Are wireline data and mobile infrastructure vendors the same?

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Abstract: This paper provides a short introduction to the differences between wireline data and mobile infrastructure vendors.

1. Introduction.

In the late 1990s the market for infrastructure used to interconnect the Internet and organisation's Intranets consolidated. At its start this market had been made up of a large number of venture capital backed start-ups and established corporations, selling products based on different communication protocols (e.g. AppleTalk, DECnet, SNA, etc.) However, once a dominant design [1] was settled on, in the shape of the Web and Internet dyad [2], the number of firms competing in the market shrank. Today, several giant US corporations dominate the wireline data market: the largest being Cisco Systems, with a worldwide market share of 41% in 2009 [3].

At the same time as the above activities, Europe's wireline voice vendors (e.g. Alcatel-Lucent, Ericsson and Nokia Siemens Networks) gained a leading position in mobile infrastructure. Following adoption of the GSM cellular standard by European telecommunication operators, the vendors agreed to cross-license essential intellectual property rights (IPR) amongst themselves: collectively this gave the vendors a cost advantage, which raised barriers to entry [4], and restricted who could enter the GSM and UMTS market [5] [6].

With the introduction of 'a new "mobile Internet" with its own complex value network delivered through smartphone terminals' [7], such as Apple's iPhone, the separate coexistence of the wireline and mobile markets is now threatened. Mobile operators have experienced an unexpected growth in mobile data usage, triggered by the like of the iPhone [8]. To stop their networks from becoming overloaded, the operators intend to install the 3rd Generation Partnership Project's (3GPP) long-term evolution (LTE) solution. Seeing the all-IP network architecture [9] used by LTE overlaps with their competency in IP [10] [11], wireline data vendors are seeking to enter the new mobile market: exemplified by Cisco Systems recent acquisition of Starent Networks, to gain access to UMTS and LTE core network products [12].

2. Issues for De Alio[1] Entrants.

If the history of the American Automobile Industry is representative, *de alio* entrants 'with relevant specialized transferable skills and knowledge' [13] stand a good chance of moving into a new market. Telecommunications industry data from the 1975-86 period suggests, entrants seeking a way into the equipment market used architectural innovation [14] to overcome entry barriers weakened by Anderson and Tushman's [15] technological discontinuities [16].

Anderson and Tushman's [15] technological discontinuity model starts the technology cycle at a point when an innovation first emerges, while Hughes' systems approach [17] provides a framework to help explain why the innovation came about in the first place: introducing the idea of a reverse salient. A reverse salient [17] can be understood by equating advances in technology to a military front, then a salient (an outward bulge in the military line) corresponds to a leap forward in technology (e.g. the jet engine versus the prop engine), while a reverse salient (a depression in the military line) can be likened to that part of a system (or its socio-technical environment) that lags the wider technology front; thus holding the advance of the overall system back (e.g. the absence of HTML, which held back growth of the Internet.)

A reverse salient, which led to the creation of the Nordic Mobile Telephone system (NMT), developed from the Scandinavian socio-technical problem of people crossing an international frontier generating unplanned mobile border-crossing traffic [18] [19]. The principal beneficiaries of NMT, Ericsson and Nokia, subsequently gained from acceptance of NMT as the baseline for the new GSM digital standard and, in time, from GSMs erosion of Motorola's analogue mobile leadership advantage [20] [21]. This shift between generations of mobile technology, which takes on average 10^{+} years [22], is necessary as 'the linkages among components that comprise the architecture constrain the further advance of the system' [23]; logically this leads to a follow up question: how do the different vendors go about changing the architecture?

Chesbrough [23] refers to 'a close correspondence between the technical structure of a complex good and the organisational structure of the firm producing that good,' while case studies have confirmed 'different technologies imposed different kinds of demands on individuals and organizations' [24]. This suggests the

[1] In this paper, for ease of reference, we refer to new startup entrants as *de novo* and diversifying entrants from another industry as *de alio*. The terms are Latin meaning 'from renew' and 'from another' respectively [13].

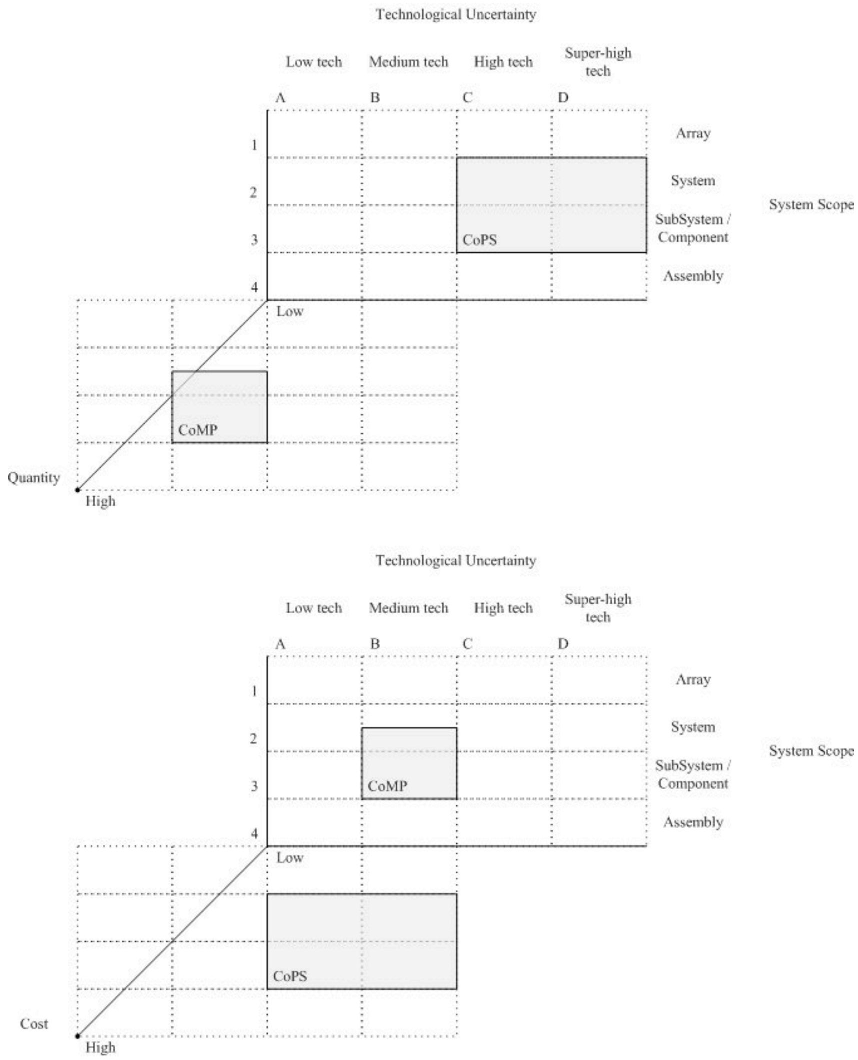

Figure 1: source amended from [26]

environment from which a product comes will influence the artefact's architectural process; therefore, before answering the question a short digression to explain the context of the reply follows.

Wireline data vendor's products are complex 'commodity items assembled from off-the-shelf standardised components' [20] that occupy the 'Mass production' category, of the large batch group, in Woodward's [24] production system. Whereas, wireline voice and mobile equipment vendors products are 'high cost, high technology goods' [25] that occupy the 'Production of technically complex units' category, of the small batch group, in Woodward's [24] production system. Davies [26] provides a further level of classification: mapping the degree of technological uncertainty against the systems scope. Using Davies [26] taxonomy, the *quantity* foundation of Woodward's [24] production system and Hobday's [25] observations on *cost* two three-dimensional grids, shown in Figure 1, are presented. As can be seen from Figure 1, for simplicity, the different markets have been reduced to two classes, which are described in more detail in the next paragraph: Complex Products and Systems (CoPS) and Complex Mass-Produced (CoMP).

CoPS [26], documented extensively in the literature, cover the wireline voice and mobile equipment vendor's products, and are made up of components (e.g. a Mobile Switching Center) or systems (e.g. a Mobile Network) with a high-technology, or super-high-technology, element. According to Davies [26], CoPS occupy grid areas C2, C3, D2 and D3 of Figure 1, but may also fall into the B2 and B3 region; however, as medium-technology 'products incorporate some new features but most technology is available, as with new models of existing products' [26] mirrors the pattern seen in the wireline data industry; this paper puts B2 and B3 into the CoMP classification: as it is a better fit with the cost, quantity and technology triad found in the wireline data market, and shown in Figure 1.

A further reason for the division of vendors into separate groups is the result of a simple test found in the definition of a *complex system*. Johnson [27] defined a *complex system* as 'a set of humans and technologies united to perform a specific function, which are collectively incomprehensible [in total] to any single person.' Accordingly, as mobile networks need several specialists [28] to design, install and operate the CoPS system (e.g. radio, switching and transport), and CoMP networks can get by with a single specialist, then by implication CoPS pass the test, but CoMP fail it. It is for this reason that the first letter of the CoPS acronym refer to *complex*; however, in the case of CoMP *complex* refers to the internal complexity of the component (not the system).

Returning to the question posed above. For CoPS and CoMP the overriding factor, and major influence, in any architecture decision is the state of the industries technical compatibility standards (TCS). TCS refer to the 'technical interface standards [which] are the collection of explicit rules that permit components and subsystems to be assembled in [to] larger systems' [29]. The method chosen to produce TCS is based on the inherent difference in the CoPS and CoMP market: in both instances the costs incurred to design and develop the system are high; however, in the former case this cost is recovered from a small pool of buyers, while in the latter it accrues from a large customer base; for each the buyer and seller relationship is interdependent and independent respectively. Consequently, due to the specific characteristics of the CoPS market its artefacts, in practice, 'are likely to be sold on the basis of pre-negotiated prices with potential buyers or on the basis of continuing relationships with particular customers' [30].

Market differences, then have led over time to separate methodologies being followed in the production of TCS. CoPS vendors seek industry coalescence around a *de jure* TCS: through 'explicit communication and negotiation before irrevocable choices are made' [30] [31]. The primary reason CoPS vendors use the *de jure* process is to avoid making architecture decisions that with hindsight turn out to be expensive market gambles, which threaten organisational survival. A secondary reason is the services enabled by CoPS form an integral part of the buyers offering to their customers (e.g. the telephony of the local telecommunications operator); consequently CoPS purchasers as a rule have deep knowledge of the systems capabilities and actively participate in settling the TCS [26]: epitomised by AT&T dictating which technology to use in subsequent generations of US telephone exchanges [32]. Summarising, by binding operators and vendors into a collective agreement on the final technical solution market certainty is improved: no party can destabilise the market with a disruptive technology following the 'freeze' of the TCS [30], and parties are reassured of a return on long term capital (R&D) investments.

Conversely, CoMP vendors use a number of different approaches to generate TCS. In some instances a hybrid approach for achieving coordination is used [31]: architectural performance limits are overcome by creating *de facto* or local standards [30], before leaving it to the market to decide the technical winner. For example, the Home Network Administration Protocol (HNAP) and Telepresence Interoperability Protocol (TIP) are local and de facto standards created by Cisco Systems, which fill a need for component interoperability otherwise overlooked by the market, but nevertheless required for market growth.

The other method used by CoMP to produce TCS is an offshoot of the *de jure* process. Typically, in the telecommunications field *de jure* TCS come from either the European Telecommunications Standards Institute (ETSI), the International Telecommunication Union (ITU) or a mixture of the two. Both of these bodies are pseudo-governmental organisations with attendant bureaucracies to keep things running; in contrast, CoMP use a less formal structure, which encourages transparency and faster decision making [33]. This process is often referred to as an Open Standard, in spite of no clear definition of *open standard* existing [34]; consequently, in this paper we coin the term *de aperio* (Latin for 'from open') to refer to TCS that are prepared using an open-process, but which may rely on IPR.

The closeness of the fit between how TCS are produced and the market they server is underlined when it is appreciated that the CoMP architecture is a loosely coupled network [30], and vendors bypass performance limitations that have surfaced, or are about to surface, in the existing system by using the flexibility of the *de aperio*, *de facto* or local standards process to propose new TCS (e.g. Frame Relay, ATM, MPLS, IPv6, et cetera), while incrementally improving their components functionality. The synergy gained from embedding the new TCS capability into the updated component enables vendors to create a market demand that forces customers to replace (or sideline), what are now classed as, legacy components with the new offering. In practice this allows CoMP vendors to reduce the technology replacement time, from the 10^{+} years found in the CoPS market to anywhere from 2 to 8 years: in the speed of transmission equipment example in Hicks and O'Brien [35] this period varied from one to three years.

3. Conclusions.

This paper has shown a number of differences between wireline data and mobile infrastructure vendors.

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