A Model for Sustaining and Investing in Immunization Information Systems

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Abstract

In the past three years, Scientific Technologies Corporation electronically sent one-hundred fifty million retail pharmacy patient immunization events to state and community public health immunization information systems. Today, as a conservative estimate, over 85% of the U.S. population has an immunization record in an electronic health information system. Health technology, data exchange and increasing online patient health records offer consumers, providers and the immunization community new platforms to proactively identify vaccine coverage gaps. As the value of online immunization information increases, the cost to sustain and leverage these new technologies escalates.

Online immunization records and integrated decision support tools are being used extensively from the pharmacy to the emergency room. They are moving from health data vaults with few users to more ubiquitous point of care services and direct consumer engagement. The data and the supporting technology infrastructure empower the community within the immunization ecosystem. To use this opportunity to reduce the impact of vaccine preventable disease on populations, investment in sustaining and modernizing existing immunization health technology systems suggest models to articulate their value and return on investment.

This paper illustrates cost and technology drivers that impact sustainability and modernization of the immunization information system infrastructure. It provides a model to support investment priority decisions and estimate costs. It reviews the technical evolution of public health immunization registries and their current legacy state providing a pathway to migrate to opportunistic third generation technology platforms. It will answer: How much should be budgeted? What can this budget achieve over the next five years? What investments should be prioritized? Is there opportunity for public-private partnerships to support sustainment cost sharing?

It shows that an investment of fifty million will modernize a quarter of the current second generation immunization systems and support the remainder over the next five years.

Keywords: Immunization Information System, IIS, Software as a Service, Immunization Ecosystem, Vaccine Preventable Disease, Public Health Data Systems, Return on Investment, Decision Support and Economic Modeling.

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DOI: 10.5210/ojphi.v11i2.10243

Background

In the early 1990s national efforts were initiated to develop strategic plans with the goal of designing and developing childhood immunization tracking systems. The Centers for Disease Control and Prevention (CDC) and a number of national organizations including Robert Woods Johnson, the Flinn Foundation, and the Annie B. Casey Foundation provided strategic planning grants for the design of these data systems. The objective was to ensure family physicians and pediatricians had the most current immunization histories of their patients. A subsequent national strategy in 1994 expanded the concept from a registry to an immunization information system (IIS) [1].

The computer technology of early systems used desktop applications and client server software operating over land line telephone connections. Early relational databases resided on government computers with few users. Immunization coverage, provider and patient reports were generated through custom software. The evolution of internet services and supporting technology in the later part of the 1990s allowed systems to move to second generation applications. These were browser-based with access to the data through Internet connections. Over the past two decades data queries for information access and larger and faster hardware served as the architecture for maintaining and evolving these systems.

Today there are sixty-four IISs built in this framework. Of these, approximately a quarter are moving toward the end of their life cycle legacy. CDC and the IIS community have identified these as most in need of modernization overhauls. To remain relevant to the national user community however, all IIS over the course of the next decade have to undergo significant modernization efforts. As a prelude to this, in 2017 CDC leadership presented four strategic priorities for the IIS community: (1) Enhance IIS performance, (2) Sustain the IIS community, (3) Influence and monitor the health IT environment, and (4) Promote adherence to standards [2].

In June of 2017 a public-private immunization registry summit convened at the Hatch in Indianapolis, Indiana [3]. Participants from the immunization technology, retail pharmacy, public health, and payer communities met to consider leveraging data value in the IIS to identify, promote and ensure continued sustainment investment from the user community. The vision of a public–private immunization ecosystem created by these stakeholders contemplated potential beneficiaries of a robust and modernized IIS data asset. The value of immunization data and public–private financial contribution opportunities were the areas of focus. Recommendations included increasing IIS data value, documenting return on investment, expanding partnerships

between public and private immunization programs and estimating future costs to modernize and sustain systems.

In March of 2018 the result of the summit was shared with CDC IIS management [4]. CDC leadership highlighted the financial and resource pressures for maintaining the existing allocations for public health to support and evolve these systems. Two primary concerns were raised. The first concern was the increasing costs to sustain the existing legacy systems. The second concern was determining a prioritized schedule of investments with a limited budget. They noted many of the IIS were overdue for technical upgrades. These upgrades are required to ensure ongoing compliance with increasing IIS functional requirements, expanding electronic data exchanges with the private sector and the expectations the information in these public health systems would be used to influence individuals, thereby decreasing the impact of vaccine preventable disease.

Additional conversations with the IIS technology and user advocacy communities emphasized individual concerns about increasing costs to maintain web-based systems, as well as an indication that tighter federal and state budgets were becoming a limiting factor [5]. Increasing costs for servers, infrastructure modernization, application support, user support from electronic data exchange onboarding, and quality control were all identified as areas needing investment. Labor resources and costs are increasing each year as the need to maintain each of their aging, customized systems grows.

Another “elephant in the room” is that government (state and federal) has difficulty in attracting significant numbers of the best developers and seems to resolve they will not have enough resources to do the work well. In addition, securing the investment to completely overhaul a state-owned and operated system from legacy to the next generation is very challenging. The response from the legislature is usually, “Well it’s still working so let’s leave it another year.” The conclusion: IIS 2nd generation systems are now a bona fide legacy that struggles with finding qualified personnel and adequate financial resources to work on antiquated platforms [6]. Over the past two decades of ongoing maintenance each has trended to custom features and components, making cost sharing difficult.

The value and use of IIS data is increasing. This was recognized by public and private participants in the Hatch Leadership Summit. The rapid change of technology, a move toward cloud-based web services, mobile technology, new development, testing and delivery tools along with innovative health IT products is creating opportunity to re-architect and re-design systems to exponentially empower providers, payers and patients. These new frameworks will eventually replace the immunization legacy systems and create a new model for an IIS platform. Skilled technical talent entering the market will be a major work force to deliver these new platforms. The question is… Should funding for the existing IIS to upgrade these legacies be replaced with encouraging and investing in modernization and third generation platform development?

In 2017 a technical framework for a third generation IIS was conceptualized [7]. The architecture was a move from fixed on-premises server applications to scalable redundant secure cloud servers. Moving from existing IIS architectures, built with integrated components tightly coupled to their underlying databases, requires de-coupling and modernization to be independent web services tested and maintained once and available for consumption by all IISs across the country.

As an example, a vaccine forecaster update would no longer be integrated into a specific IIS requiring independent integration and testing. Under the IIS 3.0 model it would be updated and tested as a single web service. The new IIS architectures would allow user communities to see the updates in the same instance the revised forecaster was deployed to all. When the time and cost is calculated to deploy a forecasting update independently into 64 second generation IISs versus a single update that is served immediately to all systems it becomes evident where cost savings occurs. To move all IIS strategically to third generation systems requires an understanding of the potential economic savings compared to traditional costs to support existing systems. A model for this economic assessment was tested with a sample of state IIS.

IIS Cost and Decision Support Modeling

To determine the return on investment (ROI) of the Immunization System Investment Model, an IIS Readiness Score and an Investment Strategy Roadmap was developed. The Readiness Score establishes the likelihood that an investment will return value. The Investment Strategy Roadmap estimates a total cost to modernize and sustain the IIS.

The model was developed using historical and present immunization costs, assessments of successful implementations and the current technology trends of existing high performing systems [8]. It was applied to existing IIS environments to validate the reasonableness of the approach.

Likelihood of Success – A Readiness Score

The ROI includes a metric which measures the likelihood of success when considering investing to modernize an immunization system. When each IIS being considered for modernization is assessed similarly, the result will be a ranked order with the higher scoring IISs providing a prioritization roadmap. These early adopters of a third generation IIS platform will help define the effort and investment required to support the transition and play a pivotal role in monitoring progress and overall accountability.

Technology and systems are only as good as the environments in which they operate. A commitment of leaders, influencers and an empowered user community will drive technology conversions and implementations to expectations of success and value.

The following table identifies the seven key IIS readiness indicators that were determined to increase the likelihood of a successful technology update:

Table 1: Leading Indicators for IIS Investment Success Measurement

Policy/Environment/Politics: IIS Investment Readiness Score						
Wght	**Success Category**	**Criteria**	**Importance Scale**	**Notes**	**Read-iness Score**	**Max points = Readiness Score x Weight**
5	Lifespan	IIS maintain immunization histories birth to death?	0 or 5		5	25
5	Exemption s	Exemptions allowed? 3+ = 1, 2 = 3, 1 = 5	1, 3 or 5		1	25
3	Rx Friend-liness	Age limits, vaccine restrictions, Public Health perception.	1-5		3	15
4	Provider Perception of IIS	Mandatory versus Voluntary, Willingness to participate, IIS reputation.	1-5		5	20
3	Public/ Private Coalition	Is there one? How often does it meet? Well represented across ecosystem?	1-5		3	15
4	Opt-Out or Opt-In	Is the IIS Opt-Out or Opt-In?	1 or 5		5	20
3	Consumer Friend-liness	Does IIS community allow for or support allowing consumer access?	1-5		5	15
Total Readiness Score Possible (weight x score) = f (∑for Each Category)						**135**

Weights are subjective for each Success Category and can be set by the user of the model as long as all IIS environments are evaluated under the same rules. These Success Categories were agreed upon by a team of immunization program and IIS experts with applied experience implementing successful systems throughout the U.S [9]. The scales established use the lower number to identify gaps and limitations. A high score indicates this success factor is optimal for advancing the utilization of information within the IIS and its community.

Accumulating the scores across all areas equates to a single Readiness Success metric. The higher the overall score the more likely the stakeholders in that state's ecosystem should expect to see a faster and more optimal return. The theory is that the higher community ownership, accountability

and proactive partnerships will drive more rapid updates and data utilization. Ownership by the state, the legislature, the provider community, and the consumers is what makes or breaks a system, and ultimately makes or breaks a major transformation of that system. The total score when compared to the Readiness Score Card, illustrated in Table 2, provides a likelihood of a more rapid uptake by the community and more tangible immunization-related results. Use of this score creates a scale to compare investment priorities.

Table 2: Readiness Score Card

IIS Readiness Score	Readiness for Modernization
100+	Excellent - The environment is near optimal for a consideration in investment.
75-99	Good - With a few environmental changes recommended to occur simultaneous with any investment opportunity for success is high
50-74	Average - A number of readiness factors are low and should be worked in parallel to a scaled investment that increases as the environment improves.
<50	Poor - The environment supporting the IIS is not at a sound readiness baseline to recommend significant investment. Improving the readiness areas is recommended prior to future funding.

This score card does not guarantee overall success. This would include other factors such as the technology and approach to move to the third generation platform, resources available (both the amount of investment dollars and staff), and the mindset and willingness of the community to invest time and energy in the change and process.

An Example of the Readiness Scale

Eight states were assessed with this approach. They ranged in population from a half million to over eleven million people. Their IIS contained immunization events from eight million to over ninety-nine million patients. Each of the eight currently requires a level of investment to modernize and move to a third generation immunization platform. Table 3 illustrates the results. Funding priorities would suggest higher score card results are optimal. Equally as important are suggestions

offered to improve the Readiness Score which would improve the likelihood of securing funding if implemented.

Table 3: Readiness Score Card for an Eight State Review

Table 3 Readiness Score Card for an Eight State Review Readiness Scores				**State 1**	**State 2**	**State 3**	**State 4**	**State 5**	**State 6**	**State 7**	**State 8**
Wght	**Category**	**Descrip-tion**	**Scale**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**
5	Lifespan	Is your IIS birth to death?	0 or 5	25	25	25	25	25	25	25	25
5	Exemptions	What exemptions do you allow? 3+ = 1, 2 = 3, 1 = 5	1, 3 or 5	5	5	25	25	25	25	15	25
3	Rx Friendliness	Age limits, vaccine restrictions, PH perception.	1-5	9	9	6	9	6	9	6	6
4	Provider Perception of IIS	Mandatory vs Voluntary, Willingness to participate, IIS reputation, etc…	1-5	20	16	8	8	16	16	12	12
3	Public/Private Coalition	Is there one? How often does it meet? Well represented across ecosystem?	1-5	9	3	3	12	9	3	3	3

Table 3 Readiness Score Card for an Eight State Review Readiness Scores				State 1	State 2	State 3	State 4	State 5	State 6	State 7	State 8
Wght	**Category**	**Description**	**Scale**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**	**Score * Wght**
4	Opt-Out or Opt-In	Is your IIS Opt-Out or Opt-In?	1 or 5	20	20	12	12	12	12	12	4
3	Consumer Friend-liness	Does your state allow for or support allowing for consumer access to IIS?	1-5	15	9	3	9	9	9	3	6
Total Readiness Score (Max = 135)				103	87	82	100	102	99	76	81

100+	Excellent
75-99	Good
50-74	Average
< 50	Poor

In this example States 1, 4 and 5 would be considered as first tier investment opportunities. State 7 a recommended third tier investment and would be advised of their indicator scores gaps and encouraged to accelerate improvements in these areas before funding. There are a variety of strategies that could be applied to the actual decision but in all cases an underlying common evaluation approach was used to provide decision guidance.

The Cost to Modernize and Sustain IIS

The cost to modernize a legacy IIS and evolve to a third generation platform and sustain going forward is part two of the model. The practicalities of budget processes and allocation of funding creates investment challenges. Each year there are limited funds allocated to IIS modernization and ongoing support. For example, if there was $40 million a year available to allocate to all 64 IISs, those making the allocation decisions would be better positioned to make optimal allocations if they understood a readiness to succeed with each investment.

Funding authorities would gain decision support knowledge if there were costs identified to modernize all IIS estimates. Budget requests driven by a model of this type are likely to establish

a process that produces more cost-effective modernization efforts, accountability and monitoring, versus a bottom-up approach where each IIS estimates its funding independently.

IIS budgets are not static each year. Labor and technology costs increase required allocations. The following table is the current annual technical support costs of eleven second generation legacy state immunization systems. Current budgets support minor ongoing application updates, application bug fixes, and user support.

Table 4: Sample of IIS Annual Technical Support Costs

	Population / Million	Annual Technical Support Costs	Immunization Events in IIS – Millions
1	< 2	$ 250,000	12
2	5-10	$ 289,000	78
3	5-10	$ 350,000	81
4	2-5	$ 678,000	61
5	2-5	$ 323,000	39
6	<2	$ 172,000	10
7	>10	$ 415,000	100
8	5-10	$ 648,000	64
9	5-10	$ 500,000	99
10	<2	$ 318,000	17
11	<2	$ 343,000	8
Total	>50	**$ 4,286,000**	**569**

Source: STC Health IIS Survey 2018

The costs do not include hardware and supporting application license costs. For example, Oracle or SQL licenses, user training, ongoing efforts to onboard provider electronic data exchanges and major IIS customizations are all areas where additional funding is often requested.

From the above table, the average annual application support cost for these 11 systems is just under $390,000. This is a labor cost for supporting new releases, application administration, and problem resolution. A bell curve using $300K as a lower limit and $500K as an upper limit results in 5 states that fall within the center of the curve. It suggests current annual application support costs for all 64 IIS to be just under $30 million.

Table 5: Total IIS Sustainment Cost

2019 Sustainment			
Per Year		**IIS**	**Annual**
$ 400,000	25%	16	$ 6,400,000
$ 450,000	50%	32	$ 14,400,000
$ 500,000	25%	16	$ 8,000,000
		64	
Basic Support			**$ 28,800,000**

These costs do not include software customization, cost for hardware, software licenses or service labor hours. Based on the eleven states surveyed for this paper, the additional budget requirements for IT servers, licenses, labor to support efforts such as electronic data exchanges (onboarding), and training will double the application support. Increasing the $28.8 million by a factor of two ($57.6M) moves closer to the true cost of ownership for system and support sustainment.

Time to Modernize

A key challenge for all technology and application solutions is to remain current with features and functions. IIS have been in existence for well over two decades. As vaccine policy and procedure changes occur, new compliance requirements are implemented, forecasts are updated and electronic data exchanges accelerated. It can be a challenge for public health to maintain the technology change velocity required to keep pace with the program demands to effectively operate a state's immunization program. Second generation IIS are robust, complex and highly integrated systems. These legacy environments require greater attention to maintain as time passes. There is a realization in the industry that, of the 64 IIS environments, a portion of these is in need of a "fresh start." Moreover, there is the understanding that over the next five years they all will require increased funding to move forward.

Sustaining costs estimated above do not account for modernizing these current systems through a migration to a third generation immunization platform. Within the next five years it is estimated that 25% of the IIS environments will require a significant investment to move from their current environments. In a recent CDC grant opportunity $1 million was used to establish an investment budget for modernizing older legacy systems [10]. Table 6 incorporates legacy migrations with ongoing sustainment costs to estimate a total investment budget to modernize the first 25% of the country's IIS infrastructure.

Table 6: Total IIS Sustainment and Modernization Estimates

Annual Sustainment				Invest $1M to Modernize with 10% Support Increases (Increases apply to those being modernized allowing for a 12-18 month process to migrate)	
Per Year	**IIS**	**Percent**	**Annual**		
$ 400,000	16	25%	$ 6,400,000	16	$ 23,040,000
$ 450,000	32	50%	$ 14,400,000	32	$ 15,840,000
$ 500,000	16	25%	$ 8,000,000	16	$ 8,800,000
	64	100%	$ 28,800,000		**$ 47,680,000**

The cost model illustrated in Table 6 utilizes a $1M allocation to modernize 16 systems. It allows a window of 12-18 months before the new system can replace existing systems, requiring ongoing support for this 25% and the remainder 75% as well. Since labor and technology costs are expected to continue to rise, this model includes a 10% annual increase in the basic budget. A projection using these assumptions provides a $47.68 million estimate to sustain and modernize one fourth of today's IIS.

However, this amount reflects only application support and modernization. It does not include supporting technology and programmatic technical resources. Therefore, the model incorporated:

Total Cost = Application & Modernization ($47.68M) +

Hardware ($120K/year each) +

Software Licenses ($50K/year) +

Technical Support ($200K/year ~ 1-2 FTEs)

These ancillary support services add $23.7M, bringing the annual budget to support and modernize 64 IIS environments to $71.3M.

Modernization Strategy

Government investment limitations mean 16 of the IIS requiring a re-launch would not be undertaken in a single year. Budget and resource limits, time to publish formal requests for new systems and the likelihood that each of the 16 locations have created a recommended environment that would lead to success suggests the evolution of the 16 would likely occur over the next 3-5 years. Table 7 incorporates this phased approach and the model calculates investment over a five-year window.

A 5% increase in the $1M each budget each year was used along with the previous 10% annual increase in sustainment costs. A baseline of $400K annually was used for each of the systems not modernized. Annual sustainment costs for systems modernized are assumed to begin in 2021 with a $500K base and a 5% increase each year to cover increasing IT support through currently available modernized resources such as cloud computing.

Table 7: IIS Budget Estimates Over a Five-Year Time Frame

Costs to Modernize and Replace the First 25% of IIS						
Year	**Replace**	**Remainder**	**Replacement Cost**	**Sustain Remainder**	**Sustain Replaced**	**Total**
2020	3	13	$ 3,000,000	$ 5,200,000	$ -	$ 8,200,000
2021	3	10	$ 3,150,000	$ 4,400,000	$ 1,575,000	$ 9,125,000
2022	3	7	$ 3,307,500	$ 3,388,000	$ 3,307,500	$ 10,003,000
2023	3	4	$ 3,472,875	$ 2,129,600	$ 5,209,313	$ 10,811,788
2024	4	-	$ 4,862,025	$ -	$ 7,293,038	$ 12,155,063
	16		**$ 17,792,400**	**$ 15,117,600**	**$ 17,384,850**	**$ 50,294,850**

The modernization cost over the course of the 5 years is $50.3M versus the $47.6M if funding could be allocated in one year. Although this is not a major difference in total cost, the likelihood of success is increased significantly as the feasibility of 16 modernization efforts being successful and occurring at the same time is low.

A total cost to modernize one-fourth of the 64 IIS over the next five years and continue to sustain the other three-fourths with a 5% increase in costs per year with ongoing IT, licensing and labor allocations illustrated above is included in Table 8 below.

Table 8: Total Annual Project Budgets for 64 IIS with 25% Modernized Over Five Years

Year	Total in Million
2020	$49.96
2021	$52.97
2022	$56.04
2023	$59.15
2024	$62.91
Total	$281.04

Summary

Investments in population-based public health immunization data assets require a national commitment. Traditionally this commitment is through federal and state government budgets. The annual ask each year for investments in these data systems should be expected to increase as they have consistently done for more than two decades of their existence. Labor and technology costs, growth in system data, quality and utilizations increase each and every year. The value and importance of these health data assets to effect the change these systems are designed to support encourage their use across the entire immunization ecosystem. Investments to execute the important evolution of IIS that involves modernization, staying current with technology changes, fully leveraging the value of the data contained in the IIS, and securing the PHI from unauthorized access and use collectively create the demand for systems and support that require the best platforms and solutions the industry has to offer.

This paper illustrates a model that supports ongoing sustainment and the modernization of public health immunization information systems over the next five years. It extended the cost model to support an approach to determine the likelihood of success based upon the supporting jurisdiction's IIS ecosystem and environment.

Implementing technology to simply have the latest and greatest is not an acceptable budget justification. IIS technology updates and support must be justified on the value of the systems and data to the end users they are designed to support. High quality data, real time information and tools to empower all users from patients and consumers to clinical providers, pharmacists, payers and the supporting communicable disease networks is essential.

If a migration from legacy IIS to currently available third generation platforms is initiated, in the next 5 years adequate and continued funding will be essential. If this process is based on the proposed theory that the data represents value to the entire ecosystem, it is time to also consider funding solutions from all stakeholders in the ecosystem who stand to benefit from a national initiative of modernized IIS infrastructure. Government funding to support these assets should be but one of those investments. If national commitments across the ecosystem were supported, the final question to be answered to round out this model could be, "What's my share?"

Table 9 is a hypothetical example of a cost sharing approach to investing in the ongoing development, modernization and sustainment of the IIS. Once migrated to third generation platforms the use of these already valuable public health data assets will provide even more benefit to everyone across the ecosystem. More importantly, the use of these assets by all the stakeholders will undoubtedly result in closing the immunization care gaps.

Table 9: An Example Cost Sharing Approach

Total Cost		$ 49,960,000	$ 52,973,000	$ 56,043,400	$ 59,154,208	$ 62,914,604
	Investment Share % of Total	**2020**	**2021**	**2022**	**2023**	**2024**
Public Health (local, state & federal)	30%	$ 14,988,000	$ 15,891,900	$ 16,813,020	$ 17,746,262	$ 18,874,381.05
Payers	20%	$ 9,992,000	$ 10,594,600	$ 11,208,680	$ 11,830,842	$ 12,582,920.70
Providers	4%	$ 1,998,400	$ 2,118,920	$ 2,241,736	$ 2,366,168	$ 2,516,584.14
Pharmacy	14%	$ 6,994,400	$ 7,416,220	$ 7,846,076	$ 8,281,589	$ 8,808,044.49
Pharmaceutical	30%	$ 14,988,000	$ 15,891,900	$ 16,813,020	$ 17,746,262	$ 18,874,381.05
Immz NGOs	1%	$ 499,600	$ 529,730	$ 560,434	$ 591,542	$ 629,146.04
Vaccine Research	1%	$ 499,600	$ 529,730	$ 560,434	$ 591,542	$ 629,146.04
Total	100%	**$ 49,960,000**	**$ 52,973,000**	**$ 56,043,400**	**$ 59,154,208**	**$ 62,914,604**

Although the cost sharing model is the topic of another paper, it should be noted that the investments in these public health assets, no matter the cost model utilized, should be open for discussions centering on cost sharing versus value received.

Limitations

The paper is not a definitive economic model to establish costs and thus a resulting budget to replace and sustain the next generation of immunization systems. The paper is a conceptual model to establish actual estimates. It utilizes actual cost data from a percent of state registries and projects these costs to the total national IIS assets. The cost models utilize an annual escalation estimate representative of expected technology and labor increases.

The application of the IIS readiness measures is based upon subjective assessments and is not statistically validated through a larger sample set. The model is intended to establish a decision framework and a general cost magnitude that establishes a first look at the future sustainability investments. As additional data is collected and the sample set increases improved cost estimates are possible.

The cost sharing approach assumes a reasonable ask for stakeholder investment and is based upon the authors' evaluation of the investment value to each sector.

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