrence of LoS in different environments; this parameter has a significant influence on the distribution of received signal strength and is therefore important to validate. One way to validate the LoS probability is to use ray tracing, which is the approach taken in this work. Ray tracing (RT) is considered an indispensable tool for modelling mmWave propagation in specific environments due to its accuracy (He *et al.*, 2019).

The challenges of mmWave propagation drive network densification, meaning a significant increase in the number of cell sites to provide mmWave coverage. Network densification complicates the design because it may be cost prohibitive to provide high-capacity fibre connections, i.e., fibre points of presence (fibre PoP), at the potentially large number of mmWave cell sites. This, in turn, leads to a need for alternate back-haul architectures that provide the interconnection between the fibre PoPs and the cell sites to enable a cost effective network deployment. For example, relay nodes that extend the high-speed connection from the fibre PoPs to the mmWave cell sites are considered. These nodes use frequencies in the mmWave band to provide a high-capacity link between the fibre PoP and the cell site. Cost effective mmWave network design relies on identifying the set of node locations from the set of candidate locations that leads to the lowest cost network.

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Problem Description

This work considers a mmWave network comprised of four node types. The set of potential fibre PoPs that can provide the high-speed connection to the mmWave network is $\mathcal{FP}$. The set of potential sites for relay nodes is $\mathcal{PS}$. These nodes provide the connection from the fibre PoPs to either (i) other relay nodes or (ii) to a cell site. The set of demand nodes that represent the traffic demand from users connected to mmWave cell sites is $\mathcal{DN}$. Demand nodes require a connection directly to a fibre PoP or via relay nodes. Finally, there is a singleton set, $\mathcal{SS}$, containing a virtual super source node, which can be viewed as the gateway between the designed network and the outer network. Thus, this node is the root of the resulting tree comprising the other three node types.

The goal is to identify the optimal locations for nodes given the sets $\mathcal{FP}$, $\mathcal{PS}$, $\mathcal{DN}$ and $\mathcal{SS}$. This should be solved quickly because of the potential number of nodes and sites needed for a large network. Figure 1 gives an example of the structure of the resulting network. Since the links between these nodes use the mmWave band, signal propagation plays a key role in identifying node locations, as the distance between nodes should be maximised to reduce the number of nodes whilst still providing low loss to achieve high data rate transmission between the nodes.

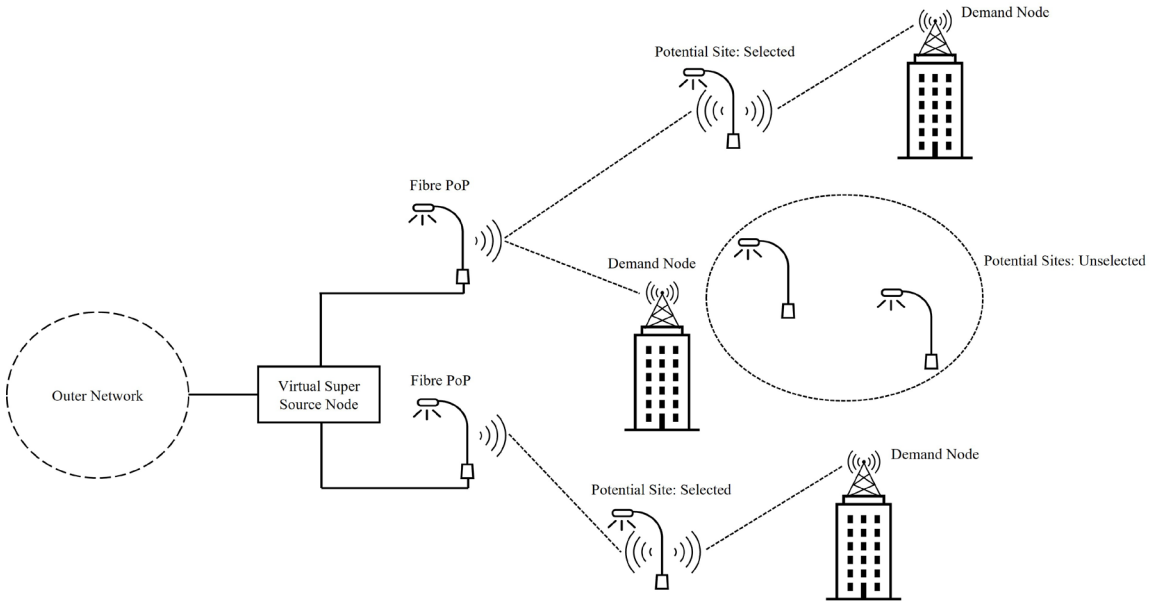

Figure 1. An example of the resulting network.

Among different propagation modelling methods, RT has been considered as a suitable candidate (Al-Hourani, 2020; Cui *et al.*, 2020). It performs simulation based on three-dimensional (3D) environment data in order to track propagation paths. To be more specific, RT can be employed to assist in the propagation modelling by identifying LoS and NLoS paths. Selecting nodes where the propagation between them is LoS removes those with NLoS paths

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where signal losses are higher and potentially intermittent due to blockages and so favours higher quality connections with greater capacity and reliability.

Scope and Contribution

The contribution of this work includes the validation of an existing LoS probability model and the development of an urban area site selection tool based on 3D city models. More specifically, we develop a ray tracer in Cesium (Cesium, 2015a) in which only LoS paths are considered, since NLoS paths are less reliable and inferior compared to LoS paths. Although specular reflections are also considered in many ray tracers for higher accuracy (He *et al.*, 2019; Zhang *et al.*, 2015; Lai *et al.*, 2019; Lecci *et al.*, 2021, Lecci *et al.*, 2020; Bodi et al., 2021), due to the high penetration loss and the lack of useful reflected paths in mmWave frequency bands, considering only LoS communication provides a useful lower bound on performance.

Using the LoS checking functionality, we developed a LoS probability simulation tool and performed simulations in several Australian downtown areas based on 3D environment data in order to evaluate a theoretical urban area LoS probability model (Andrews *et al.*, 2017) and to investigate factors that impact the model parameters.

Next, we developed a network planning tool by formulating a mixed-integer linear programming problem to minimise the overall deployment cost by proper site selection in part of the Melbourne central business district (CBD). The implemented ray tracer checks possible LoS transmissions and provides the length of each link. From these lengths, key metrics such as signal-to-noise ratio (SNR) and link capacity are calculated. Considering the link capacity and the network structure as constraints, the site selection optimisation problem is solved using an existing solver in Matlab and the result is visualised in Cesium.

Methodology

The development of the ray tracer and the RT based planning tool prototype has three stages:

- Review of the existing works that are relevant to RT-based LoS probability validation and network planning (Related Works).
- Design and development of the ray tracer as well as a prototype with the functionalities of LoS probability validation and network planning (Design and Development).
- Evaluation of the developed prototype planning tool based on the analysis of the results of various case studies (Case Study).

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Related Works

Ray Tracing for LoS Probability Model Validation

The existing literature proposes several RT-based methods for LoS probability calculation. In Al-Hourani (2020), a model for predicting the geometric LoS in different urban environments is formulated based on stochastic geometry in which the existence of buildings is modelled as points following the Poisson point process (PPP). The model is then verified using RT-based Monte-Carlo simulations, which show a high degree of agreement between the simulation results and the theoretical analysis. In Cui *et al.* (2020), a frequency-dependent LoS probability model is proposed. RT-based numerical simulations are presented to show the accuracy of the proposed model.

Apart from the buildings, the blockage caused by vegetation or the human body is also of interest. In Thomas *et al.* (2014), RT is used to come up with a distance-based blocking probability function representing blockage by other users and foliage in an outdoor mmWave local area access system. By fitting from simulation results, it was found that the blockage probability is a linear function of the link length. In Thomas *et al.* (2016), the LoS probability model under the LoS-foliage case is verified using RT technology, in which the blockage caused by foliage but not buildings is considered as a third state apart from LoS and NLoS. It is found that the NYU-squared LoS probability model (Aalto *et al.*, 2016) gives a low mean squared error when compared to the RT results.

Ray Tracing for Network Planning

RT-based mmWave network design is a two-stage problem (Danford *et al.*, 2017). Firstly, RT needs to be executed in a given geospatial dataset in order to characterise the communication environment. Based on the results computed by RT, the second step is to use mathematical models to formulate the design as an optimisation problem and utilise tools from optimisation theory to find a solution (Kennington *et al.*, 2011). From the perspective of the first step, a large body of research has been conducted on characterising the communication environment using RT. In 1991, researchers have considered RT as a design tool in radio networks (McKown& Hamilton, 1991). Efficient algorithms were developed to approximate wave propagation and calculate two-dimensional (2D) coverage maps that provide visualisation to the received power at different locations. Similarly, a ray tracer was implemented to calculate the coverage map in an indoor environment in (Ashour *et al.*, 2016). An enhanced RT algorithm was proposed that evaluates the relative change in coverage associated with displacement of the antenna location of a previously computed solution, which improves the computational complexity without sacrificing the accuracy. In Mellios *et al.* (2012), a 3D ray-

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tracing tool is combined with real-world measurements in order to derive a set of urban macrocell propagation statistics suitable for Long Term Evolution (LTE) cellular network planning. The RT study is performed in two different urban environments and the results are compared with the WINNER II/+ standardised channel model (Jamsa *et al.*, 2016).

Generally speaking, the network design problem is complex and composed of multiple aspects. One subproblem is the site selection optimisation problem, which aims to find a subgraph of a graph formed by a set of given nodes and links in order to optimise an objective function while satisfying certain constraints (Danford *et al.*, 2017). This is a classical problem that is studied in a wide range of applications, for example, communications network planning. In Kennington *et al.* (2011), the state-of-the-art optimisation methods for design, analysis and management of wireless networks including cellular and wireless local area networks (LANs) are surveyed. In Benyamina *et al.* (2012), different aspects of wireless mesh network design are discussed. Methods which are proposed to improve the performance of an existing network or to improve its performance by a careful planning of its deployment are examined. Motivated by the development of Facebook's backhaul technology named Terragraph (Choubey & Yazdan, 2016), a suite of tools to support the design and end-to-end planning of fixed 60 GHz mmWave backhaul and access networks is proposed in Danford *et al.* (2017). Given light detection and ranging (LiDAR) data representing the environment, the site locations are generated using 3D computer vision and the potential links are determined based on a LiDAR-specific LoS analysis algorithm. The graph formed by the resulting sites and links is then sent into an optimisation algorithm developed based on the Steiner tree problem (Winter, 1987), in order to minimise the deployment cost and satisfy the user demands by finding a subgraph.

Very few works in the literature have incorporated a real 3D city to study the impact of the surrounding environment on the parameters of LoS probability models. Furthermore, as far as we are aware, the aforementioned Danford *et al.* (2017) is the only study that has combined 3D model-based RT technology with the site selection optimisation problem for network planning. Thus, this area requires more exploration to understand the potential and challenges of using 3D models for these analyses. In this paper, we aim to develop an RT prototype in order to analyse a theoretical LoS probability model and perform optimisation of site selection in real 3D city models.

Design and Development of the Prototype

In this work, we developed a prototype that has two functionalities. Firstly, it can calculate the LoS probability with distance in an area of interest based on extensive RT simulations. The simulation results are then used to evaluate an existing LoS probability model (Andrews *et al.*, 2017) and investigate factors that impact the model parameters. Secondly, a network planning

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tool is implemented in this prototype, which minimises the overall cost of network deployment by selecting a proper subset of given candidate site locations. This is achieved by formulating a mixed-integer linear programming problem. Both functionalities are based on an implemented simple ray tracer. Before describing the development of the prototype, we review some important issues including the platform and datasets.

Platform

The prototype is mainly implemented in Cesium, which is an open-source platform for creating powerful 3D geospatial applications (Cesium, 2015a). It allows users to combine their own 3D data with the provided global content. The open-source JavaScript library, CesiumJS, allows users to create interactive web applications for dynamic geospatial data sharing and accurate 3D visualisation-based analysis.

While Cesium provides good visualisation of a 3D environment, it is not suitable for intensive mathematical calculations. In this work, we consider Matlab for this purpose.

For the LoS probability model validation functionality, the model is fitted to simulation results using Matlab. For the network planning functionality, the optimisation is performed using Matlab Optimisation Toolbox, which provides functions for finding parameters that minimise or maximise objective functions while satisfying constraints (MathWorks, 2022).

In order to link the two platforms, the data transfer between them is critical. In this prototype, the data is transferred by .csv files, since both platforms support this file format.

Data

To model the 3D environment dataset, we used OSM Buildings (Cesium, 2015b), which is a 3D buildings layer covering the entire world. It is available as a 3D Tileset and ready to be used in custom applications with CesiumJS or any client that supports 3D Tiles. It is derived from OpenStreetMap and contains over 350 million buildings with per-building metadata. This includes basic information like building name and height, address, opening hours, and even type of material for individual parts of buildings.

Apart from the 3D environment, the data of potential locations where the sites can be deployed is also necessary in the network planning problem. In a fixed backhaul and access network, the sites are usually set up on street furniture such as streetlights. However, the street furniture is not included in the Cesium OSM Building dataset; thus the potential locations are not available. Therefore, in this prototype the potential site locations are synthesised according to some rules which are described in the case study.

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Utility

This prototype can be used for various purposes. Researchers focusing on the study of LoS probability models can evaluate their theoretical analysis using the LoS probability functionality, while mobile network operators can estimate the network performance in a given environment. Network operators can also use the network planning functionality for site selection.

Design and Development

Ray Tracer

The ray tracer is able to check the existence of LoS between the given locations of a transmitter (Tx) and a receiver (Rx). The flow chart in Figure 2 shows how to check the existence of LoS between a Tx and an Rx. A CesiumJS function named "*viewer.scene.pickFromRay()*" is used to generate a ray based on the location of the Tx and the direction from the Tx to the Rx. It returns the intersection of the ray and the 3D environment. The existence of LoS is checked by comparing the distance between the Tx and the Rx with that between the Tx and the intersection.

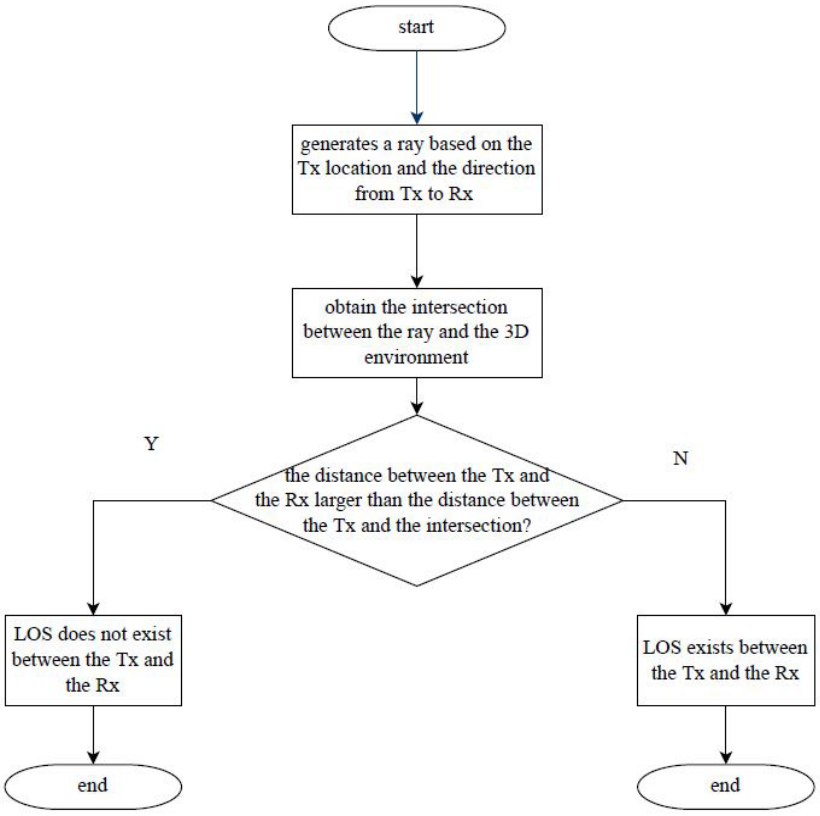

Figure 2. Flow chart of checking the existence of LoS between a Tx and an Rx.

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LoS Probability Validation

The problem of modelling LoS probability or blockage probability is of great interest due to the importance of LoS communication in mmWave transmission (Al-Hourani, 2020). A function $P_{\mathrm{LoS}}(d)$ is a deterministic non-increasing function that takes values in [0,1] and is interpreted as the probability that an arbitrary link of length d is LoS. A typical model for the probability in urban areas is given as (Andrews et al 2017):

$$\mathrm{P_{LoS}(d)} = \min\left(\frac{\mathrm{A}}{\mathrm{d}}, 1\right)\left(1 - \mathrm{e}^{-\mathrm{d}/\mathrm{E}}\right) + \mathrm{e}^{-\mathrm{d}/\mathrm{E}}, \quad (1)$$

where A is a threshold distance and E affects the speed of decay with distance d. Though the exact values of A and E vary depending on the exact environment, we should notice that the model in (1) always follows an exponential rule with distance. Theoretical works, such as Al-Hourani (2020) and Bai *et al.* (2014), study the reason behind the exponential models under different scenarios where the existence of the buildings follows the PPP.

In order to evaluate the exponential model and study the possible factors that affect the parameters in (1), we perform simulations in Cesium to calculate the LoS probability in different circumstances. For a particular distance d, the Tx and Rx locations are guaranteed to be d apart, but randomly chosen for a certain number of iterations. For each Tx-Rx pair, the implemented ray tracer checks the existence of LoS using the implemented ray tracer following the procedure in Figure 2. The LoS probability at distance d is determined by the fraction of iterations where LoS exists. Next, we fit the simulation outcomes to the model in (1) using Matlab in order to calculate the parameters A and E.

Deployment Cost Optimisation in Network Planning

In this section, we follow the work in Danford *et al.* (2017) and propose a fixed wireless network planning tool which minimises the total deployment cost while satisfying a variety of constraints, including user demands, link capacity and the structure and balance of the network. A flow chart is provided in Figure 3 to describe the main process of this tool.

Suppose the locations of fibre points-of-presence (PoPs), potential sites and demand nodes are given. A fibre PoP is a node equipped with fibre, which can be viewed as the gateway between the outer core network and the local access network that we are interested in. A potential site is a possible location to deploy a relay node, which decodes the received signal and then re-transmits the message to other nodes. A demand node is placed at the rooftop of a particular building and represents the demand from multiple users in this building. These nodes form a network that enables transmission between fibre PoPs and demand nodes in order to satisfy all the demands. In this prototype, we only consider downlink communications, in which the network traffic comes from the outer core network, goes

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through the fibre PoPs and finally arrives at the demand nodes. We assume that a transmission can only be achieved via LoS links with distance below a predefined threshold, d_{max}. Furthermore, communications are only allowed between a fibre PoP and a relay node, a fibre PoP and a demand node, two relay nodes or a relay node and a demand node. The LoS links are checked using the ray tracer in Cesium based on the method in Figure 2.

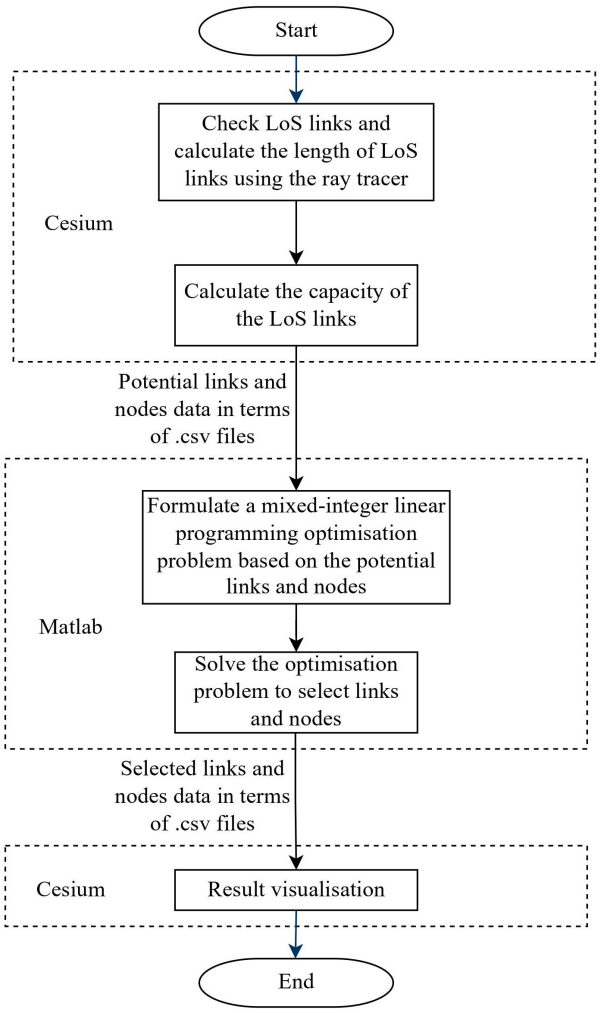

Figure 3. Flow chart of the network planning tool.

The problem of searching for a site selection that minimises the deployment cost can be formulated as an optimisation problem. Before formulating the optimisation problem, we need to specify some key metrics in the network.

a) Cost: the costs of deploying a fibre node or a relay node are different. Since this prototype focuses more on site selection rather than the total deployment cost, we assume that the cost of deploying a fibre PoP is approximately twice the cost of deploying a relay node (Lalwani, 2018) without using the exact deployment cost.
b) Capacity: we assume that the capacity of a link between node *i* and node *j* with Rank *L* (or *L* layers) is calculated as:

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$$C_{ij} = LB \times \min\left\{\log_2\left(1 + \frac{P_r}{P_i + N}\right), c_{max}\right\}, \quad (2)$$

where B is the bandwidth of the link. The first term in the minimisation function is the Shannon capacity per Hz bandwidth, calculated from the bandwidth B and the signal-to-interference-plus-noise-ratio (SINR), $P_r/(P_i + N)$, with P_r the signal power received at the output terminal of the receiving antenna, P_i the interference power of the other signals and N the noise power, all measured in Watts (W). The second term, c_{max}, is an upper bound on the per-layer spectral efficiency. For this mmWave problem, we assume that the antennas are highly directional such that the interference power is negligible, i.e., $P_i \ll N$. Thus, the SINR can be approximated by the SNR, P_r/N, and (2) can be approximated as:

$$C_{ij} \approx LB \times \min\left\{\log_2\left(1 + \frac{P_r}{N}\right), c_{max}\right\}. \quad (3)$$

The received power, P_r, can be calculated using existing LoS stochastic path loss models. In this work, we consider the model in Table 7.4.1-1 of 3GPP (2022a), which can be expressed as:

$$L_p = 32.4 + 21\log_{10}(d) + 20\log_{10}(f_c) + L_{sf}, \quad (4)$$

where L_p is the path loss in dB, d is the distance between the Tx and the Rx in metres, f_c is the operating centre frequency in GHz, and L_{sf} is a normal random variable in dB for the shadow fading with a mean of 0 dB and a standard deviation of 4 dB.

The received power in W can be expressed as:

$$P_r = \frac{G_t G_r}{10^{(L_p/10)}} P_t, \quad (5)$$

where P_t is the power at the input terminal of the transmitting antenna in W and G_t and G_r are the gain of the transmitting antenna in the direction of the receiving antenna and the gain of the receiving antenna in the direction of the transmitting antenna, respectively.

The calculation of noise power considers only thermal noise, which can be expressed as:

$$N = k_B T B, \quad (6)$$

where k_B is the Boltzmann constant and T is the temperature in Kelvins.

Next, we give a brief introduction to the upper bound, c_{max}. The spectral efficiency of a single layer can be expressed as (3GPP, 2022b):

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$$\mathrm{SE} = \frac{\mathrm{R}\mathrm{Q}_\mathrm{m}\mathrm{N}_\mathrm{s}}{\mathrm{B}_\mathrm{RE}\mathrm{t}_\mathrm{slot}}, \tag{7}$$

where R is the target code rate, Q_m is the modulation order, N_s is the number of symbols in each slot, B_RE is the bandwidth of a resource element and t_slot is the time duration for a slot. A 5G mmWave system supports different modulation and coding scheme tables. In this study, we consider a 64 quadrature amplitude modulation (QAM) maximum modulation scheme (3GPP, 2022b). The values of N_s and the $\mathrm{B}_\mathrm{RE}\mathrm{t}_\mathrm{slot}$ product are fixed. Thus, the upper bound is determined by using the maximum values of R and Q_m in Table 5.1.3.1-1 of 3GPP (2022b).

Some key simulation parameters are provided in Table 1. For a given Tx-Rx pair, the received power and the link capacity are calculated based on the parameters, as well as the link length d obtained from the ray tracer implemented in Cesium.

Table 1. Key simulation parameters in network planning.

Parameter	Value
Operating frequency f_c	26 GHz
Bandwidth B	1 GHz
Number of layers L	2
Transmit power P_t	60 dBm
Temperature T	300°K
Target code rate R	0.926
Modulation order Q_m	6
Number of symbols per slot N_s	14
The $\mathrm{B}_\mathrm{RE}\mathrm{t}_\mathrm{slot}$ product	15
Maximum per-layer spectral efficiency c_max	5.18 bps/Hz
Maximum link length d_{max}	300 m
Antenna gains G_t and G_r	0 dB
Cost of a fibre PoP	2
Cost of a relay node	1

Next, we formulate the optimisation problem as a mixed-integer linear programming problem. The objective is to select a subset of the set of fibre PoPs and potential sites (PSs) for relays in order to implement a tree-structured network that satisfies all the demands at minimum deployment cost.

We first introduce the notations used in this problem.

Inputs to Optimisation Model

The node data is given by:

- $\mathcal{FP}$: Set of all potential fibre PoPs.
- $\mathcal{PS}$: Set of all potential sites to deploy relay devices.

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- $\mathcal{DN}$: Set of all demand nodes.
- $\mathcal{SS}$: A singleton set containing a virtual super source node, which can be viewed as the gateway between the designed network and the outer network. Thus, this node is the root of the resulting tree. We assume there exists a connection between the source node and each fibre PoP with infinite capacity.
- $\mathcal{V}$: The union of $\mathcal{FP}$ and $\mathcal{PS}$.
- K_i: Cost of deployment at location $i \in \mathcal{V}$.
- D_i: Demand at demand node $i \in \mathcal{DN}$.

The potential link data is given by:

- $\mathcal{A}$: Set of all possible links, including the LoS links obtained from Cesium and the virtual connections between the source and the fibre PoPs.
- C_{ij}: Capacity of link $(i,j) \in \mathcal{A}$, where $i,j \in \mathcal{V}$.

Decision Variables in Optimisation Model

The decision variables used in the optimisation problem are given by:

- x_i: is 1 if node $i \in \mathcal{V}$ is selected; 0 otherwise.
- y_{ij}: is 1 if link $(i,j) \in \mathcal{A}$ is selected; 0 otherwise.
- f_{ij}: the flow from node i to node j, is positive if the flow is actually from i to j; negative otherwise.

Problem Formulation

The objective function is to find a subset of $\mathcal{V}$ such that the total cost is minimised:

$$\min \sum_{i \in \mathcal{V}} K_i x_i. \tag{8}$$

The constraints are partitioned into two parts, the constraints on the flows and the constraints on the network structure.

We first discuss the former. We need to ensure that the total incoming flow equals the total outgoing flow and the demand at a node:

$$\sum_{j \in \mathcal{V} \cup \mathcal{DN} \cup \mathcal{SS}:(i,j) \in \mathcal{A}} f_{ij} + d_i = 0, \quad i \in \mathcal{V} \cup \mathcal{DN} \cup \mathcal{SS}, \tag{9}$$

where

$$d_i = \begin{cases} D_I, & i \in \mathcal{DN} \\ -M, & i \in \mathcal{SS} \\ 0, & i \in \mathcal{V} \end{cases} \tag{10}$$

with $M = \sum_{i \in \mathcal{DN}} D_i$ denoting the total demand at all Demand Nodes (DNs).

Next, a link may only have non-zero flow when it is active:

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$$|f_{ij}| \leq My_{ij}, \quad (i,j) \in \mathcal{A}. \tag{11}$$

Furthermore, the flow in a link is upper bounded by the capacity of the link:

$$|f_{ij}| \leq C_{ij}, \quad (i,j) \in \mathcal{A}. \tag{12}$$

Constraints should also be introduced in order to ensure the tree structure of the resulting network. Since the demand nodes are leaves of the resulting tree, each demand node is covered by exactly one potential site or fibre PoP (Jabrayilov, 2020):

$$\begin{aligned} \sum_{I \in \mathcal{V}:(I,j) \in \mathcal{A}} y_{ij} &= 1, \quad j \in \mathcal{DN}, \\ \sum_{j \in \mathcal{V}:I \in \mathcal{A}} y_{ij} &= 1, \quad i \in \mathcal{DN}. \end{aligned} \tag{13}$$

Next, the number of links connected to a selected PS or fibre PoP must be greater than or equivalent to 2:

$$\sum_{(I,j) \in \mathcal{A}} y_{ij} \geq 2I, \quad i \in V. \tag{14}$$

Besides, the number of selected links in the resulting network is 1 less than the number of nodes. Since the number of super source nodes is 1, this constraint can be expressed as:

$$\sum_{(I,j) \in \mathcal{A}} y_{ij} = \sum_{k \in \mathcal{V}} x_k + |\mathcal{DN}|. \tag{15}$$

Finally, a node variable is set to one as long as a link it connects to is taken into the solution:

$$\begin{aligned} Y_{ij} &\leq x_I, \quad i \in \mathcal{V}, I \in \mathcal{A}, \\ y_{ij} &\leq x_j, \quad j \in \mathcal{V}, I(i,j) \in \mathcal{A}. \end{aligned} \tag{16}$$

As we can see in the constraints, decision variables y_{ij} for the links and f_{ij} for the flows are introduced. In order to formulate this problem as a linear programming problem, we restate the objective function in (8) as:

$$\text{Min} \sum_{i \in \mathcal{V}} K_i x_i + \sum_{(I,j) \in \mathcal{A}} \delta y_{ij} + \sum_{I \in \mathcal{A}} \epsilon f_{ij}, \tag{17}$$

where δ and ϵ are small values denoting the "costs" of a link and a flow, respectively. Notice that $\epsilon \ll \delta$ since the f_{ij} are usually of the order of 10^6 up to 10^{10}, while y_{ij} is binary. Although (17) increases the dimension of the problem by $2|\mathcal{A}|$, the problem can now be solved using a mixed-integer linear programming solver. The solver we consider is Matlab function "*intlinprog()*" (MathWorks, 2019) from the Optimisation Toolbox. It takes the potential node locations and links, as well as the metrics calculated in Cesium as inputs, and exports the optimisation results back to Cesium for visualisation.

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Case Study and Result Analysis

LoS Probability Validation

Case Study

Two sets of simulations are performed to verify the urban area LoS probability model in (1) and study the possible factors that affect the parameters. Firstly, simulations are performed in different 3D city models, namely Melbourne, Adelaide and Darwin, in order to investigate the relationship between the parameters and the density of the buildings. For this set of simulations, we only consider the ground-to-ground LoS probability. In other words, the Tx's and Rx's must be placed at ground level. The regions where the simulations are performed are shown by the red regions in Figures 4, 5 and 6.

Apart from cities, the height can also affect the building density. In order to investigate how the Tx height impacts the parameters in (1), another set of simulations are performed in the 3D model of Melbourne, shown in Figure 4. The Tx is placed at a certain longitude and latitude with different heights above ground level, while the Rx locations are randomly selected at ground level. The Tx location is given by the green spot in Figure 4.

Figure 4. Region for simulation in Melbourne.

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Figure 5. Region for simulation in Adelaide.

Figure 6. Region for simulation in Darwin.

Results and Analysis

Figure 7 shows the LoS probability versus distance in Melbourne, Adelaide and Darwin. The curves in dashed lines are the simulation results, while those in solid lines are fitted curves based on the simulations results and (1). The corresponding parameters of the fitted curves are given in Table 2. We observe that the threshold distances for Darwin and Melbourne are 0, while the value for Adelaide is 2. Since the Tx is always located at ground level, the value of A is expected to be 0. Nevertheless, since this does not make significant difference between the fitted curves for Melbourne and Adelaide, we consider this difference in A as an insignificant error in fitting results. In addition, the parameter E for Darwin is much larger than for the other two cities, which makes the curve decay more slowly. As can be observed in

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Figures 4, 5 and 6, the density of the buildings in Darwin is lower than in Melbourne and Adelaide. Therefore, we conclude that the parameter *E* related to the decaying speed decreases with increasing building density.

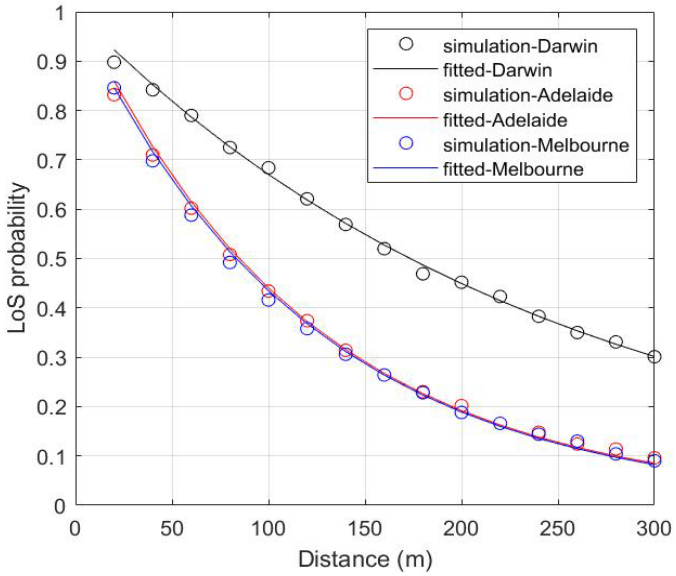

Figure 7. LoS probability versus distance in Melbourne, Adelaide and Darwin.

Table 2. Fitted parameters for different cities.

City	*A* (metres)	*E* (metres)
Melbourne	0	120
Adelaide	2	118
Darwin	0	250

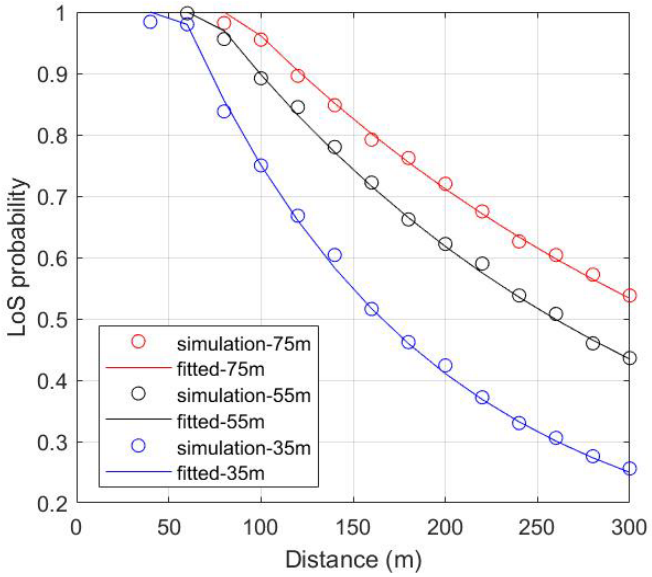

Figure 8. LoS probability versus distance in Melbourne. The Tx is placed at a certain location, 35 m, 55 m or 75 m above ground level.

Figure 8 shows the LoS probability versus distance for different Tx heights. The corresponding parameters are given in Table 3. Both *A* and *E* increase with increasing Tx height. The

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threshold A increases since the Rx's are placed at ground level; thus, no LoS probability results below a certain distance are available. The parameter E increases since the density of the buildings usually decreases with the height.

Table 3. Fitted parameters for different Tx heights.

Tx height (metres)	A (metres)	E (metres)
35	57	115
55	72	220
75	87	280

Deployment Cost Optimisation in Network Planning

Case Study

As introduced in the section on development of deployment cost optimisation, communication is possible between certain types of site pairs. An example of the node locations and potential links is given in Figure 9, in which a part of downtown Melbourne is considered as the region of interest.

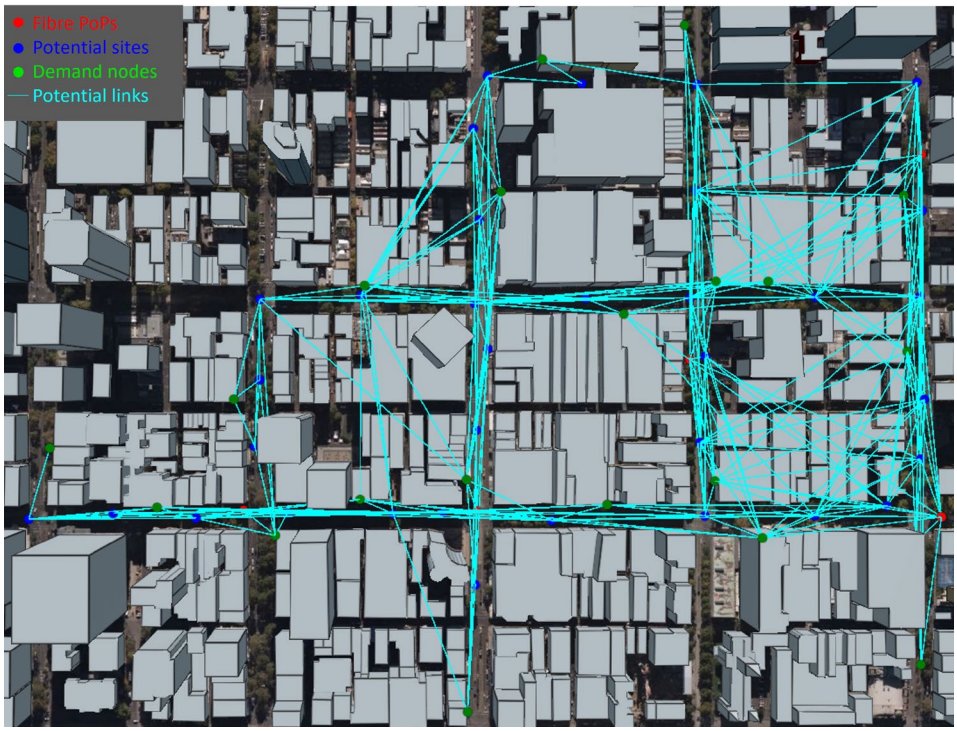

Figure 9. Potential LoS links (cyan lines) obtained from the given fibre PoPs (red dots), PSs (blue dots) and DNs (green dots).

As is discussed in the section on prototype data, the potential site locations are manually selected, since these datasets are not available. In order to approximate a practical scenario, we define the following rules for the selection of potential sites:

- A fibre PoP or a PS must be located on a streetlight. In other words, these nodes must be placed on the street with a certain height above the ground.

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- A DN must be located at the edge of the rooftop of a building. As such, the total demand of all users in a given building is represented by the demand of this node.

Results and Analysis

Using the node locations and potential links given in Figure 9 as the optimisation input, the resulting network is shown by the lawn-green lines in Figure 10. The network is divided into two parts: each of them is a tree with a fibre PoP as the root. By connecting the two selected fibre PoPs to the virtual source node, the resulting network is tree structured.

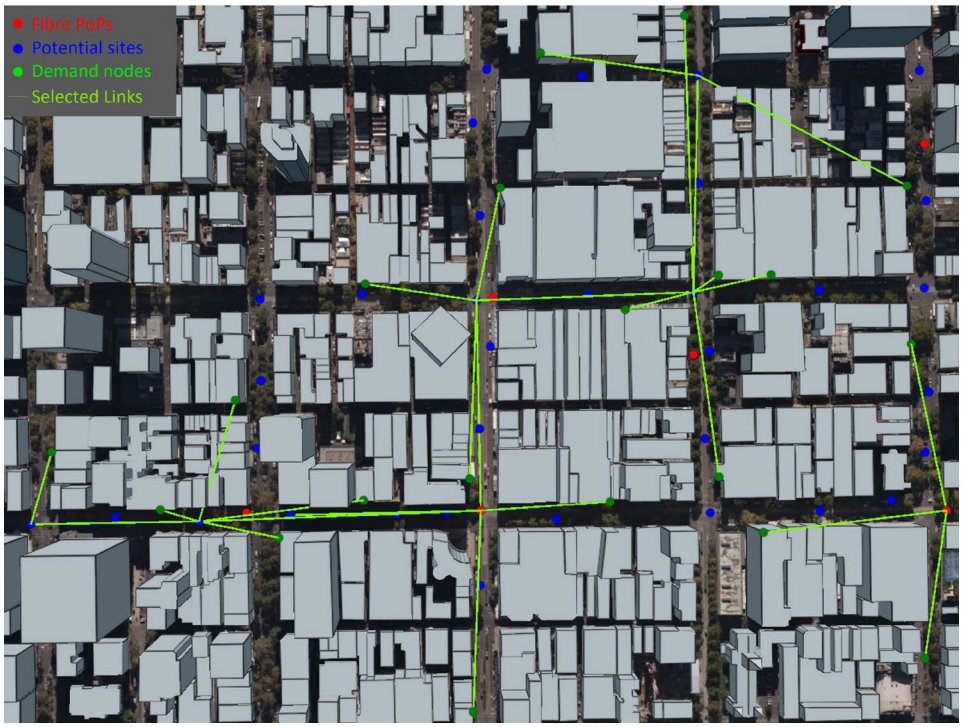

Figure 10 The selected links (lawn green lines) resulting from the optimisation problem. The input of the optimisation problem is visualised in Figure 9.

Apart from the solution to the optimisation problem, the time required to solve it is also of great interest, as we would like to know if we should partition the problem into subproblems when the size is large. Figure 11 plots the simulation time required to solve the problem with the dimension of the problem using black circles. The time required for optimisation increases slowly in the low dimension region and rises quickly in the high dimension region.

The mixed-integer linear programming problem is known to be an NP hard problem. Though it is still not known if an NP hard problem can be solved in polynomial time, we try to fit the points using a polynomial curve. It is shown in Figure 11 by a blue dashed line that a polynomial fit with degree of 7 is very close to the simulation time. The fitted curve can be expressed as:

$$f(x) = 1.32 \times 10^{-16}x^7 - 3.228 \times 10^{-13}x^6 + 3.126 \times 10^{-10}x^5 - 1.506 \times 10^{-7}x^4 + 3.827 \times 10^{-5}x^3 - 5.001 \times 10^{-3}x^2 + 0.302x - 5.628. \quad (18)$$

http://doi.org/10.18080/jtde.v11n1.640

This result might be useful when we would like to predict the optimisation time for higher dimensional problems.

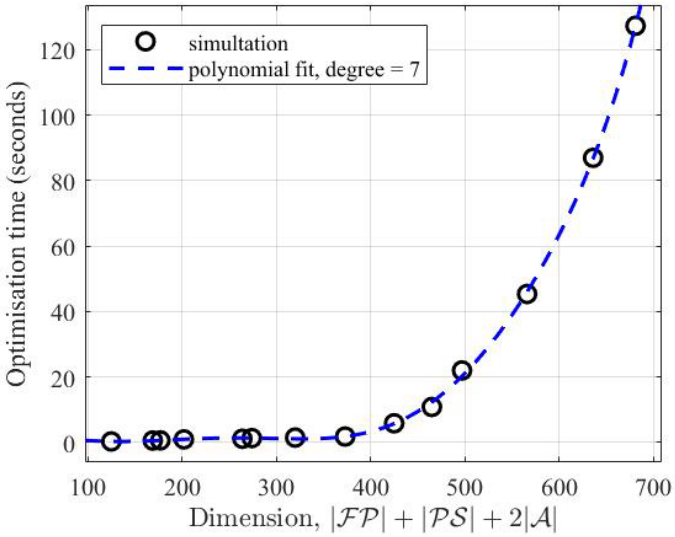

Figure 11. Time for solving the optimisation problem (black circles) and the polynomial fit (blue dashed line) in (18).

Conclusions and Future Extensions

The contribution of this paper includes the validation of an existing LoS probability model and the development of an urban area site location selection tool based on 3D city models. More specifically, we developed a simple ray tracer in Cesium in which only LoS paths are considered. Based on its LoS checking functionality, we validated an LoS probability model expressed as an exponential rule with the link length. By fitting the simulation results in different scenarios to the model, we found that the decaying speed of this exponential function increases with the building density, while the threshold distance increases with the Tx height. In addition, we develop a network planning tool by formulating a mixed-integer linear programming problem in order to minimise the overall deployment cost by optimal site selection. The ray tracer first checks potential LoS links and provides the length of each link to enable the calculation of the link capacity. The potential locations of the nodes are manually generated due to the limitation of the 3D dataset. Taking the sets of site locations and potential links as the inputs, an existing Matlab solver is used to select a subset of the sites in order to construct a tree-structured network that satisfies all the user demands at a minimum deployment cost. The optimisation results are then sent back to Cesium for visualisation. We also analyse the time required for solving this optimisation problem in order to provide a prediction to the optimisation time for larger sized problems.

In the following points, we outline several possible directions for further work.

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- The 3D geospatial dataset we are using does not contain street furniture and vegetation. It would be desirable if 3D data with these features are available. With street furniture, it would be possible to automate the process of inspecting the fibre PoP and PS locations based on 3D computer vision and machine learning techniques (Danford *et al.*, 2017). As such, it will be easier to investigate the capability of the network planning tool with increasing problem dimension. With vegetation in the data, the foliage loss can be taken into consideration when calculating the path loss (ITU, 2016). Besides, we can use the ray tracer to evaluate other LoS probability models such as NYU-squared model in which foliage is considered (Aalto *et al.*, 2016).
- Though LoS transmission plays a major role in mmWave communications, the ray tracer could be extended to include specular reflections. By considering multi-path components, highly accurate characterisation of the received signal can be achieved, including phase shift, power and Angle of Arrival. The specular reflected paths are usually calculated using the method of images, which is computationally costly (Lecci *et al.*, 2021). Therefore, it is important to understand the tradeoffs between the accuracy and the efficiency in RT.
- In the modified objective function in (17), the problem dimension is increased to $|\mathcal{FP}| + |\mathcal{PS}| + 2|\mathcal{A}|$ compared to the original problem in (8), in order to formulate the problem as a mixed-integer linear programming problem. Since the mixed-integer linear programming problem is known to be NP hard, it would be desirable to come up with a problem formulation in which the dimension is the same as the original problem.

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Stewart Julian Wallace (1954–2022)

Contributor to Global Telecommunications and Life

Enn Vinnal
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Currently Wireless Frequency Studio.

Abstract: Stewart Wallace made many contributions in his life, most notably to the development of the APT700 frequency band, the Asia Pacific Telecommunity 700 MHz spectrum, now used on mobile phones in many parts of the world. He was also an admired bagpiper, invited to play at Royal Edinburgh Military Tattoos, ANZAC commemorations and as a solo piper. Through the diversity of his upbringing, education, varied life experiences, and openness to new challenges, together with passion for each of these while also being a good listener and communicator, Stewart Wallace achieved an enviable balance of humanity and global success, doing what he loved best.

Keywords: Obituary, ITU-R Study Group 5, APT700 (3GPP Band 28), Royal Edinburgh Military Tattoo

Early Life and Education

Stewart Wallace had many interests and considerable talents, but there were some constant themes exhibited throughout his life. On one hand, he was an immensely likeable person with a fair mindset and, on another, he also had an independent adventurous streak. This tribute, or perhaps reminiscence, aims to relate some of these characteristics.

Stewart was born in 1954 and brought up in Kergunyah, a small town in the Kiewa Valley in country Victoria, Australia. He grew up on his family's agistment property. For those historically minded, he was a direct descendant of the extended Wallace family associated with Wallace's Hut in alpine Victoria, built by three Irish brothers in 1889, one of whom was Stewart Wallace, Stewart's great grandfather. By all accounts his farm life was idyllic.

His formal education began in earnest when he became a boarder at Scotch College in Melbourne. There he was drawn to one of the interests that was to continue at various other

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stages of his life. That was playing the bag pipes. He completed his secondary education at Scotch, finishing in the Class of 1971. He then went on to study Applied Science, majoring in Electronics Engineering, at the University of Melbourne, graduating in 1977. Later, he gained a Master of Engineering degree at RMIT University in 2002.

Life and Career Diversity

Having grown up in rural Victoria close to the snowfields, he became an accomplished skier, a second lifelong interest. After university he made a wonderful career choice: to become a full-time ski instructor. One could say he had the best of both worlds, working in Australia in the Southern winter and in the ski resorts of Europe in the Northern one. He remained an avid skier for the rest of his life.

He returned to the technical sphere in 1986, joining NEC, which sent him to Japan to work on high-speed microwave strip-line interconnects between memory and CPUs in the high performance mainframe computers that were being developed at this time. Japan made a lasting impression on him in a number of ways. One was its food, but he also developed a fascination for martial arts. While searching for an opportunity to learn about this, a Japanese colleague referred him to a particular Buddhist temple which was the home of fighting monks. There he learnt karate in what might seem a rather unusual way, by living the monastic lifestyle, spartan and meditative. Stewart was a vivid storyteller and one episode relates to early morning rises, having a bowl of soup for breakfast, and then being handed a bowl of water and a very small brush and given the task of scrubbing clean the wooden patio and temple stairs. That experience instilled in him a mental stamina that could be observed by those looking closely enough. Karate remained a lifelong passion and he was very proud of the level he reached.

He married Trinidad Campino Talavera in 1990 after first meeting her in Australia, during a brief trip from Chile to visit her sister in Melbourne. It must have been love at first sight because, a few days after she had returned home to Chile, he proposed to her over the phone. He later travelled to Chile to formally ask permission from her family to marry. Their daughter Alison was born in 1996 and she followed in his footsteps to become an avid skier and Pipe Major of the Presbyterian Ladies' College Pipes and Drums band. He was very proud of each of her achievements as her life progressed through university and beyond.

After returning from Japan, he joined The Ambidji Group when it was formed in 1991. This firm specialises in the development of infrastructure supporting the air transport industry. There, Stewart worked on the design specifications and implementation of land-air telecommunications for Hong Kong and Kuala Lumpur airports, as well as other projects in

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South East Asia. He told vivid stories about his experiences on those projects, both from engineering and personal perspectives.

Whisky also emerged as a lifelong interest. Stewart became a connoisseur of single malt, where a wee dram was a must each evening. He also developed an interest in brewing beer. Then there is the story about him finishing bottling a batch of beer, allowing it to properly settle, then packing forty or so bottles into the back of the family car and driving to spend Christmas holidays with the family down the coast. It was a very hot day and, shortly after departing with a boot full of luggage and home-bottled beer, the bottle caps begun to pop due to the heat; bottles exploded, beer started gushing, and the boot and its ceiling were awash with beer and broken glass. Stewart never revealed whether the car was sold afterwards; however, it most likely smelt like a public bar for a long while.

Figure 1. Attending ITU-R Study Group 5,[i] Geneva 2017

In 1999 he joined Telstra, specialising in regulatory aspects of international radio spectrum. He was an ideal person for the role, being technically astute and a congenial mixer, with a typical Australian straightforward and open manner. He was also a good negotiator, finding ways through the byzantine spectrum regulatory environment. In Geneva, he attended many meetings of the International Telecommunication Union (ITU), which examined and specified the technical and regulatory rules for allocation of spectrum to new services. In this, he was well supported by Telstra and, in particular, by Mike Wright. Mike was head of Networks and an astute and progressive innovator. Working together and with other Telstra colleagues, they developed and promoted what became known as the APT700 band, the Asia-Pacific Telecommunity ("APT Radiocommunication Program", 2023) 700 MHz spectrum ("4G LTE Band 28"), which we all use now in our mobile phones. Mike and Stewart also promoted the

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use of radio spectrum for high-altitude platforms to allow delivery of cellular services to areas experiencing disruption of normal services during fires or floods, for example. The effort to acquire spectrum for these high-altitude platforms is only now reaching finality at the ITU World Radiocommunication Conference commencing in November this year (WRC-23, 2023).

Bringing Diverse Interests Together

Figure 2. Proudly dressed for one of the many Pipes and Drums competitions in which he participated

He returned to playing the bagpipes in 2008 and these became an important part of his life. He was one of the first members of Old Scotch Pipes and Drums Band and also played with the Royal Victoria Regiment. He took his bagpipes with him on trips to ITU meetings in Geneva. He had two: an electronic chanter connected to earpieces, which he played during flights, and the main pipes on which he practiced on early mornings before ITU work. On one occasion, on the shore of Lake Geneva, he was approached by a police officer who had been sent to silence the 'caterwauling' after a nearby resident had complained about an early morning racket. In 2015, Stewart played as the lone piper in one of the Last Post ceremonies under the Menin Gate in Bruges, Belgium. He was invited to play in the Edinburgh Tattoo in 2018 as a part of the Royal Victoria Regiment, an experience he was very proud of. In 2022, he was again part of the Edinburgh Tattoo, this time playing with the Royal Edinburgh Military Tattoo house-band.[ii]

And again there is a story worth the telling. One day, on the road journey back to London after the 2018 Tattoo, a fellow piper and Stewart came up with the idea of parading up and down

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the main street of the local town with Stewart playing the pipes and his companion following behind with a hat collecting donations. Stewart remarked they were never short of beer-money.

Stewart retired from Telstra in 2018 but continued with all of his interests. He played the pipes in ANZAC day parades, in the Last Post Services at the Shrine of Remembrance, and at the East Malvern Returned & Services League (RSL). He started tutoring young people wanting to be pipers, at the East Malvern RSL. He also added a new item to his list of hobbies — he bought a Harley-Davidson motorbike. It was a magnificent machine driven sedately, even stylishly, by Stewart, though he pointed out, one too heavy to lift upright by just one person if it lay on its side. But, on the one or two occasions that this happened there was never any shortage of aficionados willing to help get it upright again.

Throughout the last thirteen years of his life, Stewart successfully undertook cancer treatment and was in remission until a few months before the Edinburgh Tattoo in 2022. Cancer was ultimately the cause of his passing. He will be fondly remembered through his many contributions and through the stories about him. He had a unique combination of talents and an open and accepting personality, which he applied to both technology development and human friendships. Stewart is survived by his wife Trinidad and daughter Ali.

Acknowledgements

This Tribute was written with contributions from Stewart's wife Trinidad and former Telstra engineer John Costa.

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Endnotes

[i] For further information on Study Group 5, see "Study Group 5 (SG-5)" (2023).

[ii] For details of the Royal Edinburgh Military Tattoo, see https://www.edintattoo.co.uk/

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Revisiting the 1965 Centenary of the International Telecommunication Union

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Abstract: The *Journal* republishes an historic paper from 1965 by Richard (Dick) Butler, later to become Secretary General (1983–1989) of the International Telecommunication Union, on the ITU and its influence on telecommunications standardisation in Australia during in its first century (1865–1965).

Keywords: History of Australian Telecommunications, International Telecommunication Union, Richard E. (Dick) Butler.

Introduction

The International Telegraph Union, the forerunner of the International Telecommunication Union (ITU), was formed in 1865 in Paris by the representatives of twenty European countries, seeking to make international telegraphy interoperable, with common protocols for users and an agreed set of international tariffs. At this time telegraph services in Australia were run by individual colonies, with limited networks and no international connections. Mail services depended upon ships and horse-drawn coach lines, such as Cobb & Co. The telephone, of course, had yet to be invented. As Dick Butler wrote: "few communities [at that time] were more interested than Australia in the development of the means for speedy and reliable long-distance communication" (Butler, 1965, p. 174)

The ITU's role is to promote and assist with the efficient utilisation and extension of the world telecommunication networks by encouraging the exchange of information and offering advice to solve telecommunication problems. The ITU is a shining example of international co-operation and the oldest inter-governmental organisation within the United Nations.

The ITU has always been a key international forum for standards setting and regulation. Perhaps its most important roles have been to ensure the technical interoperability of telecommunications services between ITU member (national) states, to allocate different parts

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of the global radio spectrum to different services, and to facilitate international co-operation in assigning satellite orbits. It also has a key role in providing expertise to improve telecommunication infrastructure in the developing world. The ITU's membership currently includes 193 countries and around 900 businesses, academic institutions, and international and regional organizations (ITU, 2023a).

In 1878, South Australia was the first Australian colony to join the ITU, after Darwin was connected to the world via an under-sea cable to Java in 1871. This cable was interconnected to the famous Overland Telegraph Line from Darwin to Adelaide, providing access to and from the other Australian colonies. Upon Federation in 1901, the new Commonwealth of Australia joined the ITU, which became the International Telecommunication Union, embracing telephony as well as telegraphy and other future telecommunication services, from 1932.

The attached historic paper highlights a number of issues particular to Australia that were considered by the ITU in its first century. An overseas call from Australia to the United Kingdom, for example, would need to transit several networks owned by different operators and over several different time zones. The quality of the call was only as good as the weakest link; and here the ITU worked tirelessly to harmonise the standards and equitably share resources to optimise the efficiency of networks.

It is a credit to the ITU that the co-operation and harmonisation in telecommunications achieved over the last one hundred years has been attained by voluntary expert representation from all countries of the world and without resorting to coercion or conflict.

Australia in 1965 was still regarded as a relatively young and developing country, but twenty years later it commanded a pivotal position in the ITU, thanks to the tireless efforts of the author of this paper.

Richard (Dick) Butler served as the Secretary General of the ITU from 1983 to 1989 and was Deputy Secretary General from 1974 to 1982 (ITU, 2023b). According to his obituary in the *Sydney Morning Herald:*

> [H]e was the highest ranking Australian in the United Nations hierarchy and the first and only Australian to be elected as head of a specialised agency in 1982. As the UN's regulator of the global airwaves, based in Geneva, he pushed for the introduction of accessible, reliable and compatible telephone, telegraphy and data transfer services in Third World countries (Butler & Hoven, 2012).

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http://doi.org/10.18080/jtde.v11n1.719

The Historic Paper

AUSTRALIAN INTERESTS IN THE INTERNATIONAL TELECOMMUNICATION UNION

*R. E. Butler, A.R.M.T.C., A.A.S.A.**

During the past 100 years or so the world has seen some astonishing scientific achievements. But probably none has been more remarkable, nor had so profound an effect upon the affairs of man, than the improvement that has taken place in the means for people to communicate over long distances. The historic "break through", with the introduction of the electric telegraph in the 1830's, has been followed no less dramatically by the development of the telephone, radio, television, the submarine telephone cable and, in more recent times, the use of the space satellite.

One hundred years ago few communities were more interested than Australia in the development of the means for speedy and reliable long-distance communication. The slow exchange of news and information with the old countries was a constant reminder of Australia's immense distance from the cultural sources of its settlers and the markets that sustained them. Even within its own boundaries, communication between the widely separated settlements was hazardous and uncertain.

Thus, the introduction of the electric telegraph into Europe, about the time the first tents appeared on the banks of the Yarra River, was viewed in Australia with understandable interest.

The expansion of the European network within national boundaries was very fast. It was favoured by the social, political and commercial challenge of the times. The first submarine cable was laid between France and England in 1851 and, with the obstacle of the sea breached, slender links began to creep outwards from the old world to the new. During the 1850's and 1860's several plans were put forward with the objective of bringing a submarine cable to the Australian shore. Similar conditions stimulated the installation of international communications.

Eventually, in 1870, the Government of South Australia entered into an agreement with the British/Australian Telegraph Company to lay a cable from Java, already linked with Europe, to Port Darwin. Fig. 1 shows the cable being hauled ashore at Darwin in 1871. Here it joined the historic overland telegraph line to Adelaide constructed with infinite labour and resource by Sir Charles Todd and his men along a difficult and inhospitable route explored some ten years earlier by McDouall Stuart. Fig. 2 shows a group of overland telegraph officers at Roper River in 1872. The first "through" message reached Adelaide from London on 22nd October, 1872 and 12,000 miles were bridged in an instant.

With the establishment of telecommunication with the outside world the individual Australian States, led by South Australia in 1878, progressively joined the relatively young International Telegraph Union, which had been founded in 1865.

Now, 100 years later, the Union is widely regarded as an impressive and long-standing example of world-wide

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Fig. 1 — The Landing of the Telegraph Cable at Darwin in 1871.

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Fig. 2 — A Group of Overland Telegraph Officers at Roper River in 1872. From left to right: J. A. Little, R. C. Paterson, C. (later Sir Charles) Todd, and J. Mitchell.

international co-operation. It is the oldest of the inter-governmental organisations which form the specialised agencies of the United Nations. Its work is largely of a standard-setting and regulatory nature. It provides the forum for the telecommunication authorities of the world to discuss the removal of inconsistencies in the arrangement and conduct of their services so that the amazing advances that have been achieved in telecommunications will be employed to the full.

The Union's role is to encourage and assist the effective and efficient utilisation and extension of the world networks by providing opportunity for the exchange of information, advice and assistance in the solution of telecommunication problems.

Australia today is no less interested in current telecommunications advances than it was 100 years ago. Certainly the speed, variety and range of our facilities have increased enormously in that time. However these have been paralleled by a vigorous national growth with all of the familiar and complex demands for service which the modern world generates. Telecommunications are now the life blood of a modern society and of virile and successful government, trade, industry and commerce.

Although the physical reality of distance no longer constitutes in itself the problem that it presented to our forebears, other barriers have been exaggerated or imposed which, if left unsolved, would detract no less from the effectiveness of our services.

The first of these is that the other end of any international communication system is owned and operated by another administration or operating agency. Frequently a third or even fourth party is involved at intermediate transit or switching points. The most immediate effect of this situation is that the quality of an overseas call originated by an Australian subscriber is affected by the standards of one or all of the networks through which at some time it passes and over which the Australian administration may exercise no direct control.

In other words the efficiency of any one national network, for international purposes, is no greater than the weakest network in the chain.

The elimination of conflicting operating standards therefore becomes a prime objective of the Union and forms a major part of the activities of the Consultative Committees.

Australia's circumstances, from the telecommunication viewpoint, are such that they require her to take perhaps more than usual interest in the work of the Union.

Our geographical position, comparatively remote from our communities of interest in the northern hemisphere and, to a lesser extent, in the south-east Asian and Pacific regions, has led to a proportionately high investment in submarine cable networks and international telecommunication installations. In addition to the long established Commonwealth telegraph and radio telephone networks, we have in recent years become substantial partners in the submarine telephone cables COMPAC and SEACOM and in a proposed global communication satellite system.

The development of common standards of equipment, techniques and procedures and the task of persuading the various nations to introduce them into their individual networks therefore are of vital consequence to the effective conduct of our own telecommunication operations and the full economic employment of our capital investments.

Inadequacies in areas of the world networks can even be carried into our national system. The adoption of subscriber trunk dialling, for instance, and the provision of automatic telex in our internal system introduces into the network problems arising from inefficiencies or shortcomings in foreign cables or networks.

A further factor affecting Australia more than most major telecommunication Administrations, and also arising from our geographical position, is the problem of differing world time regions. For example, there is no overlap of business hours between Europe and Australia. When we are at work London is sleeping. Most of Sunday in America is Monday in Australia. This in turn affects traffic volume on a particular route at a particular time. It imposes problems for Australian operators not shared to the same degree by northern hemisphere operators. In a modern world requiring large scale capacity circuits and imposing ever increasing demands for new facilities, the time differential must also be recognised in planning facilities to achieve maximum utilization of plant.

The word "persuasion" has been used in this Article when referring to the decisions of the Union. This has been deliberate in order to emphasise that the Union has no powers of compulsion. It can only *recommend* that a course of action is followed by members.

The extent to which members will put this advice into effect is of course subject to a number of factors, mainly financial, i.e. the substitution of equipment, etc. However acceptance of the principles expressed in the Recommendations is strongly assisted by the fact that the people to whom they are directed have themselves contributed to their formulation.

The opportunity that the Union provides for joint and voluntary consultation in the widest sense is the corner stone in its continued success. At the same time this continued consultation presents a strong reason why Australian participation in I.T.U. activities should not diminish in the future.

Australian conditions have provided us with unusual opportunity to subscribe to the technical studies of the Union. The magnitude of the areas covered by our domestic networks has produced telecommunication problems in our national services that are repeated within the boundaries of very few countries. For example, circuits equivalent in length to those between Cairns and Perth would

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stretch from London to Karachi. The experience gained in the solution of these problems has earned for Australia considerable recognition as a long distance telecommunication authority.

However it should not be forgotten that, despite our experience in the telecommunication field, Australia must still be regarded as a young and developing country. The expansion of our networks, involving continued substantial investment and technical commitment, is therefore inevitable. The advantages of avoiding decisions, in respect of world standards, which could be prejudicial to the continued compatibility of our telecommunication networks with the world systems are obvious. This can best be achieved by maintaining the closest possible association with the forums at which these decisions are reached.

Just as most organisations have need to review their responsibilities and management, to analyse requirements and to re-organise their methods and structure where necessary, it is also desirable that the members' collective responsibilities as a Union should be regularly examined and appraised to ensure that they still are being properly discharged. This need is accentuated in an era of rapid changes.

The most appropriate forum for such a review is the supreme body of the Union, i.e. the Conference of Plenipotentiaries, which is presently convened at Montreux. The Conference has the opportunity to decide the fundamental aspects of the Union's working methods, Headquarters Secretariat requirements and general policies, and to provide further avenues for international co-operation, improved telecommunication understandings and services generally to the benefit of the various communities.

Australia is equally interested in contributing to the improved effectiveness of the Union and like many other countries has submitted proposals for Conference consideration.

There are few of man's activities with a history of peaceful international co-operation as impressive as that pertaining to telecommunications. But it is only fair to say that the remarkable progress that has been made in this field would not have been possible without the realistic attitude with which telecommunication authorities have approached the development of their own national networks, those in other countries and the international cables and facilities which lace them into a world wide network.

The growing needs of the modern world demand more comprehensive, more rapid, more efficient means to communicate. The Union is making its contribution by encouraging the study of mutual problems in joint consultation, the sharing of telecommunication knowledge and the fruits of research, and by arranging the provision of materials, equipment and assistance, where needed, for the improvement of the world telecommunication network.

Australia, along with the other Members of the Union, has much to gain by continuing to play a full and vigorous role in these activities.

R. E. BUTLER

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