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Christian Rehtanz

Innovation in China and Europe - A comparison considering as example Wide Area Monitoring of Power Systems

Introduction

It is hard to understand or even influence the dynamics and policies that promote successful innovation. However, it is commonly accepted that innovation is one of the pillars of modern societies and their economic development. Innovation has always influenced technological and economic hypes and changed our world drastically. The internet and '.com'-hype is the recent example for this. After the hype we perceive the former revolutionary development as mature. The next hype is expected to be in the energy sector. Expected energy shortages together with global climate changes are strongly interlinked with the economy and our entire life. The energy sector requires innovation to overcome these threats. In the moment it can not be foreseen which direction the development will take, but a significant change towards clean and reliable supply of energy is undoubtedly required. The question is how societies or countries can push for innovation. This paper tries to collect some aspects about the differences in innovation management in Europe and China in general and specifically with the example of a recent innovation in the power sector, the Wide Area Monitoring of electrical transmission networks.

Innovation

The distinction between “invention” and “innovation” is that invention is the creation of a new idea or concept, and innovation is turning the new concept into commercial success or widespread use. Therefore innovation includes both the invention and its economic application.

Almost all governments give statements about innovation. 'By the end of 2020, China’s science and technological innovation ability will be greatly improved…The

comprehensive ability of China's basic science research, as well as that of the frontier fields, will be considerably strengthened. By that time, China will achieve more science and technological breakthroughs of great world influence, qualifying it to join the ranks of the world's most innovative countries.' was stated by the president of P.R. China Hu Jintao on the Fourth National Conference on Science and Technology, 9 January 2006. The German federal minister for education and research Annette Schavan says: 'We are giving education, research and innovation the highest priority on our agenda and are thus making Germany fit for the future.'

Innovation is hard to quantify, but it is definitively visible in the economic success. Some measures could be scientific activities or spending in R&D. The US and Europe are still the major sources of scientific papers but, according to a recent survey by Thomson ISI, Asia's share rose from 16 per cent in 1990 to 25 per cent in 2004. Another study by Amsterdam University for instance places China second to the US in the number of papers published in top nanotechnology journals. China's spending on R&D has trebled in seven years and is predicted to rise further from 1.2 per cent of gross domestic product in 2005 to 2 per cent by 2010. The European Union set a target of 3% for 2010. But the question is how this money is spent and how to get the maximum benefit out of it. In this respect there are fundamental differences between Europe and China.

R&D Process

The structure of governmentally funded R&D is fundamentally different in Europe and China. In China, Universities, Design Institutes and Chinese Academies are sponsored for executing research projects based on applications which are going through an evaluation process. Due to the governmental involvement in a number of manufacturing companies the results of research are handed over to these companies to make products out of it. The pilot applications for these products are taking place in other governmentally owned or influenced industrial end-user companies. This means that the R&D money is used in an optimal way for the economic benefit of all involved industries. In this strongly interlinked process the industrial demands are directly influencing the R&D activities and spending. This results in fast innovation in terms of making technology available for real applications and commercial and economic benefits.

In Europe the process is more decoupled. Universities and Research Institutes can apply for funds mainly without considering the industrial use of the results. The focus is more on invention than on innovation. In a lot of cases the results are publications or prototypes for which it is hard to find the interest of a manufacturer or even pilot customer. In case a research institute and a manufacturer are going together for a project, still the question of the first pilot application is open, which potentially limits the breakthrough of a new technology and therefore the innovation. In this system most innovation is driven by manufacturing companies themselves and from their company's R&D spending. Public research institutes and Universities are in a lot of cases more oriented on fundamental and theoretical research than commercial applications. This puts a higher focus in Europe on original inventions than on their application. In China the inventive step itself is less distinct and is frequently replaced by adopting inventive ideas from around the globe. However, the innovation targeting on the practical application is more in focus.

The former description is certainly too much black and white and for sure there are numerous cases showing the opposite. But as a general trend it explains the fast speed of innovation and technical development in China while still a lot of unique first ideas are born in the Western world.

Another aspect of the R&D process is the protection of Intellectual Properties (IP). In the past years the implementation of proper IP laws in China was lacking behind the Western world. This has misguided Western companies not to file patents in China. As a result the majorities of nowadays technologies are not protected in China and can be used freely within the Chinese market. Now more strict IP laws are in place. The next innovative steps taken by Chinese companies will be a further development of existing unprotected basic technologies. For these innovative steps Chinese companies will apply for IP protection. In an increasing number of cases this blocks international companies in their own innovation, because the internationals still does not consider IP protection in China carefully enough. The result is that the strict implementation of IP laws leads to innovation advantages in China at least in the transition period towards a well established and applied IP law system.

Wide Area Monitoring as Example for Innovation

Wide Area Monitoring of power systems is chosen as an example of a recently emerged innovation in Europe and China. This technology was chosen because it was awarded by the MIT in the year 2004 as one of the 10 Emerging Technologies which will change the world [1]. This technology shows the full innovation cycle from the invention, to first prototype applications to finally full commercial installations [2].

A Wide Area Monitoring Systems (WAMS) serves to supervise a electrical power transmission system dynamically in shorter time intervals and more precisely than other common technologies. Therefore a WAMS helps to utilize an existing power system closer to its limits while maintaining the system security and reliability. This leads to an economic advantage by avoiding blackouts or postponing the installation of new power lines.

A WAMS consists of time-synchronized phasor measurements. The measurements are taken with so called Phasor Measurement Units (PMU) installed in the substations. The synchronization is done via a GPS satellite signal. The measurements are collected in a central computer where specific algorithms create higher value information about the stability status of the supervised power system.

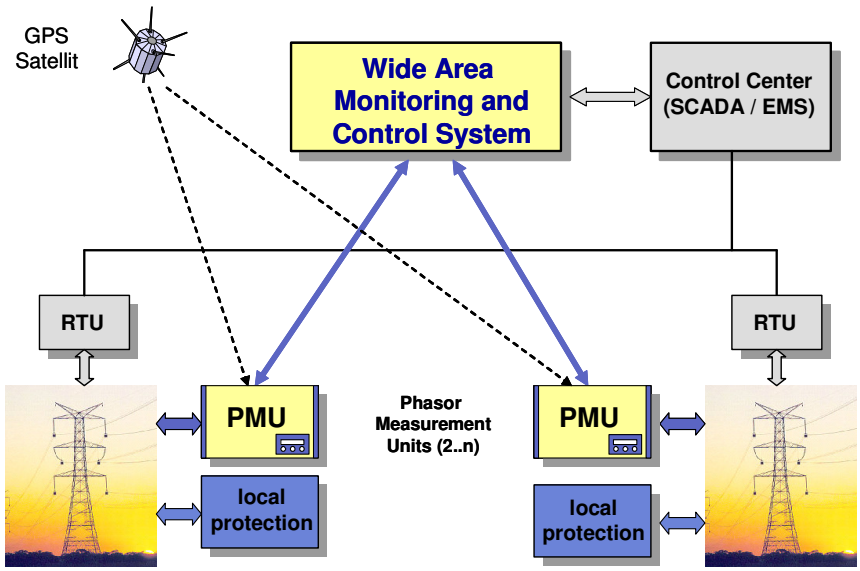

Figure 1: Wide Area Monitoring System Setup

In comparison to conventional SCADA/EMS systems the measurement frequency is much higher down to 20ms per measurement. Therefore the WAMS provides a full dynamic picture of the power system instead of a steady state one provided by SCADA/EMS. Figure 2 shows WAMS in relation to SCADA/EMS and conventional protection and local control. The specific higher level applications are listed for dynamic information generation and coordinated actions.

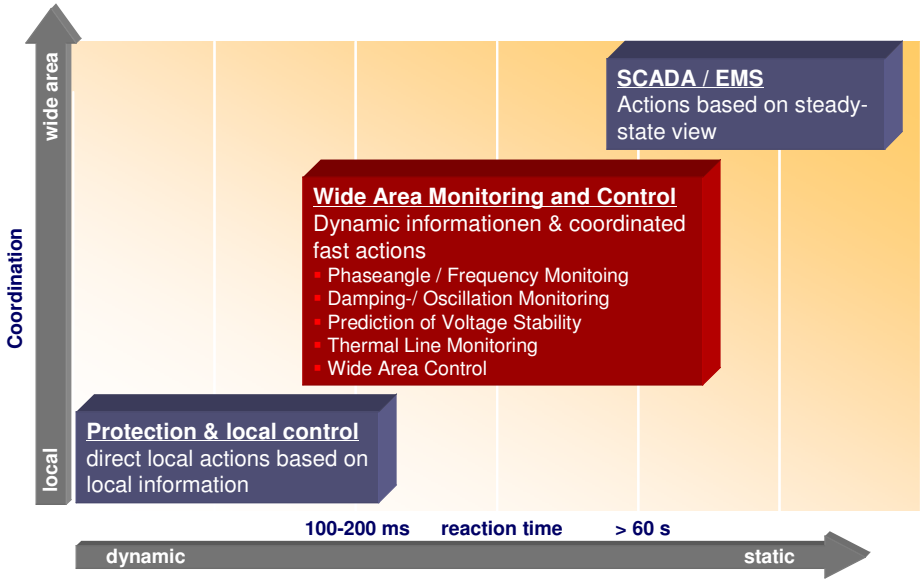

Figure 2: WAMS in relation to protection, local control and SCADA/EMS

Looking backwards, PMUs have been developed at the Virginia Tech University in USA as a research project between 1982 and 1992. Some prototypes could be implemented in some American power systems in the late 80s. The collected measurement data were shown on a screen without further evaluation. In 1998 there were still no applications available utilizing the basic measurements for higher level information. The technology was used offline and the identification of oscillatory behavior and damping of the real system from the measurements was performed manually. The data were mainly used for model adaptation.

After these early steps, several manufacturers around the world have built commercial PMUs. Since the 1990s, several PMU were available on a commercial basis from American and European manufacturers. Between 1997 and 2001 several Chinese manufacturers launched PMU which are widely applied in China nowadays.

The next step in the development of this technology is the central computer for data collection and applications. Most WAMS installations world wide use non-commercial data-concentrators, which are developed by small software companies for one specific customer. The basic functionality is the data visualization. Since 2001 ABB was the first manufacturer to develop a full commercial WAMS. The system includes PMU, data concentrator and applications. The applications are the main focus, because they create the valuable information about the status of the network. Each application has required a lot of research and development. Most of the applications are patented or patents have applied for. Beyond the connectivity of PMU, basic monitoring and data storage/export, the applications cover the following areas:

- Event driven data archiving
- Phase angle monitoring
- Line thermal monitoring
- Voltage stability monitoring
- Power oscillation monitoring
- Frequency stability monitoring
- State calculator
- Control Action recommendation
- Advanced wide area control

Except the last two, all other applications are in commercial operation today. This shows that the several inventions became an innovation. A CIGRE Task Force found that numerous transmission system operators around the world focus on the application of this technology [3]. Based on the publications of the applications and several additional research performed by several groups around the world, more and more applications are implemented in commercial systems.

If we compare the commercial application around the world (see Table 1), it is significant, that there is certain coverage of WAMS in the Western and Eastern USA as the country where it was invented first. But applications for online data evaluation came just recently. In Europe where the first full commercial WAMS including applications was launched, the interest is moderate and just taking the step from pilot to full implementations. Around the world the technology solves particular problems in some countries.

Table 1: Major WAMS installations and applications globally [3]

Applications	Switzerland	Croatia	Canada	WSCC (USA)	EIPP (USA)	Italy	Japan	Sweden	Danmark	Austria	Thailand	China	Australia	Hungary
Phase angle	X	X	X	X	X	P		X	X	X	X	X		
Line thermal loading	X									X				
Voltage stability		X		X		P						P		
Oscillation	X			X		P	X		X		X	X	X	
Frequency, power plant outage detection	P			X	X	P		X		X	X	P		
State Calculation			P		P							P		
Offline disturbance analysis	X		X	X	X	P			X	X	X	X		X
Offline dynamic model adaptation	X		X	X		P					X	P		X
Commercial Operation	X	X	X	X	X					X	X	X	X	X
University/ Research Installation							X	X	X					
In planning						X								

* P = in planning stage, X = in operation

In comparison to that, most PMU and data concentrators are installed in China with a broad coverage of the country. Today more than 150 PMU are installed and additionally a few hundreds are in planning. Ten data concentrators are installed since 2001 and interlinked with high speed communication. They cover almost the entire Chinese transmission system. Figure 3 shows the situation of this technology in China [4]. From this we can see, how quick the innovation was spread out in China after adapting the basic technology. Today China performs several research and development projects to develop and commercially implement own solutions for all applications mentioned in the list above. Therefore the speed in pushing this technology to a broad usage is very high. China will get ahead of the rest of the world in implementation and experience with this technology quite soon.

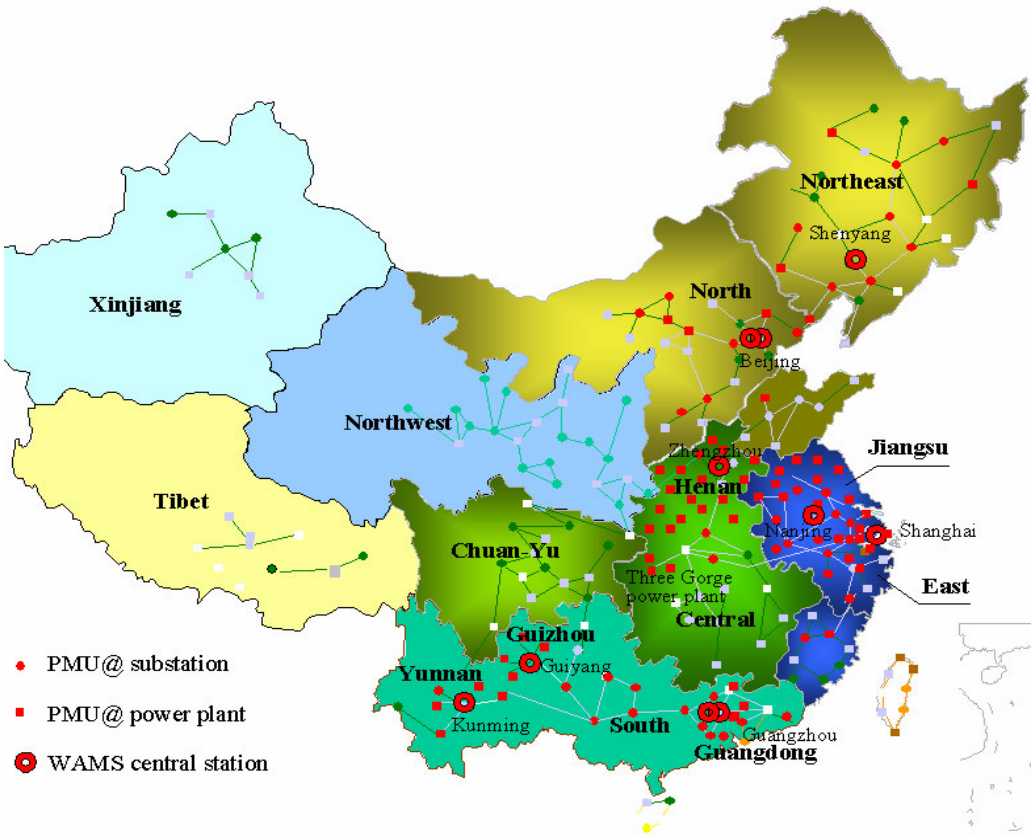

Figure 3: WAMS installations in China 2005 [4]

Conclusions

This paper has discussed innovation with the example of Wide Area Monitoring Systems in Europe and China. The clear vision in China to apply useful technology speeds up the innovation cycle drastically. Available technology is adapted according to the specific requirements with common efforts from research, manufacturers and end-user industry. In comparison to that Europe concentrates on the inventive step but is often reluctant in applying these new technologies.

Handling the technology adaptation very well, China is now concentrating on creating more inventions by itself. This is underlined significantly by the increase of investment in education, research and development in all areas. If Europe is not converting the various political promises for education and innovation support into actions it will fall behind other countries especially China both in inventions and innovation.

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