ARC

Automated **R**esidential and **C**ommercial

By

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Abstract

ARC (Automated Residential & Commercial) is the world's first mobile apartment system and distributed built environment. At its core, ARC enables container-based living in automated container high-bay towers that link together via the global intermodal transportation network. The mechanical towers and intermodal network allow each container—whether a home, store, fab lab, farm, etc.—to shuffle between towers, parking in any available slot and stacking in random access fashion. In this setup, entire neighborhoods or factories can be transferred, reorganized, and distributed across multiple locations on demand, forming a flexible grid and single cohesive living environment. Inspired by the theoretical visions of Archigram and Yona Friedman, ARC instantiates these once-speculative concepts of mobile architecture into a buildable product.

ARC directly tackles the root causes of the global housing affordability crisis—particularly misaligned incentives that reward supply suppression and the inflexible nature of local-only growth, which drives up land costs. By restructuring housing into a mobile, networked infrastructure, ARC breaks free from the traditional boom-bust supply curve that traps cities. Growth unfolds in a distributed yet connected fashion, tapping into a continual reservoir of cheaper land by expanding non-locally. Moreover, the system inverts traditional market incentives: every new tower or unit increases overall network utility in accordance with Metcalfe's Law, so instead of speculation triggering scarcity, it drives the creation of supply. Solving these acute problems lays the foundation for the creation of a City 2.0 — a distributed and reprogrammable built environment where urban growth, resource allocation, and spatial configurations adapt continuously to evolving economic and social needs.

ARC transforms static urban life into a dynamic, personalized network — where homes, services, and communities evolve around users in real time, not decades.

To verify ARC's feasibility and impact, we employ a Quantitative Urbanist (QU) framework, examining production cost curves, transport logistics, and the enhanced agglomeration effects that emerge when multiple hubs operate in synergy. Our findings show that ARC's mobile and modular design can surpass the performance of traditional (City 1.0) development across affordability, scalability, and resilience. Ultimately, ARC stands as both an immediate response to a broken housing market and a long-term blueprint for reshaping urban life, creating new forms of housing and community in which mobility, innovation, and accessibility become the defining features of the environment.

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Housing: The Problem at Local and Global Scales

Our civilization and the natural world in which it exists have been placed under enormous stress in the past century by human activity. Stress cracks are found everywhere in our modern world, threatening foremost the stability of systems we rely on but typically take for granted. A notable feature of physical stress is that while stress accumulates globally across a system, actual failure occurs locally—typically at the weakest point. In stressed systems, the global pressure is distributed evenly, but the tipping point always happens somewhere specific.

In the coming years, as more and more of the systems we rely on to sustain our way of life begin to falter, this local-global dynamic may become depressingly familiar to us. In the 20th century, human civilization reached the scale where our activities could affect the global biosphere for the first time, but the problems our activity caused for the natural world in the 20th century were relatively manageable. In the coming century, the problems will be neither small nor manageable. As the failures mount, we will begin to see which parts of the systems around us are the weakest. For the global economy, we contend the weakest link is local housing markets. This is because housing, as both a basic need and a key driver of economic activity, impacts stability and resilience across most social and financial systems. When housing systems break down, their failure cascades, affecting nearly every aspect of society.

Housing, as a product, has also seen remarkably little change since static dwellings were first invented. The same basic techniques—local masonry, on-site manual labor, static placement—have persisted with only incremental improvements since the 1700s or earlier. The fundamental structure of housing remains largely rooted in the constraints and assumptions of pre-industrial societies.

But we are not so helpless as a species that we will all simply watch as the world we built over thousands of years and hundreds of generations falls apart. Human ingenuity will produce solutions that address all levels of the problems we face, and we will persist. This weakest link must therefore be identified and reinforced—or preferably replaced—to stop the spread of failure to many other components. Only then can the system regain homeostasis. ARC is designed to address housing as the “weakest link issue.” First, as a housing product that creates new market conditions which incentivize affordability and, in its mature stage, as a second-generation urban habitat—the city 2.0—leading to new, emergent capabilities. ARC is a self-organizing urban computer—a new form of distributed city that generates the same or greater socio-economic benefits as traditional cities while avoiding the downsides of local-only growth. It is a programmable network designed to address the housing crisis and its cascading effects, creating a resilient and adaptable foundation for continual growth, and addressing what we see as the largest stress crack in the global economy: the housing affordability crisis.

A critical and often overlooked weakness of traditional housing systems is the way that fixed-location real estate ties markets to isolated, inflexible settlements. Because land and housing are immobile, local speculation becomes dominant, driving boom-bust cycles in nearly every region. Prices spike during economic booms as migration and local growth strain supply. But when conditions shift—whether due to natural disaster, changing industries, or simple migration flows—towns can hollow out and become ghost towns. This dynamic, seen historically across resource towns and, more recently, in entire cities during China’s real estate crisis, highlights the brittle nature of location-locked housing. Settlement patterns become static, disconnected from broader economic flows, and unable to adapt. The inability to share burdens across regions compounds systemic risk. Entire local economies are exposed to the extreme volatility of localized asset booms and crashes, threatening broader financial stability when housing bubbles pop.

Before we explain these properties in detail, we will take a closer look at problems in housing.

The Housing Industry in Crisis

Over the past 15 years, the global housing industry has seen massive instability, which began with the 2008 housing bubble and subsequent industry implosion, and which continues today with the aftermath of the largest global pandemic in 100 years, unchecked inflation, and sky-high interest rates.

Today, and for the foreseeable future, the world is poised to see the largest housing crisis it's possibly ever faced. The World Bank estimates that the housing crisis will likely impact more than 1.6 billion people by 2025.[1] And that figure will nearly double in just five years, with approximately 40 percent of the world's population lacking access to "adequate housing" by 2030, according to the UN.[2] The world will need more than 96,000 new and affordable homes to become available *every day* to meet this exploding demand.[1]

At the same time, stagnant wages, inflation, and low housing supply have put affordable housing out of reach for millions of people around the world. While the real incomes of all socioeconomic groups of Americans have grown since 1970, purchasing power in terms of housing has declined dramatically-- especially for middle class and low-income earners. When taking inflation into consideration, the average hourly rate for non-management workers has only grown approximately $2 since 1964.[3] What's more, today's average hourly rate is $22.58, which is about $6 lower than what a full-time worker needs to afford rent for a "modest two-bedroom apartment" in the United States.[4]

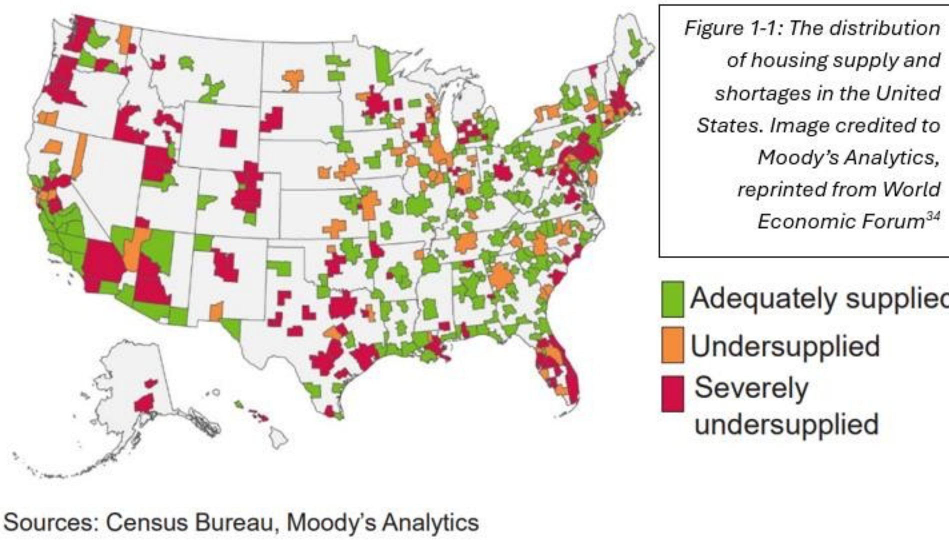

Figure 1-1: The distribution of housing supply and shortages in the United States. Image credited to Moody's Analytics, reprinted from World Economic Forum[34]

It's important to note that purchasing power has declined not in absolute terms—real incomes have grown modestly—but in relative terms compared to the escalating costs of housing, healthcare, and education. The wealthy and the very poor have seen large absolute gains, while the middle class has grown slowly, leaving many feeling poorer relative to the rising standard of living.

In tandem with wage stagnation, housing prices have also succumbed to inflation, rising nearly eight percent from 2022 to 2023.[5] This escalation is not solely the result of monetary inflation; it is also driven by structural supply constraints. Millions of homeowners, locked into sub-3% mortgage rates secured before interest rate hikes, have little incentive to sell, severely restricting available inventory even as demand remains high. With the median house price climbing to more than $400,000, the typical 20 percent down payment is now $80,000 on average. Despite the US Federal Reserve taking steps to try to curb inflation by raising the overnight rate, the impact has been to make housing even less affordable. As of the time of this writing, the average long-term mortgage rate in the United States has hit a 20-year high of more than seven percent.[6] High interest rates are driving up monthly mortgage payments by over 50 percent—and driving away buyers.[7]

It's important to note that these trends have been brewing for some time, but the global COVID-19 pandemic considerably exacerbated them. The pandemic put considerable strain on the housing industry through a variety of factors, including (but not limited to):

- Increased financial hardship and joblessness[8]
- Construction delays[9]

- Increased number of remote workers[10]

These factors have made it increasingly difficult even for the upper-quartile sector of first-time home buyers and the majority of potential homeowners have been priced out of the market entirely, resigning themselves to permanent rent payments.

The Urban Institute projects that by 2040, homeownership rates will be considerably lower among Millennials (aged 45–54 by 2040) than past generations, with the biggest impact being felt in minority communities.[11]

Figure 1-2: Displays house price to income ratio by country. Prices taken from last quarter of 2020 or from last available index at the time of printing. Growth percentage of prices determined by comparison with 2015 prices. Source credited to Bank for International Settlements and World Economic Outlook, reprinted from World Economic Forum.[34]

As ever-more citizens are progressively walled off from the possibility of homeownership, the housing market decouples from its real, human utility of providing homes for people and families. Instead, housing has increasingly been treated primarily as a financial investment vehicle, severing its connection to its basic function as shelter. Homeownership remains critical for building long-term wealth under the current system, but when treated purely as an investment, distortions arise. The capacity of a hardworking, middle-class couple to provide a measurably better life for their children while working within the rules of the socio-economic system has been the central organizing ideology of American life since the Second World War.

A scenario where housing stock does not increase, and homeownership decreases to the point where faith in the possibility of earning a better life for future generations is lost, would mean no less than the failure of the American experiment. With this failure would come extreme long-term challenges to any form of prosperity. Yet millennials are now poised to be the first American generation in over a century that will not, on average, expect to enjoy more wealth, a higher standard of living, or greater levels of satisfaction with their life outcomes than their parents.

Moreover, housing investment as it stands today drains productive capital from other, higher-impact sectors. Instead of channeling investment into technology, innovation, manufacturing, or infrastructure, vast sums are locked into static, manually-constructed housing stock, which primarily enriches through appreciation rather than through producing new capabilities or economic outputs. Traditional, site-built homes rely on labor-intensive, hourly-paid construction rather than scalable, factory-style production processes that could drive innovation and economic deflation.

Yet these issues plaguing the housing market, which have also cascaded to other markets, did not arise by coincidence. Rather, they were made almost inevitable by the economic context that requires perpetual growth to function and takes as an axiom the assumption that this will always be possible inside our existing static and disconnected urban framework. This assumption appeared reasonable in the past because human knowledge and ingenuity always succeeded in finding new technology or other conditions to sustain growth within these confines. This cycle, however, presents an existential risk to all urban development, as the platform for our economic activity—local housing markets—are not immune to the need for a technological phase transition to ensure continual growth.

The Rise and Fall of the City

Throughout their existence, cities have been the driving force behind the advancement of civilization. By concentrating people together, they inevitably also concentrate people's ideas, ambitions, artistic visions, business models, knowledge, productivity, wealth, technical skill, greed, and crime—the full spectrum of their culture and community—everything, in essence, that is uniquely a product of human nature. Thus, for precisely the same reasons that cities agglomerate the creative and productive forces of what Marx referred to as our "species-being,"[12] they are also beset with the flaws of our character. All the key features of the housing crisis may ultimately be traced back, in one form or another, to the structural problems cities must face as they are forced to keep up with the growth demands of the contemporary world.

We will examine this issue in mathematical detail in later sections, but for now we present the outline of an argument from Bettencourt and West, whose work was foundational in shaping the creation and design of ARC. We shall return to their work and its consequences repeatedly throughout. The key idea, which we assume for now but derive later, is that cities which fuel their growth primarily through technological and creative innovation grow larger at a super-exponential rate due to the explosive change such innovation makes possible. This is initially an enormous benefit, as anyone familiar with the history of technology in the past century can easily see for themselves. However, as super-exponential growth continues, it eventually runs into conflict with the finite nature of resources and—most importantly—the finite and local spatial boundaries of cities. Once unlocked, the super-exponential growth of technological innovation combined with the human imagination will place cities on a growth trajectory that *diverges* as it tends toward an infinite output of production in a finite time. Such output is unsustainable and leads to wholesale collapse of cities and economies that are overly reliant on a single good or service. Even well-diversified economies, which have some buffer against the effect of unsustainable growth in one economic sector, tend to experience boom-bust cycles because of unsustainable, super-exponential growth. The figure below demonstrates this idea using real data from the population growth rate of New York City, along with theoretical predictions from the work of Bettencourt and West:

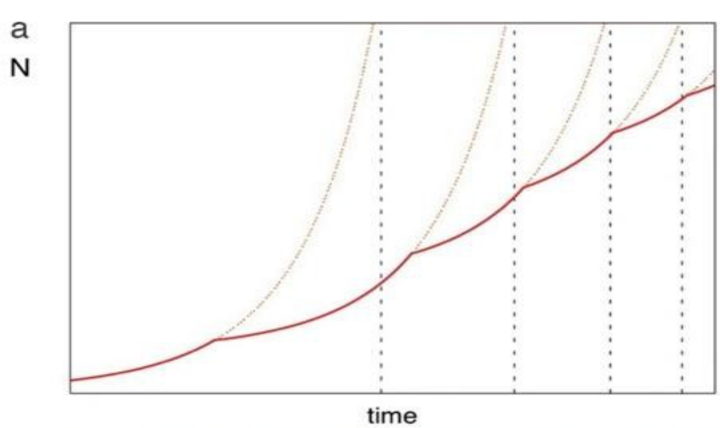

Figure 1a: The result of super-exponential growth over successive cycles avoiding collapse. Divergent trajectories are shown in orange and dotted vertical lines are critical timepoints. Notice that the dotted lines are closer after each cycle.

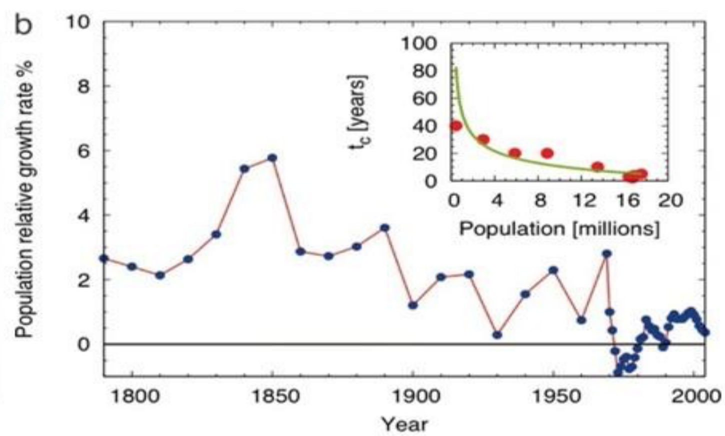

Figure 1b: Population growth rate of NYC fluctuates over time with clear periodicity. Inset: Exponential decay of time between divergences caused by super-exponential growth.

The key idea to notice is that it is possible for further innovation to stave off the effects of overgrowth caused by previous innovation, and this is largely what society has relied on throughout modernity to avoid catastrophic social failures or mass starvation. For example, human creativity and scientific progress came to the rescue at several points in the 20th century when the global population was about to exceed the global capacity for food production, but fertilizer or industrialization of agriculture, invention of pesticides, and so forth, appeared just in time to increase production to a level that could meet demand.

But local technology and innovation are not silver bullets, and they cannot save us from problems they also help to create unless the other aspect of the problem—the finite boundaries that limit local growth and cause it to become prohibitively expensive—are also addressed. A very simple argument, with math omitted for the time being, for why further innovation cannot continually be counted on to solve the problems that past innovation created is as follows:

1) Notice that population growth rates always depend on population size, because they are exponential by nature (more people make more babies per unit time).

2) Thus, if some form of innovation prevents a catastrophic population collapse and the population recovers and resumes growth, the initial population in this new round of the growth cycle is necessarily larger than the previous initial population.
3) If the initial population is larger, the initial growth rate is also faster than in the previous cycle.
4) The inevitable conclusion, given that the finite boundaries of urban populations remain fixed, is that the time until the population is again on the brink of collapse in the new cycle will be *shorter* than the time in the previous cycle.

This is depicted in Figure 1-a. Notice that the horizontal distance between the vertical dotted lines decreases each time the curve resets. Figure 1-b displays data about the population growth rate of NYC which matches model predictions for a highly diversified economy quite well. An even better illustration is given by the idea prevalent among historians that multiple industrial revolutions have taken place in the modern era.

While different authors may disagree over precise dates and key discoveries, the consensus is that four revolutions have occurred with the following key innovations and approximate dates of occurrence:

$$1rst\ revolution: manufacturing, late\ 18th - early\ 19th\ century$$
$$2nd\ revolution: technology, late\ 19th - early\ 20th\ century$$
$$3rd\ revolution: computation, mid\ 20th\ century$$
$$4th\ revolution: the\ internet, end\ 20th - early\ 21st\ century$$

Notice that the time between the first and second revolutions is on the order of ~ 100 years, the period between the second and third revolutions is ~ 50 years, and the fourth—depending on when exactly we define its occurrence—followed the third within a period of roughly $20 - 25$ years. Logically, the next candidate for a fifth industrial revolution is artificial intelligence, which is already beginning to reshape multiple sectors and could represent the next necessary phase transition. To follow this logic, the 5th industrial revolution has about 12 years to be in full swing for a population stagnation or decline to be avoided. Even if such a revolution does occur in the next decade, it would only buy society about six years to find the conditions for the 6th revolution—which would prevent collapse for a period of 3 years, and so on.

While these predictions are over-simplified, they may be understood in a manner analogous to Moore's law—but with a very different perspective on the consequences of technological advancement. The argument represents a kind of ecosystemic reality check for the fantasy of perpetual growth on a finite planet.

But we have already hinted repeatedly that there is another way out of this dilemma, which is part of the basis of ARC's design. Thanks to the emergence of technologies like the internet and social networks, and a cultural climate that has adapted to the notion of remote work and has become more accepting of mobile lifestyles than ever before, the possibility of de-localizing the city, and thus erasing the finite constraints on growth that come with localization, has become a reality. Through mobility, which decouples the basic necessity of housing from real-estate speculation, and networks, which are not confined to local growth and introduces a new set of market incentives whereby increasing supply and accessibility is in the best interest of all users, ARC offers urban development a way out of the boom-bust cycles that have historically ensnared it.

Agglomeration forces make a group of socially connected humans into something more valuable than the sum of their individual capacities: an organic, ecosystemic whole known as a *community*. Localized communities (the largest and most powerful form of which are cities) have been native crucibles for new forms of social organization and new ways of being throughout the history of human civilization. Banning together is what drives human society forward. But the impossible demand for limitless growth to occur within finite and static confines has caused the engines of human progress, communities and cities, to become trapped by a market logic which is ultimately pricing itself out of existence. An invisible boundary, much like the point of no return for a stream approaching a waterfall or the event horizon of a black hole, has already been crossed, and the path we are on leads to collapse of this type of infrastructure.

The next evolutionary step beyond the localized city is the networked meta-city: a distributed, dynamic system of interconnected hubs. Rather than isolated centers competing for finite local resources, meta-cities can wire themselves into a planetary network, sharing infrastructure, population, and opportunity across regions. This new organizational structure transforms the planet itself into a cohesive, self-organizing system—a networked civilization capable of sustaining growth without collapsing under local constraints.

Thus, as with any crisis, there is opportunity. An alternative system must be identified which:

1. Retains the principal features of communities/cities—agglomeration forces—that allows for the concentration and amplification of individual human abilities into emergent, greater-than-their-parts, organic ecosystems that drive the super-exponential growth of culture and civilization.

2. Escapes the contradictions between perpetual growth and finite space along with constantly increasing demand and constantly dwindling supply. The new housing model must, therefore, either resist localization, render growth controllable, or both. It must also be capable of producing supply in equilibrium with growing demand by providing better incentives for supply production relative to supply restriction. We will see that these two requirements are fulfilled by two, simple solutions: *mobility and network connectivity.*

3. Scales to the order of the problem and the need for a solution. The crisis facing the housing market may begin in isolated, local areas, but it will eventually cross a percolation threshold and enter a global phase. Any serious attempt at a solution to these issues must be capable of both starting small and potentially stabilizing in a small phase while also being prepared to enter a phase of accelerated expansion on demand. The system must be capable of *computing its own growth.* Historically, such proposals took the form of planned economies. Yet ultimately, these were naïve attempts to control complex systems in the same way one controls cars or simple machines. However, a century of research into dynamic systems, control theory, chaos, and complexity—coupled with the potential of network logic and spatial de-localization—have made it possible to imagine growth as a property that, while not controllable in the manner of an automaton, can be *steered* toward identifiable, stable equilibria through intelligent use of feedback.

We believe ARC is the best solution that fulfills all the above criteria. The following section outlines the ideas and background which provided the inspiration for ARC.

Seeds of Change: Cultural Movements that Inspired ARC

In this section we discuss the ideas that inspired ARC's creation along with the changes in society and technology that explain why today ARC's time has come. We begin with the natal form of the concept found in the post-war avant-garde in architecture, then consider the history of mobile and container homes. Due to their modular, standardized uniformity internationally, containers serve as the building blocks of ARC's programmable installations. Next, we examine how the changing patterns and preferences in the life choices of people today, particularly young people, have created needs which current housing options and living environments do not address, and why we believe that ARC can meet these needs. Finally, we introduce Quantitative Urbanism as the theoretical foundation of ARC's system design, which provided us with the framework needed to analyze the requirements for ARC to operate as the next generation of urban environments. Only the historical origins of QU are discussed here as the theory is described on its own in section five. These components build a story of an idea conceived ahead of its time, in the imaginations of radical artists, which had to wait for uncertain shifts in the state of the economy and societal values before the time was right for its instantiation.

The idea resulting from the conspiracy of these disparate threads is a new housing product that forms the basis for a new urban habitat, the city 2.0. The new "city" is non-local, existing in different places at once, with a nomadic yet interconnected population driving constant structural reconfiguration, causing the city to behave like a complex ecosystem at global scale. Buzzing with activity that mimics the beneficial aspects of traditional cities while removing many of their drawbacks, the city 2.0 has completely new powers that are unthinkable for the old generation of cities, allowing for completely new possibilities in the ecological role of human civilization.

Architecture's Mid-Century Fever Dream

Responding to the fluidity and dynamism of people's lives is a challenge architecture has always faced due to its fixed and permanent nature. In the present age of digital nomadism, architecture's traditional focus on fixed places finds itself challenged by its own rootedness. Buildings are constructed and people use them for a while. Then they are demolished when they no longer serve their purpose, only to be replaced by another fixed structure. This cycle is not unlike the early era of rocketry, when rockets were built for a single launch and discarded. Just as reusable rockets revolutionized spaceflight by eliminating waste and enabling continual use of high-cost systems, a new paradigm in architecture must allow structures to be repurposed, moved, and reconfigured instead of demolished and rebuilt. Mobility and flexibility in buildings, like reusability in rockets, transform a one-time expense into an enduring, evolvable asset. Today's economic and social environments demand faster and cheaper iteration and a greater level of flexibility and efficiency than fixed, single-purpose buildings can provide. The world is changing at an ever-increasing pace, and permanent buildings designed to serve the same function for years are at risk of becoming obsolete.

Another useful analogy is the early history of computing. The first computers of the 1950s were painstakingly hand-built, each one a unique machine designed for a specific task. Over time, advances in modular hardware, standardized architectures, and factory mass-production—achieving economies of scale—enabled computers to become general-purpose, flexible platforms capable of running any program. A similar shift is needed in architecture today: from static, bespoke structures to modular, programmable environments that can adapt fluidly to changing needs.

"Flexibility" in architecture is distinct from the concept of mobility. Mobility is a structure's ability to change locations while flexibility is a structure's ability to adapt its layout and function continuously to meet evolving needs. Achieving true flexible architecture was a challenge attempted many times in the 20th century. There are antecedents to the concept in the architectural philosophy of Le Corbusier,[13] who as early as 1923 expressed the prophetic view that a house was a "machine for living in."[14] In the coming century this sentiment may prove true in ways that Le Corbusier himself could not possibly have imagined.

The first genuine attempts at envisioning architecture that was flexible and mobile, however, had to wait until after the Second World War for the avant-garde artistic climate of the 1950's and 60's, when a generation of artists responding to the decimation of society brought by the war attempted to reimagine the possibilities of every facet of human life. The Hungarian-French architect Yona Friedman was a pioneer among the various architects and art collectives experimenting with flexible and mobile elements at that time. He published the first edition of his manifesto "L'architecture Mobile"[15] in 1958. The text quickly became influential in Europe and around the world and within a few years two new architecture movements had each published manifestos of their own.

In the United Kingdom, the avant-garde architecture and art collective known as "The Archigram" was formed in 1960 and released their first pamphlet detailing the principles of their new architecture in early 1961.[16] Meanwhile at the 1960 Tokyo World Design Conference, completely independent of the British architects exploring similar themes at the time, a group of young Japanese architects also formed a collective and released their own manifesto under the same name: "*Metabolism.*"[17] The Metabolists were some of the earliest architects to notice the deep connections between the building-city and organism-ecosystem relationships. The movement was originally named after the Japanese word for metabolism, *shinchintaisha*, which for the Japanese carries a connotation of continual replacement and renewal in the manner of living systems.

At this same time, on the other side of the world, the Archigram was experimenting with the same concepts but taking a much more radical and starkly futuristic approach. Whereas the Japanese were interested in the principles that might enable architecture to mimic life and take advantage of biological features, the British were pushing their imaginations to their limits to create a vision of the future that was at once captivating and alien. The art critic Reyner Banham summarized the appeal of the movement as follows:

"…chiefly it [Archigram] offers an image-starved world a new vision of the city of the future, a city of components on racks, components in stacks, components plugged into networks and grids, a city of components being swung into place by cranes."[16]

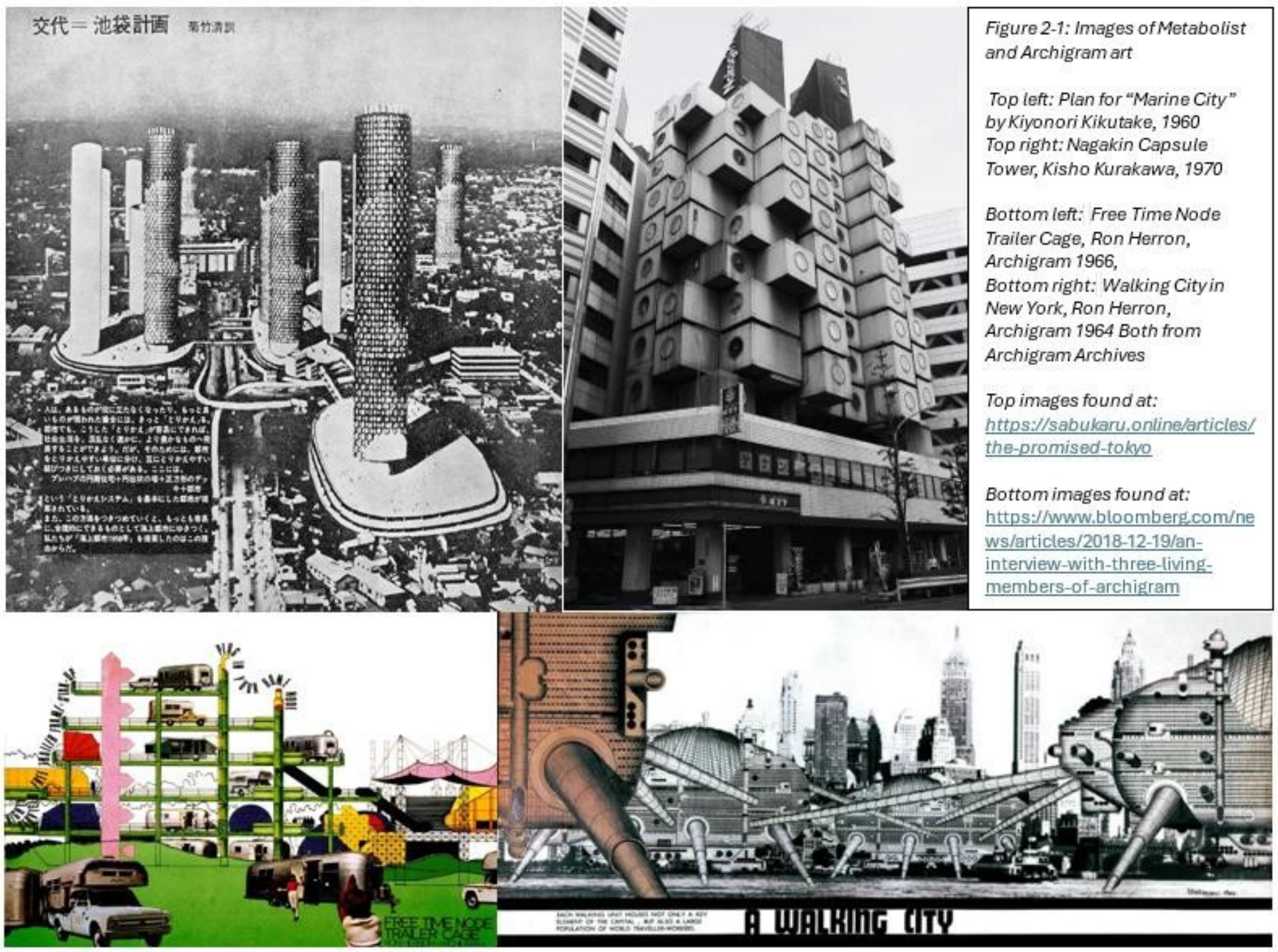

Figure 2-1: Images of Metabolist and Archigram art

Top left: Plan for "Marine City" by Kiyonori Kikutake, 1960
Top right: Nagakin Capsule Tower, Kisho Kurakawa, 1970

Bottom left: Free Time Node Trailer Cage, Ron Herron, Archigram 1966,
Bottom right: Walking City in New York, Ron Herron, Archigram 1964 Both from Archigram Archives

Top images found at: https://sabukaru.online/articles/the-promised-tokyo

Bottom images found at: https://www.bloomberg.com/news/articles/2018-12-19/an-interview-with-three-living-members-of-archigram

That two distinct architectural movements arose simultaneously in utterly separate parts of the world in the same year, sharing the same unique and radical goals seen from different perspectives, is both remarkable and presents strong evidence that the idea of reinventing human habitats was a part of the worldwide zeitgeist at the time; the notion was "in the air" of the post-war culture, metaphorically speaking.

Though different in style and emphasis, both the Metabolists and the Archigram shared a two-part goal: first completely reimagine buildings by giving them new and unprecedented powers of travel and shape-shifting (for the Archigram) or self-renewal (for the Metabolists). Next, re-imagine urban space and cities themselves, creating a totally new form of habitat for humanity. Although the details differ, the final vision of both groups sought to ultimately create a new form, or next generation design, of the city: a city 2.0.

Yet while the technology has existed to execute something in the conceptual domain of mobile architecture for a century or more, and more recently flexible architecture has also become a practical possibility, none of the Archigram's designs were ever built. The Metabolist's did succeed in getting a small number of their designs constructed, but among the designs that were realized the core notion of a self-sustaining "metabolic" building was never incorporated beyond the level of superficial aesthetic choices. What these avant-garde architects of the 1960's didn't realize, and couldn't yet realize, was the future context necessary for their dreams to find a place in reality.

First were the technological innovations required to make their ideas not only feasible but *useful* to everyday people, the most fundamental of which was the birth of the internet. Connectivity via the internet is the fundamental element that enables a nomadic and distributed population to still produce some of the same scaling and growth effects of traditional cities, while simultaneously eliminating many intractable problems traditional cities must face. And now that we are connected by the internet the human population is set free to make full use of mobile architecture. Likewise, once buildings no longer need to permanently serve the same or similar functions but adapt to the demands of whatever population is occupying it at that time, flexible architecture becomes essential. Predicting such developments and humanity's resulting shift to a non-local economy was outside the scope of what any artist of the 1960's, no matter how avant-garde, could imagine—yet it was precisely the shift required for their architectural visions to be realized.

Due to the internet, socioeconomic norms have shifted away from on-site office work to remote work. The internet made the idea of remote work a possibility, and then the COVID-19 pandemic catalyzed the shift, moving almost $\sim 50\ million$ workers from the office into remote positions in 2020 alone.[18] To an economy that was overwhelmingly based on local interactions, ideas based on mobile architecture concepts were alluring but not useful. The less a society is connected, especially over long distances, the more value it places on local interactions and the more it requires its people to be in fixed places. The internet, and the massive social networks that flourished as a result, challenged this logic, making it appear as questionable for the first time. Then the pandemic came and exploded beliefs about the necessity of fixed and permanent spaces both for economic efficiency and sustaining community.

These developments have at last set the stage, 64 years after the publication of their manifestos, for a genuine attempt at realizing the initial ambitions of the mobile and flexible architecture avant-garde: to make flexibility an actual functional principle. A truly flexible architecture will allow the structure to continuously change, to upgrade, and to be completely reprogrammable. Furthermore, the dreams of these visionary artists did not stop with the construction of just one or a few buildings that exhibited flexible function. The final ambition of architects in this tradition was to dissolve buildings, and ultimately, cities themselves. ARC carries the ambition to create a new generation of human habitat, the city 2.0, forward into the 21st century. However, as we will argue in later sections of this document, the rationale for the evolution of urban habitats is much more than just the fulfilment of an artistic dream and a new way for person and city to inter-relate. ARC's macro level organization is very intentionally designed as a response to the structural problems intrinsic to large cities. In section five of this document, we delve into the quantitative analysis of urban dynamics to show how and why ARC is capable of reproducing and improving upon the socioeconomic effects of cities, consequently demonstrating that this potential was already implicit and hidden within the original vision of the 20th century avant-garde movements in architecture. First, however, we turn to the remaining cultural threads forming the context that necessitates ARC.

The Growing Demand, Relevance, and Practicality of Mobile Homes

The concept of a mobile home is not new. Originating with the Conestoga Wagon, versions of mobile homes have been in use since the 1700s.[19] Of course, today's mobile homes—now officially referred to as "manufactured homes"—are often stationary and are too easily associated with lower socio-economic status. This is in large part due to the depictions of trailer parks in media and culture. There are, in fact, more than 22 million Americans living in mobile homes today.

Furthermore, demand for mobile homes has been growing, with a 31 percent increase in the number of mobile homes shipped in 2022 compared against 2021.[20] Prices have risen considerably in response to this increased demand. This should be no surprise, however, given the state of the housing market: median costs for mobile homes are approximately $125,000 vs. the $400,000 median price of a single-family home.[21]

But traditional mobile homes are not the only form of non-traditional housing that has gained in popularity in recent years. Since the pandemic, interest in and ownership of tiny homes (typically between 100 and 400 square feet), RVs, houseboats, and refurbished vans and buses have seen tremendous growth. The tiny house industry is primed to grow at a healthy seven percent clip over the next eight years.[22]

One type of alternative housing that came to prominence as an easy starting place for DIY homebuilders is the container home. Aside from being used to transport goods across the globe, both new and refurbished containers have been used for apartment and individual housing, farming, aquaponics, and more. In fact, they're so popular that one market analyst projects the container home industry (i.e., containers used strictly for domiciles) is expected to reach nearly $75 billion by 2025,[23] dispelling myths that they are unlivable or undesirable.

Like mobile homes, container homes are significantly less expensive than single-family homes, ranging from $50,000 - $200,000 when complete. However, unfinished containers themselves can be purchased new or used for a significantly lower cost, generally around $1,500 - $5,000, making them a popular choice for the DIY crowd.[24] One of the top advantages of container homes is that they can be stacked, customized, and modded-out, yielding creative and unique living spaces.

Since containers are the global standard for shipping, container homes perfectly fit the vision of flexible and mobile architecture. However, containers possess an additional element that is the basis of their role in ARC: modularity. Because their construction process, size, load-bearing capacity, and other structural specifics are all standardized, containers are a natural choice to become the basic building block of a rearrangeable and thereby reprogrammable building macrostructure. By freely moving, swapping, and upgrading containers, the whole building behaves in the manner of a universal computer, *an urban computer,* running "container programs" by rearranging containers.

Emerging Lifestyle Trends that Impact Housing

The emergence, in the new generation of young people, of new lifestyles with new priorities has created a currently unmet need for a housing option that can adapt and be responsive to the changes of the times. This unmet need is a key component of the demand ARC can be expected to generate in the future.

The pandemic spurred a significant increase in remote work for those who remained employed, with approximately 50 percent of all work hours being done remotely during the height of the pandemic.[25] Today, 58 percent of Americans are working from home at least one day a week.[25] More than a third of workers have the option to work from home full-time, and 87 percent of workers say they will take advantage of flexible work opportunities when they can.

With more remote work options than ever before, many people are reconsidering where they live, driving people from large cities to suburban or rural settings.[26] What's more, the pandemic spurred on a new wave of digital nomads—workers without a fixed base who travel and work remotely. This group was already growing but its growth was supercharged in response to the pandemic, growing by 50 percent in 2020 and 42 percent in 2021.[27]

These shifts in where people live and work, how they live, and what they prioritize are likely long-lasting, if not permanent, as evidenced by the many still-empty office buildings which now adorn the landscape of most American cities. Although for the majority of people economic realities demand that affordability will always be the primary factor in housing decisions, workers in a post-pandemic world value their freedom and mobility more than ever. Taking all these housing challenges and shifts in lifestyle preferences into consideration, it's clear that many people want a housing situation that can afford them the freedom and flexibility the fourth industrial revolution provides without disallowing them a place to call home, store their stuff, and live stable lives.

These general trends in life choices, primarily in younger generations but also among older people, are the result of widespread reassessment of what matters, and of what is truly important to each person as an individual. People want to work less and spend more time with the people they love. They want to have access to art and culture that moves them or makes them laugh, and they also want to have access to the natural world, in as remote and pure a state as is possible. They want community and they want privacy. They want advanced technology and ecological sustainability. In short, they don't want to choose between different forms of good life, they want to experience everything existence has to offer. They want to have their cake and eat it too. Why can't people earn a living while also spending most of their time with the people most important to them?
Why can't they live in reach of high culture and wild nature? Why can't we have modern technology but not destroy the earth? What many learned from the experience of the pandemic, especially those who may have been already asking these questions, is that the answer was always "We can't have both sides because the system can't accommodate it." This is precisely why, post-pandemic, the moment has arrived for a new kind of living environment supporting a new way of life, designed specifically to respond to the above "why" questions with "yes, why not?"

The Key to Unlock the Next Generation of the City: Economic and Scientific Theory behind ARC

Quantitative Urbanism and geographic economics together provide the basis for the theoretical framework that's been constructed for evaluating ARC's potential performance and growth, as well as the analytic modeling we have carried out to generate some reasonable predictions and expectations that may serve as initial benchmarks for the product. Of these two intersectional subfields quantitative urbanism is by far the biggest influence and inspiration, not just for the technical analysis of ARC as a system, but for the creation of the concept itself.

The field of Quantitative Urbanism (QU) originated in the first decade of the new millennium as an application of the study of complex systems. Both complex systems science and later QU were pioneered by researchers at the Santa Fe Institute. QU is primarily concerned with identifying the predictable, quantitative features that cities share across cultures, time, and space. In other words, the field seeks to formally define patterns almost all cities display strictly by virtue of being cities— concentrated population centers subject to both "agglomeration" and "dispersion" forces (as economists describe them), in which many different quantitative indices change in response to one another as the city grows or shrinks. As is typical of the study of complex systems, progress comes from finding simple rules or behaviors beneath the apparent complications of the system under study. When simple, microscopic features are scaled up to macroscale structure or repeatedly iterated, as occurs with the formation of fractal patterns, and the resulting dynamics match empirical observations, the corresponding features of the complex system under study are considered emergent from and explained by the microscopic model. The most basic and fundamental example here will forever be the emergence of thermodynamics from statistical mechanics, but examples abound in all parts of nature, and more are discovered all the time. QU is, in many senses, a "statistical mechanics" of peer-to-peer social interactions that result in a "thermodynamic" description of communities and cities. The earlier "New Economic Geography" set the stage for this advancement by analyzing the much older concept of "economies of scale" as a function of the spatial distribution of production and consumption for a particular good.

The concept of *economy of scale* has been understood at least since the work of Adam Smith and was likely recognized in some form much earlier still. It was applied to firms and companies before it was also recognized as a property of cities, with early transnational enterprises like the East India Trading Company furnishing clear examples. The most basic version of the concept applies to prices: as companies grow larger, they can achieve lower costs per unit, not only by purchasing in higher volumes but also by automating production and achieving efficiencies that scale with size. At the microeconomic level, there may be a variety of reasons why economies of scale occur: larger volumes of production may allow more efficiency per unit, or purchasing materials in bulk can result in lower input costs, or a greater number of workers can allow for increased division of labor and specialization, thereby increasing the efficiency of production. Regardless of the underlying mechanisms, however, the quantitative result remains the same: costs, inputs, outputs, or any other indicator of production increase sub-linearly with increases in scale. This effect is therefore described by a *power-law,* a simple proportionality relation between two quantities where one quantity scales with a power of the other. In the case of economies of scale, the exponent on the scale factor must be less than one. It is easy to understand, therefore, why advances in this field would ultimately come from the field of complex systems, because such relationships are ubiquitous in biology, geology, meteorology, and ecosystem studies—all fields where advances in the basic physics of the systems under study require advances in our understanding of complexity. "Quarter-power scaling" was identified in biological systems in an ever-increasing number of cases throughout the 20th century, extending from biology to geology and meteorology. Such relationships have now been found to describe an enormous variety of phenomena where optimal function requires some form of flow or transport to be optimized as well. An illustrative example is the famous scaling relation between metabolism (the power required to sustain an organism) and body mass, found to hold over more than 20 orders of magnitude, from hummingbirds to blue whales:

$$P \propto M^{\frac{3}{4}} \tag{1}$$

What this means is that, as organisms grow larger, the power they require increases along with their caloric intake requirements, but not by as much as their mass increases. For example, when the mass of an organism doubles, $M \to 2M$, the power requirements of that organism increase by $2^{\frac{3}{4}} \approx 1.68$, or 68% instead of 100%. Without these savings in power requirements, animals of any appreciable size—including ourselves—would be thermodynamically impossible. Another remarkable fact about biological power-laws is that all known relationships to body mass or volume scale with an exponent that is a multiple of $\frac{1}{4}$. To give a sense of the true ubiquity of quarter-power scaling, a highly non-exhaustive list of examples of systems found to display this behavior includes:

- Networks of veins and arteries
- River tributaries
- Glycogen structure (the tree-like storage form of glucose in animals)
- Trees themselves, in the structure of their individual branching patterns as well as the mycelium-connected network of their roots which span entire forests (aka the "Wood Wide Web")
- Fracture propagation in crystals and other chains of cascading phase transitions such as lightning and proton transfer in acids
- Countless examples in weather and non-equilibrium fluid flow such as hurricanes, tornadoes, and vortices, to name just a few…

The structure of these phenomena and many more is understood to be a consequence of optimizing transport and flow networks embedded in three-dimensional space. In the case of the metabolism-mass relationship, biological networks such as circulatory and nervous systems are responsible for transport. However, the principle of "optimal transport in D dimensions" is far more universal, following an approximate but remarkably simple mathematical relationship. When transport occurs in a fractal structure (branching or repeating pattern that looks the same at large and small scales) embedded in D Euclidean dimensions of space (normal, flat space with zero curvature) the "critical" value of the scaling exponent that optimizes transport for a given "size," (mass, volume, area, length, population, etc.) is one of the following[28]:

1) $\beta_{crit} \equiv \frac{1}{1+D} \overset{D=3}{\Longrightarrow} \frac{1}{1+3} = \frac{1}{4}$
2) An integer multiple of the critical beta value: $n\beta_{crit};\ \forall n \in \mathbb{N}$

Around the same time that the full generality and consequences of quarter-power scaling were being unraveled by complex systems scientists from disparate backgrounds in physics, biology, and ecology, the notion that economies of scale could manifest within cities and even be a driving force behind the growth of cities was pioneered by Paul Krugman's "New Economic Geography."[29] Krugman's work emphasized the counter-intuitive advantages of businesses in the same industry concentrating together in similar locations to receive greater benefits from economies of scale. The result of such a process could be the growth or even the creation of a city built around a particular industry, such as Silicon Valley and the tech industry or Los Angeles and the film industry.

The scope of the concept of economies of scale, however, would turn out to be much more general than Krugman suspected. In fact, the concept applies to all cities. 17 years after Krugman's influential 1991 work "Increasing returns and Economic Geography,"[30] which was one of three papers cited by the Nobel committee as the reason he was selected, Krugman became the sole recipient of the 2008 Nobel Prize in economics. However, just one year prior, in 2007, Luis Bettencourt and Geoffrey West published a paper titled "Growth, Innovation, Scaling, and the Pace of Life in Cities,"[31] which would lead to the establishment of quantitative urbanism. This work is arguably more influential than Krugman's work on economies of scale. The paper has received over 3,000 citations in the past 17 years since its publication.

Coming from a background of studying power laws in biology (West was the lead author of the paper that established the above formula for the critical value of beta), Bettencourt and West generalized the concept of economies of scale by showing that it was a feature of the scaling behavior of all cities, regardless of whether a particular industry was concentrated there or not. By appealing to the same general principles of geometric optimization of transport phenomena that cause power-laws to be a characteristic feature of almost all biological organization, Bettencourt and West proposed—and empirically confirmed—that the production of any shared public infrastructure should obey a sub-linear power law satisfying the definition of an economy of scale. Starting with a generic power-law of the form:

$$Y(t) = Y_0 N^{\beta}(t) \tag{2}$$

Where:

- $N(t)$ is the time-dependent population of the city, i.e. its "size"

-$Y(t)$ is the time-dependent amount of a generic quantitative metric of the city—dubbed an "urban indicator"

-Y_0 is a normalization constant that makes the expression dimensionally consistent. It has units of $\frac{Y}{person^{\beta}}$ so that it sets the amount of the indicator produced when the population increases by one.

-Finally, β ("beta") is the scaling exponent that sets the power-law behavior.

Through empirical examination of almost 400 cities in the U.S., Europe, and China, Bettencourt and West determined that indicators related to infrastructure had an average scaling exponent of $\beta \approx .8$, remarkably close to the value of $\frac{3}{4}$ related to optimal transport in three dimensions. However, when Bettencourt and West examined the data for indicators related to socioeconomic productivity, they found something much more remarkable than a simple parallel between cities and biology, and it was this second discovery that caused their paper to receive 3000 citations and led to the creation of quantitative urbanism as a distinct discipline from geographic economics. What they found was that for indicators related to knowledge, discovery, creativity, economic productivity and other forms of socio-economic innovation and invention, the scaling exponent was greater than one. This phenomenon, termed "super-linear scaling," is foreign to biology or any other known field of natural transport phenomena, marking it as potentially a unique manifestation of human knowledge and sociality. The unprecedented nature of the finding accounts for much of the interest it rapidly sparked. Some of the specific indicators Bettencourt and West reported as super-linear, with beta in the range $1.1 \leq \beta \leq 1.35$, were amounts of:

I. New patents
II. Inventors
III. R&D investment

IV. R&D employment

V. Creative employment

VI. Total wages

VII. Total deposits

VIII. GDP

All of which seem to have net positive consequences for the social and economic well-being of a city. However, along with these indicators, Bettencourt and West also found that super-linear scaling determined the amount of…

IX. “Serious” crime
X. New AIDS cases
XI. Traffic congestion

Because they are spontaneous consequences of organized social activity combined with human nature, the agglomeration forces which cities manifest must necessarily “take the good with the bad.” Without a clear understanding of when, why, and how an indicator undergoes super-linear scaling, decoupling specific indicators from the super-linear regime without affecting others is currently outside the realm of possibility. However, the intervening decades of research in QU have seen a plethora of models introduced which potentially explain the mechanisms underlying sub- and super-linear scaling. Yet, at present, there is no clear consensus within the literature on which model accounts for the scaling values of indicators with the same degree of generality as Bettencourt and West’s initial result.

Here, we simply state that this result served as a catalyst for thinking about the process of economic growth in cities with the mindset of an ecologist. It was this line of thinking that led to an understanding of the issues cities have always faced that in turn lit the path to recognizing the necessary features that ARC required if it was to act as a model for a new generation of cities.

Having described the problems facing housing and urban development which require innovative solutions to evade impending catastrophic collapse, and the cultural and social background that led to the idea for a solution, we turn at last to the solution itself. In the following section, we ask and answer the question “What is ARC?” However, as there are many facets to the answer, we must ask and answer many times in different ways.

What is ARC? The Future of Urban Development

A new housing system is needed, one that can address the issues with today’s dwelling technology and its market failures. It must match humanity's increasingly dynamic temperament and be able to keep up with the increasing pace at which the world is changing. It must be dynamic, flexible and scalable while still performing the core functions of permanent structures.

What is ARC? The Solution to the Housing Affordability Crisis

The problem: Overlapping and contradictory constraints placed on housing lead to pathological market conditions that do not respond to demand

As we explained in section 1, the housing affordability crisis stems from a fundamentally flawed market architecture, characterized by:

1. Misaligned Incentives: Supply Suppression

- The current housing market incentivizes homeowners and real estate investors to suppress supply.
- Why? Scarcity increases the value of existing assets, benefiting owners at the expense of affordability and market newcomers.
- Housing operates as a speculative asset, with decisions driven by maximizing individual asset value rather than addressing systemic needs.
- Impact: Housing supply is artificially constrained, creating scarcity that drives up prices and stifles innovation.
- In this model, housing cannot follow the price efficiency curve of other goods like smartphones, where competition and innovation make products more accessible over time.

2. Local-Only Growth: Geographic and Cost Constraints

- Traditional cities grow by expanding outward or upward—but both approaches have hard limits:
- Geographic Constraints: Cities face physical barriers like oceans, mountains, or environmental restrictions. Growth eventually halts when these limits are reached.
- Cost Spiral: As demand increases, land near the city becomes prohibitively expensive, choking off further expansion.
- Impact: Housing affordability collapses because the urban system is locked into a finite, local growth model that cannot scale to meet demand.

3. Market Failure: Housing as a Static Asset

- Housing is treated as a fixed, location-bound asset tied to land, creating rigidity in supply.
- This model cannot respond to dynamic economic and geographic changes, leaving demand unmet in key areas (e.g., high-growth cities, disaster zones).
- Impact: Millions are priced out, economies stagnate, and housing as a basic human need is subordinated to speculative financial interests.

The Solution: ARC as a New Housing Framework

ARC introduces a new market architecture for housing that resolves these systemic flaws by leveraging mobility, network economics, and distributed growth. It is not merely a product; it is a scalable, adaptive framework designed for modern economic realities.

Key Features of ARC's Solution:

1. Distributed Growth Enabled by Mobility

- ARC decouples housing from fixed land, allowing homes to move across a global network of ARC hubs:
- Mobility Unlocks Cheap Land: Unlike traditional cities, ARC can "crawl" to new, affordable inputs of land by deploying towers in rural or underutilized areas.
- Example: If one city hub becomes constrained by costs or geography, ARC's network grows elsewhere, ensuring continuous, distributed expansion.
- Why This Matters:
- Traditional cities are bound by local-only growth, but ARC scales non-locally, avoiding geographic and cost-based chokepoints.

- This flexibility ensures that housing supply can always meet demand, regardless of location—because ARC can continually crawl toward cheaper inputs of land while keeping all its nodes interconnected. Unlike traditional cities, which stagnate once local growth hits physical limits, ARC's distributed hubs operate as a unified system, sharing people, goods, and services across the network as seamlessly as if they were co-located. By skirting the rigid locality constraints of past urban models, ARC satisfies demand dynamically while preserving the connectivity that drives economic and cultural vitality.

2. Aligning Incentives: Growth Benefits All Stakeholders

- ARC introduces network economics to housing, where growth benefits all participants:
- Metcalfe's Law: The utility of ARC's network increases as more nodes (towers and units) are added, incentivizing owners to expand the system.
- Owners of ARC units and slots benefit from the usefulness of the network as it grows, rather than hoarding value by suppressing supply.
- Why This Matters:
- Unlike the current market, where supply suppression creates value, ARC's system encourages expansion, accessibility, and innovation.
- Owners are incentivized to support the network's growth, ensuring housing remains affordable and scalable.

3. Affordable, Scalable Housing

- ARC's modular, mobile units follow a technology-driven cost curve:
- Efficiency Through Modularity: Standardized, HUD-certified units can be manufactured at scale, reducing costs over time.
- Dynamic Relocation: Mobility ensures units can move to areas of demand, balancing supply dynamically.
- Why This Matters:
- ARC introduces competition and innovation into housing, driving prices down over time.
- Unlike static, land-bound housing, ARC's units adapt to economic and geographic changes, ensuring affordability and accessibility.

4. A Networked Housing Framework

- ARC is not a city—it is a distributed network of nodes connected by mobility and shared infrastructure:
- Nodes: Towers in key locations act as hubs for mobile units.
- Flexibility: Residents can relocate units across the network, following economic opportunities, seasonal preferences, or life changes.
- Scalability: New nodes can be added to the network anywhere, enabling infinite growth.
- Why This Matters:
- Traditional cities are constrained by their location, expanding only through slow, costly construction of new infrastructure like roads, rails, and satellite towns. By contrast, ARC's network is adaptive and borderless, scaling organically by linking distributed hubs into a seamless, integrated system that grows with demand, not against it.

- As the network grows, its value and utility increase, ensuring sustainable development.

Why ARC Wins

1. Breaks the Old Model

- ARC's distributed, mobile framework eliminates the constraints of local-only growth and the inefficiencies of fixed, speculative housing markets.
- By decoupling housing from land, ARC creates a system that scales dynamically to meet demand.

2. Aligns Incentives

- Growth benefits all stakeholders in ARC's network, encouraging expansion rather than scarcity.
- This creates a virtuous cycle where the system grows larger, more accessible, and more useful over time.

3. Scales with Demand

- ARC's mobility and modular design allow it to scale indefinitely, adapting to economic and geographic shifts.
- Unlike traditional housing, which stagnates under market pressures, ARC evolves to meet the needs of a dynamic, global economy.

Summarizing ARC as the solution for the housing crisis

The housing crisis is a failure of outdated market architecture, where incentives prioritize scarcity and rigidity over accessibility and adaptability. ARC solves this problem by introducing a new framework for housing, based on:

- Mobility: Housing decoupled from land.
- Network Economics: Growth benefits everyone, incentivizing expansion.
- Scalability: A dynamic, distributed system that evolves with demand.

ARC isn't just a new housing product—it is a revolutionary platform that redefines housing as a dynamic, adaptive, and scalable system. By addressing the core flaws of the current market, ARC provides a practical, sustainable solution to the housing affordability crisis.

What is ARC? A Distributed Network of Urban Computers

ARC is a network of automated container parking installations designed to store, shuffle, load and unload containerized micro-homes and stores. These micro-spaces plug into central utilities and are accessible by elevators and stairs. Docked micro-spaces can act as apartments, workspaces, retail and much more. Parking installations are linked to one another by the intermodal transportation network—the global system of ships, trains, and trucks built to move standardized containers—making ARC's network the world's first mobile apartment system and platform for mobile homes and stores. ARC enables ownership and dynamism to unify into a next generation housing product and backbone for a new type of built environment.

ARC has two main components:

- ***Containers****:* Micro-space built to shipping container specs (ISO standards) so it may be shipped inter-modally. Serves any number of purposes: housing, retail, office, gym, farming, 3D printing, fab lab, co-working, virtual reality, sensory experiences…the possibilities are limited only by the imagination of the users of ARC. A unit is a human-accessible and useable shipping container-shaped micro-space that can perform various functions on their own or in concert with other containers. Containers are the currency of the ARC system. They live on the platform and can be composed to implement a vast array of processes.

- ***RAPS*** *(Random Access Parking Structure):* what you get when you apply the concept of RAM (random access memory) to architecture. A collection of high-bay systems, accessways and utility plug-ins that containers can be automatically loaded and unloaded into in such a way that a bottom unit can be moved without moving a unit on top of it. RAPS hands containers off to intermodal carriers for efficient transportation between other RAPS in disparate locations. RAPS serve as hubs where containers can easily plug into shared systems for internet, HVAC, utilities, and more. This seamless plug-in architecture forms the physical backbone of ARC's modular network and is the key enabler of its potential for exponential growth.

ARC can quickly and easily reorganize its elements, making it a truly fungible built environment. New market and urban dynamics which were not possible within a static environment can emerge and evolve with the network. Such radical creativity embodied in a human habitat creates a breeding ground for novel and dynamic modes of human life and socioeconomic relationships.

When customers buy into ARC, they buy the right to park their unit on the platform, which in turn means that they now own a part of the network. ARC formalizes this in the United States through Rights to Use (RTUs). RTUs will be sold as parking points and will enable container owners to access ARC's network of RAPS. They will own a slice of the network and will be able to park indefinitely with this one-time acquisition. Thus, purchasing an RTU becomes conceptually equivalent to purchasing a virtualized parking space which also represents a share of the underlying networked land and hubs. Customers effectively own a virtualized version of a slot in the RAPS network which can manifest as any available slot in any location. By buying permanent parking rights on our network users come to own a share of the total number of container parking spaces on the ARC network, which is thus owned by the users collectively.

ARC will build sites in beautiful and stylish locations while providing regular access for customers to shuffle their units between locations so that they may enjoy the natural as well as ARC-built amenities. Owners can shuffle between sites of varying architectural or functional type, demography, culture, landscape, and climate.

The shuffling of containers allows a high throughput of people and services between RAPS sites. This arbitrage allows sites with small populations to support a diverse number of services and social options otherwise restricted to the large, static populations of cities by rotating services and people through the network. This sharing of containers (which can be supplies, useable spaces, processes, or full of workers) leads to what one could call "distributed agglomeration": ARC behaves as a single, distributed, "non-local city" because of its ability to draw upon agglomeration-like efficiencies which bypass the spatial component of agglomeration, and the attendant congestion and increased incidence of crime, created by cities.

The power of cities comes from the high number of interactions between people and things they enable. It is these interactions that make urban settings economically, culturally and informatically vibrant. ARC supercharges the flux of these interactions via container sharing. Market principles dictate that economic and cultural output must grow in direct proportion to the flux of interactions through the ARC network—but in a new and distributed way. The result is a re-imagination of the urban ecosystem, taking the benefits of the traditional city and distributing them across a network of sites occupying formerly disconnected land areas. The efficacy, functionality and diversity of ARC can grow exponentially as more nodes are added.

Since ARC is a network, we can sell slices of that network directly to customers. And this importantly marks a switch from housing's traditional supply and demand economics to a network model. This is extremely important because expansion of ARC's housing supply is encouraged under this model rather than stifled.

What is ARC?

ARC is a network of random-access parking structures (RAPS) for container homes and commercial spaces. Container apartments, stores, experiences and more can be detached and transferred to other RAPS on request, forming a distributed city-like ecosystem.

RAPS: the backbone of ARC

RAPS serve several functions simultaneously within ARC. RAPS are the backbone physical substrate of ARC as well as a random-access memory analogue. On a conceptual level, RAPS may be understood as the embodiment of the concept of RAM (random access memory) within the context of modular and mobile architecture. As the framework which enables the modular reconfiguration of container spaces, RAPS also serve as the literal foundation of each ARC hub. The confluence of the physical, living habitat with computation over the virtual space of container modules and their configurations evokes the core vision behind the ARC project—to reimagine urban life and design through a flexible, dynamic system where spaces can be accessed and reconfigured on demand.

RAPS, as well as the entire network, can change configuration over time, evolving to meet users' needs. ARC's network in this sense can be seen as a "housing cloud" that allows users to run "container programs," slotting containers with various functions into available parking spaces in a specific sequence to implement a desired process. Detachability, mobility, and composability make ARC a computer—a universal urban system in the computational sense whose computational capacity is given by container throughput speed and the number of container slots on the network. Containers can detach in random access fashion, be upgraded, and shared between distant RAPS. RAPS can also be reconfigured on demand, able to serve any function based on the types of installed containers, making the type of built environment ARC is introducing completely reprogrammable.

❖ ***RAPS***

Basic RAPS has five macro components: reefer racks, a high bay system, utilities, adapters, and elevators.

Note: The images that follow show a basic, low-cost version of the RAPS structure, focused purely on mechanical assembly. Our actual launch products, as shown in the renders on our website, are designed to be exceptionally high-end and beautiful, delivering a luxury experience rather than industrial aesthetics.

- Reefer Racks
- *Container High-bay System*

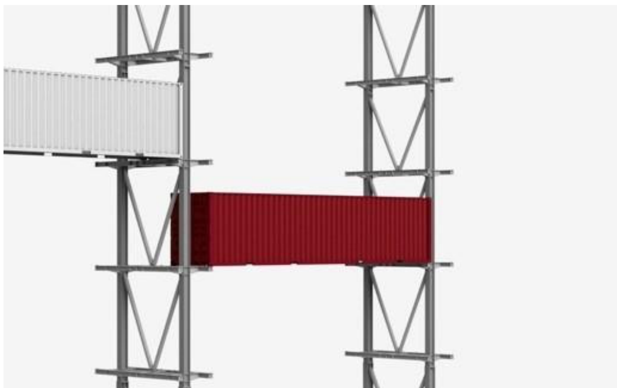

Figure 3-2: Like the high-bay storage and retrieval systems used in warehouses but built for shipping containers. There is a gantry-type device central to these systems that moves in a 2D plane and can shuffle containers between slots as well as hand themoff to container transportation. The system ARC plans on using is manufactured by a company in the EU. The high-bay system pictured above is their system. This company has fulfilled an order for one already andthe technology is live and operational in a port in the Middle East today.

Figure 3-1: A permanent scaffolding that attaches to the exterior of a high bay system with built in stairs that acts as a cheap way a human can access a container on a higher level.

- *Utilities*

  Utilities such as black water (toilets, sewage), grey water (sinks, showers), clean water, fiber optics, power, HVAC, central heating, and cooling run up the reefer racks to adapters where the units plug into them. With RVs and mobile homes systems are redundant, with ARC they are shared.

- *Adapters*

  The utilities come together inside an adapter that will connect the units to RAPS, enabling their function. Many can be used from the RV or yachting industries.

- ELEVATORS

  Elevators may be attached to the end of a reefer rack for accessibility purposes.

Software

ARC will develop a customer-facing smartphone application and a website that will provide residents with the means to interact with ARC's features, purchase or sell shares of the network, schedule transfers (run container programs), and connect with the ARC community. The following are ARC's key software components:

❖ ***Wallet***

The wallet will serve as an account where the customers can store and manage parking points. Users can use the app to rent or buy points and can see what the spot rate is—managing their purchases and rentals from their wallets. They can also contact a broker for larger point trades or connect with other point holders and negotiate directly. The wallet will allow them to buy and sell points, accept or offer incentive to leave or occupy an occupied slot, as well as providing each other with enhanced liquidity and possibly borrowing options.

➢ ***Scheduling and Slot Management***

Customers will be able to schedule unit transfers and pick their next slots (provided they have sufficient parking points for those slots). As the tech scales, this feature will grow into the ability to run container programs; provided they have the required balance, customers will eventually be able to run any possible container program—or design a brand.

➢ ***Community Engagement***

Customers will be able to participate in community votes and discussions, indicate preferences and interact with a virtual community bulletin board in the app. The app will also allow owners to contact management, maintenance, utility, emergency services, and more. The goal is that this feature will grow into self-governance.

Transportation Technology

In addition to the technology used to make RAPS, ARC will rely on intermodal technology for moving containers to and from RAPS. The choice to use shipping containers as the base unit of ARC displays much of its utility here, as the intermodal network is already a network of “cables” spanning the globe that ARC can hijack for its purposes bypassing the need to lay any “cable”. In this analogy ARC is not only a computer but a network of computers (an internet) day 1.

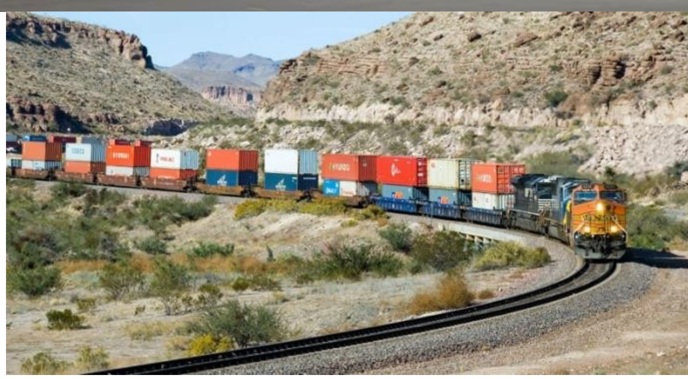

Figure 3-3: Examples of intermodal transportation technology that may be immediately employed for transporting ARC units by land or sea.

Top left: Tractor trailer

Top right: Cargo ship (equipped with rotor sails)

Bottom left: Freight train

What is ARC?: The City 2.0

ARC as a "universal" urban system is not just an analogy but a core feature of ARC. The ARC network can implement any function that can be defined in terms of an arrangement of containers. The universality of "container programs" suggests that an infinitely scaled ARC network would form a model of computation equivalent to a Turing machine: a built environment capable of rearranging discrete functional units (containers) to execute a wide variety of human-defined processes. In this sense, ARC represents the first urban computer—a physically instantiated, reconfigurable substrate for hosting diverse social, economic, and industrial "programs."

The way containers are arranged and interact with each other defines how processes will run—whether it's a supply chain, a retail operation, a production cycle, or something we cannot yet imagine. Any urban or factory process can be mapped to ARC by identifying the right container types, arrangement, and evolution of that arrangement to implement that process. The system can run a true urban operating system, where containers can be swapped, reconfigured, and connected to perform a wide range of functions built easily by users on ARC's OS. The number of functions ARC can host grows exponentially with the number of container slots. The network acts as a distributed urban computer running various functions as container programs. When reconfiguration is recognized as an operative functional aspect of the architectural arrangement, time becomes a parameter which is now essential for describing the state of the space. This opens a new universe: 4-Dimensional retail and production and endless possibilities, experiences, services, monetization opportunities and functions are waiting to be explored here.

The computational capacities of ARC are a key reason we believe this idea we are exploring is an evolution of the city: the City 2.0. programmable, controllable, and responsive to the conditions and drivers of growth these are precisely the survival requirements for future human habitats.

ARC is Built to Evolve with You

In the previous section we described what ARC is in terms of its structure and function, its conceptual purpose, and its technology and physical components. Each of these is a distinct yet valid definition, based on different approaches to understanding the complex and multi-faceted reality of a system that—quite literally—has many moving parts. But perhaps the most fundamental perspective on ARC is non-pre-stateable and cannot be described before ARC is in operation. How could this be the case and what does it mean? It means that the deepest level of ARC's definition will be created by its users, and this is why it cannot be determined until the users discover it for themselves. Just as with any traditional housing development or city, the vitality that we attempt to measure indirectly in terms of agglomeration forces and economies of scale is a result of the community that only exists in and through the people that live there and the relationships they build with one another. Behind the socioeconomic indices, models of growth, technology, intellectual property, and real estate development, the fundamental substance of all habitats is people, the lives they lead, and the choices they make. As the creators of ARC, understanding this truth means recognizing that in the end, our vision of ARC is just an outline and the users themselves will truly define what ARC is. If we have done our job correctly, then we have drawn that outline in such a way that it accommodates the largest diversity of these contents that is possible. This is because, as Pasolini wrote in the script for *The Flower of the Thousand and One Nights:* "The truth lies not in one, but in many dreams."[32]

ARC is an Ancient Way of Life: Nomadism and Humanity

Examining the root causes of the current housing affordability crisis can lead to a sense of inevitable hopelessness. Under the existing market structure, real estate functions both as an asset and a consumption good. Owners profit by restricting the supply of housing, thereby inflating prices—a dynamic that ultimately works against affordability. Regulatory interventions and subsidies often treat only the symptoms, stalling the crisis but rarely resolving the deeper structural problems. Concentrated low-income housing, for example, can create new social and economic challenges without fundamentally addressing the distortions that keep housing unaffordable.

A critical insight is that "real estate" and "housing" need not be synonymous. Real estate is tied to land—a fixed commodity with unique properties that resist standard economic solutions—while housing fulfills a basic human need for shelter. By separating housing from land, we can move beyond the incentive structure that forces up prices through artificial scarcity. Mobility is the simplest yet most transformative way to achieve this: when dwellings can relocate, real estate speculation no longer automatically prices people out of owning a home.

Land's fixed nature makes it prone to speculation and market manipulation. However, mobile housing—especially when technologically advanced and offering a desirable quality of life—de-couples one's "home" from the land beneath it. This freedom dissolves the contradiction between profiting from real estate and meeting the universal need for housing. The incentives that previously fueled supply shortages become much less relevant when the product (housing) does not depend on a single, immovable plot of land.

ARC embraces this approach by offering modern, high-tech, and luxurious mobile homes. Rather than reinforcing outdated notions that "mobile" equals "low-income," ARC reclaims nomadism as an ancient and deeply human tradition. For most of our history, humans were nomadic, from the earliest Homo Sapiens to our hominid ancestors who migrated out of Africa nearly two million years ago. The drive to explore and move freely is a defining characteristic of our species which is older than civilization itself. With ARC, advanced technology can satisfy our innate desire for both personal comfort and mobility in ways that traditional, land-bound housing can never match.

Community need not be lost in this new form of mobility. ARC's digital platform connects every location in its network, allowing residents to stay informed and socially active. The physical transportation system enables homes to move seamlessly between different "nodes" of the city, so residents and businesses can follow opportunity, convenience, or personal preference. Services can likewise optimize their presence by shifting resources wherever demand is highest. Freed from the congestion and rigidity of a single urban location, ARC communities gain the benefits of city life—shared infrastructure, social interaction, and economic opportunity—without suffering many of its drawbacks.

A future in which entire neighborhoods can reconfigure themselves at will—whether to avoid natural disasters, stimulate growth in targeted regions, or gather for special events—redefines our fundamental concept of "city." By detaching the home from the land, ARC opens the door to a new era: a City 2.0 built on mobility, resilience, and collective well-being. Nomadism, the original human lifestyle, now returns in an elevated form that addresses the structural failures of today's housing markets. Through ARC, what once seemed an inevitable crisis can transform into a hopeful vision of freedom, adaptability, and renewed community.

ARC is a Modern Way of Life: Social Networks and Community

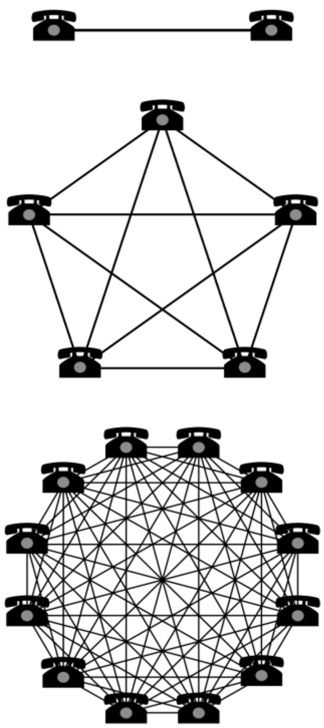

Figure 4-1: Completely connected, undirected, simple graphs represent Metcalfe's law for networks. The number of edges required grows as $\propto n^2$, depicted here for $n = 2, 5, and\ 12$

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Social cohesion—the strength and structure of relationships between individuals—is the foundation of any thriving community. In ARC, as in traditional cities, it is the network of social interactions that generates resilience, opportunity, and collective value**.** The most parsimonious model of such a social network is an *undirected, simple graph*. A graph is any spatial distribution of *nodes* connected by *edges.* The graph is "undirected" when edges connect two nodes without any definitions of flow between the nodes, and "simple" when every edge connects exactly two nodes, so that there are no multi-edges or self-edges. As a model of a social network, a graph of this type restricts social connections to *pair-wise* interactions, so that each edge represents an interaction between two people without considering interactions at the level of groups. If a graph with these properties is also *completely connected*, then it represents an idealized limit case of social cohesion: the situation where everyone knows everyone else. For a graph with n nodes, complete connection will require $\binom{n}{2}$ (read as "n choose 2") edges, which evaluates to the triangular number:

$$\binom{n}{2} = \frac{n(n-1)}{2} \tag{3}$$

Which in the limit of large n becomes $\propto n^2$, proportional to the square of the number of nodes.

When this model is applied to the problem of estimating the utility of a technological network or a social media network, with a normalization coefficient added in to give proper units for both sides of the equation and fit empirical data, this result is known as *Metcalfe's law:*[33]

$$V = An^2 \tag{4}$$

While it is clearly not possible for everyone to know everyone else in a city of any appreciable size, Metcalfe's Law provides an upper bound on the potential utility of social networks by modeling how the number of possible interactions grows with group size. In ARC's network, early adopters will experience this dynamic firsthand: while participation may initially be more costly, early members capture outsized network advantages, becoming central nodes as the network scales. As with early entrants in digital networks, this positioning offers disproportionate access to resources, influence, and long-term returns as the system matures.

A network is never more costly to own and operate than in the early days of its existence, when only the pioneer users are members. ARC early adopters will be familiar with the process of an economy of scale ramping up and will recognize that early participation, though initially costly, grants unique advantages as the network grows. Let's say, on day one, a 100-point parking pass buys a single container slot. After scaling drives the price down to 10 points per slot, that same 100-point pass buys parking access to ten slots. Early adopters therefore enjoy much more parking capacity than those who join later. We'll dive into the product's financialization for buyers in later documentation—this analogy should suffice for now. Commercial participants in particular—especially those with bold or experimental ventures—are encouraged to consider early adoption, as ARC's early residential communities are likely to attract adventurous, entrepreneurial individuals uniquely open to new forms of living and commerce. For the right pioneers, ARC offers a rare opportunity to build early influence in a mobile, distributed economy that will evolve across locations and industries.

Here, we have only sought to define the basis of the network model which users will be familiar with already, and be clear about the fact that we understand the outsized costs early adopters bear and have intentionally structured the financialization and development plan to ensure that as the network scales up we will repay early adopters as generously as possible for their pioneering spirit and willingness to both take risks on such a madly ambitious vision of the future and bear the initial costs for boutique scale.

ARC is a Free Way of Life: Transcending Categories

One key challenge in housing today is that urban and rural settings are vastly different in terms of housing, each with its own unique benefits but also challenges and tradeoffs. People who live in urban settings enjoy the convenience of amenities such as shopping, transportation, entertainment, etc. Those who prefer rural settings often trade that convenience for additional space and a closeness to nature. Likewise, the advantages of urban settings are inseparable from the congestion and crime that accompany the benefits of agglomeration. City dwellers incur additional costs in transportation time and safety to mitigate these adverse effects which are absent or greatly diminished in rural settings.

ARC enables its users to forge lifestyles of their own design that combine these traditional categories in any ratio they prefer, and in so doing the freedom of life in ARC transcends any such traditional lifestyle category. ARC creates a synthesis between urban and rural settings through the creation of a new type of built environment. Unlike suburban or peri-urban spaces, ARC sites will not necessarily be in an urban-to-rural transition area but will themselves be a mix of the two. Because of container throughput, owners can station their container in a small rural site when they desire the connection to nature without sacrificing the convenience of urban living. New services and amenities can cycle through the container slots in an area, offering city-like diversity in a small-population rural setting. Residents and operators can also buy access to multiple container slots, giving them access to more than one container space at a time, with the option to combine them and open walls between them in any way they prefer.

While ARC's network-wide design greatly reduces congestion compared to traditional cities, it is important to acknowledge that within very large individual ARC developments, internal congestion pressures may still arise. However, ARC addresses this at both the node and network level. Internally, even large nodes are organized through an efficient substrate of RAPS structures, allowing for fluid container shuffling and dynamic reconfiguration. In addition, ARC uses algorithmic container colocation—curating proximity similarly to how a personalized social media feed operates—so that containers, services, and residents are dynamically clustered around each user's preferences and schedule. This curation ensures that, even inside scaled nodes, users experience a personalized, efficient environment that minimizes congestion relative to static urban models. Meanwhile, at the network scale, the ability to dynamically transfer containers between nodes further distributes activity across the entire system. While some nodes or slots will naturally become highly desirable at certain times (due to seasons, events, celebrity presence, or prime locations), pricing mechanisms for container parking will reflect this demand, dampening excessive convergence while incentivizing broader distribution. ARC's system thus spreads opportunity more evenly across the network, ensuring that every user can find "their" node—the one aligned with their preferences, schedule, and community—and enabling a level of dynamic, demand-responsive urbanism not achievable in traditional cities.

Regarding the resilience of ARC compared to traditional property ownership, it is true that if a node is lost due to war, coup, natural disaster, or other catastrophic events, the containers physically present at that node may be lost unless evacuated in time. However, because ARC units are tied to network-wide parking rights (RTUs) rather than to a specific land parcel, owners retain their proportional share of the entire network even if their individual container is lost. This structure is inherently safer than traditional static real estate, where loss of a single location often means total financial loss. On the question of long-term node expansion: while it is true that speculative landholders around a node could eventually limit its physical growth, ARC is specifically designed to avoid dependence on continuous local expansion. Since we live on only ~2% of the planet's landmass, there is vast availability of open land globally for future node placement. As one node fills its local footprint, ARC can seamlessly initiate new nodes in entirely new regions, linking them into the network. Crucially, as the network adds new nodes, older, spatially constrained nodes still gain value—both because expanded network capacity brings more people and services that can flow through them, and because increased connectivity provides residents there with more options, schedules, and economic opportunities. In this way, ARC nodes benefit nonlocally from the scaling of the network itself, reinforcing Metcalfe's Law dynamics. While our modeling assumes uniform desirability across locations for simplicity, we acknowledge the reality that human preferences are uneven. However, ARC's algorithmic feed and distributed curation architecture specifically counteract this force, smoothing demand across nodes and allowing the network to flexibly meet user needs even as some hotspots inevitably emerge. This careful balancing of dynamic curation, economic incentives, and nonlocal scaling ensures that ARC remains resilient, adaptable, and equitable even as it grows.

The Mathematics of Urban Growth: Demonstrating ARC's potential as a Next Generation Built Environment

Quantitative Urbanism (QU) Background Summary

To prepare for the quantitative comparison between ARC and traditional cities, we first summarize key findings from Bettencourt and West's framework of urban scaling. A detailed derivation of these dynamics, necessary to properly construct ARC's growth model, is provided in the Appendix for interested readers**.** Their work shows that many urban indicators—such as wages, innovation, and GDP—scale super-linearly with population size, governed by a power law of the form $Y(t) = Y_0 N$^$\beta(t)$, where $\beta >$ 1 for innovation-driven metrics. This super-linear scaling explains why cities drive innovation and wealth generation, but also why, if unmanaged, they tend toward super-exponential growth, instability, and eventual collapse.

The dynamics of growth and collapse are illustrated in Figure 5-2, a phase diagram showing how population trajectories behave under different scaling regimes. In this diagram, stable growth requires careful management: without it, super-linear forces push cities into instability as populations cross critical thresholds. Even cities that achieve temporary stability through innovation must innovate faster and faster as they grow, because their divergence clock shortens with size.

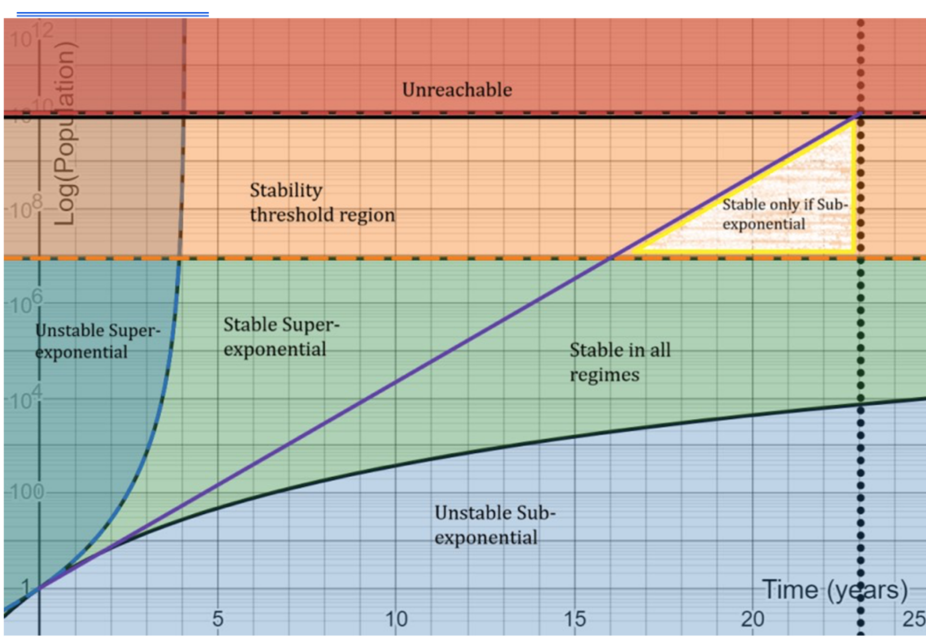

Figure 5-2: A phase diagram for growth regimes of N(t) in Population-time space. Time shown is 40 years while population ranges over ten orders of magnitude. Thus, log-linear axes are the appropriate perspective. Straight purple line is $y = e^x$ in log-linear space. Green to orange boundary is placed at the population of NYC, orange to red boundary represents the theoretical maximum population of the world.

ARC's innovation is to decouple growth from fixed spatial constraints. Through container mobility, dynamic control of interaction density (gamma), and modular scaling across distributed nodes, ARC transforms the challenge of super-linear dynamics into an opportunity. Instead of relying solely on physical expansion or endless local reinvention, ARC distributes growth across space and time, programming stability while preserving the benefits of urban scaling.

With this theoretical framework established, and using Figure 5-2 as a baseline reference, we now construct and analyze a parallel growth diagram for ARC to directly compare its growth dynamics to those of traditional cities.

Quantitative Comparison of ARC vs. the Traditional City

Before we can make a meaningful comparison of ARC with cities, it is helpful to point out some limitations of current QU models and the necessary simplifications they must make to be tractable. Real cities are extraordinarily complex systems; that they admit of general, rule-based patterns that hold across time, space, and culture is already highly remarkable. It should not, therefore, be surprising that exceptions may be found to any of the predictions discussed thus far. The most obvious objection that can be made to Bettencourt and West's arguments is that cities with economies driven by indices like wages, GDP, or research—all of which are in the super-linear regime and should, therefore, cause *super-exponential* population growth followed by catastrophic population collapse—do not appear to inevitably collapse every decade or so.

Indeed, inevitable collapse is not a model prediction for cities that drive some growth via super-linear indicators. Rather, collapse is the model's prediction for cities that derive *all* their growth through super-linear indicators. This is, in fact, an extremely rare condition for modern economies. Growth based on expansion of infrastructure is, in general, a necessary part of any city's economy, and infrastructure-related indicators display sub-linear scaling from economies of scale and act as a stabilizing factor for the health and stability of the city. Furthermore, the fundamental substrate of any population growth is always consumption—regardless of macroeconomic trends, individual humans must eat, preferably daily. And consumption is a linear indicator, essentially by definition: the amount of food required to grow or maintain an individual neither increases nor decreases with the population.

These considerations dictate that exponential and sigmoidal growth curves will tend to always be operating at some level in the population dynamics of a city. Super-linear exponents and the super-exponential growth they cause result from features of economies and cultures that can only appear as super-structures on top of the material basis of a city: reliable infrastructure and a reliable supply of necessary resources.

This does not mean, however, that the risk of collapse posed by runaway growth can be ignored. Nor does it imply that growth can continue indefinitely at the global scale: the planet's physical constraints—finite land, energy, and resources—ultimately impose hard limits on any model of expansion, regardless of internal network efficiencies. ARC's design focuses on managing local and network dynamics to avoid internal collapse, while recognizing that sustainable planetary-scale growth will require broader ecological constraints to be respected. The allure and the risk of super-exponential growth come from its ability to take over a robust and stable economy. Real-world examples are products or industries that tend toward boom-bust cycles, especially when the inflated market or asset has localized production. Mining towns that cease to exist once whatever ore in the area is depleted are a straightforward example, and the majority of commodity bubbles in history have resulted in the devastation of the local economy most involved in the production, transportation, or sale of the inflated commodities.

But, of course, in all such cases, before the collapse of the local economy in some unfortunate part of the world, many people became fantastically wealthy because of the bubble. It seems rational to wonder why it can't be possible to combine an economy based on super-exponential growth with a slower-growing, stable sector, and thereby reap the benefits of both regimes.

With a mature and sufficiently established ARC network, this may indeed be possible. Likewise, cities like New York and London also have economies that consist of exactly such mixtures and do so without completely collapsing every 10-20 years. Without *completely* collapsing is the key concept, however, because the populations of these cities are by no means insulated from the worst consequences of market volatility. The poor in large, "world-class" cities do not get rich when speculation runs rampant in an asset class, but they dutifully absorb and share the consequences among themselves, often for many years to come, when enormous yet imaginary wealth vanishes overnight.

From a mathematical perspective, it is easy to see why it is so difficult to balance super-exponential growth with any combination of standard exponential or sub-exponential growth, though the latter two readily combine in any amount. The reason is because the super-exponential growth curve *diverges*, as was explained earlier. The mathematical consequences of divergence, however, may not be clear to every reader.

To make matters confusing, mathematicians use the term "linear" in distinct ways. Although an exponential growth curve is "exponential," it is also part of the class of linear *functions,* because any number of exponential curves can be added, and the result will still be an exponential curve. This use of "linear" is the meaning the term takes in "linear algebra," and is a statement about the capacity to combine objects, i.e. to create "linear combinations." Exponential and sub-exponential growth curves "readily combine" because both are linear, so it is possible to take a weighted average of any amount of such curves and get back another curve in the same family, with properties that are a blend of the input curves.

The divergence of the super-exponential curve, on the other hand, is a non-linear property. You can't add infinity to anything finite and get back an average of finite and infinite—the concept itself is incoherent. Consequently, any economy where super-linear indicators become the dominant sector driving growth is attempting to ride a tiger. Returning to consider the graph of figure 5-2, but with trajectories for different economic strategies included, will illustrate this point better than words.

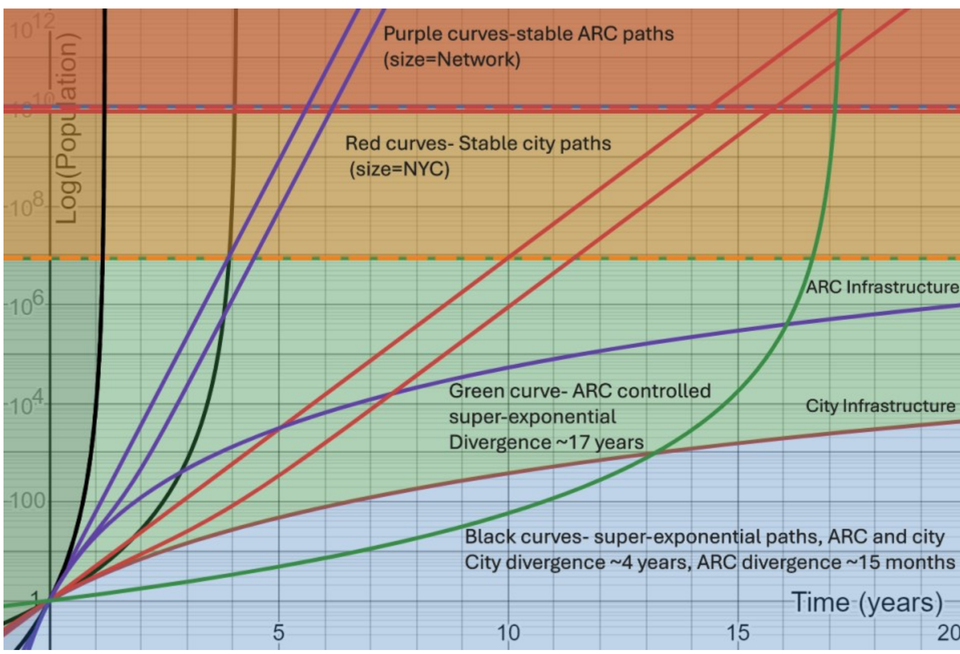

Figure 5-3: Trajectories of $N(t)$ in log-linear space for ARC (purple curves) and a traditional city with a population the size of New York City (red curves) under four conditions:

1) Growth driven by sub-linear exponent: the two curves approaching a horizontal asymptote

2)&3) The pairs of curves that are close to straight lines (in log-linear space) represent standard exponential growth, $\beta \approx 1$: steeper slope and a linear combination of trajectories in 1 and 2: less steep slope.

4) The two black lines are driven by super-linear exponents, ARC diverges faster.

***The green curve is an example of a controlled growth trajectory that ARC could program. It is super-exponential but takes 17 years to diverge and is stable for 16 years and 6 months.**

In figure 5-3, we have plotted growth trajectories for ARC and for a city the approximate size of NYC, with a carrying capacity of $\sim 10\ million\ people$. In red there are three typical growth trajectories for the city. The infrastructure-driven city trajectory is also the boundary between the green and blue regions. ARC somewhat trivially remains two orders of magnitude above the city along the infrastructure trajectory due to the simple fact that it is not limited by a locally defined carrying capacity. Networks do have size limits analogous to carrying capacities in the framework defined by Metcalfe, but these limits are not of the same order as the size limits on a city. Simple consideration of the fact that Facebook has $\sim 2\ billion$ users, while the world's largest city has $\sim 40\ million$ people should make this point obvious. At the same time, one might expect the lack of a localized population to significantly weaken returns to scale. Indeed, they do, by ~ 3 orders of magnitude. This loss of returns to scale at the *local level* must be compensated by agglomeration and returns on scale via one or both features that distinguish ARC from a city: network effects and nomadic community.

Numerically and hence economically, the network alone provides more than enough agglomeration to allow ARC to outgrow a traditional city over a wide range of parameter values. Although the social connections mediated virtually are weaker, on average, than those made face-to-face, the metric is ultimately an issue of scale, and a physical city simply cannot keep up with a virtual network in a competition to organize the most people.

If ARC sites are on the larger end of their size range, housing $\sim 10{,}000$ people at maximum capacity, and the network as a whole consisted of 100 such sites for a total population of 1 million people, the agglomeration these sites generate together with the network would produce a growth rate equivalent to a city of $\sim 50\ million$ people, i.e. larger than any city in history.

If we push the ARC parameters to the edge of what is reasonable, making sites extremely small with a maximum capacity of 100 people, and furthermore take the weakest model of the network found in the literature, scaling it as $n \log n$ rather than n^2, with the smallest values of normalizing coefficients reported in the literature, $\sim 10^{-9}$, then when the ARC total population is again 1 million we calculate a growth rate equivalent to a city of $\sim 14\ million$ people. Below we summarize the numerical comparison with these and other variations of parameter choices, any of which could be used to calculate growth trajectories in the graphs of figures 5-2 and 5-3.

ARC-production function: Network + Local	Site capacity: N_i	Total capacity: $\mathbb{N}$	ARC/City production ratio	Equivalent city population with standard: $\beta = 1 \pm .2$	Equivalent β if equal population
$\mathcal{A}\mathbb{N}^2 + \sqrt[5]{N_i}\mathbb{N}$, $\mathcal{A} = \frac{1}{\log(\mathbb{N})}$	10,000	1,000,000	663.53	$N = 103{,}661{,}616$	$\beta = 1.87$
	1,000	10,000,000	56,872.61	$N = 9.17 \times 10^{10}$	$\beta = 1.88$
	100	100,000,000	313,985.87	$N = 3.81 \times 10^{12}$	$\beta = 1.89$
$\mathbb{N}\ln(\mathbb{N}) + \pi_d\mathbb{N}$	100	1,000,000	10.34	$N = 7{,}003{,}189.04$	$\beta = 1.37$
$\mathbb{N}\log(\mathbb{N})$	100	1,000,000	.38	$N = 445{,}101.83$	$\beta = 1.13$

Table1: Sample values for ARC vs traditional city at equivalent population or equivalent beta

From Table 1, we see that the standard production function, $\mathcal{A}\mathbb{N}^2$, for networks, combined with returns to scale applied only to local site populations, out-produces any city of comparable size. If we completely turn off any local input to the production function and likewise take the weakest definition of the network production, $\mathbb{N}\log(\mathbb{N})$, and further restrict the network carrying capacity to a highly unrealistic value of 1 million users, then we find that the network finally loses to the city, with network production falling to 40% that of a city of the same size. We stress that to obtain this result, we had to limit the network's maximum size to a value smaller than a large city (an inversion that in itself defeats the purpose of a network), scale the network with the weakest possible model *and* turn off all in-person interactions at ARC sites (effectively stating that no form of community is present at the sites themselves). Any one of these criteria is extremely unreasonable and unrealistic on its own, and we had to combine all three before traditional cities became capable of outperforming ARC by less than an order of magnitude.

In other words, ARC can easily outgrow a traditional city under any realistic set of assumptions. But simply growing as fast as possible is not a solution to the problems the housing market and modern urban economies face. ARC is worthy of being the City 2.0 because of its capacity to program and control its growth trajectories so that it may enjoy the benefits of super-linear scaling and super-exponential growth all while remaining on a stable and sustainable growth trajectory. We examine these capabilities of ARC next.

Controlled Programming of Urban Growth

A key insight that followed from the work of Bettencourt and West was the explication of the factors which control Beta. Ribeiro et al. proposed one of the most elegant and parsimonious models in the literature, reducing both the sub-linear and super-linear scaling exponents to functions of two other, measurable parameters. And luckily, both these parameters are *controllable* by the ARC network. They are the social interaction distance decay exponent, "gamma," and the fractal dimension of the city geography, which is an indirect measurement of the city's population density:

$$\gamma \equiv \text{social distance decay constant}$$

$$D_f \equiv \text{fractal dimension}$$

$$\textbf{social interaction strength} \equiv I = \frac{1}{r^{\gamma}} \#(7)\#$$

$$\textbf{population density} = \boldsymbol{\rho(r)} = \frac{\boldsymbol{\#of\ people}}{\boldsymbol{area}} = \boldsymbol{\rho_0}\frac{\boldsymbol{r^{D_f}}}{\boldsymbol{r^{D}}} = \boldsymbol{\rho_0 r^{D_f - D}} \qquad (\mathbf{8})$$

With these definitions, the sub-linear beta value can be expressed directly as the ratio of the two parameters introduced above, while the super-linear beta value follows from its relationship with the sub-linear value:

$$\beta_{-} = \frac{\gamma}{D_f} \qquad (9)$$

$$\beta_{-} + \beta_{+} \approx 2 \qquad (10)$$

$$\beta_{+} = 2 - \frac{\gamma}{D_f} \qquad (11)$$

Crucially, for the social experiment of constructing a living, urban computer coalesced from a network of moving parts—the vision behind ARC—both these parameters (gamma and fractal dimension) are not merely measurable but dynamically controllable. The importance of this point cannot be overstated. It means that beyond offering new modes of habitation, ARC represents the possibility of continuously steering the conditions of public life and civic growth. Specifically, ARC can optimize gamma—the social distance decay exponent—by strategically shaping how often and how easily interactions occur between users, across both local and distributed spatial scales. When and where conditions are appropriate for growth, ARC can dynamically steer gamma through:

1. **Increasing container throughput** within and between nodes, enhancing the fluidity of encounters and lowering effective social distances.

The concept of a distance-decay coefficient for social interactions is a purely descriptive measure: it captures the fact that the intensity of interactions generally falls off with distance, without assuming why. Traditional models fix geometry in time, treating spatial distances as static, but ARC's mobile architecture removes this constraint. When containers circulate across the network—whether cyclically or in response to demand—social cohesion receives a dynamic, periodic stimulus. Simply put, increasing container throughput increases the odds that users will encounter more people, services, and experiences aligned with their needs and interests. The mobility of containers therefore becomes a tool for actively cultivating proximity between compatible users, enhancing the network's value without requiring permanent increases in density.

2. **Algorithmically curating container colocations**, so that individuals, services, and activities are placed into proximity based on user preferences and predicted interactions, maximizing useful social contacts relative to distance.

3. **Stimulating high-frequency transport schedules** between hubs, enabling short-timeframe relocation of containers and services to create new high-density interaction zones dynamically.

4. **Offering dynamic incentives** (such as discounts, social rewards, or convenience perks) for users who relocate to balance social density across the network, smoothing hot spots and creating diverse local environments.

These tools allow ARC not only to expand physical capacity like traditional development (through investment in transport or land), but more importantly, to program the strength, frequency, and distribution of human interactions—the true driver of gamma optimization. This is how ARC becomes not just a new housing system, but a programmable civic ecosystem.

5. **Increasing population density**

In traditional cities, population density emerges endogenously, bound by geography and static infrastructure. In ARC, by contrast, density becomes a programmable variable, shaped by the mobility of container residences and services. While every site still has physical capacity constraints, container mobility means density can flex dynamically over time—responding to demand, events, seasonal cycles, or community needs. This allows localized growth to be directed, accelerated, or moderated without requiring permanent construction or expansion. For users, this flexibility opens the door to new modes of living: from high-density vibrant communities to quieter, more spacious arrangements, adjusted dynamically based on evolving preferences. The ability to scale density in a programmable way is one of ARC's foundational breakthroughs, offering urban planners and residents alike a living, adaptive system that continuously balances economic vitality with livability, harmonizing growth with the universal human need for shelter, community, and opportunity.

Table 2: The operational differences between ARC and traditional urban development

	Traditional development of cities		*ARC*	
	Characteristic features	*Defining variables*	*Characteristic features*	*Defining variables*
Super-linear scaling	*Uncontrollable super-exponential population growth*	*Agglomeration forces, population size and density*	*Controllable super-exponential growth*	*Rate set by network social contacts and programmable architecture*
Carrying capacity	*Population collapse when exceeded*	*Fixed by individual consumption/production parameters and scaling exponent*	*Can be perpetually increased*	*Individual consumption/production balance, scaling exponent, Network flux*
Periodic population singularities	*Can only be prevented by "innovation" that resets individual cost and production parameters*	*Time between crashes grows irreversibly shorter as population increases*	*Can be prevented by innovation or simple redistribution*	*Frequency increase due to population growth can be offset or reversed by expansion of network*
Congestion	*Inevitably increases at same rate as other super-linear indicators*	*Scaling exponent, population, endogenous geography*	*Not super-linear due to container mobility and network expansion*	*Container density, RAPS density, transportation network expansion*
Crime	*Increases along with other super-linear indicators*	*Scaling exponent, population, population density*	*Not super-linear; virtual network doesn't enable physical crime*	*Local site population and population density (commensurate with small town levels)*

Conclusion

We are on the cusp of a seismic shift in housing, both in the United States and around the world. Market forces and stagnant housing innovation are making it expensive and challenging to achieve the age-old dream of owning property. As supply falls further behind demand due to poor market design, both sale prices and rents will continue to rise faster than income. Without fundamental changes in the market structure, the future of housing looks grim.

At the same time, the COVID-19 pandemic supercharged the fourth industrial revolution and inspired people to re-evaluate how they live and work. People are looking to spend their money and live their lives in more fluid ways, enabling them to travel, have new experiences, and engage with others in more dynamic ways.

For those who want freedom and flexibility but don't want to leave ownership behind, ARC is the habitation solution for you. Our users will have all the amenities and services that urban living offers embedded in a plethora of attractive and engaging environments while also taking part in a global community which confers all the advantages of the network dynamics that define social life in the 21st century.

The number of interactions between people and services is the driving force behind the vitality of urban life in cities — ARC is designed to maximize this quantity and optimize the benefits it confers. By restructuring housing into a mobile, scalable network, ARC escapes the old scarcity curve and builds housing into a platform that grows with every user.

When container mobility, modularity, and connectivity are organized into an organic network, market, and community, ARC doesn't just reshape housing — it creates a new mode of human life. The possibilities may exceed what can even be conceived from today's vantage point.

Our goal is to provide a platform for container homes — enabling customers to travel the world without leaving home, with their treasures, memories, and friends synchronizing and coming along for the ride. The world needs a housing solution that is not dependent on government subsidies and does not consign people to stagnation or decline. That solution is ARC.

Appendix

Here we examine the breakthrough result of Bettencourt and West in detail, so that the framework we have constructed for comparing ARC to traditional cities can be properly derived. Recall that the discovery of super-linear scaling in technology and innovation driven urban economies began with the assumption that some form of a power-law must hold between population size and any "urban indicator," i.e. a quantitative metric correlated with growth:

$$Y(t) = Y_0 N^{\beta}(t) \tag{A.1}$$

The details of this expression are discussed in section 2. The important point is that, when the chosen indicators $Y(t)$ were associated with technology and innovation, cities of varying size and culture across the globe were found to have beta values in the range of $1.1 \leq \beta \leq 1.35$. We also explained heuristically in section 1 that super-linear scaling translates to super-exponential growth rates, which in turn are both a blessing and a curse for the locally constrained, finite boundaries of traditional cities. We now follow Bettencourt and West to give a full derivation of the heuristic claims of section 1.

To understand the dangers involved with super-linear scaling, we need to first clearly understand that growth and scaling are not the same thing. Growth refers to increases in the amounts of real quantities, in this case city populations and the various indicators that grow along with population: wages, resources, infrastructure etc. The scaling exponent, β, controls the ratio between population growth and indicator growth. And since β is an exponent, changes in the value of β cause *exponential* changes in the growth ratio. To see the effect of changing the value of beta on the population growth rate, the equation for producing an indicator as a function of population must be compared with an expression for consumption of an indicator as a function of the same population. Bettencourt and West construct the following function for consumption of $Y(t)$:

$$Y(t) = RN(t) + E\left(\frac{dN(t)}{dt}\right) \tag{A.2}$$

The parameters R and E represent consumption of Y for $maintenance/person$ and $birth/person$, respectively. R is then the cost (in units of Y) to maintain an individual over unit time, and E is the cost (in units of Y) to add an individual to the population, multiplied by the time required for an individual to grow to maturity. Setting this expression for consumption of Y equal to the power-law that sets the production of Y (A.1) and then rearranging for the population growth rate gives the following differential equation for population growth driven by an indicator Y:

$$\frac{dN(t)}{dt} = \left(\frac{Y_0}{E}\right) N^{\beta}(t) - \left(\frac{R}{E}\right) N(t) \qquad (A.2)$$

Which has the general solution:

$$N(t) = \left[\frac{Y_0}{R} + \left(N^{1-\beta}(0) - \frac{Y_0}{R}\right) e^{\left[-\frac{R}{E}(1-\beta)t\right]}\right]^{\frac{1}{1-\beta}} \qquad (A.3)$$

This solution has radically different time-dependence for the different regimes of beta. The simplest case is when $\beta = 1$. The growth equation becomes separable because beta drops out of the expression and then $N(t)$ may be factored out so that the r.h.s. simplifies to:

$$\frac{dN(t)}{dt} = N(t)\frac{(Y_0 - R)}{E} \rightarrow \frac{dN(t)}{N(t)} = \frac{(Y_0 - R)}{E} dt \rightarrow \int \frac{dN(t)}{N(t)} = \int \frac{(Y_0 - R)}{E} dt$$
$$\rightarrow \ln\big(N(t)\big) + c = \frac{(Y_0 - R)}{E} t + c \rightarrow N(t) = c * e^{\frac{(Y_0 - R)}{E}t} \xrightarrow{c = N(0)}$$

$$N(t) = N(0)e^{\frac{(Y_0-R)}{E}t} \tag{A.4}$$

The solution is simple exponential growth where the population increases or decreases over time depending on the balance of production and consumption, i.e. the sign of $Y_0 - R$. An important point to recognize here is that when the scaling exponent is exactly linear, the population grows or decays exponentially, as all populations of reproducing organisms do. This is a consequence of the fact that people give birth to more people, and the more people there are, the more people are born. But also, the more people there are, the more people die in unit time. The rates of births and deaths thus depend on the size of the population itself, which is the definition of exponential change and the conceptual justification for why e^x is its own derivative: $\frac{de^x}{dx} = e^x$. This point is crucial for understanding the consequences of a super-linear scaling exponent on population growth.

But before examining the super-linear case it is helpful to understand the sub-linear case. Because beta values of $\frac{1}{4}$ and $\frac{3}{4}$ are commonplace in biological transport systems, the sub-linear case is also well-studied, and the solution (A.3) follows a *sigmoid,* a function with a characteristic "S" shape, which looks like exponential growth during early times, when the balance of resource production and consumption favors production. As the population grows, however, they consume more and more of what is ultimately a finite supply of resources. From the long-time limit of equation #4, we find that the population switches from exponential growth and begins to asymptotically approach a limit where the population must stop growing:

$$\lim_{t\to\infty} N(t) = \left(\frac{Y_0}{R}\right)^{\frac{1}{1-\beta}} \tag{A.5}$$

This limit is the *carrying capacity* of the system, a standard concept in ecosystem biology which we see here must also apply to human populations. It demonstrates that any system where growth is driven by economies of scale will eventually reach a limiting size and stop growing.

Indeed, the inevitable reality that all resources are ultimately finite means that any population will eventually stop growing regardless of what the solution to a differential equation modeling the system says will happen in the long-time limit. And this truth is precisely the reason that *super-linear scaling represents an existential crisis for the stability of cities.* Mathematically, when $\beta > 1$, the solution of equation A.2 grows at a *super-exponential rate,* causing the population function to diverge to infinity in finite time—which a real population obviously cannot do. What does the divergence of the function mean, then, for the real population? The answer is collapse. The response of any natural system to a divergent driving force will be a brief, chaotic phase of turbulence followed by the breakdown of the system itself.

However, the empirical reality is that cities do not appear to inevitably undergo total collapse in finite time, though there are certainly many instances in history where once thriving cities have collapsed. Bettencourt and West analyze the divergence and arrive at the following conclusions, which are essential for understanding the true significance of ARC's design:

I. The divergence occurs when the initial value of the population exceeds the expression for the carrying capacity in the sublinear case:

$$N(0) \geq \left(\frac{Y_0}{R}\right)^{\frac{1}{1-\beta}} \tag{A.6}$$

II. The time to divergence is given by:

$$t_c = -\frac{E}{(\beta-1)R}\ln\left[1-\frac{R}{Y_0}N^{1-\beta}(0)\right] \approx \left[\frac{E}{(\beta-1)R}\right]\left(\frac{1}{N^{\beta-1}(0)}\right) \tag{A.7}$$

Which, for large populations, is dominated by the inverse of the initial population.

III. Because human populations are not dependent on a single resource in the same way other species occupy a single niche in an ecosystem, it is possible for the divergence to be delayed by changing the conditions for population growth in a way that "resets" the boundary conditions of the solution. This is how Bettencourt and West interpret episodes of technological innovation as well as their explanation for why all cities do not collapse in the time given by t_c.

IV. But the same technological innovation that enables cities to grow super-exponentially while avoiding collapse also traps cities into cycles which require innovation to occur ever more frequently. The reason for this is simple to understand—The time until divergence is proportional to the inverse of the initial population:

$$t_c \propto \frac{1}{N^{\beta-1}(0)} \qquad (A.8)$$

Every time innovation or some other sufficient change in the growth conditions of the economy manages to forestall the collapse, population growth resumes *with a larger initial population.* Because growth is super-exponential, the larger the initial population the faster the population will grow to unsustainable levels, forcing innovation to proceed at an ever-faster rate to avoid collapse.

These growth dynamics are conveniently summarized and compared in the log-linear graph of $N(t)$, presented earlier in section 5:

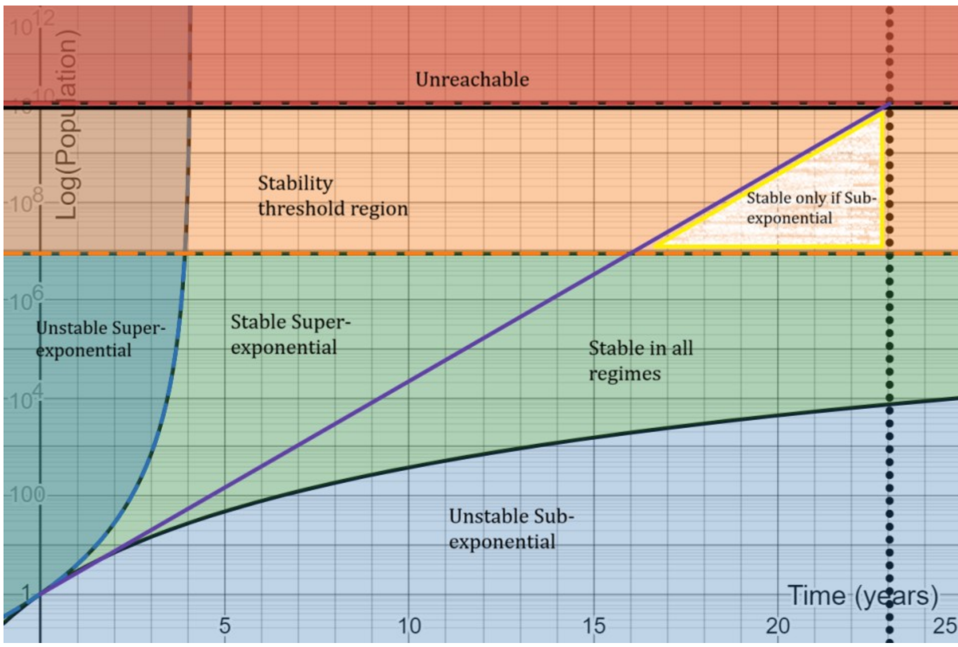

Figure 5-2: A phase diagram for growth regimes of N(t) in Populationtime space. Time shown is 40 years while population ranges over ten orders of magnitude. Thus, log-linear axes are the appropriate perspective. Straight purple line is $y = e^x$ in log-linear space. Green to orange boundary is placed at the population of NYC, orange to red boundary represents the theoretical maximum population of the world.

Placing the transition toward instability at the approximate population of New York is a choice that has some approximate character to it. There are, of course, larger cities in the world. The population of Tokyo, currently the world's most populous city, is approximately four times that of New York. In the context of a log-scale graph, however, 8.7 million and 37 million are close to the same order of magnitude, and it is difficult to envision a city of 100 million with a stable population when perpetual growth is an assumed requirement of a functioning market. That $\sim 10^7$ is the limiting order of magnitude for cities around the world seems to be a reasonable assumption.

This assumption is also convenient for purposes of comparison with ARC, because 10 million just so happens to be the order of magnitude we find that cities must *exceed* if returns to scale and agglomeration forces are to have any chance of out-scaling network effects and digital nomadism.

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