



**TECHNO-ECONOMIC RESEARCH  
FOR FUTURE ACCESS INFRASTRUCTURE NETWORKS**

**RESEARCH ON DRIVERS FOR ULTRA BROADBAND  
SERVICES AMONG INTERNATIONAL EXPERTS –  
SUMMARY**

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## Executive summary

The use of the Internet has completely altered since its introduction a few decades ago. Where functionalities used to be limited to basic emailing, surfing simple websites and the like, the Internet has now grown up. More and more sophisticated applications are launched and ever more people join the Internet broadband community. This has resulted in more and more bandwidth being demanded. According to some, this ever growing bandwidth demand can be resolved by deploying Fiber To The Home (FTTH) in which optical fiber is rolled out up to each and every living or working space. Nevertheless, even if fiber is indeed able to meet this increasing bandwidth demand, it is known from past experience that mere technological excellence hardly ever convinces users to switch to a new technology (see e.g. the failure of WAP and DAB). Users will only migrate if a new technology can provide them with new or improved services, in this case services that are only possible or at the very least run better over fiber. Since it is ultimately the user that decides whether or not to adopt, this study explicitly adopted a user-oriented perspective. An international panel of twenty-one experts from seven different countries was consulted to give their view on user benefits and services of FTTH. This represented a first, qualitative and non-representative exploration of the issue. Experts especially pinpoint video applications as promising. Some augmented video applications are indeed deemed very interesting, although this study also suggests that both their technological feasibility and mass market adoption could lag behind. While in the long run, these services might indeed be convincing, three services in particular might make a difference in the short term, namely online content management, desktop sharing and on demand streaming.

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## 1 Context and scope

The Internet has undergone a succession of major transformations since its introduction a few decades ago. In the beginning, when users still had to dial up, the World Wide Web's utility was confined to crude functionalities such as basic emailing and browsing unsophisticated websites. In a very short period of time, however, the Internet has developed into an ubiquitous tool with a whole spectrum of possibilities of which the utility is so ingrained in people's daily routines that they cannot imagine life without it anymore. An avalanche of new and innovative applications has completely altered the Internet's utility and uses, which resulted in more and more people going online and more and more bandwidth being required. Indeed, Nielsen's Law, postulated in 1998, stipulates that the bandwidth available to high-end users increases by fifty percent on average per annum (Nielsen, 1998). Thus, according to this law, 100 Mbps should be available by 2015. Since the demand for enhanced as well as novel and bandwidth-intensive applications is ever increasing while symmetry-requiring functionalities are on the rise, Nielsen's Law subsists.

As a consequence, countries and cities all over the world largely invest in Next Generation Networks (NGNs) that can indeed provide the required bandwidth. In most cases, these initiatives are driven by public-private partnerships (PPPs) that align the interests of different private and public players. Typical examples of private players in such cooperation are network operators and service providers. Public parties involved are often local communities, municipalities and governments. The latter justify the roll-out of NGNs by the desire to improve the 'quality of place' for citizens and enterprises, to attract new companies and job opportunities and to close the digital divide. Moreover, high-speed network infrastructure also allows them to capitalize on the 'creative cities' phenomenon in which cities gain prestige by attracting brain workers and by positioning themselves as cities worth visiting, living and working in. Private parties, on the other hand, seek to tap into a new pool of revenues by benefiting from the first mover advantage in providing innovative and advanced broadband services (Nuciarelli, Sadowski and Achard, 2010).

One kind of NGN, namely fiber-to-the-home (FTTH) is sometimes rolled out. Although skeptics state that current infrastructure (cable and xDSL) will suffice, PPPs as well as either private (e.g. operators) or public players (e.g. municipality, public energy provider) do nevertheless roll out fiber in the light of a profound belief in fiber as the access infrastructure of the future. Although one cannot deny that fiber indeed has some significant benefits over other

infrastructure such as cable or wireless, this is a very technology-deterministic approach of which the adage *'if you built it, they will come'* is the crux. However, it may be clear from the past that end-users are only willing to adopt new technology if it provides them with perceived added value and benefits (see e.g. the failure of WAP and DAB). With regard to fiber networks, Noam (2008:2) notes that *'it is common to rush into talks of technology or rollout strategy without first considering the utility to users. If one builds an oil pipeline one must first be sure that there is an oil supply at one end and demand for it at the other'*. Thus, there is an obvious need for user-centric research to identify value-added services that benefit from fiber's network potential in terms of high speed, symmetry and low delay. In addition, the TERRAIN project aims at assessing whether users are indeed awaiting these enhanced and novel applications and whether user adoption will indeed follow the major investments in and roll-out of optical fiber network infrastructure.

## 2 Method

One of the goals of the TERRAIN project is to account for a user-oriented approach to study user adoption. As a research group, MICT is responsible for this user-centric research and wants to explore which (future) applications are fully appropriate to benefit from superfast and high-bandwidth FTTH access infrastructure. Which (future) applications can persuade people to migrate from non-fiber-subscriber to fiber-subscriber? And does there exist a genuine and satisfactory demand for these applications? This exploratory expert study entails a qualitative research approach where the aim is not representativeness but exploring all possible views and opinions and defining relevant use cases for FTTH.

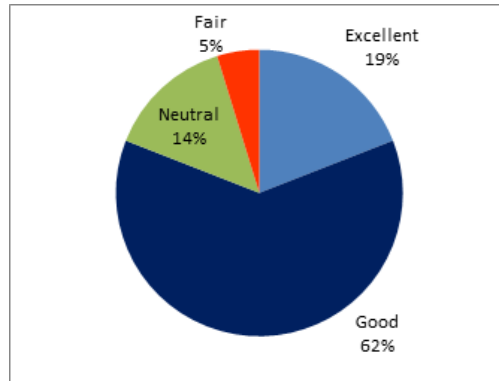
Based on existing projects combined with literature research, a long list of likely high-bandwidth services was drawn up. This list was further discussed and refined in an interdisciplinary workshop with project partners. As a result, a short list of the ten most viable and interesting use cases was drafted, namely:

- Surveillance cameras
- Virtual classrooms with augmented immersive possibilities
- Health monitoring systems
- Online multiplayer gaming
- Online content storage and management
- Future Internet-protocol television (UHDTV and 3DTV)
- Video telephony
- Desktop sharing
- On-demand video streaming
- Immersive 3D tourist environment

In order to get a better picture of genuine drivers and use cases for FTTH, expert views and opinions were taken into account via a qualitative online survey. A panel of international experts was derived from literature and personal contacts, as well as TERRAIN consortium members. A total of twenty-one experts from eight different countries in Europe, North America and Australia completed the questionnaire. Some 53 percent of respondents is working in the public sector (especially research institutions), while others are mainly employed by equipment vendors and telecom operators. Most of them have a mainly technical background, but a considerable part also indicated expertise in regulatory issues, content & applications, and business models.

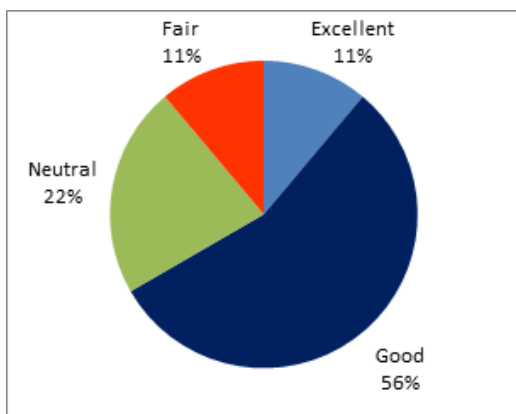
### 3 Results

#### 3.1 Overall user satisfaction of fiber services

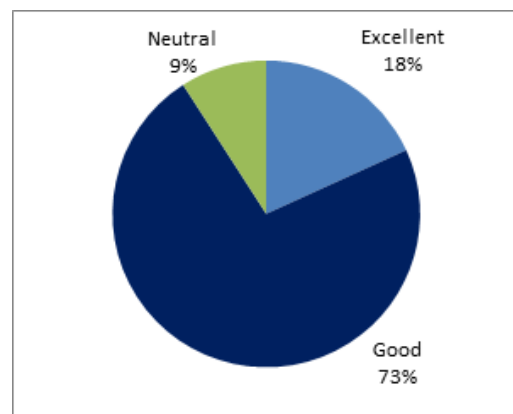


**Figure 1: Overall user satisfaction of fiber services**

A first question assessed the overall satisfaction of fiber services. This appears to be 'good' (62 percent) to 'excellent' (19 percent) (see figure 1). Strikingly, experts' views from countries that have no experience with fiber are more positive compared to 'hands on' experts living in countries that already make use of fiber networks (see figures 2 and 3). We can conclude that the expected overall user satisfaction is higher than the perceived satisfaction once fiber is rolled out. Both experts from countries with and without fiber roll-outs note that satisfaction is highly dependent on the fiber topology and network architecture, bandwidth and services offered but also on whether an open access business model is pursued.



**Figure 2: Countries with fiber rollouts**



**Figure 3: Countries without fiber rollouts**

### 3.2 Fiber’s technological benefits

The next question assessed the added value of fiber over other infrastructure such as copper (xDSL) or coax (DOCSIS 3.0), in order to reveal some of the possible drivers of FTTH. Twenty people responded to this question and their answers were quantified in order to give an idea of which benefits are considered most important.

Benefit	Times mentioned
Bandwidth and speed	13
Symmetrical bandwidth	7
Response time, lower latency	6
Higher signal quality	2
Drives competition	2
Reliability	1
Drives innovation	1
Lower prices	1
Future proof	1
Electromagnetic insensitivity, no interference	1
Connection and integration	1
Signals can travel longer distances	1
For business users: allows large numbers of individual users and hosted applications	1
<b>Number of respondents: 20</b>	

Most respondents agree on the most obvious benefits, namely bandwidth and speed, symmetrical bandwidth and lower latency. There are, however, a vast number of other benefits, that are only mentioned once or twice. Again, experts from countries who have experience with fiber roll-outs are less positive, since three out of eight such experts indicate that fiber offers little or no advantage in terms of bandwidth and every other meaningful measure compared to coax and copper, especially for home users.

### 3.3 Killer applications

A following question asked participants whether they believe killer applications for fiber exist. A majority of respondents believes fiber to enable innovation and ten out of twenty experts pin-point video applications as showing great promise.



Better video quality should enhance a number of video cases such as high-quality video conferencing and gaming, peer-to-peer based communication, eLearning, HD video, and advanced health services such as remote check-up and prescriptions. Of all experts, twenty percent indicate that streaming of photos, documents and videos as well as multiple HD streams will constitute the killer application for fiber. Twenty percent perceive remote and secure storage in the cloud and easy data access a killer application. Energy management via smart metering/grids is indicated by three experts as a promising service. Twenty-five percent, however, have indicated that fiber will not enable any killer applications. Again, a lesser optimism can be observed in countries with experience in roll-outs. Four out of eight such experts report not to anticipate any killer applications. They argue that current (copper and coax) and future technologies (wireless) can perfectly satisfy customer demand.

### 3.4 Overall use case popularity

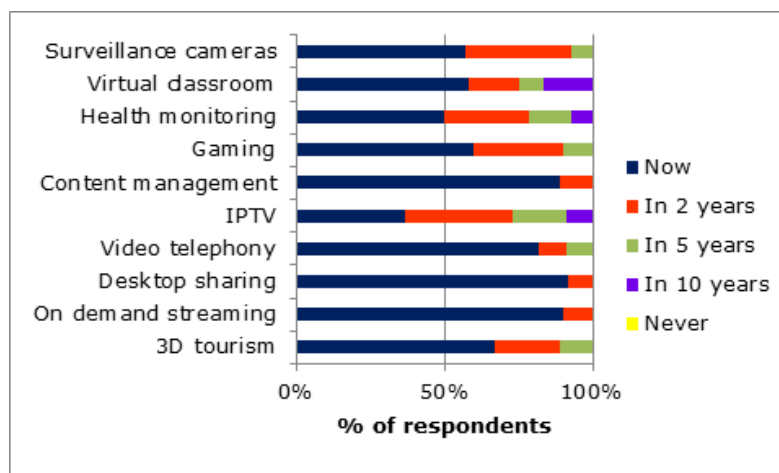
Then, experts were asked to choose their personal three most convincing services and to rank them subsequently. Based on this ranking, use cases were given five (ranked first), three (ranked second), and one (ranked third) points. The sum of these scores is given in the table below.

This ranking summarizes the panelists' views on the general market potential for each use case. It brings to light some very interesting and perhaps unexpected conclusions. The experts find health monitoring systems and online content management the most convincing use cases. These use cases obtained high scores and three experts rated them most popular. The top three is completed by desktop sharing, followed by the eLearning-application and online multiplayer gaming. The second four use cases will make less of a difference, while the market potential of an 3D tourist environment appears to be nil. These findings might seem somehow surprising, since traditional video delivery applications – which were expected to benefit from fiber's high-bandwidth capacity – were found less convincing. Enhanced video applications, however, are highly valued in terms of market potential.

Ranking	Use case	Score	Number of times in 1 <sup>st</sup> place
1	Health monitoring systems	18	3
2	Online content storage and management	16	3
2	Desktop sharing	16	1
4	Virtual classrooms with augmented immersive possibilities	15	1
5	Online multiplayer gaming	14	2
6	Video telephony	11	2
6	Surveillance cameras	11	1
8	Future Internet-protocol television (UHDTV and 3DTV)	6	0
8	On-demand video streaming	6	0
10	Immersive 3D tourist environment	0	0
<b>Number of respondents: 13</b>			

### 3.5 Time horizons

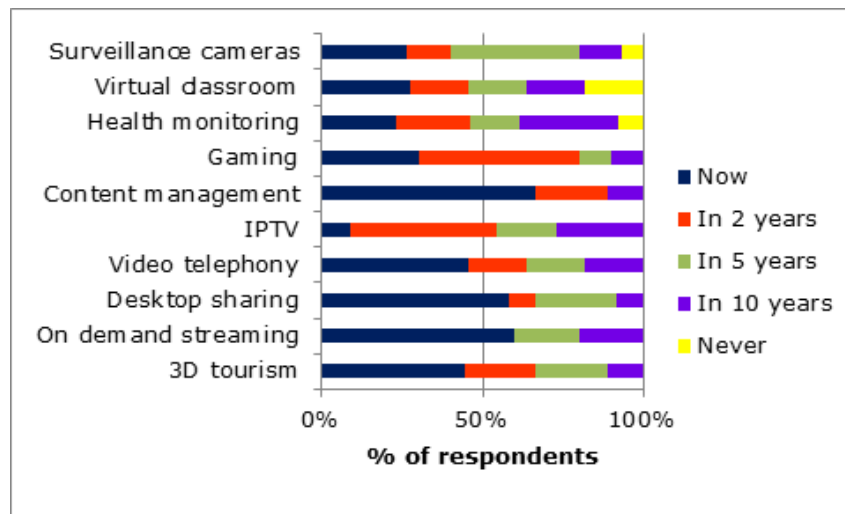
Furthermore, we gathered expert forecasts on the development and breakthrough of these applications. We asked respondents when the use cases are expected to be technically available and when they expect these cases to reach the mass market.



**Figure 4: Time to service availability**

None of the applications' underlying technology (see figure 4) is assumed to be infeasible. Respondents believe that most of the applications can be launched in the near future. Four use cases were found market-ready, amongst other content management and desktop sharing systems, respectively ranked as number two and three in the former 'overall popularity' ranking. Surprisingly, health monitoring systems - identified as the most promising service - were considered less market-ready. Future Internet-protocol television is considered the least plausible use case as the majority of experts believes that its technology is not yet ready. These findings may suggest that technology will not be the main barrier for the deployment of high-bandwidth applications. Participants confirm that most applications can be brought to market within two years, with the exception of future television services, which are considered to be more long term oriented.

For the content management, desktop sharing and on-demand video streaming use cases, respondents expect a time lag. While the technology is already available, they believe that demand will only follow later on. Thus, according to our expert panel, technology is expected to come ahead of the market. While about 50 percent of respondents think that health monitoring systems are market-ready, only 25 percent estimates that there is a market for such a service at this moment. Hence, a time lag is expected between the actual possibility to enable an application from a technological stance and the time needed to reach critical mass (about 15 percent of the market). Generally, the time lag seems bigger for less popular use cases than for the most likely services, although a considerable part of the experts expect health monitoring systems no sooner than within ten years. Participants are least positive with regard to future IP television. Although most respondents believe it will reach the general public in two years, a significant part anticipates this use case only reaching the average man in the street in a time-span of five to even ten years.



**Figure 5: Time to reach mass market**

### 3.6 End-user groups

After assessing time horizons considering technological feasibility and reach of the mass market, respondents were also asked whether they believe a specific use case to be primarily a B2C, B2B scenario or both. This is especially important because use cases that are both B2B and B2C oriented have a much greater potential in terms of return on investment (ROI) for providers than either mere B2B or B2C applications. In this context, the applications identified as most promising earlier on, do rather well.

Figure 6 clearly shows that content management applications and surveillance cameras are considered appropriate for business as well as for consumer use. Health monitoring, online gaming, Internet-protocol television and on-demand video streaming are seen as applications almost only relevant for consumer markets. In contrast, video telephony and desktop sharing are identified as business applications. Apart from this analysis, most use cases can be utilized by private as well as business end-users, which holds prospects for further development of these applications. As the development of these services will be subject to economies of scale on the supply and demand side, a larger sales potential should eventually lead to a cheaper and even faster development process.

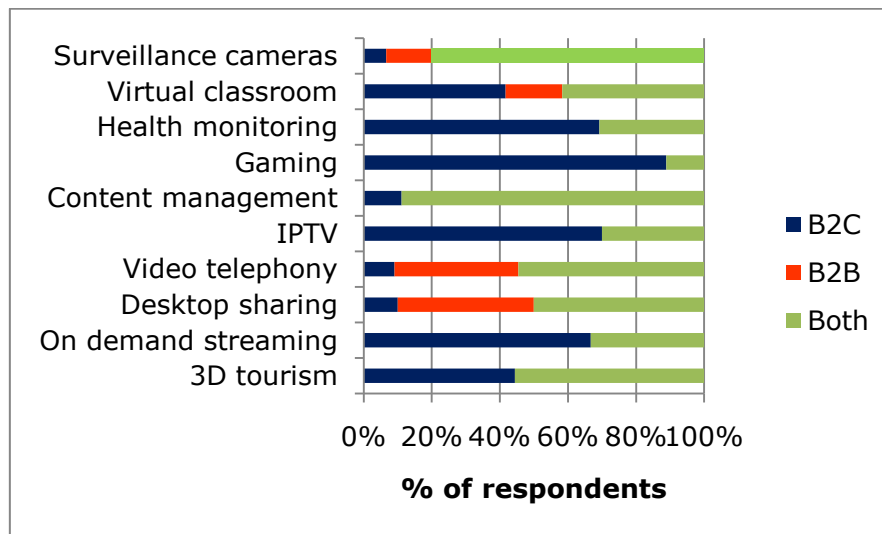


Figure 6: B2B, B2C scenario or both

## 4 Conclusions

The focus of this expert panel study was twofold. On the one hand, we tried to identify applications that can generate added value to fiber networks. On the other hand, we tried to reveal some drivers for Internet users to migrate from their current connection to high-performance FTTH broadband networks. The basic assumption of this research is that developing and deploying technology without an adequate understanding of user requirements beforehand is not the path to follow, since an overrated belief in an innovation’s mere technological benefits too often results in failures (e.g. WAP) and overestimations of adoption potential. That is why an explicit emphasis of the interdisciplinary TERRAIN project lies on adopting a user-centric approach to identify what future users want, whether the technology is ready for these services, and when these services will reach the critical mass before proceeding to roll-out of comprehensive FTTH networks.

These aspects are summarized in figure 7 below, in which the X and Y axes represent the time it will take until a use case will reach the mass market and until a use case’s underlying technology will be available respectively. The magnitude of the resulting dots represents the overall ranking of popularity. Hence, the greater a dot, the higher the market potential is estimated. A blue dot further represents a use case that is judged mainly a B2C scenario, while a green dot represents both a B2B and B2C scenario.

Experts found most of the presented use cases possible from a technological perspective. Regarding the time it will take a use case to persuade the general public, however, respondents expect a time lag. Some services will take a longer time to be adopted by the mass market. A whole range of video-based applications are anticipated to benefit from the technological improvement that fiber represents compared to other network infrastructure such as copper or coax. At first sight, this conclusion might seem largely incompatible with video-telephony only being ranked sixth in popularity. That is why not the individual use cases are important, but the underlying drivers (a.o. better image quality, low delay and increased interactivity) are able to convince end-users to migrate to fiber. A lot of these services (namely desktop sharing, on demand video streaming, health monitoring systems, virtual classrooms and online multiplayer gaming) are rated important. Hence these are not contradictory viewpoints. It can be concluded that video does constitute a very important service, if and only if it represents an added value over basic video applications such as plain video telephony.

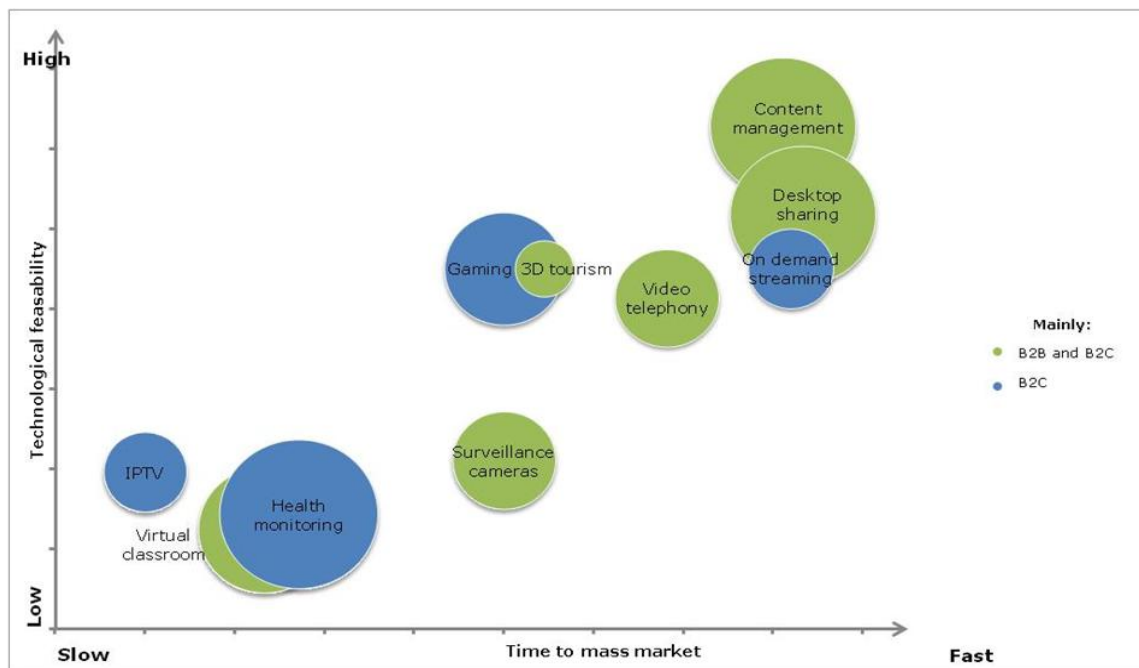


Figure 7: Use cases positioning

This research further identified some very interesting use cases that can drive fiber adoption because they are both technologically feasible and will likely be adopted by end-users in the short term, namely online content storage and management, desktop sharing and on demand video streaming. Moreover, the former two use cases are very highly rated in terms of market potential. Although health monitoring systems are believed holding the highest market potential, they are behind in terms of time horizons as experts think their underlying technology is currently not ready while the critical mass is expected within two years at the earliest.

It must be emphasized that these findings should be considered explorative, as they are only based on the views and opinions of 21 international experts. However, the results show which services might be identified as value-added services and which might hold business opportunities for service providers.

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## About the TERRAIN project

### Techno-Economic Research for futuRe Access Infrastructure Networks

The TERRAIN project investigates the rollout of optical fiber in the access network in cooperation with other utility networks as a future-oriented solution. To meet the high costs of the fiber installation it focuses on optimizing the cooperation between all actors - equipment vendors, telecom operators, utility companies, municipality, FTTH interest group, GIS software suppliers, and multi-disciplinary research groups. All aspects will be analyzed from a techno-economic point of view, considering technical, social, economic and regulatory sub-problems.

### Partners



### More information

<http://www.terrainproject.be/>

Research on drivers for ultra-broadband services among international experts - summary



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