



Innovation via a Thin LMS: A middleware alternative to the traditional learning management system.

Marc Wells

Business School
Imperial College London

David Lefevre

Business School
Imperial College London

Fotis Begklis

Business School
Imperial College London

This case study describes how a middleware software solution, originally developed to enable course materials to be delivered to tablet devices, eventually replaced an incumbent ‘monolithic’ LMS at a Business School in the UK. This middleware solution is termed a ‘Thin LMS’ and consists primarily of software that integrates data and materials from other information systems hosted by the institution.

The advantages and disadvantages of this approach are discussed and it is proposed that the Thin LMS approach offers a viable alternative to the monolithic LMS in certain institutional contexts.

Keywords: E-learning, information systems, LMS, monolithic LMS, thin LMS, VLE, integrator, integration.

Introduction

This case study describes a 2-year process, between March 2011 and March 2013, in which a middleware software solution, a ‘Thin LMS’, gradually replaced the use of a more traditional ‘monolithic LMS’ at a Business School in the UK. A ‘Thin LMS’ is defined here as a learning management system that primarily seeks to integrate external data and software tools. It is defined in contrast to the ‘monolithic LMS’, which seeks to contain all data and software tools within itself.

This business school, the host institution, forms part of a larger research-based university in the UK. The incumbent monolithic LMS was a commercial system that had been used to deliver online learning at the university over the previous 12 years. In March 2011, a decision was made to provide students on one MSc degree programme with tablet devices in the academic year commencing October 2011. The primary motivation being a programme level learning outcome stating that students should graduate with practical knowledge of contemporary technologies. It was determined that the provision of tablet devices would assist in the achievement of this outcome. The integration of these tablet devices into the delivery of teaching and learning was not a goal at the outset however it was recognised that students would want to use them to access content

and communications within the incumbent LMS. Investigation into the compatibility of this LMS with the tablet devices chosen revealed a number of critical issues. The technology adopted to build the LMS was unstable on mobile platforms, a significant proportion of the content within the LMS was inaccessible and the user interface did not translate well from PC to tablet. These issues led to the decision that the use of the incumbent LMS on the tablet devices would result in an unacceptable user experience for the students.

The monolithic nature of the incumbent LMS did not allow the institution to select those tools that were compatible with the tablet devices and discard those that were not. This problem is common to all traditional LMSs and has previously been recognised by Bush and Mott (2009),

“The education technology landscape is best characterized by monolithic, enterprise technology silos with rigid, often impenetrable walls. Course management systems (CMSs), for example, are generally “all-or-nothing” propositions for institutions, teachers, and students.” (Bush and Mott 2009)

This inflexibility in the structure of the incumbent LMS resulted in the system being deemed unsuitable in its entirety and it became necessary to identify an alternative system.

Year one - The ‘Hub’ version 1

The initial development, in year one, is now described.

Year one - System specification, build and deployment

Version one of the Hub was developed by the e-learning team at the host institution over the summer of 2011. Development began with a system specification clarifying the functional requirements. These were divided into two categories. First the system was required to deliver content, primarily course materials, and do so in a way that made these materials readily accessible via both PC and tablet devices. Second, the system was required to deliver and facilitate course communications. A key requirement in this latter category was close integration with popular social networks. As elsewhere, students at the host institution were active on social media networks and had expressed frustration at the lack of integration between these networks and the incumbent LMS.

A review of alternative LMSs in May 2011 did not identify a system that demonstrated an acceptable level of compatibility with the chosen tablet devices and the e-learning team investigated the possibility of developing a system in-house. The solution they proposed was to build an online learning environment using the same techniques they were using to build other websites. When building a website this team first selected a content management system (CMS) and then added functionality to this system through the use of compatible ‘plug-ins’ and by linking to other institutional information systems through the use of application programming interfaces, ‘APIs’. The management team approved this approach and development began.

The build started with the selection of a CMS. In order to enable the functional requirements stated above, the primary requirements for the CMS related to communications. For example, the CMS needed to facilitate discussions, integrate with social media platforms and include a tablet application to enable teaching staff to post content to students. This led to four online ‘blogging’ tools being considered; Blogger, Tumblr, WordPress and Posterous. The latter of these was chosen due to the usability of its interface, the ease at which social media could be integrated and the simplicity of its supporting tablet application.

Following the selection of a CMS, the subsequent challenge was to identify a tool, compatible with the CMS, that would enable teaching staff to share course files via a process that was acceptable to them. Almost all course materials within the incumbent LMS took the form of files such as lecture slides, tutorial documents,

case studies and readings. A cloud based documentation system was identified as the solution and two such systems were considered, 'Box.com' and 'Dropbox'. At the time, only the latter had the required level of compatibility with the chosen tablet devices and this was the system selected.

Thus, Posterous and Dropbox were chosen as the primary technology tools. A more detailed specification then followed which took the form of 'wireframe' prototypes of individual webpages. In response to student requests, a communication feed, similar to those adopted in common social media platforms, took prominence within the interface. Content was arranged in accordance with the organisational structure at the institution in which 'faculty', supported by 'programme teams', deliver degree 'programmes' consisting of 'core courses' and 'elective courses' which are assessed via 'coursework' together with 'exams' and are delivered over 'academic years' comprising 'terms'. The adoption of these structures enabled a more cohesive user experience than that possible within the incumbent LMS, which contained just one level of hierarchy, the 'course', and presents these courses in a linear alphabetical list.

The resulting system was termed 'The Hub' and was designed, developed and deployed in four months by one member of technical staff within the institution's e-learning team. At this stage the 'Hub' was not viewed as an alternative LMS but solely as a vehicle to solve the problem of delivering course materials and course communications to tablet devices. Some common course related administrative tools, such as quizzes and assignment submission, remained within the LMS. In addition, course areas were replicated within the incumbent LMS on the assumption that students would use these areas when using a personal computer.

Year one - Results

Providing two versions of each online course area, one in the Hub and one in the incumbent LMS, enabled students to draw comparisons between them. A survey of students (n=67, response rate = 97%) found 'the Hub' to be the preferred system. Students were asked to rate five different characteristics of the two systems from between 0 (very poor) and 5 (very good). Table 1 shows mean scores for the two systems.

Table 2: Comparative evaluation scores between the two systems

	The Hub v1	Incumbent LMS
Overall	4.55	3.42
Look and feel	4.32	2.92
Navigation	4.27	3.02
Usefulness	4.51	3.86
Ease of use	4.51	3.23

The Hub was rated more highly in each category and, for overall experience, the Hub was rated 4.55 out of 5 compared to 3.42 for the incumbent LMS. This survey also found that 97% of students preferred to download materials from 'the Hub' rather than the incumbent LMS. Qualitative feedback relating to the Hub received from both students and staff members was almost all positive. The following examples, taken from a focus group discussion, illustrate the general response.

'It is easy to access the hub and we can quickly access news and important information... and download course material (student 32).

'The Hub (was) very easy to use... In fact, I preferred it over (The incumbent LMS) as the same information was available in a much more easy-to-use format in one place, rather than having to go through the ordeal of (The incumbent LMS) options and pages' (student 7).

'Essentially [the Hub] was very useful for broadcasting to students, we were able to alert students to

changes, clarify issues ... to me it was like a distribution list, I could respond back to everybody and say, this is what you are doing' (lecturer 3).

'I think [the Hub] is an absolutely fantastic idea because it provides a central platform of coordinating everything ... The fact that you have a central point of contact through which you can run important announcements that might not only impact your class but other classes. And you can actually see what the other people are doing. That I found extremely useful' (lecturer 6).

The project also gained the support of the student union who stated,

"This innovation will greatly improve the student experience for teaching. The use of interactive tablets not only aids understanding, but also provides an alternative learning environment. The interactive nature of the courses opens the doors for all types of learners. The more enjoyable the learning experience, the more appealing to students the course is."

Year one - Summary

Version one of the Hub solved the problem of how to provide course materials and communications to mobile devices. In addition, a number of unexpected benefits emerged. First, the system was considered by teaching staff and students to be an alternative and preferred system to the incumbent LMS. Second, both staff and students embraced the concept of a social media approach to communications and the sense of community this created. This approach replaced the majority of communication channels previously used by teaching staff, students and the administration team. Third, having an increased level of control over the system enabled the e-learning team to create a user interface that matched the organizational structure of the institution and this led to increased clarity and a greater sense of community as areas of the Hub were created to reflect the social groups in existence at the institution.

Year two - The Hub version 2

The response of students and staff to the combination the Hub and tablet devices had been sufficiently positive in year one for the project to be continued for students starting October 2012. The teams administering degree programmes at the host institution were given the option of using either the incumbent LMS or the Hub on their programmes and these teams chose the latter for 10 of the 14 programmes. As a result, the majority of students at the institution would be using the Hub as the primary web based system for their studies in the academic year 2012 to 2013.

The success of the project in year one together with a resulting higher profile within the institution led to the broader engagement of school staff and the formulation of enabling structures such as a project management team and more formal project documentation. To illustrate, a working group was established to oversee the project comprising representatives from the teaching staff, the administration teams and the e-learning team. Student engagement also increased and the Hub became a standing item at all Staff Student Committee (SSC) meetings. As a result of this activity, four additional goals were set for the project in the academic year 2012 to 2013.

1. To enable the School to move to a paperless programme delivery
2. To make a positive contribution to the students' perception of the School and its programmes
3. To conduct pilot projects in the use of iPads to change learning practice
4. To conduct pilot projects in the use of iPads to change teaching practice

The ambition to move to a paperless delivery comprised a number of dimensions including a desire to move to a more 'seamless' learning environment defined by Chan et al. (2006: 6) as follows:

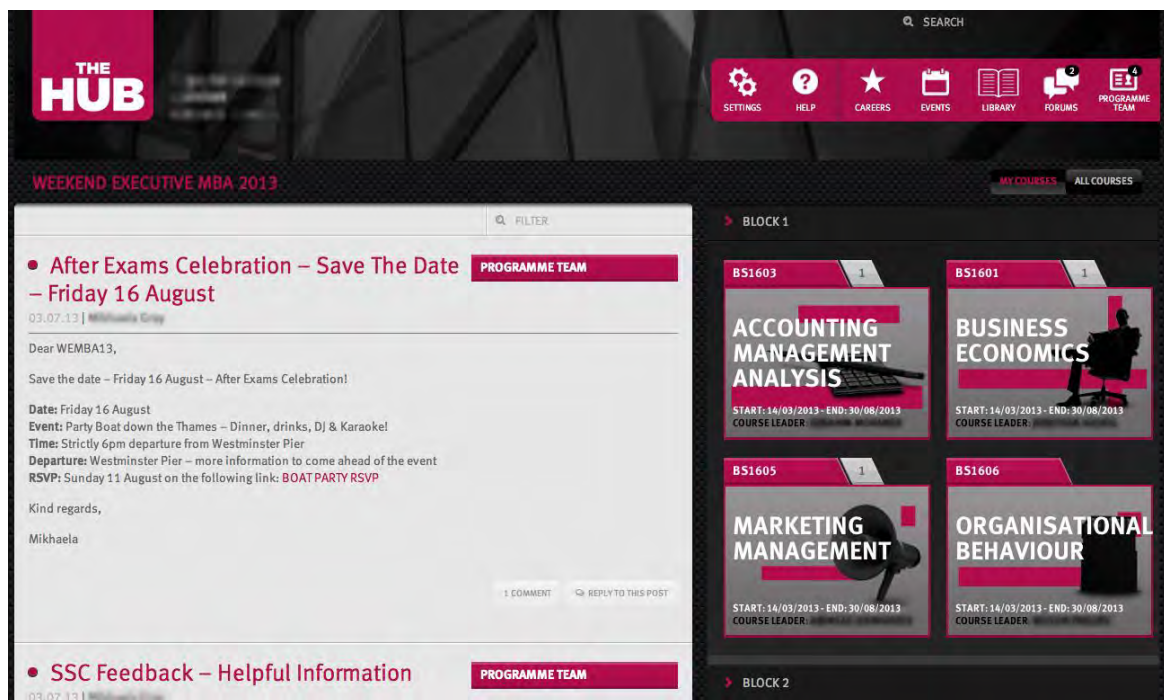
"We see ubiquitous access to mobile, connected, personal, handhelds creating the potential for a new phase in the evolution of technology-enhanced learning, marked by a continuity of the learning experience across different environments. We term this 'seamless learning'." (Chan et al. 2006 p.6)

The portability of the tablet devices together with the ability to access the Hub through any device was considered to be a tool to facilitate such a seamless environment and promote an increased sense of 'connectedness' to the institution. In year one the students had used the incumbent LMS to submit assignments and conduct quizzes but, as this LMS was incompatible with tablet devices, this approach was incompatible with the concept of a seamless learning environment. Enabling this functionality in the Hub became a requirement for year two.

Year two - System specification and build

In year two the structure of the design remained essentially as per year one. The information feed retained prominence within the interface. Content was organised around each student's learning path and the information architecture mirrored the organizational structure of the school. However, several changes were made in response to year one feedback and to incorporate the additional functionality. The latter were primarily minor improvements to functionality such as a notification feature to indicate when content had been changed and the ability for students to view all courses on a degree programme rather than just those on which they had been registered.

Figure 19: The Home screen of the Hub featuring the communication feed



A significant step was to engage the services of an external design firm who were given the freedom to create a 'look and feel' for the Hub that reflected the brand and values of the institution. It was also at this stage that the concept of an integrative platform, the 'Thin LMS' emerged.

The integrative platform

The use of the incumbent LMS required course information and content to be copied manually from other information systems at the institution and in year one this approach was adopted for the Hub. As part of their feedback on the project, administrative staff asked if it was possible to reduce the volume of such work through integration with other information systems. Working closely with the central IT services department, the e-learning team explored this possibility and the idea of the Thin LMS emerged. A core design principle was adopted in which the Hub would comprise middleware that incorporated feeds from other systems through the use of RSS/XML based information feeds and APIs. In year two, information was integrated into the Hub from the following systems:

Table 3: List of integrated services in year two

System	Information obtained	Connection
Student record system	Course information: Title, description, timetable and syllabus. Student information: Photograph, e-mail address.	CSV/XML
Social media (Facebook/Twitter)	Communications made through the Hub appear in social media platforms and visa versa.	WordPress plug-in
E-mail server	Communications can be sent to the Hub by e-mail. Notifications can be sent to e-mail from the Hub.	AJAX
Cloud based file server (Dropbox)	Files are placed within the cloud-based server. An interface to this server appears within the Hub.	API
Library information system	The library system supplies an electronic version of a course-reading list with hyperlinks to the resources listed.	RSS/XML
Lecture capture system (Panopto)	The lecture capture system records all classes. A feed from this system then presents the recordings to students via the Hub.	RSS/XML

In this manner almost all content within the Hub took the form of data feeds from existing systems and the degree of manual work reduced substantially. That which remained consisted primarily of uploading digital materials such as interactive courseware and computer based assessments.

Choice of technology

In year one the Hub system was non-critical in that all course areas were duplicated within the incumbent LMS and students were informed that the project was at a pilot stage. In year two neither of these factors were present and thus closer attention was paid to the robustness of the system and the following measures were taken to address this. Responsibility for the development of the system moved from the single in-house technical developer to an external software firm thus removing a potential single point of failure. Conversely, the hosting of the system was moved onto internal web servers so that matters of data protection and security could be addressed. In order to ensure that the system would be sufficiently scalable and reliable, version one of the Hub was discarded and the system was rebuilt.

As per version one, a blogging platform was chosen as being the most appropriate tool to facilitate communication. The firm providing the tool used in version one, 'Posterous', had been purchased and closed during the previous 12 months and was no longer an option. An alternative system 'Wordpress' was chosen as it met the criteria required, offered the simplest integration with college systems and was structured via a 'plug-in' system. This latter characteristic enabled the Hub specific code to sit in a separate 'plug-in' which would not need to be changed should the core code do so.

As discussed above, the Hub connects to a number of institutional information systems via XML/RSS feeds or APIs. The former feeds are encrypted and placed on the web server hosting the Hub. A Wordpress plug-in, the 'Hub Feed Manager', then retrieves the information and outputs to the Hub in the appropriate place. The seamless learning approach was implemented using 'responsive design' in which a webpage first detects the screen on which it will be rendered and then adapts itself to an appropriate format. Assignments were implemented using Dropbox via an API called 'Jotform'. Quizzes were implemented via an online tool called 'ProProfs'. However, the use of these technologies were considered to high risk and were therefore piloted on just one programme in year two. For the remaining nine programmes, the quiz and assignment functions were performed in the incumbent LMS.

Year two - Results

In October 2012, 671 students and 84 teaching and administration staff started to use version two of the Hub. As on June 2013 this version of the Hub has received 342,791 individual visits and 1.8 million page views meaning that, on average, staff and students logged on to the Hub 1.66 times per day over the initial nine months. While, a full evaluation of the Hub is still in progress, an initial survey of students was conducted in in January 2013 (n=147, response rate - 22%). As in the evaluation in year one, this survey first asked students to rate a number of characteristics of the system. The responses are summarised in table 3 below.

Table 4: Summary of responses to survey conducted in January 2013

	The Hub v2
Overall	4.25
Look and feel	4.22
Navigation	3.78
Usefulness	4.43
Ease of use	3.99

The survey also attempted to gather data relating to the aims of the seamless learning environment. Students were asked whether their use the Hub had made them feel more connected to their programme when away from the school as compared to previous degree experiences. The responses to this question are summarised in table four.

Table 4: Sense of connectedness

	Number of responses
I feel much more connected	39.86%
I feel more connected	46.62%
There is no difference	11.49%
I feel less connected	1.35%
I feel much less connected	0.68%

Qualitative data was also gathered by posing the open question, “What has been your overall experience of using The Hub for your studies?” The positive responses to the survey tended to focus on usability. For example,

“I really like the hub. It's very convenient to access all the formation about the courses at any time. It's very well-structured making it easy to look for things.” (Student 1)

“I have found it relatively easy to find documents and navigate which is the key criteria I judge it on.” (Student 2)

“What I love about the Hub is that it is very structured, you can find all the information in the relevant places and it is very helpful to save time.” (Student 3)

Negative responses also tended to focus on the usability of the Hub from which the conclusion can be reached that this is an issue of primary concern to the students.

“I love the Hub but the navigation is not easy from my Mac laptop, the website does not appear clearly” (Student 5)

“(The Hub) Need(s) to be more user-friendly” (Student 6)

An analysis of system usage suggests the use of the Hub led to an increased level of student activity with the online learning environment. The use of the Hub in year two was compared to the use of the incumbent LMS in the previous academic year. Using a sample of three degree programmes revealed the number of visits by students to be 61% higher when only the Hub was used compared to when only the incumbent LMS was used. This is shown in table 5.

Table 5: Number of visits to 16 courses on Incumbent LMS and the Hub

System	Number of visits
The Hub Oct 2012 - June 13	43,302
Incumbent LMS Oct 2011 - June 2012	26,860

Students' use of electronic resources, such as eBooks and journal articles, also increased as a result of the integration between the Hub and the library's online system. The library reported a 700% increase in the number of visits to such resources.

The level of activity among teaching staff also increased. For example, table 6 shows a comparison of the number of teaching materials placed into each environment, again using a sample of 3 degree programmes.

Table 6: Number of course materials placed in the learning environment

System	MSc 1	MSc 2	MSc 3	Total
The Hub Oct 2012 - June 13	77	64	116	257
Incumbent LMS Oct 2011 - June 2012	82	46	61	189

The number of learning materials placed within the learning environment increased by 36%. In addition to uploading more course materials, teaching staff were also more likely to do this themselves rather than requesting that administration staff do this for them. On courses that used the incumbent LMS, 20% of teaching staff chose to upload materials and communications directly into the LMS. However, this percentage increased to 72% on courses supported by the Hub. Staff on 105 of the 149 courses comprising the 10 degree programmes choose to load materials and communications directly into the system.

Year two - Summary

The evaluation of version two is on-going however the initial survey of students together with an analysis of system usage suggests that the benefits observed in year one were present for the additional nine programmes that used the Hub in year two.

In addition, noticeable increases were observed in the volume of student and staff engagement with the online learning environment when the Hub was used. This increase in engagement was accompanied by a substantial reduction in time spent on course administration due to improved systems integration. The initial survey also suggests some success in achieving a seamless learning environment in that students reported a stronger sense of connectedness to the institution as a result of using the Hub.

Year 3 - The Hub version 3

As of June 2013, the administration teams for all degree programmes at the School have decided to adopt the Hub from October 2013. The assignment submission and quiz tools piloted during the implementation of version two proved sufficiently robust and these functions will be conducted via the Hub and not the incumbent LMS, albeit using different technology tools. Given this, the Hub will have replaced the incumbent monolithic LMS from October 2013. Further developments are also planned including the addition of learning analytics to provide students and teaching staff with greater visibility on usage and comparative performance.

Discussion

This case study detailed the development of a 'Thin LMS' and explained how this system replaced an incumbent 'monolithic LMS' over a two year period. The host institution in this case study experienced a number of advantages and disadvantages in adopting this approach and these are now discussed.

A greater degree of control of the user interface. The incumbent LMS appeared designed to be usable across numerous institutions however this 'one size fits all' can mean that the one size does not fit at all. In this case study the ability to structure a learning management system so that it corresponds to the organizational structure of the institution, and the ability to create a 'look and feel' that was consistent with the university brand and imagery, resulted in an improved user experience which was valued by staff and students.

A closer integration with institutional information systems. The greater degree of control inherent in the Thin LMS approach allowed a closer integration of the learning management system with other information systems. This led to increased accuracy and volume of data and communications within the LMS while significantly reducing the work required to administer the system.

The adoption of 'best-in-class' tools. The Thin LMS approach enabled the institution to choose the best tools available and not just those that were packaged within the LMS. As Bush and Mott (2009) suggest, this is not possible with the traditional monolithic LMS

“.. Even if you use an open source CMS like Moodle, you are (without significant customization) bound to use Moodle's content publishing tool, Moodle's quiz tool, Moodle's gradebook,”
(Bush and Mott 2009)

That the e-learning team were able to adopt tools, such as DropBox and Facebook, that were already widely used by staff and students is likely to be one cause of the noticeable increases in engagement observed.

An increase in innovation: In this case study the Thin LMS facilitated a greater degree of innovation. It could be expected that commercial LMS vendors would be able to innovate to a greater degree than a single institution would be able due to having larger resources at their disposal. However vendors have not been particularly innovative. This may be due to the fundamental design approach of the common monolithic LMS systems which Britain and Liber (2004) suggest focuses only on,

“establishing a viable functioning system rather than supporting innovation” (Britain and Liber 2004)

In this case study an increase in control over the learning system enabled significant innovative steps. For example the integration of 'best-in-class' tools and information from other systems. In addition, the working group formed to oversee the project felt a degree of empowerment not experienced in relation to the incumbent monolithic LMS in that their update requests, and therefore innovations, could be more readily enacted.

A loss of advanced learning features. From a pedagogical perspective, the more advanced learning features, such as the integration of learning pathways with analytics and subsequent assessments, could be considered among the most attractive features of the monolithic LMS and these features are not readily replicated within a Thin LMS. Quizzes too are more problematic for teaching staff in the Thin LMS introduced here as staff now need to forward quizzes to the e-learning team to be uploaded into the system rather than doing this directly. Such issues could be considered to disempower teaching staff or rather to disempower the minority who used such tools while empowering the majority who did not.

Changing roles within central IT services department: In this project, the work required to conduct systems integration was different, and often more complex, than the work required to administer a monolithic LMS. Securing the time of staff with the relevant skills was an initial challenge during the development stage.

Scalability: The host institution in this case study is a Business School forming part of a larger research-based university. A key advantage of the Thin LMS approach was the ability to structure the system to mirror the structure of this School. This advantage may be lost should the system be adopted across the university as the organisational structure of departments varies. Another potential barrier to the scalability of the approach is that the success of the project was likely due in part to the close relationships present between the e-learning team and the teaching staff. The trust formed as a result of these relationships assisted in the adoption of the system. This type of project may be more problematic when conducted across a larger organization in which relationships are more fragmented.

Cost. The relative costs of the Thin LMS adopted in this study compared to the incumbent LMS are yet to be evaluated but are considered to be either cost neutral or lower. One indicator to support this is that the initial development costs of the Thin LMS over the two years were less than the annual licence paid to the vendor for the incumbent LMS.

Summary

This case study has described how a middleware software solution gradually replaced the use of a more traditional 'monolithic LMS' at a UK based institution. This approach was termed the Thin LMS and the advantages and disadvantages were discussed. It is proposed that the Thin LMS approach offers a viable alternative to the monolithic LMS in certain institutional contexts.

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Authors' details: Marc Wells. Email: m.wells@imperial.ac.uk

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