APPLICATION OF COMMON KNOWLEDGE OPERATOR AND DISRUPTIVE THINKING PERSPECTIVE IN CASE OF MOBILE OPERATING SYSTEM MARKET

AURIMAS GIRCYS

Faculty of Politics and Management
University of Mykolas Romeris, Lithuania

Abstract: Paper is a case study of mobile operating systems market, where mobile operating system makers share a distributed knowledge of mobile operating system basics and different levels of information about consumer expectations. According to the basic logics, it is reasonable to expect that if it is commonly known that a choice *A* is better than a choice *B*, any agent *i* will prefer the choice instead of an inferior one. In case the mobile operating system makers some chose a completely different outcome which is rather based on disruptive thinking instead of common knowledge.

Introduction

Every single MBA student has read the cases of Xerox and IBM where these two companies were so focused on their mainstream customers that they did not see the raising new markets. This is how Xerox lost a copier competition to Canon and IBM lost a personal computer competition to Compaq. Our research focus is similar case emerging in the mobile operating system market. There is Nokia with its Symbian operating system leading the mobile operating system market for now and there are Apple and Google that entered the mobile operating system market only three years ago but are already a serious threat to any other mobile operating system creator. I presume that the reason for this success is a disruptive thinking and the paper framework itself has a logical chain which will verify this proposition.

Just like Canon or Compaq, Apple entered the market that seamed already full at the point of entrance. For example in 2006 Lithuania had 30% more cell phone users than inhabitants. Could the market be more overcrowded? As the story goes, we will find out that it clearly can be.

At the point of Apple's entrance there was a clear understanding of mobile operating system users. These were business class cell phones designed specifically to fit the business class demands. When iPhone first came out (January 9, 2007), it brought a different user experience and an application market. To Apple phone was not just an instrument to have a voice or text chat: it expanded user experience to a different level by allowing them to download and install various games, programs and social applications. For example, one of the most popular application nowadays is called "Bump-it" and has a very simple task - it allows users to exchange their private information (name, e-mail and phone number) when two users bump their phones. This simple application brings a vast amount of joy to customers who have the devices, capable running the application. Would any serious business-man ever need this kind of application for a successful business? Of course not, and this is exactly why this application emerged on Apple's system but not on the Nokia's.

Half a year later, in November 2007 Google revealed its own mobile operating system, called Android OS. The main difference between Google and Apple at that very moment was a fact that Apple had its own devices in which it had iPhone OS installed and Google just provided an operating system which was allowed for various manufacturers to be applied and further developed. Soon we saw many Android powered devices, such as Motorola Droid, HTC Hero, and even LG Ally. One thing that both iPhone OS and Android OS have in common is that they drain the battery of the phone so badly that you have to charge your phone every single evening. What business user would ever want a phone that dies after an hour of conversation? None, and this is exactly the reason of iPhone's and Android's success.

At this matter, this paper has a goal to analyze strategic alternatives of mobile phone operating systems, simulate supply/demand within the market and identify the consumer preferences.

Identification of interacting groups

This research focuses on two interacting groups: mobile operating system manufacturers and mobile operating system consumers. Basically, this is a typical supply-demand interaction where supply side is a mobile OS manufacturer and a demand side is being represented by users or as it will be stated in this paper, group *U*. At the current moment the supply side or group *G* has seven members: Apple with iPhone OS, Google with Android, Nokia with Symbian OS, and BlackBerry with Research in Motion. Basically we will presume that all mobile phone operating systems belong to a group *G* or in other words: $G = \{s, r, i, a, w, l, o\}$

The demand side or group *U* consists of all worldwide mobile phone users that chose mobile phones running mobile operating systems. Old school cell phones that do not have a mobile operating system running on it and their users do not belong to the object of this research.

Any person worldwide has an option to join the *U* group by purchasing a cell phone that runs a mobile operating system. The larger group *U* is, the bigger is the market share of members within group *G*. This choice to become a member of *U* group might depend on multiple

factors: individual rationality, their consumer preferences, personal income and of course newspaper headlines. If all members of group U worldwide shared same information (e.g., yellow painted cell phones were the best options to choose), all of them would choose same products as long as there was no price, stock or transportation barrier. This is the common sense for a rational individual. Same could be applied to the supply side. If all users had identical choices, the group G would consist of single worldwide preferred mobile operating system manufacturer. As currently there are seven members within group G and their market share is constantly changing, we might say that there are few reasons for this diversification: some users made a wrong choice or they did not share the full common knowledge at the point of choice. Making a wrong choice having full information is a rather irrational option and despite the fact that sometimes it is very rational to take irrational steps in order to build a credible reputation, this level of thinking might be reasonable to be looked for at the level of warfare but not at the level of consumer choices. Due to this reason this paper will follow the logics that all users share different levels of information (both true and false) and take an optimal choice depending on the information sources available at the time of choice. As it has been mentioned, some users might take next step depending on their personal experience, some might be seeking for newspaper headlines to help them make the choice. Independently of the motives, why some individuals will decide to become members of group U, this reasoning seems to look valid for them.

Choosing alternatives

As it has been previously mentioned, there is always a simple way to make a decision - create a model where your rivals have two options: cooperate or fight. This would be a typical example of prisoner's dilemma and applying it in mobile operating system market wouldn't provide much of academic addition nor would it set any objective for any academic debate. To verify the alternatives of group G member properly this paper chooses Harrison (1995) six step model and applies this model to identify the best possible alternatives. The mentioned model is both complex and extensive way to choose among the alternatives. It highly depend on how extensive is the analysis on every single step but at the same time it also brings a great structural format for the research.

Step one of Harrison's six step model is relatively simple - it's setting objectives. Basically, every member within group G has a goal to make as much profit as possible still keeping a good reputation. This might sound as a very simple objective, but as we will see later on in this paper, profit and reputation sometimes have inverse ratio.

Step two is rather more complicated. It's searching for alternatives through scanning the internal and external environment of the organization for information. Let's presume that s,r,i,a,w,l,o shares the distributed knowledge of a fact φ or that "everyone in G knows φ" as noted previously by Halpern and Moses (1990).

$$E_G\varphi \equiv \bigwedge_{i \in G} K_i\varphi$$

φ in our problem stands for an information which is essential to make a mobile operating system. As all members of group G have their own mobile operating systems it's relatively easy to verify the fact that they do share the φ. Still, some operating systems are more popular, and some are less. For example, Nokia's Symbian OS (s) had a market share of 44.3 percent in 1st quarter of 2010 (Schonfeld, 2010), Apple iPhone OS (i) had a market share of 15.4 percent and Google Android (a) had a market share of 9.6 percent in 1st quarter of 2010. If everyone in G knew only φ and the sales of mobile operating systems strictly depended on this information, all members of group G would have an equal share of the market as the customers would be indifferent to the mobile operating systems. The diversification in popularity of mobile operating systems shows that there has to be extra information to φ that shapes the competitiveness of mobile operating systems. Otherwise, from the user perspective $s \equiv r \equiv i \equiv a \equiv w \equiv l \equiv o$

Based on the earlier mentioned diversification in popularity of mobile operating systems it is clear that this equation is false and there is a β, Δ of which is known to every manufacturer. In other words, $s = \varphi + \Delta\beta_s$; $r = \varphi + \Delta\beta_r$; etc.

If β is a variable which shapes the sales of mobile operating systems, it is clear that every mobile operating system manufacturer shares a different $\Delta\beta$. Another thing, which is also clear about $\Delta\beta$, it's that Δ is constantly changing among the companies. Otherwise the market share of s wouldn't have shrunk by 4.5 percent comparing 1st quarters of 2009 to 2010 and market share of a wouldn't have increased by 8 percent during the same time (Schonfeld, 2010).

By searching for alternatives through scanning the internal and external environment members of group G can identify $\Delta\beta \uparrow$. If any member of group G wants to implement the increase of $\Delta\beta$ in practice, there are three ways to do that:

1. Steal a customer from another member of group G;

2. Bring a customer from outside of group U and turn him into a mobile OS user;

3. Sell a new device running same OS to a current user;

All three options are viable and widely practiced in reality. As the main objective of every member of G group is to make as much profit as possible still keeping a good reputation, we will have to identify how these three options correlate with the objective. This brings us to step three of Harrison's six steps, which is to compare and evaluate the alternatives by formal and informal means.

Let's evaluate all three alternatives: first of all, stealing a customer from another member of group G does bring you a sale with a profit increase and it also affects your reputation. Let's not forget that stealing a customer is not the same as stealing a candy and usually it can be interpreted very positively in relation to company's production quality. For example, during last year Symbian's market share shrunk by 4.5 percent and iPhone OS has increased its market share by 4.9 percent. Windows Mobile lost 3.4 percent of the market and Google Android increased its sales by 8 percent. From the consumer perspective it does not mean that Google or

Apple are evil, it just means that these two companies brought a product which is gaining recognition in the market.

$$\Delta s \downarrow \cup \Delta \omega \downarrow \Rightarrow \Delta i \uparrow \cup \Delta a \uparrow$$

Second option is to bring someone new into the group *U*. In fact, the larger the group *U* gets the bigger the sales of group *G* is. In other words

$$\Delta U \uparrow \Rightarrow \Delta G \uparrow$$

Gartner provides some numbers on market share of various mobile operating systems and this lets us use the trend analysis in order to predict the future outcomes within the market. Let us presume that 1Q09 to 1Q10 has been a critical period for mobile operating systems market and that from this year growth rate will be decreasing by 10 percent each year. This lets us presume that in five years the most popular mobile operating system could be Google Android with 37.6 percent market share and second most popular would be iPhone OS with 32.7 percent market share. Currently leading Symbian OS would get to the third place and Microsoft Windows Mobile operating system could become a totally insignificant member of a *G* group.

TABLE 1. ESTIMATED YEARLY MOBILE OS MARKET SHARE BASED ON 1Q09 TO 1Q10 GROWTH

Company	Growth comparing 1Q09 to 1Q10	1Q10 Market Share (%)	1Q11 Market Share (%)	1Q12 Market Share (%)	1Q13 Market Share (%)	1Q14 Market Share (%)	1Q15 Market Share (%)
Symbian	-4.5	44.3	40.3	36.7	33.5	30.8	28.6
Research In Motion	-1.2	19.4	18.3	17.4	16.5	15.8	15.2
iPhone OS	4.9	15.4	19.8	23.7	27.2	30.1	32.6
Android	8	9.6	16.8	23.2	28.8	33.6	37.6
Microsoft Windows Mobile	-3.4	6.8	3.7	1.0	0	0	0

Source: Schonfeld, 2010.

Step four, according to Harrison, is to practice the art of choice.

In our case it is a moment when every single member of group *G* selects the course of action from a set of alternatives. This course of action by microeconomic axioms depends on one simple criterion: how big is the utility that the outcome brings (as in our case *U* represent group of users, utility will be expressed with *T*). If $T_1 > T_2$, then the members of group *G* choose the course of action which leads to T_1.

Previously we discussed the matter of reputation and mentioned that profit and reputation sometimes had inverse ratio. This point fits very well the utility maximization dilemma, as it is resolved with two factors: profit gained and reputation lost. In other words, $\Delta T_n = \{\Delta P_n, \Delta R_n\}$. To make the problem less complex we will presume that both functions are linear, therefore:

$$P_3 - P_2 = P_7 - P_6$$
$$R_2 - R_3 = R_5 - R_6$$

This lets us interpret the point of choice at a very simple way. In this case ΔP and ΔR have constant values that differ only for individual members of group *G* or:

$$\Delta P_s \neq \Delta P_r \text{ and } \Delta R_s \neq \Delta R_r$$

Earlier we discussed the matter of information and a fact that. Now we can clearly point out that at a point of choice every single user of group *G* seeks out to maximize his utility but its maximum utility is limited with as this variable has a different value for every single member of the group. Just like in step two, estimation of $\Delta \beta$ is crucial for member of the group *G*, as once again it determines their market share. At this moment it is needed to point out that market share and utility is not the same. $\Delta \beta$ determines your market share and utility is gained strictly depending on your $\Delta P_n + \Delta R_n$ because at the very first step of Harrison's six step method we pointed out that the ultimate objective for every member or group *G* is to make as much profit as possible still keeping a good reputation.

From basic economics it is clear that larger market share equals to bigger profit and therefore as $\Delta \beta$ determines the market share, it also determines ΔP. As $\Delta P = T - \Delta R$ we can easily point out a relation between knowledge that different members of group *G* have and their reputation in the market. In other words

$$\Delta \beta_n \Rightarrow \Delta P_n$$
$$\Delta P_n \Rightarrow T_n - \Delta R_n$$
$$\Delta \beta_n \Rightarrow T_n - \Delta R_n$$

To sum up, the larger the value of $\Delta \beta_n$ is, the more utility members of group *G* may keep even with a reduced reputation. Therefore, we can say that the course of actions that members of group *G* will choose strictly depends on the same indicator that leads to a greater market share of each member. This variable ($\Delta \beta_n$) is crucial in all terms of this paper.

Harrison's step five is rather logical and the idea to

implement the decision when the choice is transformed from an abstraction into an operational reality requires a more detailed analysis of group *G* members on an individual level.

As we have previously discussed, group *G* contains of seven individual members. To be more precise, each decision that a member of the group makes, is based on the variables that we have previously estimated: $D_s \Leftarrow \Delta\beta_s \cup \Delta R_s \cup \Delta P_s$; $D_r \Leftarrow \Delta\beta_r \cup \Delta R_r \cup \Delta P_r$; etc.

Final sixth step according to Harrison is a verification and control of the whole logical sequence. This step is needed to make sure that every single member of group *G* actually achieves what he is seeking. As every single member of group *G* has a goal to make as much profit as possible still keeping a good reputation, chosen decisions or D_n differs from this objective only by a variable $\Delta\beta_n$ which represents individual knowledge on the matter that is not shared within the group *G*. This basically is an answer to our problem of choice.

Mobile operating system strategies

Typically, all individuals, companies or even countries always have these two strategies: cooperation and fighting. These two alternatives occur from the very first moment when at least two participants happen to be in a single market. In our case, mobile operating system market or market that only consists of group *G* has seven participants. These seven participants may have complex strategies when they identify all the rivals and chose appropriate strategies to interact with every single one of them or they may chose rather more simple strategies when they compete or cooperate only with a small set of companies and chose to ignore presence of the others instead.

When we were following Harrison's six steps, we stated out that decisions that members of group *G* make are influenced by $\Delta\beta_n$, ΔR_n, and ΔP_n. This is one side of the decision making process which is very logical and sequential but it does not take into account the strategies of your rivals. Let's fix this and make the problem closer to the reality. Let's presume that the strategy, chosen by the group *G* member still has a value D_n but in this case it is influenced by the decisions of other members of the group.

$$D_a \Leftarrow D_s \cup D_r \cup D_i \cup D_w \cup D_l \cup D_o$$

The reason, why in this case there is equality between a chosen strategy and a decision is because before the point of choice each member of group *G* has several strategies and once the optimal strategy is chosen, we might also say that the member of group *G* has made up his mind and has taken the decision. The way these strategies are chosen can be expressed in matrix, decision tree or a game tree. Depending on the values that you prescribe to each alternative, the outcomes can differ.

As it has been previously mentioned, there is a rather simpler way to choose among the strategies. This option allows members of group *G* compete or cooperate only with a small set of companies and chose to ignore presence of the others instead. If we take a look at the mobile OS market share growth rate comparing 1Q09 and 1Q10, we will see that the only two companies that managed to increase their market share within this year were Apple and Google. If a similar growth rate level remains for few more years, Google might start dominating the market. From this point Apple should see Google as a major competitor. In fact, according to last posts on TechCrunch, Apple does see Google as one now and so do the majority of Apple users (Siegler, 2010). If we recall the Apple/Microsoft warfare ten years ago, there was a similar case: Microsoft was pointed as a major villain and Apple - a top hero. Once again, let's point out that Apple never competed with the other hardware manufacturers like HP or Dell but always tried to show its different endgame user experience which could only be felt by Microsoft Windows users. Remember the slogan "Mac OS is a virus-free platform"? Somehow it's gone now. So is the rivalry between Apple and Microsoft. Things is that if PC/laptop users tend to upgrade their hardware or buy new products every three to four years, mobile phone users do it quite more often. In European networks like Vodafone, two year contracts with a discount on a new mobile phone device are extremely popular. Even more users tend to purchase a new device with a warranty, use it for half a year and then sell it on e-Bay or local clone of it. Used devices are popular among parents who want their kids to be in reach and this cycle lets same old customers come back to the shop and purchase a new device. Another thing, if an average family of four has around three computers at home (one for every kid and one for parents), the same family usually has five to six cell phones. Lithuania with its three million inhabitants has more than four million cell phone users. This means that roughly 30 percent of population has two cell phones. Coming back to the topic, let's set a question: Why should Apple further compete with Microsoft when the new constant source of income is cell phone market? Despite the fact that Nokia with Symbian OS is still the market leader, constantly increasing popularity of Apple's and Google's mobile operating systems within the market is like a sign that these two companies are the new top rivals. Because of this reason, $D_a \Leftarrow D_i$ and $D_i \Leftarrow D_a$.

In the theory of game strategy it is important to know whether your rival has a dominant strategy. If he does, Dixit (1993) states that you should know that your opponent will always choose this strategy and at the same time you should go for an optimal best contra strategy.

As both Apple and Google seek to gain the larger market share sometimes at the cost of profit it is quite clear that both of these companies have a dominant strategy of reputation building. Still, even if the goal for both of the companies is the same, the road chosen differs a lot. As it was mentioned, Apple is a device manufacturer and Google is a software builder. Do we recall the case of IBM and Microsoft? IBM implemented de facto standard for PC hardware manufacturers but Microsoft was the one that provided operating system. Few years later IBM's PC hardware standards remained, more hardware manufacturers came in, Microsoft's operating system has turned into default operating system on vast majority of

the machines but IBM itself lost a large amount of market share to the newcomers. Could it repeat again? Could Google with its Android OS become the leading mobile operating system manufacturer and Apple simply "fall" of a tree?

This could be the case if the user could choose an operating system when purchasing the phone or if he could install another operating system on his phone just like in the case of personal computers. For now vast majority of the users do not know how to gain root access to their mobile phone and even if they knew how to do this, most of them would see no point in doing it. Because of this, toying with the operating systems after the phone is purchased is usually left behind and the point of choice among operating systems still remains at the moment when the customer purchases the device.

Despite the fact that Google and Apple are major mobile operating system rivals, their approach on the problem is completely different. Apple is manufacturing devices and installing its operating system on them, and Google instead is a mobile operating system manufacturer which has only released one Google phone so far (Nexus one). These different approaches hide completely different way of thinking behind the scene. It is not a secret that right after the phone is being sold, every single manufacturer has a goal to make a new, sustainably improved model to attract same customer to the shop once again. Sadly, most customers do not really want to buy a new phone every two or three months therefore phone manufacturers need to find a new way to make money. Apple is constantly releasing minor updates to the phones and charging the users for downloaded OS updates. Still this is not the main source of income - application stores are. This is the starting point of rivalry between Apple and Google. Apple App store is only available for iPhone users; Google Application market is available for HTC, LG, Motorola and other phone users as long as they run Google Android. For now vast majority of applications worldwide are available on Apple App store, but Google is catching up quite fast and it has the largest percentage of free applications available for mobile OS users. These application markets are designed to attract non-business users and this is exactly the example of disruptive thinking that Apple and Google are applying. If Nokia is building devices with long lasting batteries, Apple and Google is focusing on user experience and do not really care about that fact that users have to charge their devices every evening. Apple and Google do not target the mainstream business customers but rather the so called casuals (kids, students etc.) that are new to smartphones not because they wouldn't want it, but because up until Apple's iPhone all smartphones with mobile operating systems were focusing on business users.

Simulation of supply and demand side interactions

Let's briefly review what we have discussed so far: there are mobile OS suppliers, that we call group *G* and the mobile OS users, that we generally call group *U*. Group *U* members usually are business users or the casuals (teenagers etc.). Group *G* contains two types of companies - ones that are both device and operating system manufacturers (like Nokia, Blackberry and Apple) and ones that are only operating system builders (like Google and Microsoft). In order to gain larger market share every single member of group has either to attract new customer to group *U*, or to take over one from other members of group *G*.

For years, smartphones were only the phones for business users. A casual user did not really need one. Of course, ability to check different e-mail accounts was useful but in most cases this was nearly the only advantage of smartphone that casual users could experience. And to be honest, this experience did not really repay the slow booting of the phone and loading of applications. Because of this, vast majority of group *U* consisted of business users at the most. Few years ago a new era for mobile operating systems came up - mobile phone hardware was improved, devices no longer required stylus for touchscreens and mobile networks became fast enough to load smoothly social applications such as YouTube, Facebook, Flickr, Twitter and the others. Casual users got a motive to be interested in smartphones, running mobile operating systems. Apple with its iPhone was the very first to step into the market of the casuals and provided a finger friendly experience that brought a vast amount of joy to the users. Even more, Apple decided to bring a relatively expensive device to the market and in many countries having a genuine iPhone turned into a proof of welfare in the family.

To keep the income at a constant level even when the phones were sold out, Apple created and App Store - an online market of Applications for iPhone users. This store is as successful as big the market share of Apple iPhone is. Understanding this point, Google came up with an analog system on Android OS. Android Market is the place where the Android OS users can download and purchase various applications. From Google's perspective, it's very reasonable to handout its mobile operating system to as many mobile phone manufacturers as possible. As Google does not really make money on constructing and selling the phones (even its Nexus One in fact was manufactured by HTC), it has to make sure it has a constant increase of Android OS users as they are the Android Market users as well.

There is one major difference in the whole concept of Android Marketplace and iPhone App Store: from the end-user point of view, Apple App Store brings a possibility to purchase new applications for the device as majority of applications in the store are paid, and Google brings up an opportunity to download most of applications for free. The catch here is that Google's intentions to provide downloads for free it based on the concept of advertising. Most of these free applications have an advert bar which of course is touch sensitive and customized to match area, where the user lives. Therefore, the more free applications are downloaded, the bigger is the auditorium for Google's adverts. This is a completely new level of thinking - no wonder why Nokia is losing the market share - business users do not really need to change their phones to show off among friends in class, but kids do and Apple with Google is exploiting this new user group which Kim (2005) would call the Blue Ocean.

As it was mentioned previously, there are two major types of mobile operating system user groups: business users and casuals: $\Delta U = \Delta U_b + \Delta U_c$

Business users expect the mobile operating system to be a handful tool to assist in daily work and casuals expect fun and social experience from the device

$$\Delta U_b \uparrow \Leftarrow h$$

$$\Delta U_c \uparrow \Leftarrow e$$

Fun and entertainment is exactly what mobile operating system marketplaces bring. The market which provides more content to the user seems to be more attractive to the one. Same is with developers - the platform which allows you to have more users that download your products looks much more attractive than the one with less potential customers. At this point Google's strategy to spread out its Google Android among as many phone manufacturers as possible really does make sense. The more spread the platform is, the more interest the developers show in building applications for the platform. This leads to a larger content on the marketplace and better user experience.

$$e \uparrow \Rightarrow \Delta M \uparrow$$

The more there are casual users among the whole mobile operating system user population, the more interest in developing social applications the developers have and the more applications end up in the marketplace.

$$\Delta U_c \uparrow \Rightarrow \Delta M \uparrow$$

Therefore, if increasing the amount of handful tools for business users still could have been a viable strategy few years ago, the market shape at user level is shifting nowadays and the companies that are stepping forward, are the ones that concentrate on entertainment ($e \uparrow$) which leads to $\Delta U_c \uparrow$ and overall increase in profit.

Conclusion

The paper had a goal to focus on raising market of mobile operating systems. Two major groups (mobile operating system manufacturers and users) were identified at the starting point. Mobile operating system manufacturers were brought to a single group G which later on was analyzed on the basis of common knowledge and strategies that are being used to achieve the objectives. Second group at the starting point was left as single unit or group U, which later on was diversified into the business users and casuals. While solving the case it became clear that the diversification in group G is based on different target groups (Nokia with Symbian OS is targeting mainly business users and Apple with iPhone OS is targeting mainly casual users) and the constant increase of Apple's and Google's market shares is based exactly on the point that these companies focus mainly on casual users (those, that would rather have a YouTube stream than a five days lasting battery on their phone). This paper has identified Apple and Google as two companies which clearly brought disruptive innovations to mobile operating system business. Just like in the cases of IBM and Compaq (were Compaq brought personal computers to home users while IBM was protecting its mainstream market) or Xerox and Canon (were Canon brought a copy machine to every small business company while Xerox was still building bigger and better copiers for their mainstream customers) Apple with Google will take over Nokia's, Blackberry's and Microsoft's positions in the mobile operating system market as Apple and Google target casual users instead of business ones that are the mainstream customers of Nokia's and Blackberry's smartphones. And the interesting thing is that despite the fact that history is once again repeating itself, Nokia and Blackberry do not see it coming.

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