CONNECTED INTELLIGENCE ERA: THE GOLDEN AGE OF MOBILE

CHETAN SHARMA

A MOBILE FUTURE FORWARD PAPER
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History and Background

In 1925, a Soviet economist Nikolai Kondratiev observed in his book “The Major Economic Cycles,” that the growth of human history has been intertwined with economic cycles that resemble waves spread across multiple decades (figure 1). The duration of the cycles might vary but the pattern repeats itself. If we study the technology revolutions of the last 300 years that have shaped human history – the industrial revolution, the age of steam and railways, the age of steel, electricity, and heavy engineering, and the current age of information and telecommunications, each of these cycles lasted on average 50 years. There was GDP growth with every cycle and with each technology cycle, we made earth a better place to live even though sometimes it might not seem that way.

Figure 1. Kondratieff Waves

Early in the 20th century, an Austrian economist, Joseph Schumpeter expanded on the theory of business cycles and development and wrote perhaps one of the most influential book in economics – “The Theory of Economic Development.” Schumpeter posited that the entrepreneurs changes the equilibrium of any business cycle and is the prime cause of economic development (figure 2), which proceeds in cyclic fashion along several time scales. In fashioning this theory connecting innovations, cycles, and development, Schumpeter kept alive the Russian Nikolai Kondratieff’s ideas of 50-year cycles.

![Figure 2. Schumpeter’s Waves](image)

In 2003, another economist Carlota Perez from Venezuela expanded on the Kondratiev cycle theory in her book, “Technological Revolutions and Financial Capital: The Dynamics of Bubbles and the Golden Ages.” She drew upon Schumpeter's theories of the clustering of innovations to explain why each technological revolution gives rise to a paradigm shift and a New Economy and how these opportunity explosions, focused on specific industries, also lead to the recurrence of financial bubbles and crises (figure 3). By analyzing the changing relationship between finance capital and production capital during the emergence, diffusion and assimilation of new technologies throughout the global economic system, Carlota’s book discussed some of the pressing issues in front of us.

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4 [http://cnx.org/content/m43441/latest/?collection=col11417/1.2](http://cnx.org/content/m43441/latest/?collection=col11417/1.2)
5 [http://www.carlotaperez.org/](http://www.carlotaperez.org/)
This brings us to the present time. Where are we in the big economic cycles? Are we in the golden age of the last technology cycle of information and telecommunications that gave birth to the Internet and the modern wireless ecosystem as we know it or are we perhaps on the verge of a new age that will transform human history for the next 50 years? Given that the markers of transition are not always clear, we won’t know for sure which wave we are embarking on for some time but we are fairly certain that we are entering the *golden period of the mobile industry*. There is also a strong possibility that we might be onto something new, something more transformative, something different that we would humbly propose is the start of the *Connected Intelligence Era*. These two operative words are going to define the next phase of human evolution. The confluence of mobile broadband network, smarter devices, pervasive connectivity, and our ability to program the intelligence around us is going to dramatically change every industry vertical from the ground up. Consider the health industry – sensors inside the body can send alerts days before a stroke, telemedicine can help direct a surgery in remote parts of Bhutan, mobile devices will educate and guide us on nutrition, wellness, and medicine compliance. In fact, technology might eliminate the need to go to a doctor completely except in the case of

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7 Source: Technology Revolutions and Financial Capital, Carlota Perez, 2002
chronic diseases or an emergency. Some of this is already happening but we will see implementations on a global scale that will hopefully reduce the enormous burden on the global GDP.

Similarly, the travel and tourism industry is being transformed by intelligence at the fingertips of travelers in unfamiliar lands. The education segment especially in the developing world is being changed by the availability of affordable tablets. M2M is making the energy sector reinvent itself. In a few years, it will be hard to imagine a car without mobile broadband connectivity.

As we outlined in our Mobile 4th Wave paper series, change is in the air. Mobile is becoming the critical tool to drive human ingenuity and technological growth. Fueled by the revenue growth curves of voice, messaging, and access, the industry has flourished beyond anyone's imagination.

We as an industry are on the verge of incredible milestones in human history. Very soon, for the first time, mobile connections will exceed humans on the planet. Mobile broadband networks are being deployed at the fastest pace ever. Smartphones are in such great demand that in some countries, feature phones are already going extinct. The trifecta of fast broadband networks, well-designed mobile computing devices, and the insatiable supply of content, applications, and services has unleashed consumer demand like never before.

The last thirty years of industry growth were primarily driven by network access to voice, messaging and data. The next thirty will be defined by access to services and solutions that are customized to the individual consumer lifestyles. Enterprises around the globe are also rethinking their business processes and business models and how they can take advantage of the connected intelligence around us. As an industry, we have reached an annual run rate of $1.7 trillion in revenues. But how will the next trillion dollars be generated? Which services are going to dominate? Which players will get the lion share of the revenue stream? How will regulators regulate? How are we going to deal with the vexing issues of privacy and security? How will consumers adapt to the changing dynamics and will we truly realize the potential of the 4th wave? The next decade will yield the answers and determine the new winners of the mobile ecosystem.

In this paper, we make the case that we are in the beginning of the “Golden Age of Mobile” and discuss its impact and the early years of the transformation some of which we are already starting to see.

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8 Chetan Sharma Consulting estimates that by early 2015 we would reach this milestone
9 Source: Chetan Sharma Consulting, 2014
Task – The Unit of Productivity and Human Progress

If we break down any era of human progress or zoom into the impact of any technology on human adoption and its subsequent success or failure, it is important to do so using the lens of the task economy: the time it takes to complete a task and the cost of integrating that technology into human work flow. The daily routine of any human can be broken down into hundreds if not thousands of tasks: getting up in the morning, getting ready, commuting, being productive at work, engaging in commercial transactions for physical and digital goods, connecting with colleagues, customers, friends, and family, keeping fit, eating, rejuvenating, getting from point A to B, and connecting with the world and interests before trying to get some sleep. This process repeats itself time and time again. In fact, versions of this process have been occurring since the beginning of humankind. The human endeavor has been about mastering task minutiae and using tools to gain efficiency, time and money.

In his 1943 paper titled “A Theory of Human Motivation,” the famed philosopher Abraham Maslow theorized his observations of human needs and curiosities. His pyramid came to depict the human hierarchy of needs. If we map the physiological, safety, love, esteem, and self-actualization needs onto how much we spend as a community, it correlates rather well. As you would expect, human spending behavior is tightly tied to basic needs. The amount of money we spend on these basic needs might vary by demographics or region but in aggregate, we tend to spend the most on things that are at the bottom of the pyramid – shelter, food, and water.

Time and time again, inventions have revolved around taking the inefficiency out of the task economy and making us better at what we do. For example, the industrial revolution introduced new manufacturing processes based on machines rather than hands and changed the textile and other industries which in turn impacted economic activity in meaningful ways. Steam engines and railways provided a better solution to the problem of moving humans and goods from point A to B. The age of steel and electricity further improved solutions to the transportation problem. The age of oil and automobiles made us more mobile than ever before. Countries who adopted these solutions first benefited tremendously and gained competitive advantage for their citizens. We all have been living and benefiting from the age of Information and Communications technology. The Internet and the cell phone have transformed the task economy further and made us even more efficient.

If we drill down into each of these technology eras, the broad technology introductions gave birth to companies that took advantage of the fundamental inventions and captured a good share of the GDP. The industrial revolution gave birth to companies in textiles, iron making, metallurgy, steam power, machine tools, chemicals, glass making, agriculture, mining, cement, transportation, etc. If we fast forward, the age of information and telecommunications led to companies in computing (which is constantly evolving), chipsets, phones, services, social networks, Artificial Intelligence

engines, robotics, commerce, advanced medicine, etc. Each cycle brought forth a new set of players who either eviscerated the incumbents or built upon the shoulders and progress of others.

With the advent of sensors with connected intelligence, computing becomes more ambient. Each node on the network can provide a piece of the puzzle that helps discern and anticipate the tasks one has to accomplish. So, instead of feeding the computer a set of data and rules, the personal intelligence mesh works with us and for us without interrupting us. This could be for small and mundane tasks like automated rerouting of vehicle in congestion to more complex assignments such as planning a perfect vacation with family on four continents. In some instances sensors work to anticipate the needs and demands of a single individual (home, parking, office) and in other a set of sensors look to predict the needs of a larger group (store, traffic, stadium, enterprise). This multimodal sensing will enable to squeeze the most out of the task economy and help us focus on the important tasks vs. the routine ones.
The Advent of the Connected Intelligence Era

In her book, Carlota suggested that the golden age in any era starts in the Synergy phase (figure 3). She writes that \textit{the conditions are there for dynamic expansion and economies of scale. Given the appropriate framework, growth will tend to be steady and harmonious while not necessarily as exuberant as in Frenzy. It can be felt across society and proceed at a healthy rhythm. Production is the key word in this phase.} The phase after Synergy is that of Maturation which is the twilight of the golden age. This is the phase when the benefits from the existing cycle plateaus and the new technology cycle starts to form (figure 4).

The historical evidence suggests that each of the technology cycles lasts approximately 45-50 years. While we are not completely done with traditional computers that have become pervasive due to the Internet, and mobility, we have the ingredients to launch the next technology curve.

Mobile networks are pervasive with almost all developed countries at or near 100\% penetration and emerging markets above the 50-70\% range which means that we are at the tail-end of providing coverage to anyone who needs and can afford a mobile device. Granted, in terms of actual humans using the Internet or a mobile phone, we are at 40\% and 50\% penetration respectively, however many access technology problems have been solved. It is just a question of distribution, affordability, and time.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{golden-age.png}
\caption{The Golden Age of Mobile: The Connected Intelligence Era (Adapted from Carlota Perez’s book)\textsuperscript{11}}
\end{figure}

The age of information and telecommunications has laid the foundations of the “Connected Intelligence Era” wherein ubiquitous connectivity will be able to harness the intelligence programmed in the contextually-aware objects around us. By tapping into the power of the cloud and connectivity, these self-aware objects (which can be machines, medical pills, household appliances, clothing, food, vehicles, etc.) can start to communicate with other objects, pieces of information, and humans. This allows these self-aware objects to make intelligent decisions that cut the time it takes to accomplish

\textsuperscript{11} Source: Chetan Sharma Consulting, 2013

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The Advent of the Connected Intelligence Era | www.mobilefutureforward.com
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a ‘task’ and improve efficiency at the same time. This has impact on how technology is instrumented and how it is sold (business models).

**Technology Revolutions and GDP**

Technology revolutions obviously have an impact on the GDP. New jobs are created, old jobs are lost. Countries that understand the trends early and invest earlier than others, can create competitive advantages that last a generation. If we do the GDP analysis of each of the technology cycles, it is clear that the new cycle is a net positive to the society at large with more GDP per capita than on the previous curve (figures 5 and 6). For the first 3 cycles, the GDP per capita only went up by approximately 2x, however, during the last cycle (if we assume that the cycle ended in 2012), the GDP/capita went up 11x. It was largely due to the democratization of access to information and communications which enabled a poor farmer to similar access to information as a sophisticated hedge manager in London.

![Figure 5. Technology Revolutions and the impact on GDP](image.png)

**Source:** Chetan Sharma Consulting, 2014
If we assume that the connected intelligence era will last another 40+ years, we could see at least a 5-6x jump in global GDP from the previous era (figures 5 and 6).

**Are We Entering the Golden Age of Mobile?**

Looking at the same data around the progress with mobile, one can come to two different conclusions. The first one being that the mobile industry is maturing and we are seeing the best days of mobile now and as such mobile’s golden age is really the prime period of the information and telecom cycle. The point of view could be that most of the key elements of the last cycle have matured and we are embarking on a new technology era – the connected intelligence era.

**Mobile’s Golden Age as part of the Information and Telecom cycle**

Building upon Carlota Perez’s theory, we could also make the argument that we are entering the Golden Age of Mobile on the last curve that is driven by the Internet and Telecom. After all, we are entering the maturity time period of the cycle and trying to extract the most out of this curve before we hop onto the next one. Will this last 5 years or 10 or more? It is hard to say because most of the time, the emergence of the curve and its impact is not understood at the birth but rather a few years or even a decade into the life of the curve. In the early stages, it is hard to understand how an emerging technology will impact society and the economy.

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13 Source: Chetan Sharma Consulting, 2014
Mobile’s Golden Age kicking off the Connected Intelligence Era

However, it is also possible, that we are entering a new era that is defined by connectivity and intelligence that enables us or machines to interact with physical or virtual objects in ways that were just not possible before. Another key element of this evolution is the programmability of this intelligence so that it can react to situations and exceptions. If we layer connectivity, intelligence, and programmability on top of our “task graph,” our world view and how we interact with it fundamentally changes. We will explore this with a couple of vertical industry examples a bit later in the paper.

Figure 7. Regardless of which model prevails, we are entering the Golden Age of Mobile

As we established in our 4th wave series papers, if we peel the growth in the mobile industry over the last 40+ years, in most markets, the first three curves are either saturated and declining are or are going to peak in the next 5 years and follow the fate of their predecessors. So the golden age of voice and messaging has already come and gone for most part in most of the markets. For mobile data, the growth is still strong in almost all the markets (few exceptions) and one could argue that given the proliferation of LTE and mobile broadband services in the developed markets, these markets are experiencing a boom that would characterize its most productive period yet. From a revenue perspective, this growth is bound to peak within a few years. As such, the new growth for mobile is going to come from the 4th wave. 4th wave brings industries beyond the traditional mobile players on board in defining new services, new business models, and new experiences for the consumers. When we layer the “connected intelligence” on these new services, we truly enter a period in the mobile industry evolution that starts to mimic a new technology cycle.

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15 http://chetansharma.com/4thwaveandthenextrillion.htm
Coming back to the question of “Are we in the Golden Age of Mobile?” The answer is unequivocally yes (figure 7). The only debate is if this lies on the previous curve or are we embarking on the Connected Intelligence (or whatever it might be called in the future) curve. The paper is essentially a thought experiment to contemplate the possibility of the emergence of a new curve that could fundamentally rearchitect societies and economies.
Golden Age of Mobile – Thinking Objects

So, the natural question is *what really defines the “Golden Age of Mobile”*? What will be its impact and who will be the beneficiaries? Returning to the discussion we had in the introduction – the ability to intelligently connect these contextually-aware objects with their surroundings is what the new age is all about. Connected objects can think for themselves and make intelligent decisions. Instead of just taking orders, they can provide context to others in the network, analyze data in real-time, and bring otherwise mundane objects to life.

In-effect, each object in the network becomes software-defined from a sprinkler to a cereal-box, from headlights to digestible pills, from street lights to tiles, from thermostats to toys, the objects and things around us *start to think*. They do self-configuration, self-optimization, self-diagnosis, self-healing – essentially, once activated they become an active (without being dependent) participant of the network mesh that includes other objects and other screens.

In the early days, the cost of integrating intelligence into everyday objects will be high but with time this will become part of the production process and enable a rapid rise of the connected intelligence economy.

The ecosystem has labelled the early incarnations of this golden age as “Internet of Things” or “Connected Devices” but when these things were being defined, it was mostly about “connectivity” and less about intelligence.

The notion of “Internet of Things” or “Connected Devices” itself is not new. In 1991, the late Mark Weiser of XEROX PARC, considered the father of ubiquitous computing, dreamed of an always on, always connected world in which humans and computers are seamlessly united.

Once we start to tie adjacent and even what might seem disparate pieces of information together intelligently, we start to see new business models and new value propositions emerge that take the industry to the next level.

Let’s discuss the scenarios in the home first by talking about sprinklers. Most of today’s sprinklers have set timers which are time based. The water valve gets activated at a certain time depending on how it was set it. Ideally, this should be sensor based, where the detection of moisture should dictate when the sprinklers are turned on and for what

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16 The actual use of the term “Internet of Things” came into being in 1999 with Kevin Ashton of AutoID center at MIT introducing this into the geek lexicon. Before Machines to Machine (M2M), there was Bill Joy’s Device-to-Device (D2D). Since then the vision has morphed several times into the present thinking of providing IP connectivity to everyday objects to make them more functional and useful. From wearables to automobiles to industrial automation, the use cases are endless and we are just trying to make sense of what such a connected world will mean to productivity, human behavior, safety, privacy, and the society at large.

duration. This is managed by a set of rules around moisture levels, weather patterns and forecasts, and the amount of water a person wants to use.

Same goes for window glass panes which can change their shade according to the angle of the sun or open up to let fresh air in to cool down the house instead of completely relying on the air conditioner. All this with minimal human intervention. The owner is alerted only in the case of exceptions like maintenance or problems with the infrastructure. Essentially, every node on the grid is intelligent enough to do its job based on the knowledge it has about the context and its role on the grid and the different nodes on the network work in harmony to optimize performance whether it is inside the house or outside.

Sensors have been around for decades. What is changing is that they are becoming sufficiently intelligent to take commands or give orders to other machines based on certain rules.

Similar capabilities can be applied to security, heating and cooling systems, entertainment, social interactions, and automobiles. Further, the enterprise can reap even greater rewards via the connected intelligent network.

For example, it is hard to conceive of innovations at the gas stations. There are over 121,000 gas stations in the US. These gas stations generate most of their revenue ($250 Billion annually) by selling gas and convenience store items. It can be inconvenient for consumers to go inside the store and many rather do their transactions from their cars and be on their way. By introducing smart sensors, the gas stations of the future can be completely reimagined to improve efficiency in delivering gas to the pump as well as boost sales of the convenience stores.

Similarly, GE used sensor data to completely change their business model. Instead of selling aircraft engines, they rent them out on a per-hour basis. The data enables them to fine tune their maintenance schedules and thus optimize revenue and margins per engine on a global scale to the nearest hour.

Microsoft recently worked with an elevator company to integrate the data from their elevator assets around the globe (over 8600 elevators) and get a real-time feed of the status of each elevator so that the company could do preventative maintenance instead of waiting for something to fail. It used machine learning to predict with certain accuracy if something is going to go wrong and how quickly the tech needs to be dispatched to proactively fix the problem. Such implementations have tremendous ROI.

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18 Sensors could be alerting other entities like neighbors, law enforcement, pets, teachers, friends, etc. depending on the use case scenario
21 Satya Nadella Keynote, WPC, July 2014
http://www.digitalwpc.com/Community/Pages/Home.aspx#fbid=Gn2wc2Ple_T
By connecting the objects intelligently, a network of opportunities can be created that start with cost savings but then quickly move towards new revenue streams.

Until recently, drones were something that only defense forces used in wars. Today, in addition to entertainment purposes in the consumer segment, drones are being used in agriculture to monitor farms and get real-time data on yield, disease, and moisture content. Energy companies are using drones for monitoring thousands of miles of pipelines and oil rigs. Emergency services send drones to the crisis location ahead of the humans to gather vital data and provide real-time feed to arriving units. There are efforts underway to deliver food, medicine, and other goods to folks in remote areas, war zones, or emergency situations. The law enforcement units in different countries are using drones for monitoring the long borders which is hard to do with just human force. Archaeologists are using drones to map out endangered historic sites. The connectivity and intelligence in drones allows them to do tasks that might be considered hazardous or inefficient by humans.

In fact, some of the leading companies like GE (Industrial Internet\textsuperscript{22}), Ericsson (Networked Society\textsuperscript{23}), and Cisco (Internet of Everything\textsuperscript{24}) have talked about the use of sensors to transform existing operations, societies, and business models. Their studies have predicted trillions of dollars of impact on how we do things, from private sector to public, from developed to emerging markets. In each of these scenarios, mobile is at the center of objects and entities that are connected intelligently to help with better decisions, information, and doing tasks from the mundane to the most sophisticated – all armed with intelligence to make the best decision in any given context.

Based on the research done by several preeminent economists mentioned in the Introduction, these technology cycles last 40-50 years. According to the estimates, we are already into the 44\textsuperscript{th} year of the cycle, right around the time when the new technology cycle typically emerges.

\begin{footnotesize}
\item[22] http://www.ge.com/stories/industrial-internet
\item[23] http://www.ericsson.com/thinkingahead/networked_society
\end{footnotesize}
How Will the Golden Age Reshape Industries?

There are 14 trillion-dollar industries (figure 8) in the world and it can be argued that mobile is having the biggest impact on all of them in the most fundamental ways:

Figure 8. Global Trillion Dollar Industries

- Health – ECG, glucose measurement, skin disease diagnosis, ultrasound, gut analysis etc. can be done with the help of sensors and smartphones
- Retail – Starbucks generates billions of dollars from its mobile app
- Transportation – Uber and Lyft are reshaping the travel industry and much more
- Insurance – Monitoring good behavior is providing rewards for drivers, monitoring good health habits is providing lower premiums to citizens
- Entertainment – consumers are cutting cable and moving their consumption to mobile devices. In most emerging markets, mobile is by far the biggest channel for media consumption, digital advertising, and engagement

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25 Source: Chetan Sharma Consulting, 2013
• Travel – Hotels and Airlines are providing routing check-in capabilities direct from mobile through identity management, clean hotel rooms based on absence of guests in the rooms, let passengers place orders from their phones on planes.
• Enterprises – are introducing not only smartphones and tablets but wiring the workflow via sensors to be a proactive organization vs. a reactive one.
• Food and beverage – consumers are more informed than ever before by sensors that give a real-time perspective on what they should eat and avoid, change the food delivery industry.
• CPG – mobile allows brands to build a direct relationship with the consumer vs. via the middlemen.
• Home – there is significant activity in making the everyday machines in the house more intelligent e.g. thermostats, security alarms, windows, video monitoring, sprinklers, locks, entertainment systems, lighting systems, etc.
• Waste Management – preventing food wastage, collection of garbage.
• Manufacturing – increase efficiency, monitoring, optimization of the manufacturing supply chain, parts, and workers. Predict and schedule maintenance windows.
• Utility – help manage load on the grid and provide real-time feedback to the consumers and their objects on optimizing usage.
• Mining – manage safety for workers, automate deep drilling by robots.

We expect the role of mobile to be central in the evolution of all these trillion-dollar industries and more. This has a direct impact on how industries behave in different regions, how countries try wrestle with the GDP growth and job creation, and how CEOs address churn and competitiveness in an economy that can change the fortunes of the big and small in a matter of a quarter or less.

In the next two sections, we will discuss how mobile and connected intelligence are shaping the automobile and health care industries.
**Connected Cars**

*Kids born in 2014 in some countries might never have to learn to drive.*

Transportation and in turn automobiles play a significant role in our lives. It is part of a significant expense that has also led to major congestion, safety, and pollution issues around the globe. Consider these statistics:

- Urban Congestion leads to 11-13% of time wasted
- Parking is the cause of 7-21% of urban traffic
- Traffic lights help waste 11-13% of fuel
- Accidents cost $1 trillion per year in the US
- Recalls cost $2-3B per year in the US

Yet, we are so dependent on cars to get us from point A to B safely. The promise of a connected car is to move passengers from point A to B as cheaply, as safely, and as quickly as possible. By integrating intelligent connected sensors with the car’s electronics, we can enable a truly connected car. Safety, productivity, cost reductions, new business models, exception detection, reduction of recall rates and congestion, city planning are all benefits that can be derived from connected cars.

![Figure 9. The Autonomous Car Roadmap](image)

Additionally, today’s version of the connected car is nothing but a stepping stone towards autonomous cars. Consumers are well aware of the benefits and when the cost curve falls in the right place, they will get on the connected car bandwagon. The arrival of autonomous vehicles is not a question of ‘if’ but rather ‘when.’ We are already seeing different features that will enable an autonomous car of the future being rolled out in

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26 Source: Chetan Sharma Consulting, 2014
today’s vehicle – driver alertness, stop sign assist, automated parking, lane control, intersection navigation, collision avoidance, navigational assistance, etc.  

Figure 10. The Connected Car Competitive Landscape

We are seeing some of these features come into the enterprise market more quickly where trucking or field service vehicles are armed with technology that improves worker safety and productivity.

Further, if we marry the Uber (ridesharing app company) business model with Autonomous Vehicle Technology (figure 9), we get an opportunity to fundamentally rearchitect societies, and urban and suburban living. Cost savings could be enormous. So would be the destruction of the incumbents who stick to the old business models. The car industry could completely morph into a services-based industry as the computing becomes more fundamental to automobiles (figure 10). Obviously, this will work its way over the next few decades but some of the early work in business models, technology, policy and regulatory changes is already here.

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27 This has impact on city and urban planning, housing, commerce, and quality of life. Some of the advances in connected cars are driven by players outside the auto industries like Google and AT&T in an effort to bring the auto industry in line with the computing industry.

28 Source: Chetan Sharma Consulting, 2014
Many European capitals like Helsinki are rethinking transportation and efficiency. Similar efforts are underway in the US though at a slower pace. But this is bound to happen. What enables an Uber Autonomous Car is the “connected intelligence.” Connected intelligence about the consumer, about the fleet, and about the context and environment around the consumer that can be packaged in an experience that is the safest, the quickest, and the cheapest. Thousands of sensors will work with billions of pieces of data objects in real time to offer the best experience to the consumer and thus set off a multi-trillion industry.

Connected cars will form a critical component of the smart cities movement and will make them more livable, safer, and enjoyable. A completely autonomous car might be years away but the feature/functionality that makes up an autonomous car will get introduced at a rapid pace and within a matter of 5 or so years we could see almost all OEMs offering some form autonomous connected cars in the marketplace.

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29 Helsinki is moving towards a system of “mobility on demand” by 2025 that seeks to eliminate the reasons for owning a car - [http://www.theguardian.com/cities/2014/jul/10/helsinki-shared-public-transport-plan-car-ownership-pointless](http://www.theguardian.com/cities/2014/jul/10/helsinki-shared-public-transport-plan-car-ownership-pointless)
Healthcare

Kids born in 2014 in some countries might reduce their potential visits to a human doctor in their lifetime by 95%.

If you recall your last doctor’s appointment for a common ailment or injury, do you remember the set of questions and checkboxes that the doctor went through? Doctors or nurses have an algorithm assisted by paperwork that helps them come up with a diagnosis and prescription for the patient. Most of the time, there isn’t a single task in that human algorithm that can’t be replicated by the computer algorithm. Answer a set of questions with a computer and it will perform no worse than a doctor if not wildly better because the patient can get treatment without endless waiting and dealing with the health system bureaucracy. In fact, the legendary investor Vinod Khosla postulated:

Technology will reinvent healthcare as we know it. It is inevitable that, in the future, the majority of physicians’ diagnostic, prescription and monitoring, which over time may approach 80% of total doctor time spent on medicine, will be replaced by smart hardware, software, and testing. This is not to say 80% of physicians will be replaced, but rather 80% of what they currently do might be replaced, leading to new possibilities and functions for physicians. Healthcare will become more scientific and more consistent, delivering better-quality care with inexpensive data gathering techniques, continual monitoring, more rigorous science and more available and ubiquitous information leading to personalized, precise and consistent insights into a patient.30

A Johns Hopkins study31 found that as many as 40,500 patients die in an intensive care unit in the U.S. each year due to misdiagnosis, rivaling the number of deaths from breast cancer. Yet another study found that ‘system-related factors’, e.g. poor processes, teamwork, and communication, were involved in 65% of studied diagnostic error cases.32 ‘Cognitive factors’ were involved in 75%, with ‘premature closure’ (sticking with the initial diagnosis and ignoring reasonable alternatives) as the most common cause. These types of diagnostic errors also add to rising healthcare expenditures, costing $300,000 per malpractice claim.33 There are literally thousands of such studies that scream of inefficiency and brutal negligence that end up costing thousands of lives.

The wellness phenomenon that Fitbit and others started will start to encroach on the healthcare management space where we move from a diagnostic healthcare system to a preventative one. Instead of treating heart attacks, we would be preventing them in advance. The sensors in our blood stream will alert us of the changes we need to make in

31 http://qualitysafety.bmj.com/content/21/11/894.abstract?id=647c745e-4b1f-45e4-8883-a700adfc0005

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our lifestyle, diet, and work environment in real time. We should also be under no illusions that this is easy to do. The healthcare segment is one of the worst industries in terms of mobile and information technology adoption. Inefficiency, bureaucracy and incumbency are hampering its evolution to the connected intelligence era but things are starting to change.

Now smartphones can take ultrasounds, measure ECGs, analyze blood samples, and help treat Alzheimer’s disease. Some of the emerging markets have tapped into the power of mobile networks and devices to build a sophisticated emergency health management system that serves not only the remote rural areas but have become a fabric of the urban environment as well.

Another area that “connected intelligence” in healthcare is expected to have a huge impact is in eldercare. Thanks to the advances in medicine and the general awareness of healthy living, people are living longer which means that the elderly population is growing quickest amongst various age segments in many countries. For example, a quarter of the Japanese population is over 65 years old. This figure was under 12% in 1989. This poses some serious challenges to the healthcare system in that country. Other countries are either facing the dilemma or will be in a similar situation in a few years. The use of technology can enable the elderly population to lead a healthier life that relies less on human nurses being around them all the time and can give families piece of mind.

Integrating technology into healthcare will take time. The bigger obstacles are the regulatory regimes and a slow moving bureaucracy that is slow to adapt to changing times. However, over time, we expect, health care to be fundamentally transformed by connected intelligence.
Mobile’s Fourth Wave is Shaping the Golden Age

About three years ago, we started to explore Mobile’s Fourth Wave (figure 11) that is documented in two papers and a book on the subject: Operator’s Dilemma (And Opportunity): The 4th Wave, Mobile 4th Wave: Evolution of the Next Trillion Dollars, Mobile 4th Wave: Mining the Trillion Dollar Opportunity. In these series of discussions, we have argued that the mobile industry is fundamentally transforming and players need to adapt to these changes or be left with altered fortunes.

In fact, mobile’s fourth wave is what is defining the golden age of mobile as more companies outside the mobile ecosystem embrace mobile and shape their own industries. This has been true in each of the trillion dollar global industries. There are already hundreds of companies – both old and new like Google, Facebook, Uber, Starbucks, Square, Hertz, BMW, AT&T, Intel, Qualcomm, Amazon, Netflix, Samsung, Apple, GE, Caterpillar, and others who are gaining from the fourth wave in the golden age of mobile.

Startups create more net-jobs than the incumbents who lose net-jobs and that’s what fuels the economy. This was observed first by the astute Joseph Schumpeter and it has been true in each of the previous cycles. As we observe the golden age, similar things are happening. The likes of Facebook, Uber, Twitter, Airbnb, Netflix, FlipKart, King.com are adding thousands of jobs while players like Nokia, Microsoft, Motorola, Alcatel-Lucent, Blackberry are shedding jobs but the overall economy is moving forward thanks to the innovation and ingenuity of the fourth wave of startups around the world.

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35 [http://chetansharma.com/4thwaveandthenextrillion.htm](http://chetansharma.com/4thwaveandthenextrillion.htm)
38 Haltiwanger, Jarmin, and Miranda (2010) established that new businesses account for about 70% of gross job creation and disproportionately contribute to net job creation.
The Building Blocks of the Golden Age

There are a number of key elements that will make up the building blocks of the Golden Age as shown below (figure 12) but the golden age stack has three dominant layers:

- **Access,**
- **Tools,** and
- **Solutions.**

As figure 12 illustrates, the golden age stack can be broken down in three fundamental sections each necessary to the ecosystem. The most basic piece is that of access to the network using a variety of protocols. Without connectivity, the utility of the object is limited.

![Figure 12. The building blocks of the Golden Age](image)

Next, the enabler layer that consists of Tools and APIs. This is an important layer that glues access with solutions and services, and empowers solutions to really shine. The toolkit consists of some basic functionality like cloud, billing, analytics, and communications but also some sophisticated “intelligence” pieces that bring life to the solutions, things like context which will increasingly become the most valuable currency of the golden age. Having an understanding of the various aspects of a consumers life that is relevant to the application, in a trusted manner, is crucial to getting scale long-term.

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39 Source: Chetan Sharma Consulting, 2014
The contextual element can take disparate feeds of information (figure 13) and develop a real-time profile of a human or an object that is well served by the service or the application. The data for developing this context might come from the same provider or a combination of several partners who participate in this contextual economy and enhance the efficiency of the end-node.

The final main piece of the puzzle is specific solutions and services across the various verticals like health, retail, transport, travel, and education. There are a number of companies in each layer (in fact each layer is a multi-trillion dollar economy), and some companies go across the entire stack. Some might play heavily in one vertical category across the stack (Amazon in commerce) but play a supporting role in other verticals (Amazon serving its cloud offerings to startups in health and education). Over time, the value moves from the bottom layers to the top, in most vertical segments. As such, even some of the access providers like AT&T and Telefonica have been investing heavily in providing solutions across the stack. This also explains why some of the device OEMs are struggling as the hardware becomes commoditized and without services, margins continue to shrink.

Additionally, there are a number of supporting segments like system integration capability, venture funding, and creation of new businesses.

While each layer discussed above plays an important role, there are three essential pillars of the golden age:

- Intelligence,
- Data, and
- Trust

As we explored in the two papers: The ABCs of SMB Transformation: Apps, Broadband, and the Cloud and Mobile Apps Privacy Framework, cloud and data are already transforming the enterprise and a new framework is needed for privacy and trust. This becomes even more important in the connected intelligence era when yottabytes of data will be moving among trillions of nodes. Without a trusted, secure environment, the vision will fizzle and consumers will not embrace a broken architecture.

Context is going to become the most important currency in the connected intelligence world. Providers who have a better understanding of the customer at any given instant, and who can decipher the needs and wants of consumers and enterprise customers before even they can, are the ones who will have leg up in the ecosystem. Companies like Google, Apple, AT&T, Telefonica, Facebook, Microsoft, and Starbucks are investing heavily in this “intelligence” and we are already seeing some of the early incarnations of such a world.

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40 Please see the 4th wave papers for more details on the subject.
41 http://chetansharma.com/ABCs_of_SMB_Transformation.htm
42 http://chetansharma.com/mobileprivacy.htm
It is also clear that the real long term value of the Golden Age is in the data. Data enables new business models. This is as true for an auto OEM as it is for a retail merchant. There is also a need for data brokers who can effectively create a trusted marketplace for connected intelligence data. Clearly, there are a number of participants vying to be that data broker and it will be fascinating to see who emerges as the top 2-3 players (or more) that help bring the various segments together.

Players in the ecosystem will also have to come up with new and better frameworks for dealing with the privacy and security of data. Given that the number of connected nodes in any household are multiplying by the month, the opportunity to attack and compromise data and peace of mind is too lucrative for hackers to resist. A recent research study found that 80% of connected devices are vulnerable to attacks. It is rare for leaders in the digital world to use trust and privacy as their competitive advantage. However, in the golden age of mobile, it will be of paramount concern for end-users and they will pay a premium to be associated with brands they can trust with their data while driving value from that data.

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43 Source: Chetan Sharma Consulting, 2014
44 http://danielmiessler.com/HP_IoT_Research_Study.pdf
Finally, distributed computing enables us to not only do computation at a much lower cost but also enables entrepreneurs to move fast and provide consumers a better experience that takes into account their context. The ability to tie all this together is what will define the Digital Lifestyle Solution Providers (DLSPs) of tomorrow.\footnote{For more discussion around DLSPs, please refer the 4\textsuperscript{th} wave series papers}
Impact of the Connected Intelligence Era on Employment, Policy, and Competitiveness

Technology has made life better for humans every step of the way. With each cycle, human productivity has improved, raising the standard of living worldwide. Access to affordable computing has dramatically altered the landscape for jobs, competitiveness, and human progress. However, each introduction brings a set of questions for society at a micro level. As we alluded to earlier, there could be fundamental restructuring of societies and economies. As is generally the case, many will not be prepared for changes that are coming. While there are numerous changes that will occur, probably, the most impactful might be on employment.

Historically, with every new technology curve, there is a net job increase. Also, new technology is used to substitute capital for labor to gain efficiencies in cost and time. While the jobs associated with the older technology curve start to diminish, the new technology curve typically enables new types of jobs that keep the economies growing for the future. However, this growth is not evenly spread amongst nations. In aggregate, the US has probably benefitted the most as is evident from the rise in its GDP over the last 100+ years and especially in the last two decades. The most profound disruptions have come from the US market which then have spread throughout the globe, whether it was the Internet or the Cellular Phone.

The golden age of mobile involves automating tasks at the most basic level. For example, if we consider a set of tasks an airline passenger generally encounters, a number of them have already been automated. At Oslo airport, passengers do not have to interact with humans until they get to the security line. The printing of boarding passes, luggage tags, check-in of luggage, readjustment of seats etc. are all done by machines. In the future, even the security checks will be completely automated just like the grocery self-checkout lines or the Global Entry US program. So, from entering the airport to sitting down in your seat on the plane, all tasks will be automated in the not too distant future. This automation means the jobs of baggage handlers at aircraft terminals or security points are largely going to be eliminated. Similar scenarios will play out in other industries.

Will the education systems, the policy framework, and the politics respond to this change in time?

http://www.cbp.gov/global-entry/about
In one of the most detailed study on the subject, authors, Carl Benedikt Frey and Michael A Osborne wrote in their paper, “The Future of Employment: How Susceptible are jobs to Computerisation?”

We examine how susceptible jobs are to computerisation. To assess this, we begin by implementing a novel methodology to estimate the probability of computerisation for 702 detailed occupations, using a Gaussian process classifier. Based on these estimates, we examine expected impacts of future computerisation on US labour market outcomes, with the primary objective of analysing the number of jobs at risk and the relationship between an occupation’s probability of computerisation, wages and educational attainment. According to our estimates, about 47 percent of total US employment is at risk. We further provide evidence that wages and educational attainment exhibit a strong negative relationship with an occupation’s probability of computerisation.47

According to the paper, 47% of US jobs could be at risk. In Europe, this risk could be even higher (figure 14).48 In the past, when agriculture and manufacturing jobs disappeared, the service sector picked up the slack and created millions of new jobs. But what happens when the service jobs themselves are at a risk? Do we enter unchartered territory?

Analysis of past US employment data (figure 15) and also forecasted data (figure 16) clearly show that there will be a number of industry sectors that will suffer big losses, though there will be increase in net-jobs. Historically, we have always seen a temporary impact on net-jobs but also a strong resurgence due to new jobs that are created.

48 http://www.bruegel.org/nc/blog/detail/article/1394-the-computerisation-of-european-jobs/
Figure 14. Impact of automation on jobs\textsuperscript{49}

\textsuperscript{49} The Future of Employment, Carl Frey, Michael Osborne, University of Oxford, 2013
Figure 15. Changes in Wages and Employment Numbers 2004-13 (US)\textsuperscript{50}

One aspect that might be different this time around is that new jobs will require higher skills. Will nations catch up and focus on beefing up their education systems? In the US, over the last 10 years, workers with at least a bachelor’s degree have gone from 33\% to 39\%.\textsuperscript{51} In a couple of decades we might need this to be at 75\% or higher. Will the country move fast enough? Will other countries benefit due to a disparity of skilled workers and the economy. How will countries like China and India tackle the problem for their massive populations? The social structure in Europe is making many countries uncompetitive. Will European governments be able to change course? The new era poses a significant number of questions to policy makers, incumbent enterprises, and workers.

The biggest difference this time around is that changes are happening at a much faster pace and the education system and the policy regime might not be able to keep up with the shifts. As such, we might see more turbulence in job markets. Undoubtedly, there will be significant friction, shifts in economic climate, and nations adapting to the circumstances.\textsuperscript{52}

\textsuperscript{50} Source: bls.gov, Chetan Sharma Consulting, 2014  
\textsuperscript{51} Source: bls.gov, Chetan Sharma Consulting, 2014  
\textsuperscript{52} Several economists and observers have argued that just like previous generations of technologies, the new era of automation won’t be any different and we will figure out a way to create more jobs for. E.g. this point has been eloquently argued by Erik Brynjolfsson and Andrews McAfee in their book “The Second Machine Age.”
In China, the employment-to-population ratio has declined from 75% in 1991 to 68% in 2012. For the US, it declined from 60% to 58%, Japan has suffered a 10% decline and, India a 5% over the same period. At the same time, countries like Peru, New Zealand, Netherlands, Israel, and Uruguay have seen double digit growth during this period. While the reasons for these changes have varied, the underlying fact has been that we are living in a much more complex, interconnected employment world than ever before. Given the global and connected nature of businesses and opportunities, employment gain in one geography might mean a shift in opportunities for another.

The connected intelligence era is for certain going to have an impact on policy, jobs, education, and competiveness. Initially, automation generally cannot compete with lower wages, giving emerging markets a temporary advantage but what happens when some of the mundane tasks that were outsourced can be completely automated? When the cost of automation drops to a level when outsourcing stops making sense, we will see the movement in net jobs across borders. There will also be a net transfer of jobs from humans to machines in the other direction. 3D printing could potentially destroy the

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**Figure 16. Future changes in Wages and Employment Numbers 2012-22 (US)**

In China, the employment-to-population ratio has declined from 75% in 1991 to 68% in 2012. For the US, it declined from 60% to 58%, Japan has suffered a 10% decline and, India a 5% over the same period. At the same time, countries like Peru, New Zealand, Netherlands, Israel, and Uruguay have seen double digit growth during this period. While the reasons for these changes have varied, the underlying fact has been that we are living in a much more complex, interconnected employment world than ever before. Given the global and connected nature of businesses and opportunities, employment gain in one geography might mean a shift in opportunities for another.

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53 Source: bls.gov, Chetan Sharma Consulting, 2014
54 Source: World Bank, 2014
China’s hold on manufacturing jobs\textsuperscript{55} and task automation could eliminate many of the jobs that have been shifted to India due to labor cost advantage.

Historical trends point to increased productivity and employment levels\textsuperscript{56} while the lack of visibility into “new categories” of jobs (which always happens) of the future makes people nervous. The truth is that it is too hard to predict as the impact on jobs is a slow moving process that can last several decades. The trends are not clear for a long time and timing of any discernible shifts are just too hard to predict. Additionally, different regions will see the impact positively or negatively to varying degrees.

Smaller nations will be able to adapt more quickly because they can make changes to their systems and processes more faster than others and we might see a shift in how and where new jobs are created. This will keep policy makers up at night for years to come.

\textsuperscript{55} In fact, since 1996, China has seen a 25% decline in manufacturing jobs. In this case while Chinese worker is displacing an American worker (which has seen a steeper decline), automation has reduced the workforce on both ends (Source: The Second Machine Age). As a proportion of output, manufacturing accounted for 40% of Chinese GDP in 1980 compared with 32% in 2014 (http://www.businessweek.com/articles/2014-04-28/why-factory-jobs-are-shrinking-everywhere)

\textsuperscript{56} Though it is not an immutable law
Conclusions

As more consumers go online and embrace mobile, change is accelerating and is helping bring significant improvements in how consumers and enterprises function. Each of the previous technology cycles have brought forth seismic changes to the world order and played a pivotal role in progressing human ingenuity and opportunity for all. The cycle of telecom and Internet had an exponential impact on the global economy and brought many nations into the global public conversation. The elements that start a new era of technology evolution are in place and we may be entering the ‘connected intelligence’ era that will take our global economy to the next level.

The future looks bright with the transformation of every industry as they improve processes that benefit consumers and workers alike – in fact it will help each of us to lead a more productive life. The competitive environment at each level is likely to be impacted. Individuals, enterprises, and nations who catch the curve early are likely to reap high rewards for many years to come. As is the case with each cycle, we have to also guard against the dark side of the technology. In the case of the connected intelligence era, data is the two-sided sword. It can lead to enormous benefits from saving billions of dollars and millions of lives. However, misuse of that same data can lead to not only stunting growth in the early phase of the curve but also damaging the public trust. There will be a significant role and responsibility for regulators and policy makers to engage with the community to understand this new technology. In this way, we can all be proactive participants in understanding the characteristics of the curve and growing the economy to stay competitive.

Connected Intelligence will shape and morph in different regions to adapt to the needs, wants, and likes of the demographics. People in Shanghai might seek solutions for pollution while in London for congestion, citizens in Thimpu might look for tools to manage urban invasion while in Rio to manage crime. The priorities will be shaped by the culture and the demands of the land at any given point in time.

Whatever the twists and turns in the coming years and decades, the embrace of the connected intelligence economy will play a vital role in our lives.

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About Mobile Future Forward

**Mobile Future Forward** is mobile industry’s premier thought-leadership summit that attracts some of the most influential minds in the mobile industry who are very instrumental in shaping the industry, in innovation adoption, and in managing the growth of revenues and profits. For the 2014 summit, the experts and visionaries from around the globe will gather in Seattle on Sept 24th to explore the mobile industry 3-5 years forward, envision what the user experiences and use cases look like, discuss and debate the challenges and opportunities in the journey to that vision. The Theme for 2014 is “**Connected Intelligence Era: The Golden Age of Mobile.**” The focus will be on understanding the opportunities and the challenges of the next technology wave.

More information at [www.mobilefutureforward.com](http://www.mobilefutureforward.com)
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About the Author

Chetan Sharma is President of Chetan Sharma Consulting and is one of the leading strategists in the mobile industry. Executives from wireless companies around the world seek his accurate predictions, independent insights, and actionable recommendations. He has served as an advisor to senior executive management of several Fortune 100 companies in the wireless space and is probably the only industry strategist who has advised each of the top 6 global mobile data operators. Chetan serves on the advisory boards of Ericsson, Telefonica, Kymeta and a number of other startups. Some of his clients include NTT DoCoMo, Disney, KTF, China Mobile, Toyota, Comcast, Motorola, FedEx, Sony, Samsung, Alcatel Lucent, KDDI, Virgin Mobile, Sprint Nextel, Skype, AT&T Wireless, Reuters, Juniper, Qualcomm, Microsoft, Reliance Infocomm, SAP, Merrill Lynch, American Express, and Hewlett-Packard.

Chetan is the author or co-author of a dozen best-selling books on wireless including Mobile Advertising: Supercharge your brand in the exploding wireless market and Wireless Broadband: Conflict and Convergence. He is also the editor of the Mobile Future Forward Book Series. His books have been adopted in several corporate training programs and university courses at NYU, Stanford, and Tokyo University. His research work is widely quoted in the industry. Chetan is interviewed frequently by leading international media publications such as Time magazine, New York Times, Wall Street Journal, Business Week, Japan Media Review, Mobile Communications International, and TechCrunch, and has appeared on NPR, WBBN, and CNBC as a wireless data technology expert. He is also the chief curator of the mobile thought leadership executive forums – Mobile Future Forward and Mobile Breakfast Series.

Chetan is an advisor to CEOs and CTOs of some of the leading wireless technology companies on product strategy and Intellectual Property (IP) development, and serves on the advisory boards of several companies. He is also a sought after IP strategist and expert witness in the wireless industry and has worked on and testified in some of the most landmark cases in the industry such as Qualcomm vs. Broadcom, Samsung vs. Ericsson, Sprint vs. Verizon, Openwave vs. 724 Solutions, and Upaid vs. Satyam. Chetan is a senior member of IEEE, IEEE Communications Society, and IEEE Computers Society. He has Master of Science degree in Electrical Engineering from Kansas State University and Bachelor of Science degree from the Indian Institute of Technology, Roorkee.